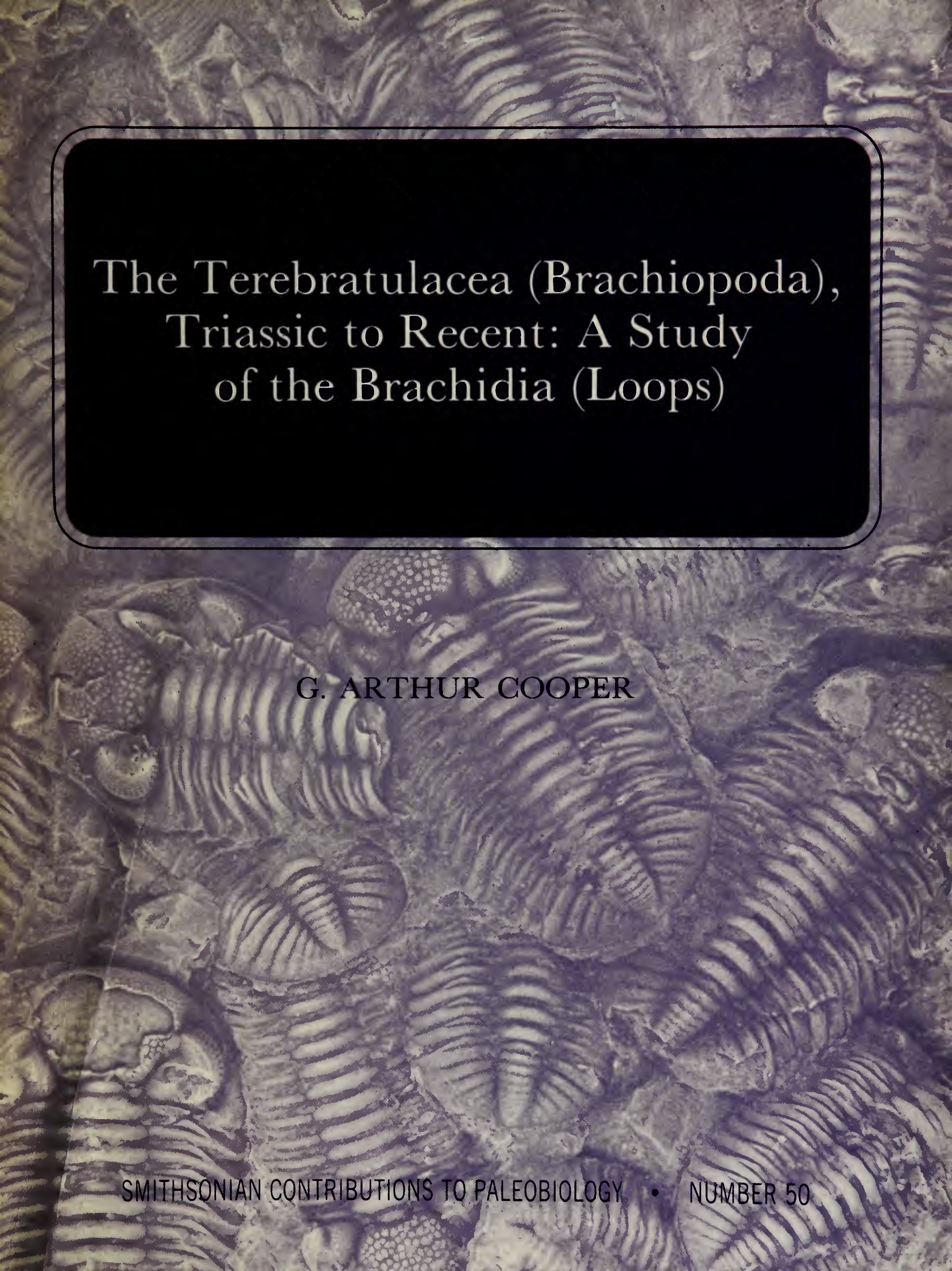


The Terebratulacea (Brachiopoda), Triassic to Recent: A Study of the Brachidia (Loops)

G. ARTHUR COOPER

SMITHSONIAN CONTRIBUTIONS TO PALEOBIOLOGY • NUMBER 50

SERIES PUBLICATIONS OF THE SMITHSONIAN INSTITUTION

Emphasis upon publication as a means of "diffusing knowledge" was expressed by the first Secretary of the Smithsonian. In his formal plan for the Institution, Joseph Henry outlined a program that included the following statement: "It is proposed to publish a series of reports, giving an account of the new discoveries in science, and of the changes made from year to year in all branches of knowledge." This theme of basic research has been adhered to through the years by thousands of titles issued in series publications under the Smithsonian imprint, commencing with *Smithsonian Contributions to Knowledge* in 1848 and continuing with the following active series:

Smithsonian Contributions to Anthropology
Smithsonian Contributions to Astrophysics
Smithsonian Contributions to Botany
Smithsonian Contributions to the Earth Sciences
Smithsonian Contributions to the Marine Sciences
Smithsonian Contributions to Paleobiology
Smithsonian Contributions to Zoology
Smithsonian Studies in Air and Space
Smithsonian Studies in History and Technology

In these series, the Institution publishes small papers and full-scale monographs that report the research and collections of its various museums and bureaux or of professional colleagues in the world of science and scholarship. The publications are distributed by mailing lists to libraries, universities, and similar institutions throughout the world.

Papers or monographs submitted for series publication are received by the Smithsonian Institution Press, subject to its own review for format and style, only through departments of the various Smithsonian museums or bureaux, where the manuscripts are given substantive review. Press requirements for manuscript and art preparation are outlined on the inside back cover.

S. Dillon Ripley
Secretary
Smithsonian Institution

SMITHSONIAN CONTRIBUTIONS TO PALEOBIOLOGY • NUMBER 50

The Terebratulacea (Brachiopoda), Triassic to Recent: A Study of the Brachidia (Loops)

G. Arthur Cooper

SMITHSONIAN INSTITUTION PRESS
City of Washington
1983

ABSTRACT

G. Arthur Cooper. The Terebratulacea (Brachiopoda), Triassic to Recent: A Study of the Brachidia (Loops). *Smithsonian Contributions to Paleobiology*, number 50, 445 pages, 17 figures, 77 plates, 86 tables, 1983.—The narrowly rostrate brachiopods of the Terebratulacea have long been a challenging subject. The interior details of many have long remained unknown. The usual method of studying the interior is by serial grinding (sectioning). Some workers are content with the information revealed by the sections; others give visual reality to the sections by reconstructing the loop and cardinalia. Noting the unlikely results of many of these reconstructions, a better way of revealing the interior suggested itself, i.e., revealing the loop by excavation of the matrix. This method, when matrix is workable, makes possible more accurate measurement and depiction of the loop. Making statistics of parts of the loop to use in comparing these structures in different genera is described. Certain characters and proportions of parts of the loop used in classifying genera are explained. External characters of generic importance are noted for each genus.

The systematics of 208 genera of short-looped brachiopods of which 70% have revealed their loops by excavation or by being silicified are considered along with revision of families and the making of additional categories. It is indicated, with evidence, that the type of the Loboidothyrididae (Loboidothyridacea of Makridin) of the Jurassic has a short loop without conspicuous terminal points (flanges) rather than a long, long-flanged loop. It is recommended that the family definition of the Loboidothyrididae be altered to suit the facts of the structure of its leading genus, and that the Loboidothyridacea be abandoned. The Lobothyrididae, supposedly with short-flanged loop, has a loop with fairly long terminal points, and is thus in need of revision.

It is suggested that *Pseudodielasma* of the Permian is stucturally a possible ancestor of Terebratulidae with abbreviated terminal points. The origin of the Loboidothyrididae (now Tchegemithyrididae) is postulated to be from the Triassic family Angustithyrididae of the Dielasmatacea according to Dagis (1974). The Permian *Ectoposia* is a possible ancestor of the Angustithyrididae. Available collections were inadequate for the study of the loop development of any genera except living ones. Information on the development of a Mesozoic long-flanged loop is known from the work of Dagis (1968) on *Viligothyris*.

All known genera of the Terebratulacea were studied either by original preparations of the loop or from the literature. Lack of adequate collections prevented the detailed study of the Pygopidae. Fifty-eight genera of Jurassic brachiopods were developed to show the loop, fifteen of them Buckman's hitherto poorly known genera. An additional four unplaced genera were developed. Thirty-six Cretaceous genera revealed the loop, and fourteen genera of Tertiary Terebratulaceans are known from excavated loops. Forty-seven genera of short-looped brachiopods are known from description and serial sections only and without reconstruction of the loop. The loops of seven genera are unknown. Illustrations of all prepared genera are presented, and in addition, some reconstructions from serial section in the literature. Diagrammatic drawings of important loops of dissected specimens are illustrated. It is concluded that preparation of the loop, when possible, is preferred and is more accurate and less time consuming than reconstruction from serial grinding (section).

OFFICIAL PUBLICATION DATE is handstamped in a limited number of initial copies and is recorded in the Institution's annual report, *Smithsonian Year*. SERIES COVER DESIGN: The trilobite *Phacops rana* Green.

Library of Congress Cataloging in Publication Data
Cooper, G. Arthur
The Terebratulacea (Brachiopoda), Triassic to Recent
(Smithsonian contributions to paleobiology ; no. 50)
Bibliography: p.
Supt. of Docs. no.: SI 1.30:50
1. Terebratulida, Fossil. I. Title. II. Series.
QE701.S56 no. 50 [QE797.T29] 560s [565'.32] 82-600308

Contents

The Terebratulacea (Brachiopoda), Triassic to Recent: A Study of the Brachidia (Loops)

G. Arthur Cooper

Introduction

In studying the Terebratulacea recorded in Muir-Wood (1965:H773–H816), I noticed that the reconstruction of *Plectoidothyris* (fig. 692: 5b) appeared to be faulty and its parts not wholly in accordance with the serial sections (fig. 694) from which it had been produced. These sections are not complete, nor were they complete in the paper in which they first appeared (Muir-Wood, 1934:539). The serial sections do not show the transverse band and the crural processes are not clearly discernible. It seemed only natural to test the reconstruction by preparing another typical specimen, in this case, not by serial sectioning, but by excavation of the loop. The loop so prepared (Plate 51: figures 13, 14) proved to be quite different from its reconstruction. The reconstructed loop is faulty in depicting concave, slender, descending elements, the very narrow transverse band, and the open spaces where it joins the descending lamellae. Although the hinge plates of excavated loop and reconstruction are similar, the crural processes of the reconstruction are too short. This exercise in comparison led to the notion that the short terebratulid loop could be exposed in many genera, thus confirming or supplementing reconstructions from serial sections. The result reveals many reconstructions and excavated loops at variance, due no doubt, to incomplete serial sections and different methods of reconstruction, or misidentification of the specimen.

Serial sections are the only recourse left when attempting to reveal the interior of a terebratulid shell with matrix impossible of removal by mechanical means. Defects in serial sections that militate against accurate reconstruction are (1) failure to record the parts of the loop at its distal end, resulting in failure to record the full length of the loop; (2) failure to indicate the position of the crural processes that are a focal point in the loop; (3) too big intervals between suceeding sections of the shell; the lack of detail, bluntness, and brevity of most crural processes in reconstructions undoubtedly due to missing the distal point of the crural process (Plate 63: figures 6, 18); (4) failure to record or publish the distance between sections and the distance from the beak at which the terminal points disappear—the distance between sections was left out of all the serial sections reproduced from many sources in the *Treatise on Invertebrate Paleontology* (see Muir-Wood, 1965); (5) incomplete or incorrect outline of the dorsal valve enclosing the reconstructed loop. As explained elsewhere this prevents the preparation of accurate statistics from serial sections.

G. Arthur Cooper, Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

Theoretically there is no reason that loops cannot be reconstructed accurately from serial sections. Barczyck (1969:10, 11) and Singeisen-Schneider (1976) have pointed out some of the difficulties of making accurate reconstructions when the serial sections are made at an angle to the loop, or when the loop is not parallel to plane of articulation. This is another factor that leads to discrepancies between excavated loop and reconstruction from serial sections. Still another factor is misidentification of species. Makridin's reconstruction (1964:277, fig. 77) of the loop, of his *Postepithyris* is based on Russian specimens, not a topotype from France. Tchorszhevsky (1974:50, footnote) regards the Russian specimen as specifically different from the French one. This difficulty arises with other genera, especially when the cited type and sectioned specimen are from widely separated areas of geological realms. The postulated long loop of *Loboidothyris* is based on a species called *Loboidothyris*, not the type, and later made the type of *Nalivkinella*.

The above problems proved sufficiently intriguing to inspire the effort to prepare by excavation the loops of all genera from Triassic to Recent in the USNM Collection (National Museum of Natural History, Smithsonian Institution) amenable to such treatment. This has resulted in revealing the loops of most of the poorly known Buckman genera and many others. From modest beginnings the work brings together all of the genera, although not all of their loops, of Triassic to Recent, described through 1980. Many of the genera are described by use of serial sections without reconstruction of the loop, nevertheless statistics have been prepared from many of the serial sections when adequate and the information so obtained applied to their classification. Serial sections are not reproduced herein except in one unusual case. This monograph is not meant as an indictment of a useful and instructive method when properly performed but is offered as help in sharpening our methods of revealing the loop. Serial sections make possible a study of parts of the loop not possible with the excavated loop. In the future it is recommended that both excavation and preparation of serial sections of the loop be prepared, abundance of material permitting. The two methods supplement each other. However, matrix permitting excavation of the loop gives a permanent reference and undistorted view of the loop. Furthermore, excavation of the loop is generally less time consuming than preparation of serial sections.

PREVIOUS STUDIES OF LOOP.—Few publications exist that have good illustrations of the short loops of fossil brachiopods. Depiction of these structures has generally depended on accidental finds of specimens showing a complete loop. Deliberate preparation of the loop from matrix-filled specimens by mechanical means was seldom undertaken. Almost as rare as accidental finds is the occurrence of specimens amenable to preparation by acids. In an effort to correlate the generic value of the dorsal adductor scars with the nature of the cardinalia, Sahni (1928b) undertook the preparation of certain Jurassic genera. Sahni successfully excavated the loops of *Pseudoglossothyris*, *Plectoidothyris*, and *Ptychtothyris* but illustrated the results with sketchy drawings. Sahni's (1929) work with the Chalk brachiopods showed that the loop of many genera could be excavated.

Of the older literature there are some outstanding efforts to depict the loop. Davidson (1851–1852, 1852–1855, 1864, 1874–1882) illustrated the loops of 14 terebratulaceans representing as many genera. Some of the restored loops are mentioned under their respective genera in the discussions following. In general these drawings of Davidson are correct in proportions but lacking in detail, especially detail of the hinge plates. In some examples Davidson relied on experience rather than on observation and supplied a loop gratuitously, for example the *Terebratulina* loop supplied for the dorsal valve of *Dyscolia* (Davidson, 1886–1888, pl. 3: fig. 2). This is true also of some Cretaceous species in which the supplied loops deviate strongly from reality (Davidson 1874–1882 supl. pl. 2: figs. 14–16).

Deslongchamps (1862–1884) illustrated the loops of several Jurassic forms such as "*Lobothyris*," *Pseudotubithyris*, and *Dictyothyris*. Seguenza (1865,

1871) illustrated the loops of a number of species of the Italian and Sicilian Tertiary, many lacking in details of the hinge plates. Quenstedt (1868–1871) illustrates the loops of many species. Here is given an accurate drawing of the loop of *Oleneothyris* from New Jersey, USA. This may be contrasted with Whitfield's (1885, pl. 1: fig. 23), which is more like that of Davidson's figure of *Terebratula* (1874, supl. pl. 2: fig. 1) than that of true *Olenothyris* (Plate 6: figures 5, 7, 10).

Benecke (1866) figured a drawing of the loop of *Terebratula tornacensis*. Vincent (1893) illustrated the loops of *Terebratula ortliebi* Bayan, *T. bisinuata* Lamarck, and *Liothirina kickxi* Galeotti from the Tertiary of Belgium.

Rothpletz (1886–1887) illustrated the loops of many species by sketchy and inadequate line drawings. Fischer and Oehlert (1891) gave excellent figures of some modern terebratulids living in French and eastern Atlantic waters: *Gryphus*, *Dyscolia*, and *Stenosarina*?.

The use of photography in illustrating fossils provided more accurate depiction. Sacco (1902) illustrated the loops of some Italian Tertiary brachiopods from which the matrix had been removed. In 1934, Muir-Wood published the reconstructions of the loops of *Lobothyris* and *Plectoidothyris* that have been reproduced in *Osnovy Paleontologii* (see Makridin, 1960) and *Treatise on Invertebrate Paleontology* (see Muir-Wood, 1965). The finest study of the loops of Jurassic forms is that of Arcelin and Roché (1936), who illustrated by photos and drawings the loops of six genera in remarkable state of preservation. Dubar (1925, 1942) illustrated the interior of silicified Jurassic species from the French Pyrenees and Morocco. Ochoterena (1960) figured the delicate loop of a strongly plicated Mexican species from the Jurassic. Muir-Wood (1959, 1960) illustrated the loops of *Dallithyris* and *Abyssothyris*. Steinich (1965) and Popiel-Barczyk (1968) illustrated the loops of *Carneithyris* and *Chatwinothyris*. Asgaard (1971) developed the loop of *Faksethyris* and in 1975, in a revision of Sahni's work, illustrated the loops of many Cretaceous specimens. Cooper (1972, 1973a,b, 1977) illustrated the loops of many Recent species. Foster (1974) figured the loops of a number of Antarctic species.

Dagis (1963, 1965, 1968, 1972, 1974) has produced detailed but somewhat stylized reconstructions of terebratulid loops and has given the loop development of *Lobothyris*(?) and *Viligothyris* in visual detail. His reconstructions of loop development are important in taxonomy.

Dzik (1979) illustrated the loop of silicified specimens, and a reconstruction of the loop of "*Terebratula subsella*," herein referred to *Epithyris*. Nekvasilova (1980) figures a loop of *Pygites*. Singeisen-Schneider (1979) has restored the loop of several genera.

Although we now have greater facilities for the preparation of the interior of brachiopods, the emphasis is on serial sectioning (grinding). However, some authors present only the serial sections, thinking as Ager (1965:221) did, that reconstruction of the loop is unnecessary, and that direct comparison of serial sections is adequate. Others such as Makridin (1964), Dagis (1968), Prosorovskaya (1968), Barczyk (1969), Smirnova (1975a), Tchoumatchenko (1976/1977) Rollet (1966, 1968, 1972), and Boullier (nee Rollet; 1976, 1981) give visual, albeit often stylized or sketchy reality to their serial sections.

An interesting example of incorrect depiction of a loop is Deslongchamps (1859, pl. 11: fig. 11) figure of *Terebratula trigeri*, showing a short loop with short terminal points, a fairly typical terebratulid loop. Later Deslongchamps 1862–1865, pl. 20: fig. 2) published a correct drawing of the loop based on a fine silicified specimen with its long terebratulid loop.

Limitations of This Study.—Although actual exposure of the loop of a terebratulid is very desirable, it is not possible to excavate the loop of all specimens because of physical difficulties with the matrix filling fossil shells. This particular study presents some of the difficulties and its value is limited thereby.

The collection of Mesozoic and Cenozoic brachiopods in the National Museum of Natural History, Smithsonian Institution is fairly extensive but it is lacking in depth; many of the lots consist of one, two, or three specimens, which do not offer much choice of material suitable for excavation. The collection was accumulated largely through exchanges and mineral dealer purchases. The identification of some of the specimens is often suspect. As with serial sectioning, which is destructive of material, an investigator may be restricted to developing only one or two specimens because of limited supply. Neither method gives any advantage in studying variation of the interior details of these brachiopods. One of the defects of the present study is the fact that some genera and species were so restricted in number of specimens that only one individual could be excavated, in some cases the only specimen was used after preparation of a plaster replica. Loops like other parts of a brachiopod are variable (see Plate 60) but one good loop is better than none.

Another limitation of this study is the inability to assign some species in the literature to many of the old and new categories described herein. Not only does this stem from lack of depth of the collection but from the confused nomenclature in the literature. Lack of interior details of many described species precludes assignment to new genera or old ones discussed herein. In some instances species now assigned to Buckman genera must be reassigned. The announcement by Tchorszhevsky (1971a) that he has 38 new genera of Jurassic brachiopods in his studies of the Russian Jurassic points up some of the problems as do the undefined genera and species of Askerov (1964, 1965). The difficulty of matching prepared specimens to serial sections is great, and to match reconstructions from serial sections with dissected forms is equally troublesome. It will thus be a long time before many Mesozoic and Cenozoic brachiopods are assigned to their proper genera.

The genus *Sphaeroidothyris* is an interesting case in this connection. Three specimens of similar external appearance, identified as *S. sphaeroidalis*, furnished three quite different loops when excavated, loops so distinctive that the specimens cannot be placed in the same genus unless the traditional importance given to internal characters is abandoned. The specimens in question are illustrated on Plate 44: figures 6–11, showing a short, wide loop; Plate 49: figures 21–23, with a moderately long-flanged wide loop, and Plate 36: figures 4–6, with a long-flanged, narrow loop.

Buckman (1917:23) sought to obviate the problem of specific uncertainty because of homeomorphy when he stated: "Names of genotypes are stated thus *Tetrarhynchia tetraëdra*, J. Sowerby sp., for a special reason: it is to indicate that the example figured in this work is in all cases to be the genotype. This is to avoid any doubt as to which becomes the genotype in case of misidentification. In such event the genotype of *Tetrarhynchia*, for example would be quoted as *Tetrarhynchia tetraëdra*; S. Buckman, non J. Sowerby sp." This caution has not been recognized, because Buckman in his generic descriptions used the expression "type" in the text when citing his "genotype," an expression used in his plate legends. In the case of *Lobothyris* Buckman cited J. Sowerby's species (*punctata*) as type but figured a French specimen as "genotype" (Buckman, 1917:107, pl. 20: fig. 7). In this connection Sučić-Protić (1971:5) cites the type of *Lobothyris* as follows: "Type species *Terebratula punctata* Sowerby 1912, Lias of France," a shell internally different from the British *Terebratula punctata* (see discussion of *Lobothyris*, p. 103). Muir-Wood (1934:542) selected one of Sowerby's specimens as type of the species, thus fixing the named type as a British form.

ACKNOWLEDGMENTS.—In any monograph of this sort the author is dependent on many colleagues for help, for specimens, for criticism of contentious views, and encouragement. I am indebted to Dr. P.G. Baker, Derby, England for specimens that yielded good loops of *Plectothyris*. Dr. D.I. MacKinnon, Canterbury College, Christchurch, New Zealand, gave the specimen of *"Liothyrella" gravida* that yielded a superb loop. Dr. Danielle Gaspard, Orsay, Paris, France furnished the specimens of *Postepithyris cincta* and *Concinnithyris rouenensis* that produced excellent loops. Dr. Harry B. Whittington, Cambridge University, Cambridge, England helped immensely with specimens from the British Jurassic and Early Cretaceous. These yielded the important loop of *Terebratula perovalis* from Dundry, England, others, such as *Rhombothyris*, *Praelongithyris*, *Platythyris*, and still others that proved to be new genera. Dr. Howard Brunton, British Museum (Natural History), helped with exchanges from the unrivalled collections of his museum. Dr. H.H. Torrens, Keele, England, helped with advice and encouragement. Dr. T.J. Palmer, Oxford University, Oxford, England, helped with encouragement, advice and helped me obtain the specimens of *Cererithyris intermedia* that produced a remarkable loop. Dr. Michael Bassett, Cardiff, Wales, exchanged specimens that yielded a good loop of *Terebratula eudesi*. Dr. Y. Almeras gave me good and timely advice on the role of variation in the study of loops. Drs. Elliott Dawson and Joyce Richardson, New Zealand Oceanographic Institute, New Zealand, helped with fine specimens of *Liothyrella neozelanica* that gave a good series showing the variability of the loop of this species. Dr. F. Hirsch of the Israeli Geological Survey furnished specimens of *Striithyris* and *Bihenithyris* that produced good loops.

To Dr. Ellis F. Owen, British Museum (Natural History), I am especially indebted for our discussions of Mesozoic brachiopods and help in obtaining specimens. His extensive knowledge of these brachiopods and advice, helped me avoid some of the pitfalls of the homeomorphy rife in these difficult brachiopods.

I am indebted to Miss Carolyn Sigman, Wilmington, North Carolina, for the type specimens on which the genus *Tanyoscapha* is based. Dr. Brian Mason, National Museum of Natural History, Smithsonian Institution, collected the specimens of *Mimorina magna* (Hamilton) in New Zealand, one exceptional specimen showing the surface zigzag ornament.

Thanks are given to Mr. Ellis F. Owen of the British Museum (Natural History), for reading and criticizing the manuscript. His extensive knowledge of Mesozoic brachiopods helped me avoid some of the pitfalls of misidentification. Dr. Howard Brunton, British Museum (Natural History), read the parts on Tertiary and Recent brachiopods. Dr. Albert J. Rowell, University of Kansas, read the introductory and critical parts of the text. I benefitted greatly from his and Dr. Brunton's suggestions. I thank them for their help.

I am indebted to Mr. Frederick Collier of the National Museum of Natural History, Smithsonian Institution, and Dr. Anthony Coates, George Washington University, for collections of French Liassic and Bajocian limestones that yielded superb silicified loops of genera proposed by Y. Almeras. Mr. Donald Dean, National Museum of Natural History, Smithsonian Institution, helped with information on mechanical preparation of specimens. Mr. Rex Doescher of the same Museum prepared some of the plaster casts of specimens to be dissected.

Mrs. Josephine W. Cooper prepared translations of many of the Russian articles and most of the descriptions of Russian genera discussed herein, a great help in understanding many unusual forms.

Mr. Lawrence Isham, Visual Aids Specialist, National Museum of Natural History, Smithsonian Institution, made the drawings of the loops on Plates 64–76, histograms, loop diagrams and the restored lophophores. These drawings help in showing loop outline and profile.

ABBREVIATIONS.—

B or BB	British Museum (Natural History), Cromwell Road, London SW7 5BD, England
MNHN	Museum National Histoire Naturelle, 55 Rue Buffon, 75 Paris (5^E), France
USNM	former United States National Museum, collections in the National Museum of Natural History, Smithsonian Institution; occasionally referred to as "National Collection"

Methods

PREPARATION OF SPECIMENS

Although direct preparation of the loop, if successful, yields a specimen that can be referred to and compared with others, the method, like serial sectioning, has serious problems and faults.

The first problem is selection of a specimen that has a workable matrix. Chert or silicious material usually cannot be excavated. Hard limestone of some specimens can be excavated as with *Avonothyris* (Plate 48: figures 1–10). If the loop and matrix are dark or very light colored it may prove difficult to distinguish loop from matrix. A moderately hard, uniform matrix is often ideal, but the softer ones, such as chalk, marl, shale, and some sands, are most easily worked. Some of the Buckman genera come from one of the Jurassic Oolites and are usually difficult to excavate because the oolites are pressed into the loop and make it hard to follow the loop structures. However, some weathered specimens from the oolites or ones that are partially marly, are readily cleaned. Given a satisfactory matrix a loop can be developed in one to five hours, which is far less time than it takes for all the necessary chores in grinding, photographing or drawing their patterns, or etching successive sections and pressing them into plastic strips. The loop of *Epithyris* (Plate 42: figures 13–16) took 2½ hours from start to finish; that of *Avonothyris* (Plate 48: figures 7–10) took 15 hours; some chalk brachiopods took an hour or less.

Specimens with workable matrices should be excavated to expose the loop. This is the only sure way to obtain correct measurements of the loop. It also obviates the problems of orientation in the preparation of serial sections, establishes accurately the position of the crural processes, and insures obtaining the full length of the loop.

The methods used by me are similar to those described by Sahni (1928:118–120) with minor differences, especially the method used to remove all or part of the ventral valve. The tools used in preparing the specimens illustrated herein consist of a dental apparatus with an assortment of small burrs, and small carborundum or diamond discs, or cones, and a pin vise and needles. The ventral valve is removed by grinding off on a diamond disc, then biting off the ventral beak with a nipper to free the sockets or break the teeth if they are frozen in the sockets. The dental apparatus with burrs, cones, or discs is used to rough out the troughs between the inside wall of the shell and the outside surface of the loop. The bulk of the excavation and the more delicate parts of the operation are accomplished with needles having shapes ground according to need and held in a pin vise. The needles (Cooper, 1956a:4) are slender and are bevelled to make a digging point and sharp scraping edge.

If the matrix permits, and the shell is thick enough, the loop may be prepared with part of the ventral valve in place (*Concinnithyris*, Plate 26: figures 29–31). If the matrix is not as amenable as chalk or marl, the beak of the ventral valve is removed. This has the advantage with some specimens of pulling the teeth out of the sockets, thus revealing the nature of the sockets and the socket ridges. More often, however, the teeth break off and remain in the sockets. They may or may not be removable later. When frozen in the sockets the teeth make illustration difficult.

The next step, after the removal of the ventral beak, is to excavate for the cardinal process, which is a focal point of reference in the remainder of the operation because the crural bases diverge from each side of it. The cardinal process should be discovered but not brought into relief until the loop has been exposed completely. Cleaning the cardinal process is fraught with difficulty because it is usually a thin shelf readily broken in holding the specimen during excavation. Loss of the cardinal process was suffered in some preparations early in the work when experience was accumulating (*Ptychtothyris*, Plate 39: figures 19, 20).

After the cardinal process is located, excavation proceeds along the inside wall of the shell, between it and the cardinal process in order to locate the outer hinge plates and socket ridges. After the hinge plates are located, excavation by careful scraping should be done on the anterior side of the cardinal process to locate the ventrad edges of the outer hinge plates or crural bases on each side of the cardinal process. The posterior of the loop is now revealed. The next step is to excavate along the lateral surface of the loop facing the inner wall of the shell. A note of caution is needed here in the excavation of the attachment of the outer hinge plate to the crural base. At the anterior end of the outer hinge plate of most genera, the distal tapered end of the outer hinge plate is usually continued as a ridge for some distance along the outside of the crural base or crural process. This taper often produces the "keeled" hinge plates of Middlemiss (1959) and Muir-Wood (1965). This tapered ridge is delicate, often friable, and can be easily lost. In tracing the side of the loop in forms with long terminal points like *Aromasithyris* and *Lissajousithyris*, the anterior terminations are drawn to a fine point and often difficult to trace. Furthermore, the lateral branchs of such loops may curve anteromedially before terminating (*Strongylobrochus*, Plate 50: figure 33).

After the descending elements of the loop have been successfully discovered, the most difficult tasks of all confront the preparer, that is, discovering and developing the transverse band and crural processes. Locating the transverse band can be managed in two ways. (1) By shaving with sharp needle edge (not point) or grinding with a fine carborundum cone or disc until the thin, usually curved, line of the transverse band appears midway between the ends of the terminal points near the crural processes and bisected by a line from the cardinal process. The trace of the transverse band is often hairlike and not easily recognized. Once this flattened or broadly U-shaped band or bridge is found, it can be excavated from midvalve laterally and followed to its junction with the terminal points. This is the easier method. (2) By excavating at the inside anterior ends of the terminal points until the junction with the transverse band is found, then follow it toward the center of the valve.

Another delicate operation is the excavation of the terminal points and their junction with the transverse band. In some of my preparations the precise tip of the terminal point has been seen but was lost in the course of the work. Specimens such as *Aromasithyris* (Plate 46: figures 7, 8) with very long terminal points and broad weblike attachment of the transverse band are difficult to excavate because the webs form a line of weakness between matrix and loop, causing part of the descending lamella to spall.

After the loop has been blocked out and the transverse band found, it is important to perfect the exposure of the crural processes and the cardinal process. The former are discovered in following the side of the loop. These may have been broken off in the specimen before cleaning but they may be so thin as not to be brought readily into relief. In any event, a portion of the matrix, in the harder ones, must be left to support the crural processes. The crural processes are best seen in side view. The cardinal process is difficult to excavate because it must be freed from the anterior side as well as its posterior. It is usually a very thin shelf easily broken by too much pressure.

After the loop and its accessories have been brought into relief and tidied, the matrix, which may be white or light colored like the loop, is painted black under the microscope. The loop then stands in relief and is easier to study and photograph.

As with serial sectioning, a disappointment can be the discovery that the loop is imperfect ("*Sphaeroidothyris*," Plate 49: figures 21–23). Recent Terebratulacea are often found with parts of the loop broken or deformed. So it is with fossils. I have prepared many specimens and obtained the hinge plates and descending lamellae in good detail only to find the transverse band missing. Such specimens are not a total loss because they give considerable information about the cardinalia (*Ptychtothyris*, Plate 45: figure 7). Some specimens are found with the loop perfect on one side but parts missing on the other (*Stiphrothyris*, Plate 43: figure 31). These are almost as good as perfect, because the loop being bilaterally symmetrical, only a longitudinal half is needed for understanding (*Plectoconcha*, Plate 59: figures 13, 14). Nevertheless, it is a disappointment when one discovers, after all his care and effort, that the loop was imperfect to begin with. In one instance, that of *Epithyris maxillata* (Sowerby) from France, the strongly protuberant, central flattened portion of the transverse band (bridge) was lost in the removal of the ventral valve, a process that must be done carefully to avoid such a mishap.

In preparing the loop of Recent specimens, a weak solution of clorox may be used to dissolve the flesh. This must be done with care. The specimen must not be allowed to remain in the solution long after the clearing of the flesh because the clorox tends to soften the organic tissue from shell and loop, making them spongy and friable.

Illustration of Specimens

In paleontology good illustrations are vital to understanding. The purpose of outlining the loop by blacking the matrix is also to assist in its illustration. Before photographing, the prepared specimen is sprayed with a fine dust of ammonium chloride which subdues the black and highlights the lighter colored loop. In illustrating the loop, a full view from the ventral side is made and another of the side view. A few with protuberant transverse band are photographed from the posterior. Photographing the side view exactly is usually not possible because the loop is so deep inside the dorsal valve that the side of the shell partially or wholly obscures the loop. A true side view is thus not possible without removing the side of the shell. Consequently most of the side views shown here are only partial lateral views. The true side view is illustrated by drawings.

A defect in some of the ventral views is the highlight produced by the supporting matrix between the cardinal process and the pointed, often needle-like ends of the crural processes. In specimens with hard matrix, this support must be left, but tends to obscure or interfere with the proper lighting of the loop. The supporting matrix in the illustrations tends to suggest a thick transverse band.

The drawings of the loops (Plates 64–77) described herein have some defects not due to the artist, but to defects in the prepared specimens. The teeth frozen in the sockets obscure these cavities and may impair recognition of the socket ridges. In removing the ventral valves of some Recent specimens the socket plates may be broken by the resistant teeth. Representation of the socket plates in the drawings may not give their true outline. It is also difficult for an artist to recognize parts of the hinge plates because these are not always clear in the dissected specimen. In spite of these difficulties the drawings give the form of the loop and its profile. They are not stylized as in some of the reconstructions from serial section.

Definitions of Figure Abbreviations

Figure 1*a,b*

The term loop as used in this monograph includes associated structures such as cardinal process, socket ridges, and outer hinge plates. These structures are really parts of the loop because they are the foundation or attachment of the loop. They also figure importantly in evaluating generic characters.

Bridge of the Transverse Band (BrTB): This is a term used by Arcelin and Roché (1936) for the flattened crest of the transverse band. It is a variable feature, narrow or wide in relation to the width of the loop, broad or narrow in relation to loop length, nonexistent when the transverse band is angular (*Oleneothyris*) or roundly arched as in *Apletosia*.

Cardinal Process (CPr): In most terebratulid genera this is commonly a flattened boss or shelf, usually thin, transversely semi-elliptical in outline, with roughened myophore or muscle attachment surface. This surface may be flat or nearly so, or concave and surrounded by a low ridge on the sides and anterior. In some genera a small medium ridge is present on the myophore, and the cardinal process is bilobed because of a median indentation produced by the ridge. In a few Cretaceous genera the cardinal process is greatly swollen, as in *Chatwinothyris* and *Carneithyris*. In these two the swelling may be so great as to obscure the outer hinge plates. The median ridge on the myophore is often prominent in these genera and the related *Ogmusia*. In Recent and Tertiary genera it is commonly similar to that of most of the Mesozoic genera but in some obese forms is deeply concave (*Apletosia*). No post-Mesozoic terebratulacean species has been seen with a grossly swollen cardinal process.

Crus (Cr): This is the part of the crural base between the distal end of the outer hinge plate and the crural process. It is supposed to be homologous to the rhynchonelloid crus but it is not easily identified in all terebratulaceans. In many genera of this superfamily the outer hinge plate is extended for some distance along the outside surface of the crural base, nearly to, or actually onto the crural process. In some genera, *Liothyrella* and *Terebratula*, the crural processes originate at or very close to the junction of the crural base with the fulcral plate so that there is no definable crus. The measure "d" (see below) is the measure of the crus or the crural base between the distal end of the outer hinge plate and the crural process.

Askerov (1965) compared some crura in the Terebratulacea to the crura in the Rhychonellacea. The identification of these types of crura was based on serial sections. They are not readily identified on the prepared or exposed loop. Askerov recognized four types and used these to define several families.

Dagis (1974:37–44) depicted sections of these crura and used some of the Askerov terms, especially in his definitions of the Lobothyridinae and Loboidothyridacea. In addition Dagis identified undulifer crura in *Lobothyris* and *Postepithyris*, and prefalcifer crura in *Dictyothyris*, and *Zeilleriidae*, *Aulacothyridae*, and all *Dallinacea*. A dielasmoid type is also described.

Tchorszhevsky (1974:42–45) redefined some of the Askerov terms and added some new ones. He recognized three main types.

1. Infulifer (as of Askerov). The outer hinge plates attach to the crura [crural base] on the dorsal side. There are three subtypes: lobothyroid (as of Dagis, 1970), the crural bases having the form of thin, narrow, arcuately curved, gradually widening plates (*Rhapidothyris* Tuluweit, 1965); lobothyropsoid, the crural bases wide, thickened at the dorsal margin and crescentic in shape; turkmenithyroid, the crural bases and crura in early stages lobothyropsiod, rapidly widening and curving outward (*Bejrutella* Tchorszhevsky, 1972).

2. Postepithyrisoid (prefalcifer and in part laminifer of Askerov). Outer hinge plates gradually widen and pass into crura. There are two substages: arculifer, new, crura arcuately curved, approximately parallel and coalescing with the outer hinge plates along the mid portion, projecting ventrally and dorsally to an equal degree (*Rugithyris* Buckman, 1917); prefalcifer (of Askerov), crural bases and crura are arcuately curved, converge ventrally to a varying degree and attached to outer hinge plates along the ventral margin, *Dictyothyris* as an example (Figure 2b).

3. Muirwoodelloid (dalmanifer, falcifer, and septifer types of Askerov). Outer hinge plates wide, arcuate, inner margins curved ventrally forming processes developed to a varying degree, crura thin, narrow, curved arcuately and attached to outer hinge plates on inner side at the point of their curvature. There are two subtypes: pseudoarculifer (falcifer of Askerov), crural bases and crura project ventrally beyond the limits of the surface of the outer hinge plates (*Perennithyris* Tchorszhevsky 1974); Karadagathyrisoid (septifer type of Askerov): crural bases and crura do not project beyond the limits of the surface of the outer hinge plates (*Karadagathyris* Tchorszhevsky, 1974).

According to Tchorszhevsky (1974), Muir-Wood and Askerov erred in not delimiting the outer hinge plates and crura. Muir-Wood included the crura in the structure of the outer hinge plates, and Askerov called the union of the two elements the crura.

Crural Base (CrB): This is herein regarded as the ridge or blade leading from the cardinal process to the crural process, which is located along the inner margin of the outer hinge plates and to which the outer hinge plate is attached. It includes the crus. The crural base is the inside wall of the trough formed by the outer hinge plate and the socket ridge. The crural base in some genera (*Gryphus*) is flush with the inner edge of the outer hinge plate and in rare examples such as *Gibbithyris*, *Placothyris*, and *Heterobrochus*, it

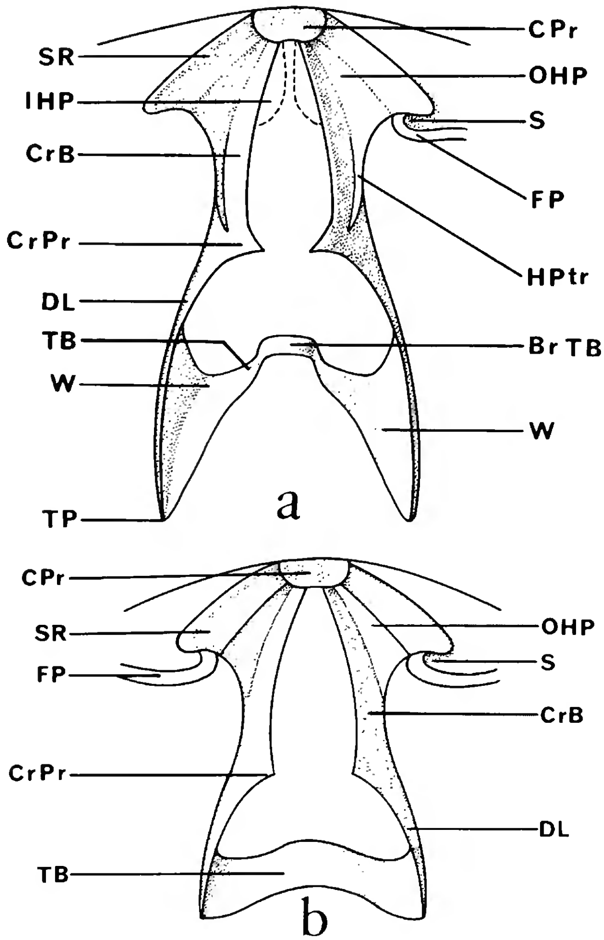


FIGURE 1.—Diagrams showing parts of the loop: *a*, jurassic terebratulacean with long terminal points (diagram modified after Almeras, 1971:99); *b*, hypothetical view of a Recent terebratuclacean; abbreviations same as in *a*. (BrTB = bridge of the transverse band and transverse band; CPr = cardinal process; CrB = crural base and crus; CrPr = crural processes; DL = descending lamella; FP = fulcral plate; HPtr = outer hinge plate taper; IHP = inner hinge plate; OHP = outer hinge plate; S = socket; SR = socket ridge (inner socket ridge to some authors); TB = transverse band; TP = terminal point (flange of Makridin); W = web).

is below the inner edge of the outer hinge plate and is the type seen in serial section called "pendent" by Muir-Wood (1965:H818, fig. 697-H; herein Plate 76: figure 15).

In some genera, such as *Nucleata*, *Dyscolia*, *Aenigmathyris* and a few others, identification of the crural base or crura is often difficult. *Nucleata* is described by Askerov (1965) as without crura; Dieni, Middlemiss, and Owen (1973:192) define the Pygopidae as "Terebratulacea lacking true crural base." In Nekvasilova's (1980, Pl. 5: figs. 1, 2) showing the loop of *Pygites*, crural bases are clearly visible. Not so easily seen are those of *Dyscolia* and *Aenigmathyris*, which have similar loops to that of *Pygites*. *Nucleata* has a similar type of loop and its crural base, a part of which is the crural process, can be traced posteriorly as a low ridge along the inside of the outer hinge plate. The posterior position of the crural processes opposite the anterior ends of the hinge plates or fulcral plates indicates lack of crura but there is a crural base.

Crural Process (CrPr): This term refers to the part of the crural base that is triangularly expanded and tapered into an obtusely angular or needle-like point. The crural processes are usually directed toward the ventral valve, often slightly anteriorly and usually more or less strongly toward each other, when they are said to be approximate. In the following discussions the crural process is often used loosely to refer to the expanded part of the crural base that bears the points. In some examples the points have been broken or lost in preparation or were not preserved. The crural processes are a focal point in the loop and their position is herein given importance in generic definition and family arrangement. In some genera they are located so close to the fulcral plates and distal end of the outer hinge plates that they technically eliminate the crus. *Liothyrella* and *Terebratula* are examples. In other genera they may overhang the transverse band, exaggerating the length of the crus and rendering the descending lamellae unmeasurable. The measure of "a" in the statistics defines the position of the crural processes. In the living animal the crural processes serve as support for the posterior part of the lophophore. The position of the crural processes in some genera is so close to midloop that the statistic a/Ll varies between slightly greater and slightly less than 0.50 in specimens of the same genus.

Descending Lamella (DL): This is the lateral part of the loop that supports the transverse band anterior to the crural process, the anterior extension of the crural base. It is usually a thin ribbon of varying width, often laterally bowed (especially in many Jurassic genera). In Cretaceous to Recent genera it is straight but never conspicuously bowed inward. The descending lamella is variable in length and separates the crural processes from the transverse band. The separation may be long in many Jurassic genera, short in Cretaceous to Recent genera. In some genera the crural process slopes directly to the transverse band without the development of a recognizable descending lamella (*Tanyoscapha*). In genera having long terminal points (*Lissajousithyris* for example), the descending lamella has a long taper and forms the margin of the broad, weblike attachment to the transverse band.

Euseptoidum: The median ridge in the dorsal valve, usually low and thick, approaching a septum in height. It serves as a myophragm.

Flange (fl): Middlemiss (1959:96) states:

> In some species the inner lamina of the [outer] hinge plate passes anteriorly into the crural process while the outer lamina continues anteriorly along the outer side of the base of the crural process as a flange [hinge plate taper-HPtr]. This flange may attach to the base of the crus but slightly above it so that the crus extends below the flange as a *crural keel*. In some species the keel can be traced back into the car[d]inalia, giving a keeled hinge plate, while in others it is developed only in the region of the crura (text-figs. 1, 14).

The keel occurs when the outer hinge plate is attached to the crural base between its dorsal and ventral edges. This feature is well shown in some serial sections.

Tchorszhevsky (1974) uses these skeletal elements, quite varied in form and degree of development, that reinforce classification and can be used for the purpose of systematics. He proposes the following classification: (1) perennithyrisoid (from the genus *Perennithyris*; not described in this paper) processes of the outer hinge plates developed weakly, uniformly (fig. 3a); (2) goniothyrisoid (from the genus *Goniothyris* Buckman, 1917) – processes well developed, overhanging deeply into the cavity of the dorsal valve and having one curvature (fig. 3a,b); (3) karadagelloid (includes the septifer crural type according to Askerov) – processes very wide and long, delicate, overhanging deeply into the cavity of the dorsal valve, having two curvatures and may rest upon the floor of the dorsal valve fig. 3.

The identification of keels and types of crura, being based on structures and pattern seen in serial sections, has not proved useful in this study. The position of the outer hinge plate attachment to the crural base is used herein as explained in the section on systematics, but it is not as complicated as Tchorszhevsky's schemes.

Fulcral Plate (FP): This is the floor of the socket that usually appears at the distal end of the socket as a narrowly curved or flattened plate, thick or thin, often partially or wholly obscured by shell deposit. In some genera, as *Colosia*, the fulcral plate is extended laterally as a prominent ridge that buttresses the posterior of the shell. In many genera ridge is not developed or is a mere token.

Hinge Plate Taper (HPtr): A ridge of varying length and width on the crural base or crural process represents the anteriorly narrowing outer hinge plate. This taper often extends to the crural process and makes a ventrad curve on its surface toward the points of the crural process but not on them. The taper may extend along the dorsal edge of the crural process or less commonly on the ventral edge. It is also known to occupy the middle part of the outer face of the crural base (see flange above).

Inner Hinge Plates (IHP): These are rare structures that appear in one Jurassic genus (*Viligothyris*) and a few Cretaceous and Tertiary genera. They have not yet been seen in Recent terebratulaceans. *Neoliothyrina* and *Harmatosia* of the Cretaceous, and *Pliothyrina* and *Plicatoria* of the Tertiary are examples. Inner hinge plate development is variable (Plate 5: figures 3, 9, 8) because the plates are marginal thickenings on the inside of the crural bases in the apical part of the shell in some species. In others they form horizontal, flat plates on the inside of the inner margin of the crural bases and unite or overlap apically at midvalve to form an undivided, often sutured plate. These inner hinge plates do not have the regularity of the outer hinge plates and are regarded as of secondary origin by Dagis (1974:15). They are not to be confused with the descending "inner" hinge plates or septal plates of the Terebratellacea.

Terebratula (sensu stricto) is often cited as an example of a brachiopod with inner hinge plates, although it does not possess these structures. This mistaken notion arose through the works of Buckman and Sahni, who identified British Tertiary shells as *Terebratula*. These are now placed in *Pliothyrina* and *Apletosia*. The function of the inner hinge plates is not known. They probably had relation to the dorsal pedicle muscles that are normally attached to the outer hinge plates and socket ridges. They may have buttressed or strengthened this attachment or have furnished additional surface for muscle attachment.

Outer Hinge Plate (OHP): The outer hinge plate, the site of dorsal pedicle muscle attachment, is the narrow triangular partition lying against the crural base and lapping onto the socket ridge, thus uniting the crural base and socket ridge to form a trough in which the dorsal pedicle muscles were lodged. When well defined the plate may be flat or nearly so (*Dallithyris*), concave ventrally (*Tichosina*), long and concave (*Plicatoria*), or short and concave (*Plectoidothyris*). In some genera the outer hinge plate is very narrow or not developed (*Apletosia*), the socket ridge and crural base in contact. In *Gibbithyris* the outer hinge plate is convex ventrally, a recurrent condition in the Mesozoic Terebratulacea.

The outer hinge plates in serial section form patterns that have been named (Middlemiss, 1959:97; Muir-Wood, 1965:H818; herein Plate 76: figure 15). The patterns are not usually consistent because a hinge plate may be initially V-shaped in section, becoming U-shaped anteriorly. Also the "clubbed" shape of the crural base is not always positively or easily recognized, nor is the hinge plate itself always recognizable.

The outer hinge plate is attached to the crural base at its dorsal edge, more rarely the ventral edge and occasionally in between. When attached between the two edges, part of the crural base projects below (dorsad) the outer hinge plate to produce the keels of Middlemiss and the "processes" of Tchorszhevsky.

The diagrams of Middlemiss and Muir-Wood pertaining to the hinge plates are collective, that is, the hinge plate consists of three separate entities, not individualized: the socket ridge, outer hinge plate, and crural base. They do not indicate these separate elements as noted by Tchorszhevsky. Middlemiss was concerned only with a restricted lower Cretaceous group of terebratulaceans and recognized only four types: concave clubbed, horizontal tapering, virgate keeled, and concave piped patterns. In Middlemiss's definitions the clubbed and piped parts are the crural bases. The virgate keeled hinge plate has a high crural base and narrow outer hinge plate fused to the socket ridge.

To Middlemiss's four types Muir-Wood added four more patterns without separating crural base from outer hinge plate and the latter from the socket ridge: U-shaped, virgate, pendent, and ventrally convex. The U-shaped pattern is similar to the clubbed type of Middlemiss but without clear differentiation of the crural base, which must be the inner vertical element. V-shaped virgate only lacks the keels. Many hinge plates V-shaped posteriorly become U-shaped anteriorly. The pendent type is a special form restricted to a few genera such as *Gibbithyris*, *Heterobrochus*, and *Placothyris*. Ventral convex, in which the outer hinge plates are concave dorsally, is a rare type, exhibited by *Trigonithyris*.

Burning or roasting the shell before sectioning may improve visibility in the sections, but it tends to obscure the parts of the hinge plate and its junction with the crural base and socket ridge.

Socket (S): The socket is a long narrow trough bounded by the inner shell wall (outer socket ridge of some authors) and the outside-facing surface of the socket ridge (inner socket ridge of some authors). The socket extends in a gentle curve from the cardinal process to its distal opening, widening as it progresses. Near the cardinal process it is usually covered or filled with shell tissue. The socket is floored by the fulcral plate.

Septum: A high thin septum in either valve is seldom seen in the Terebratulacea except as an aberration (Deslongchamps, 1862–1885, pl. 20: figs. 7–11).

Socket Ridge (SR): The socket ridge (often called inner socket ridge) is the upturned part of the fulcral plate that bounds the inner side of the socket. It is usually a thin or stout plate, but in rare examples (*Carneithyris*) may become greatly swollen. The socket ridge may be erect and the socket fairly wide or it may be inclined toward the socket; it rarely overhangs the socket.

Terminal Point (TP): This term refers to the lateral extensions of the loop (flanges of Makridin, not Middlemiss) anterior to the crural processes. These are variable and are most prominent in Jurassic genera: *Lissajousithyris*, *Monsardithyris*, and *Arcelinithyris* in the Bajocian. In Recent terebratulaceans the loop is generally without measurable terminal points. *Apletosia* and *Oleneothyris* are unusual Tertiary genera having a loop with long terminal points. Makridin (1964) followed by Dagis (1965, 1968, 1972, 1974) used the long and short (flanges) terminal points of the loop as a basis of higher classification, naming Lobothyrinae (short terminal points) and Loboidothyrinae (long terminal points). The term terminal points is preferred herein to Makridin's flange because of conflict with the prior use of flange in a different sense by Middlemiss.

Although Barczyk (1969:11) and Almeras (1971:110, 120) are not enthusiastic about the use of the relative length of terminal points in classification, the scheme, although artificial, has merit in bringing together genera with similar interiors. The possible development of long loops into short, although suggested by the evolutional trend shown in this study, cannot now be detected in individual cases.

Transverse Band (TB): The transverse band (occasionally referred to as the jugum) is the anterior transverse part of the loop that usually takes the form of a more or less strongly elevated arch connecting the descending lamellae (Dl) or the part of the loop anterior of the crural processes. The ribbon comprising the arch may be broad (in the longitudinal direction) as in *Epacrosina fulva* (Blochmann) or thin (longitudinally short) and delicate as in *Liothyrella*. The transverse band may be wide (transversely) as in *Stiphrothyris* and *Maltaia* or contracted laterally, thus narrow as in *Stenosarina* and *Najdinothyris*. The crest of the arch may be flattened (bridge) for a third to a half the width of the loop or may be broadly or narrowly rounded, or fairly sharply angular as in adult *Oleneothyris*. The base of the arch may be narrow (short in the longitudinal direction) or long, depending on the terminal points. The anterior margin of the transverse band may bear a median reentrant and the part bounding the reentrant may have small points (*Gryphus*).

The median flattened part of the transverse band, the bridge, may be strongly protuberant, projecting ventrally beyond the distal ends of the crural processes as in *Epithyris* and *Stenogmus*. The transverse band may range from horizontal to an inclination toward the posterior of 50° or more. The crest of the loop is variable relative to the distal ends of the crural processes, extending ventrally beyond them, equalling their extent or recessive.

Tchorszhevsky (1974:46) identified four types of transverse band. (1) Simple loop as in Orthotomidae Muir-Wood, 1965 and Nucleatidae Schuchert and LeVene, 1929b, in which the transverse band consists of two equal parts that unite at the inner margins in the plane of symmetry. (2) In the Lobothyridinae Makridin (1964), in which the transverse band is composed of three parts, the band proper, usually rounded and in a central position and two lateral portions that coalesce with it. The transverse band itself represents the result of the final development of the vertical plate (its ventral part) of the centronellid loop. (3) Characteristic of terebratulids with complex ontogeny (the families Tchegemithyrididae Tchorszhevsky, 1971; Muirwoodellidae Tchorszhevsky, 1974) in which the loop undergoes a metamorphosis. In this case the loop consists of five parts: transverse band proper, two vertical and two lateral plates. The transverse band here, as distinct from the preceding, is the result of the development of a ring on the central margin of the vertical plate of centronellid type. The vertical plates are structures that have separated from, and grown out of, the vertical plate of this loop and the lateral have separated from the horizontal plate of the loop. (4) Peculiar to the family Loboidothyrididae Makridin, 1964. The transverse band in these forms was formed at different stages apparently by four plates, one of which (the upper horizontal) was resorbed during the process of shell growth, but the protuberance ("ears and shoulders") on the band of mature shells, allows its identification.

This difficult account gives no proof of the development of the various plates mentioned in 3–4. The phenomena set out by Tchorszhevsky need confirmation other than that now in the literature (the loop developments worked out by Dagis for *Viligothyris* and *Lobothyris* (Dagis, 1968, 1974)).

Web (W): This term is suggested for the part of the loop with long terminal points in which both sides of the base of the transverse band are broadened for a considerable distance. The loop of *Lissajousithyris* is an example. Webbed terminal points characterize those loops that have long terminal points (flanges of Makridin).

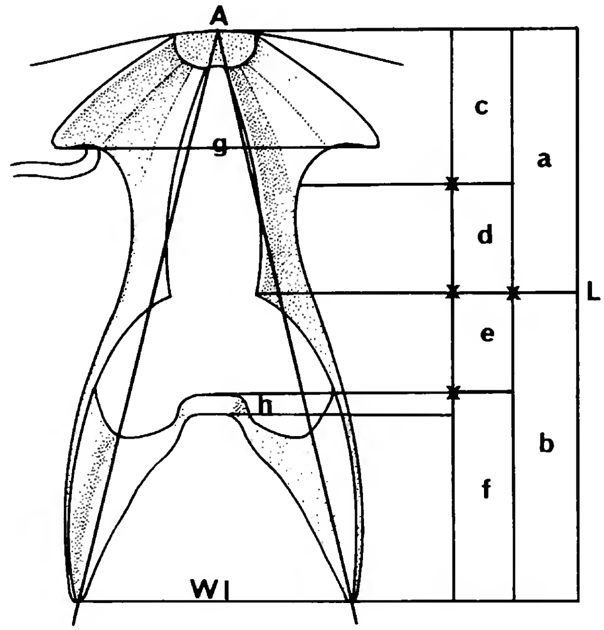


FIGURE 2.—Parts of the loop used to measure for statistics in tables (A = loop angle; a = distance from cardinal process to tip of crural process (a focal point in the loop); b = distance from tip of crural process to end of terminal point; c = measure of outer hinge plate; d = measure of crus, from end of outer hinge plate to tip of crural process; e = distance from crural process to bridge (or apex) of transverse band; f = length of terminal points; g = width of hinge; h = measure of transverse band at its apex; Ll (a + b) = length of loop; Wl = width of loop).

Terminology for Loop Measurements

FIGURE 2

The following terms are similar to those used by Almeras (1971:99) in his excellent discussion of the loop characters of some Jurassic brachiopods (see also Boullier, 1976:92). It seems desirable to anglicize two of Almeras' abbreviations: w is used in preference to l for largeur (= width), and l is used instead of b for boucle (= loop).

A = loop angle, a measure of the angle formed by lines drawn from the middle of the cardinal process or apex through the terminal point tips or anterolateral extremities of the loop not having significant terminal points.

a = length of the loop from the posterior shell margin or cardinal process to the crural processes. This is a measure of the outer hinge plate length and crus length combined and serves to position the crural processes in the loop.

b = length of the loop from the crural processes to the anterior ends of the terminal points. This is a measure of the length of the descending lamellae to the terminal points in Jurassic genera; to the anterolateral extremities in genera without terminal points (some Cretaceous and most Recent and Tertiary genera).

c = length of the outer hinge plates from the posterior margin to the end of their junction with the crural base. This is often an ambiguous measurement because of difficulty in determining the taper of the hinge plates or their true length.

d = length of the loop from the anterior end of the outer hinge plate taper to the crural process (= crus, if recognizable) (c + d = a).

D = dorsal valve.

e = length of the loop from the crural processes to the crest of the transverse band, a variable often dependent on good preservation.

f = length of the loop from the crest of the transverse band to the end of the terminal points. This is a measure of the terminal points, if any, or of the transverse band itself if the terminal points are absent (e + f = b).

g = the transverse distance between the distal ends of the socket ridges, a measure of the hinge.

h = the measurement of the width (in a longitudinal direction) of the crest of the transverse band. Very narrow in many genera, long in others, and may nearly equal measure of f.

l = loop.

LD = length of the dorsal valve.

Ll = length of the loop.

WD = width of the dorsal valve.

Wl = width of the loop at its anterior.

Relationship of Parts of the Loop

a/Ll = relation of the outer hinge plate, crus and part of the crural process to the length of the loop. Measured from the cardinal process to the tip of the crural process.

b/Ll = relation of the descending lamellae (measured from the point of the crural process to the end of the terminal points) to the length of the loop.

c/Ll = relationship of the outer hinge plate (including taper) to the length of the loop.

d/Ll = relationship of the crus, if recognizable, to the length of the loop. In genera with long tapered plates this measure is 0.00.

e/Ll = relationship of the distance between the points of the crural processes to the crest of transverse band to the length of the loop.

f/Ll = relationship of the distance between the crest of the transverse band and the distal tips of the terminal points to the length of the loop.

g/WD = relationship of the hinge width to the width of the dorsal valve.

g/Wl = relationship of the width of the hinge to the width of the loop.

h/f = relationship of the longitudinal measure of the crest of the transverse band to the length of the terminal point (f).

h/Ll = relationship of the longitudinal measure of the crest of the transverse band to the length of the loop.

WD/LD = relationship of the width of the dorsal valve to the length of the dorsal valve.

Wl/Ll = relationship of the width of the loop to the length of the loop.

Ll/LD = relationship of the length of the loop to the length of the dorsal valve.

Wl/WD = relationship of the width of the loop to the width of the dorsal valve.

Measuring the Loop

Measurement of the parts of the loop is seldom a precise operation because of difficulties involved with poor specimens, incomplete preservation, and the bias of the observer. The troublesome parts are the outer hinge plates because of their variable taper, the crura because of the uncertainty at where to end the outer hinge plate taper, the crural processes, the descending lamellae, and parts of the transverse band. Lack of clean-cut terminal points makes difficulties in separating genera such as *Dyscolia* and *Abyssothysis*, in which the transverse band is directed horizontally or anteriorly and the loop has nicely rounded anterolateral extremities.

Strongly virgate hinge plates have the outer hinge plates greatly reduced or not definable. Most inaccurate is the measurement of the hinge plate that tapers anteriorly along the outer surface of the crural base. In some genera this taper extends to a point dorsad of the crural processes or on them. In such specimens, if the measure is taken to the end of the taper, the crus becomes undefinable and will measure zero or be very small.

The measurement of the descending lamellae is also dependent on the observer's judgement. It is not always possible to tell accurately where the crudely triangular crural process ends and the descending lamellae begin. In some genera the transverse band appears to be attached to the anterior side of the crural process (*Tanyoscapha*).

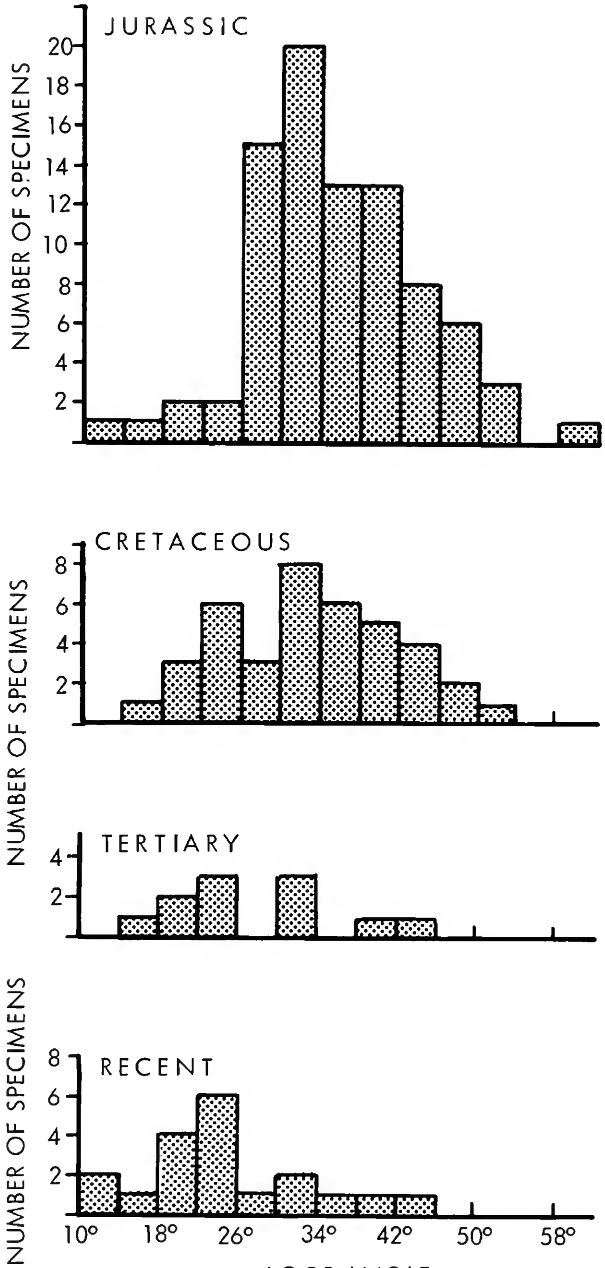


FIGURE 3.—Histograms showing loop angle from Jurassic to Recent.

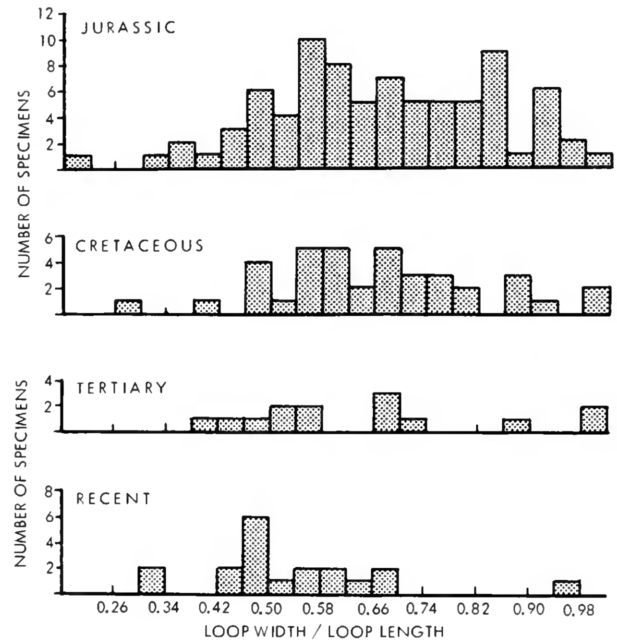


FIGURE 4.—Histograms showing relationship of loop width to loop length (Wl/Ll) from Jurassic to Recent.

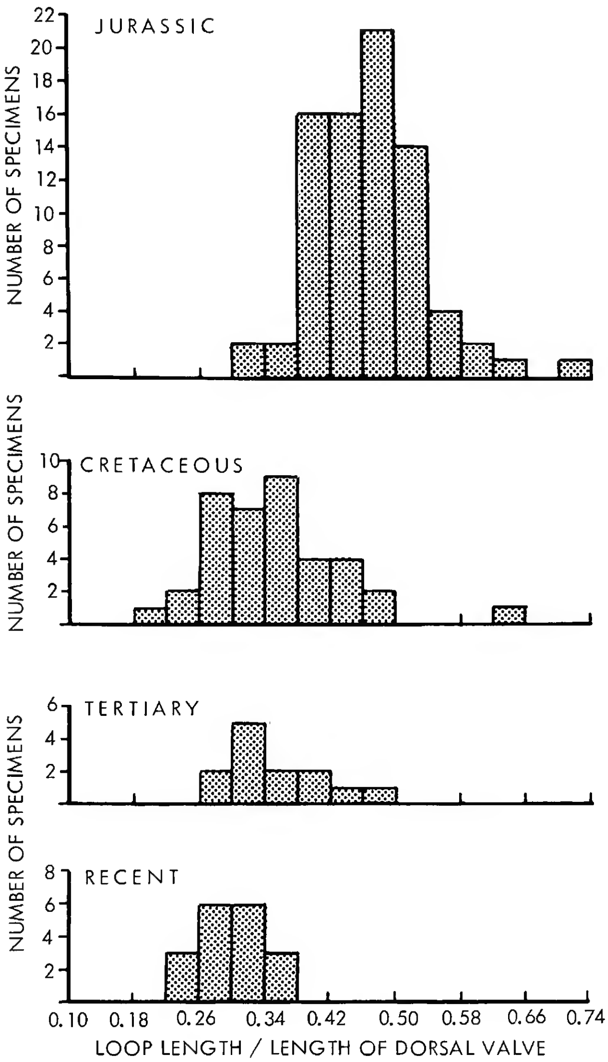


FIGURE 5.—Histograms showing relationship of loop length to dorsal valve length (Ll/LD) from Jurassic to Recent.

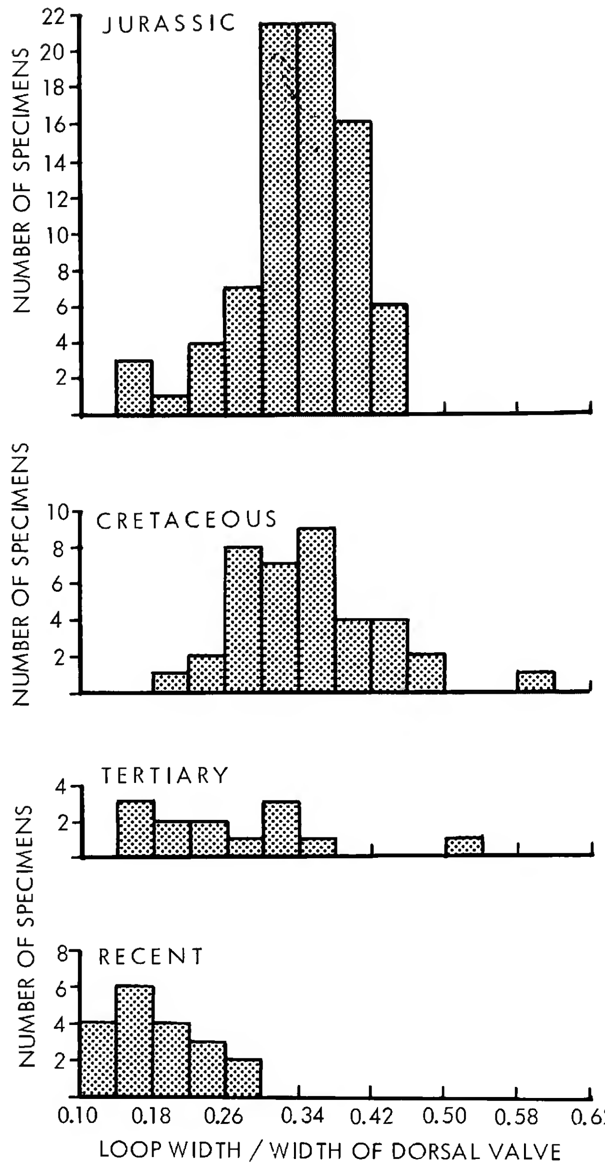


FIGURE 6.—Histograms showing relationship of loop width to dorsal valve width (Wl/WD) from Jurassic to Recent.

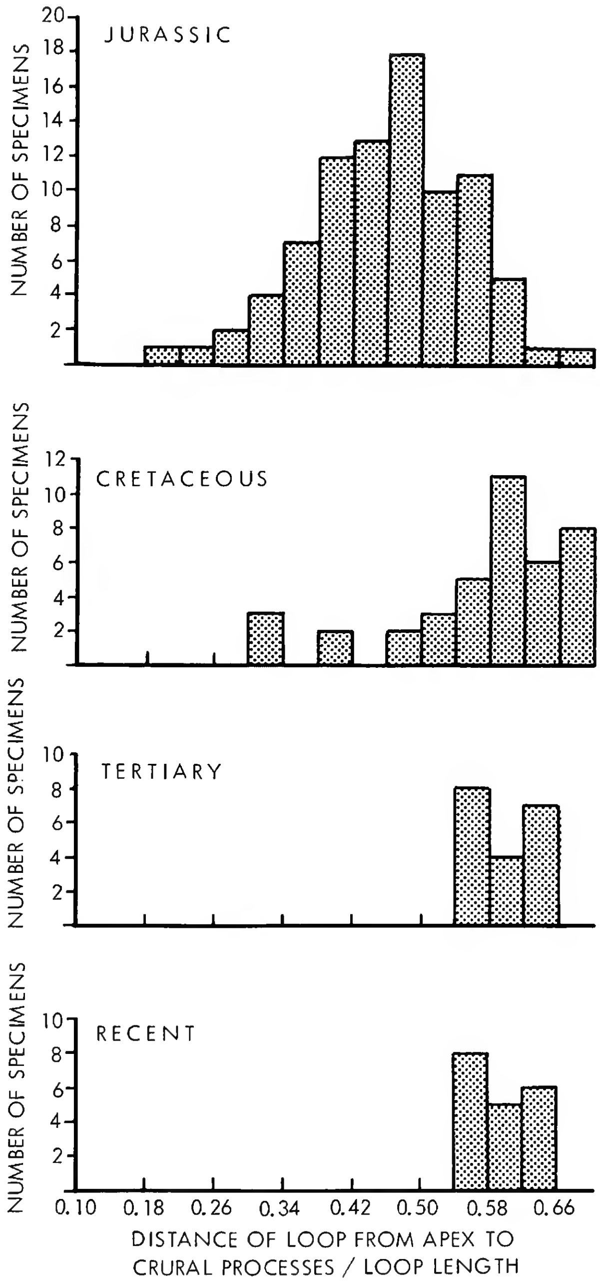


FIGURE 7.—Histograms showing relationship of loop length to distance from apex to crural processes (a/Ll) from Jurassic to Recent.

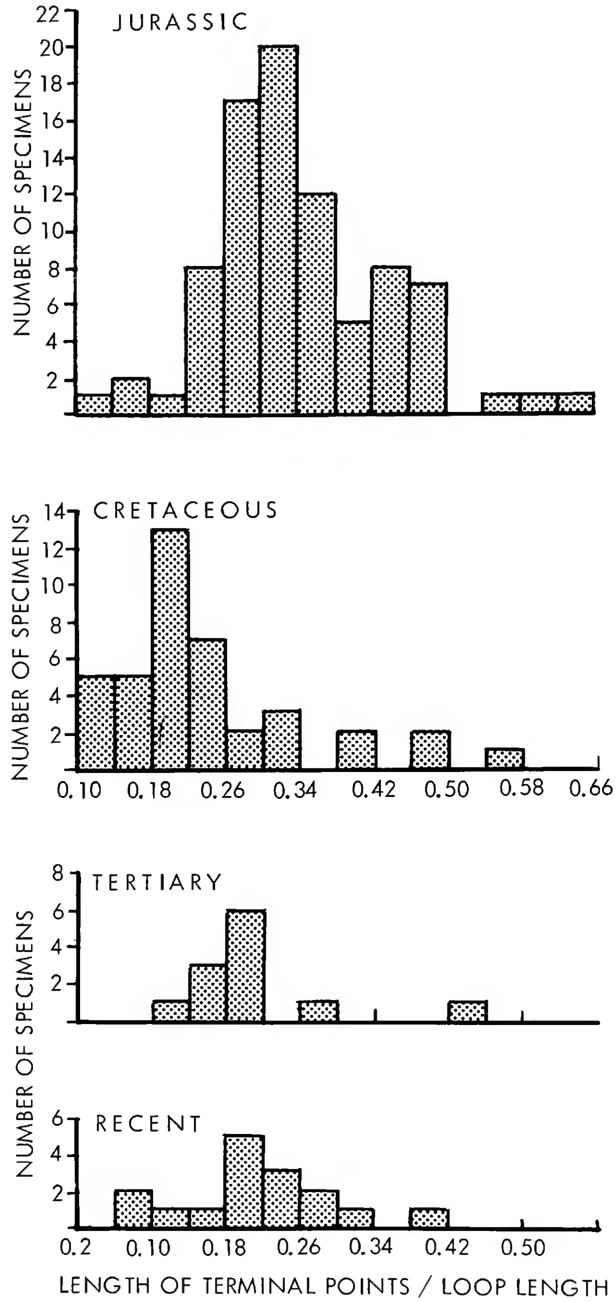


FIGURE 8.—Histograms showing relationship of length of terminal points to loop length (f/Ll) from Jurassic to Recent.

Measurement of the transverse band is troublesome and the numbers can be misleading if the parts of the band are not separated. A loop with fairly long terminal points may appear statistically like a loop with very broad transverse band but no terminal points. The differences in the longitudinal measure of the transverse bands may be compared by using the statistic h/f. The larger the number, the longer (in a longitudinal direction) will be the transverse band. h/f = 1.0 will be equal to the measure of f for any species.

Measurement of the loop angle is taken from the apex of the cardinal process (the umbo) to the terminal points. In genera with rounded anterolateral extremities of the loop, it is taken from the same apical reference to the point at which the descending lamella changes direction at its junction with the transverse band. *Aenigmathyris* is an example of a brachiopod with a loop having an anteriorly directed transverse band without terminal points.

Loop width is measured between the distal tips of the terminal points. Again a loop like that of *Aenigmathyris* is measured for width between the two points at which the anteriorly directed transverse band meets the descending lamellae. Bulging loops such as that of *Strongylobrochus* gives a deceptive idea of loop width when the measurement is taken between the tips of the terminal points. In this example, two measurements may help in understanding the loop, one at its widest point, the other at the tips of its terminal points. This loop also yields a deceptive angle when measured from cardinal process to terminal point tips. A much greater angle is shown by taking the angle from the sides of the bulging loop.

Measurements from Serial Sections

It is possible to prepare the same statistics as outlined above from adequate serial sections. The complete and measured serial sections must be in more detail than the average and it is vital that a complete measure of length and width of the dorsal valve be given. These data on sectioned specimens seldom appear in papers using serial sections to show the interiors of their specimens. The remarkably detailed and accurate sections of Almeras (1971) are unique in this respect. Sučić-Protić (1971) gives full measurements for her detailed sections. Almeras gives full data for the location of critical parts of the loop with his sections. Another deficiency of many serial sections is that no indication is given of the final disappearance of all traces of the loop. Serial sections should be recorded to the full length of the loop, with all sections bearing numerical relationships to those above and below. This practice provides vital statistics for understanding the serial sections.

A plaster replica of the specimen should be prepared before sectioning and illustrations of the sectioned specimen should be published.

In generating statistics from serial sections key points must be ascertained: the length of the outer hinge plates; the position of the crural processes, a major focal point for the study; the length from the crural processes to the crest of the

Table 1.—Average statistics of Jurassic to Recent Terebratulacea (range of each period in parentheses)

Proportions	Jurassic	Cretaceous	Tertiary	Recent
∠	37° (14°–62°)	34° (15°–51°)	32° (17°–58°)	25° (10°–43°)
Wl/Ll	0.67 (0.21–1.00)	0.67 (0.31–1.00)	0.65 (0.40–1.00)	0.54 (0.31–0.95)
Ll/LD	0.47 (0.31–0.66)	0.35 (0.22–0.60)	0.36 (0.27–0.49)	0.29 (0.24–0.36)
Wl/WD	0.34 (0.15–0.49)	0.26 (0.13–0.44)	0.27 (0.15–0.52)	0.19 (0.12–0.28)
a/Ll	0.47 (0.21–0.67)	0.58 (0.31–0.70)	0.61 (0.43–0.74)	0.60 (0.56–0.64)
c/Ll	0.35 (0.18–0.67)	0.50 (0.13–0.67)	0.55 (0.28–0.77)	0.51 (0.42–0.63)
f/Ll	0.35 (0.15–0.65)	0.25 (0.13–0.55)	0.22 (0.12–0.44)	0.22 (0.02–0.39)
h/f	0.23 (0.03–0.65)	0.54 (0.08–1.19)	0.50 (0.19–1.12)	0.73 (0.41–1.00)

transverse band; the length of the descending lamellae; and the length of the terminal points. It is not easy to detect the taper of the outer hinge plates. The crural processes appear usually as a lengthening of the dashes showing the section of the lateral parts of the loop just after disappearance of the hinge plates, but the exact height or apex of the crural processes may not appear in the sections, thus making a small inaccuracy in the statistic. The sections may completely miss the apex of the needle-pointed crural processes. There is thus a possible error, slight or large, but usually present in determining the true length of a and b. This error appears in most reconstructions that show blunt or indistinct crural processes. The transverse band is not always present in a sectioned specimen and may be lacking from a prepared one but it is a most important part of the loop. In Jurassic forms with long terminal points, the length of the points should be indicated although they may not appear in the sections presented (a defect of the Sučić-Protić (1971) sections). As a final note the length and width of the dorsal valve should be recorded with the sections.

A major source of error in generating statistics from serial sections is the accuracy of the outline of the dorsal valve framing the reconstructed loop. In the Sučić-Protić (1971) reconstructions some of the outlines are inaccurate and others do not match the measurements or enlargements given for the sectioned specimen. In one genus the outlines of the reconstruction have the greatest width at the posterior with anterior taper, but the reverse is shown by photographs of the specimens (see *Inaequalis*). Inaccurate outlines lead to errors in Ll/Ld, Wl/Wd, and g/WD. The first is one of the most important statistics.

Barczyk (1969), Singeisen-Schneider (1976), and Rouselle (1965a) have pointed out some of the difficulties encountered in serial grinding, the first two showing that reconstruction of an artificial experimental loop cut at different angles produced entirely different appearing reconstructions. Barczyk (1969:11) summed up his findings by stating: "One may conclude that sectioning a single specimen for reconstruction of its loop cannot give true information on the internal structure of species examined."

Origin and Possible Evolution of the Terebratulacean Loop

The beginnings of the Terebratulacea are obscure. Williams and Wright (1961) postulated the origin of the loop from the Spiriferida because an Ordovician spiriferid, *Protozyga*, had its lophophore supported by a simple loop, suggesting that of *Centronella* (but without echmidium). There is no terebratulid known from Middle Ordovician to Early Devonian, when *Mutationella* appears. Their postulate encounters difficulties beside that of stratigraphic sequence, in the necessity to supply the early terebratulid with endopunctate, deltidial plates and a different type of beak than that usually found in the Spiriferida. Although a loop is known to have developed in an impunctate stock (*Enantiosphen*), it seems more likely that the terebratulacean loop originated from an already punctate stock of the Orthida, of which there was an ample supply in the Middle Ordovician to Early Devonian.

Once established, the loop-bearers developed in more than one direction. In elaborating the centronellid loop, a simple structure consisting of laterally bowed, descending bands uniting anteriorly, the two branches separated by a median plate, the echmidium. Evolution from the centronellid loop went in two directions, one toward development of a short loop and the other toward the production of a long loop. The echmidium or median plate of the centronellid loop was the generating site of the loops of both stocks. In one group a bud or ring developed on the echmidium, which by resorption and subsequent deposition ultimately formed a loop with long descending lamellae and closed ascending bands to produce the cryptonellid loop, of no immediate concern here.

In the other direction the echmidium or median plate split and by resorption and subsequent deposition the short lateral lamellae were united by a transverse band to produce the terebratulid short loop. Three groups separable by their cardinalia were produced at this time. The Cranaenidae and Notothyrididae have an undivided hinge plate and the latter family retained the median plate or echmidium in the adult condition. The third stock, Dielasmatacea, has a divided hinge plate with the crural bases supported by septal plates that reach the floor of the valve or unite with a median septum. The Cranaenidae and Dielasmatacea in North America retained their primitive dental plates in the ventral valve, but in Europe and Asia some dielasmatids lost their dental plates (*Hemiptychina*). The Dielasmatacea and Notothyrididae extend into the Triassic, and the former had a large development at that time and may have been the initiating stock of the Tchegemithyridae of the Jurassic. The Notothyridae retained its primitive centronellid loop form and seems to have been terminal in the Triassic.

Of immediate concern is establishing the possible origin of the terebratulid loop of the Mesozoic to Recent genera. By aborting the dental plates and eliminating the septal plates and/or undivided hinge plate, the Cranaenidae or Dielasmatacea could produce a terebratulid. Two early genera have all the characters of a plastic terebratulid: *Oligothyris* Cooper (1956b) and *Pseudodielasma* Brill (1940:317; see also Cooper and Grant, 1976:2911) of the Permian (figures of the latter genus on Plate 48: figures 11–14 and Plate 49: figure 24). Both genera are devoid of dental plates and each has a simple loop without inner or outer hinge plates. It is doubtful if either of these gave rise to the long-flanged loops of the Jurassic.

Pseudodielasma, although a highly evolved form, retains characters that make it, structurally, a possible progenitor of the later Terebratulidae. It is a very small shell, measuring 4–10 mm in length. Its exterior is typically terebratulid, with narrow, incurved beak and relatively large foramen. The species, 13 of them, are commonly biplicate. Internally little is known of the ventral valve musculature because small size and poor preservation of shell surface are not conducive to fidelity. An excavate pedicle collar of considerable length is present but dental plates are unknown. The genus is abundant in the Word Formation (Willis Ranch Member) and in the Whitehorse Formation, both of Texas.

In the Glass Mountains of West Texas several species have been described, some of which have yielded well-preserved loops. Loop development, however, is not known. The loop is simple in structure, being narrowly triangular, moderately long (Ll/LD = 0.35), and delicate. The socket ridges are steeply inclined and directly meet the crural bases without outer hinge plates. The crura are long, flat blades expanding into blunt crural processes that are situated anterior of midloop, the descending processes are short and form the anterior slope of the crural processes. The transverse band is either straight or directed slightly anteriorly. Proportionately it is fairly wide.

Absence of outer hinge plates and the nature of the transverse band are reminiscent of the Dyscoliidae and Acrobelesiinae. That *Pseudodielasma* is structurally as well as chronologically antecedent to some Terebratulidae is evident but there is too great a lack of information on Triassic

FIGURE 9.—*Ectoposia wildei* Cooper and Grant, Permian of West Texas, Word Formation, Hess Canyon Quadrangle, USNM 153346, showing long loop with prominent web, possible relative of the Angustithyrididae said to be a progenitor of the long-flanged Tchegemithyrididae (Loboidothyrididae of Dagis).

short-loop brachiopods to be sure of its role in evolution.

Little is known of the terebratulid loop in the Triassic and there is much to learn about these brachiopods in the Liassic. The dielasmatid type of loop and cardinalia occurred commonly in the Permian and Triassic, some with complicated loop development (Dagis, 1968, 1974). Dagis (1974) notes that two different types of loop development occur in the Mesozoic, one concerns short-flanged types, the development of which is like that of Dielasma. In this the loop grows by median division of the nepionic centronellid loop and insertion of the transverse band between the descending lamellae. This type of development was described for the Russian "*Plectoconcha*" and *Lobothyris* by Dagis (1968, 1974). With loss of the echmidium this is the kind of loop development of many shortlooped genera such as *Chatwinothyris* (Steinich, 1965) and modern *Liothyrella*. In these modern types the lateral lamallae are given off from the outer hinge plates or socket ridges, grow anteriorly toward each other, and are joined by deposition of the transverse band, the loop growing by resorption and redeposition.

The long-flanged loops of Makridin (1964) of the Jurassic have a more complicated development originating from the Triassic Angustothyrididae that have their roots in the Dielasmatacea (Dagis, 1974). The loop evolves by development of a ring on the echmidium, followed by cleavage and resorption of the median plate, with subsequent stages similar to those seen in the Dallinacea. The Angustothyrididae according to Dagis gave rise to the Loboidothyrididae of Dagis [= Tchegemithyrididae]. The long-flanged stocks existed into the Cretaceous (Spasskothyridinae Smirnova), with a possible hangover, *Oleneothyris*, in the Paleocene.

Throughout the Mesozoic, genera are known that have small or no terminal points, loops that are essentially modern in aspect, *Placothyris*, *Colosia*. This type appears to be rare in the Triassic, less so in the Jurassic and prominent in the Cretaceous to Recent. Modern brachiopods have no extended anterolateral points on the loop and thus represent the end of evolution in that direction. Inasmuch as the long-flanged loop of the Jurassic tends through time to become shorter and narrower, various stocks may have produced the short-flanged forms of the Cretaceous. To trace the descent of the modern terebratulid with our present knowledge, is a hopeless and fruitless exercise.

In recapitulation the Mesozoic brachiopods with short-flanged loops may have arisen from the early *Oligothyrina* or *Pseudodielasma* that have no dental plates, no outerhinge plates, essentially plastic genera. Once established it is a question whether the short-flanged forms existed through time as a single stock or were augmented by addition of originally long-flanged genera that had shortened the long points to disappearance. The brachiopods with long-flanged loops are thought by Dagis to have arisen in the Triassic from the long-looped dielasmatacean family Angustothyrididae. The long-flanged loop declined into the Cretaceous and disappeared in the Paleocene. The long-looped Dielasmatacean *Ectoposia* Cooper and Grant (1976:2898, pl. 762: figs. 77, 78) is a possible ancestral relative of the Angustothyrididae and Tchegemithyrididae.

Taxonomic Considerations

Generic Characters of the Loop

Many features of the loop must be considered in evaluating its relevance to generic differentiation. Of considerable importance is the relationship of its width to its length (Wl/Ll), a character often cited in generic descriptions. This relationship, along with the loop angle, defines the shape of the loop, whether somewhat rectangular or deltoid. The length and width of the loop relative to these dimensions of the dorsal valve position the loop in a given specimen. Many loops, especially those of living brachiopods, occupy about a third of the dorsal valve length. In the Mesozoic, loops are more variable in this feature. They also vary in the same species as do other characters mentioned above.

A relationship of considerable importance is that of a/Ll, which defines the position of the crural processes in the loop. These may be posterior, median, or anterior in position. These positions probably determined the dimensions of the median coil of the lophophore. When well anterior the median coil must have had a narrow opening where attached. The position of the crural processes determines the length of the crura and the length of the descending lamellae. The family Plicatoriinae is characterized by the great length of the crura. This character is also used to identify the Jurassic *Dolichobrochus*.

Another important relationship, one emphasized by Tchorszhevsky (1974), is that of the length of the outer hinge plates and their attachment to the crural bases. This relationship determines the type of crural assemblage seen in serial sections. When the attachment is in the middle of the crural base a keeled section is produced, when attached to the dorsal margin of the crural base, several combinations occur depending on the concavity and width of the outer hinge plates or their absence, producing U-shaped, virgate, or V-shaped patterns. When the attachment is on the ventral edge of the crural base a pendent or ventrally convex pattern may be produced. These patterns are not restricted to any one family but appear in different families at different times.

The length of the terminal points has been given great importance in making genera and families. This feature was emphasized by Makridin (1964) and used by Dagis (1968, 1972, 1974) and Tchorszhevsky (1974). The loop development of Jurassic genera is known only in *Lobothyris*, which has terminal points of intermediate length, and *Viligothyris*, which has long terminal points. It is better known in a number of Cretaceous and Recent genera. Loop development is not known in a sufficient number and variety of Mesozoic genera to be used as a guiding principle in creating taxa higher than family level. Consequently length of the terminal points is only useful in bringing together like forms, the loop development of which cannot be safely predicted.

The dimension of the crest of the transverse band in a longitudinal direction is a useful tool in genus differentiation. In evaluating this feature of the loop, the statistic h/f is useful because it shows the relationship of the longitudinal length of the crest to the terminal points. In some Recent and Cretaceous genera it is 1.00 or over; in some Jurassic genera and a few Cretaceous ones it is 0.50 or less; in many Jurassic genera it is often less than 0.25.

Loop support, struts or mantle plates of Kvakhadze, such as those of *Erymnia*, are a repetitious character produced in several stocks in Mesozoic as well as Recent. These structures as described herein seem to be primary although the young of the various genera are not known.

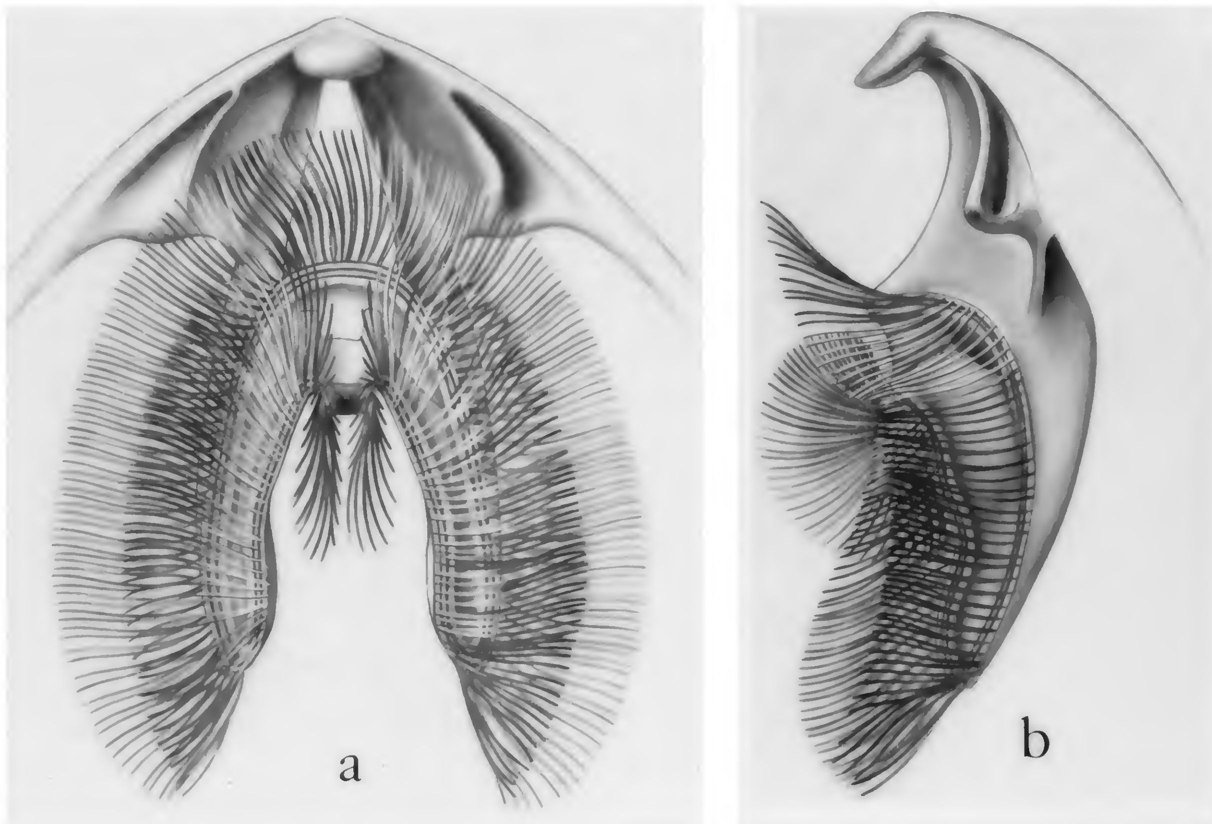
Inner hinge plates are a rare feature and usually regarded as a generic character. They are rare in the Jurassic, less so in the Cretaceous, and unknown in modern genera.

The socket ridges are seldom of importance in generic definition. Their exceptional development in *Rectithyris* was one of the characters used by Sahni in his description of that genus. A similar extravagant development occurs in *Capillarinia* and is a distinction from *Capillithyris*.

The cardinal process of most short-looped brachiopods in this study have similar characters, usually a flat semielliptical plate without a shaft. In a few genera such as *Carneithyris*, *Chatwinothyris*, and *Ogmusia*, the cardinal process is extravagantly developed, bulbous and shafted, and with a strong median ridge.

Variation of Loop Parts

Seven species of as many genera, each represented by several specimens, give visual information on loop variation. Their statistics also show the variation of different parts of the loop. The species are *Animonithyris dorenbergi* Felix (Plate 34; Table 3); *Acrobrochus hendleri* (Cooper) (Plate 58, Table 65); *Colosia zieteni* (Loriol) (Plate 35, Table 10); *Epithyris oxonica* Arkell (Plates 41, 42, Table 14); *Gryphus* (Plate 10: Table 73); *Liothyrella neozelanica* Thomson (Plate 60, Table 75); *Monsardithyris ventricosa* (Hartmann) (Plate 47, Table 22);



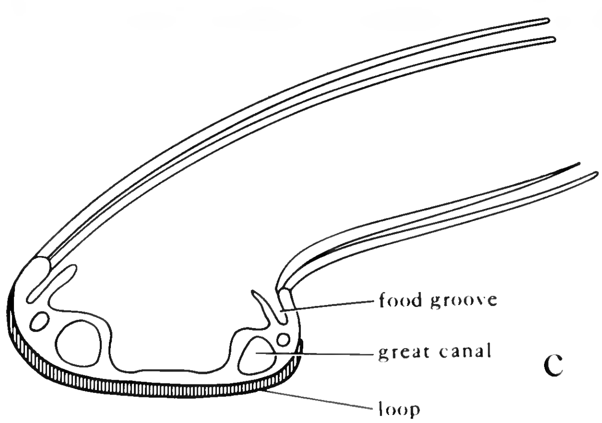


FIGURE 10.—Hypothetical lophophore of *Lissajousithyris*, a genus with unusually long terminal points: *a*, ventral view, ca. × 5.3, showing lophophore rigidly attached to full length of terminal points and with small median coil; *b*, side view of same, ca. × 3.4 (see Plate 46: figure 20 and Plate 71: figures 19, 20); *c*, hypothetical cross-section of lateral arm of lophophore through terminal point, showing long filaments, ca. × 9.5.

Morrisithyris phillipsi (Morris) (Plate 38, Table 23). There is obvious variation in loop angle, transverse band and terminal points, length of outer hinge plate taper, and less conspicuous variations of crural process position and other parts.

Foster (1974, figs. 18, 19) shows loops of *Liothyrella* having variation in the position of the crural processes, loop angle, and longitudinal length of the transverse band. The greater length of the transverse band of loops illustrated in fig. 19 compared to those of fig. 18, which have a narrow transverse band, suggests a taxial difference (see *Acrobrochus*).

The Lophophore

The next problem for consideration is what type of lophosphore did the terebratulids of the

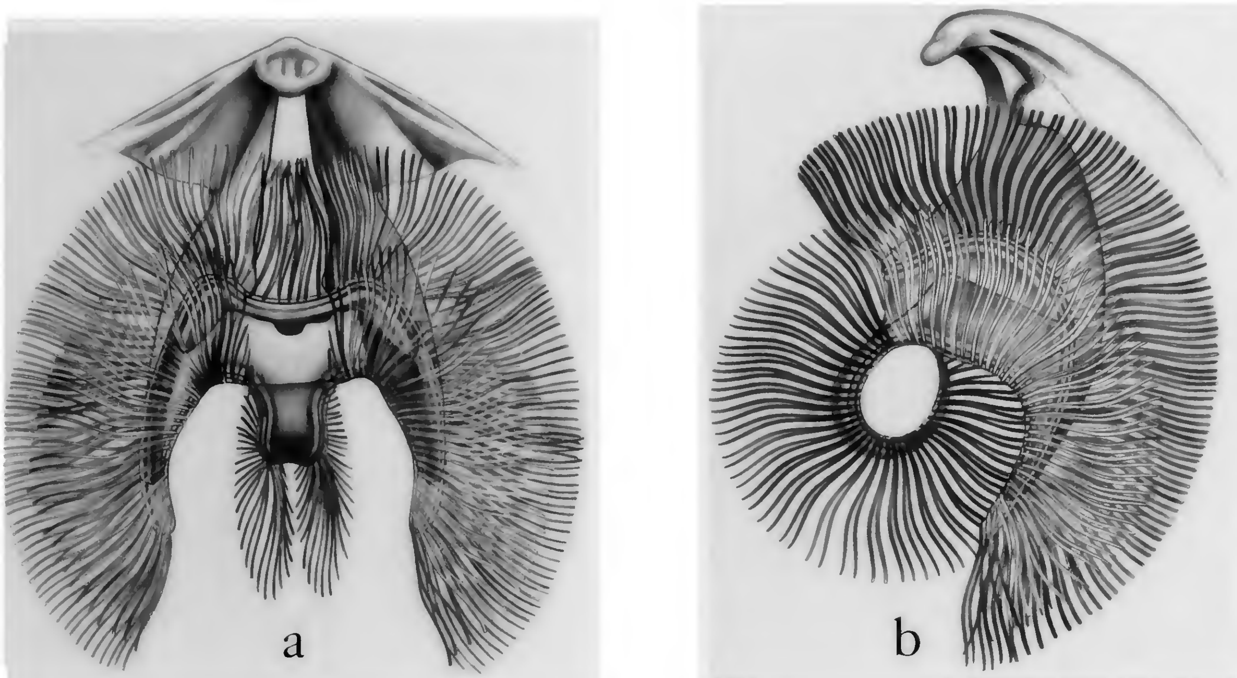


FIGURE 11.—Hypothetical lophophore of Jurassic *Postepithyris* with loop stage intermediate between that of *Lissajousithyris* and *Plectothyris*: *a*, ventral view, ca. × 3.2, showing anterior part of lateral arms free from terminal points; *b*, side view of same loop, ca. × 3.2.

fossil record have? The modern Terebratulacea have several types of lophophore, that of *Dyscolia* is a trocholophe[1], *Abyssothyris* has a modified plectolophe, *Chlidonophora* a subplectolophe, *Terebratulina* and *Gryphus* a plectolophe, and *Eucalathis*, an uncertain type. The majority of modern Terebratulidae have a plectolophe or a modified one consisting of bowed lateral "arms" and a median coil, unstrengthened except for calcareous spicules in some families. A similar type probably existed in the majority of short-looped forms since their origin, because all possess crural processes and a transverse band to which the posterior of the lophophore is attached.

The form of the loop of *Cranaena* and *Dielasma*, so similar to that of *Liothyrella* and *Gryphus* of modern seas, was such that it probably supported a plectolophe. This observation will hold for all of the short-looped forms without long terminal points or with poorly developed points. The genera of the following families were probably supplied with a normal plectolophe: Terebratulidae, Gibbithyrididae, Bothrothyrididae, Dictyothyrididae, Tegulothyrididae, and Cnisnamtocentridae.

The members of the Tchegemithyrididae and other familes with moderately long-flanged loops probably had a somewhat modified plectolophe. Genera such as *Rouillieria*, *Lissajousithyris*, and *Exceptothyris* undoubtedly had the lateral arms of the lophophore supported for their entire length by the terminal points. A narrow loop like that of *Najdinothyris* probably had a narrow median coil similar to that in *Stenobrochus*.

In the genera with long terminal points it is likely that the great brachial canal of the lateral branch of the lophophore occupied and followed the upturned margins of the loop. The membrane uniting the two sides of the lateral arm occupied

[1] The trocholophe of *Dyscolia* is figured by Fischer and Oehlert (pl. 6: fig. 3i, k). In most terebratulids, except some abyssal genera, the lophophore occupies nearly the entire mantle cavity. It seems incredible that the small trocholophe of *Dyscolia* is adequate to sustain such a large shell as *Dyscolia*, which may measure more than 2 inches (55 mm) in length.

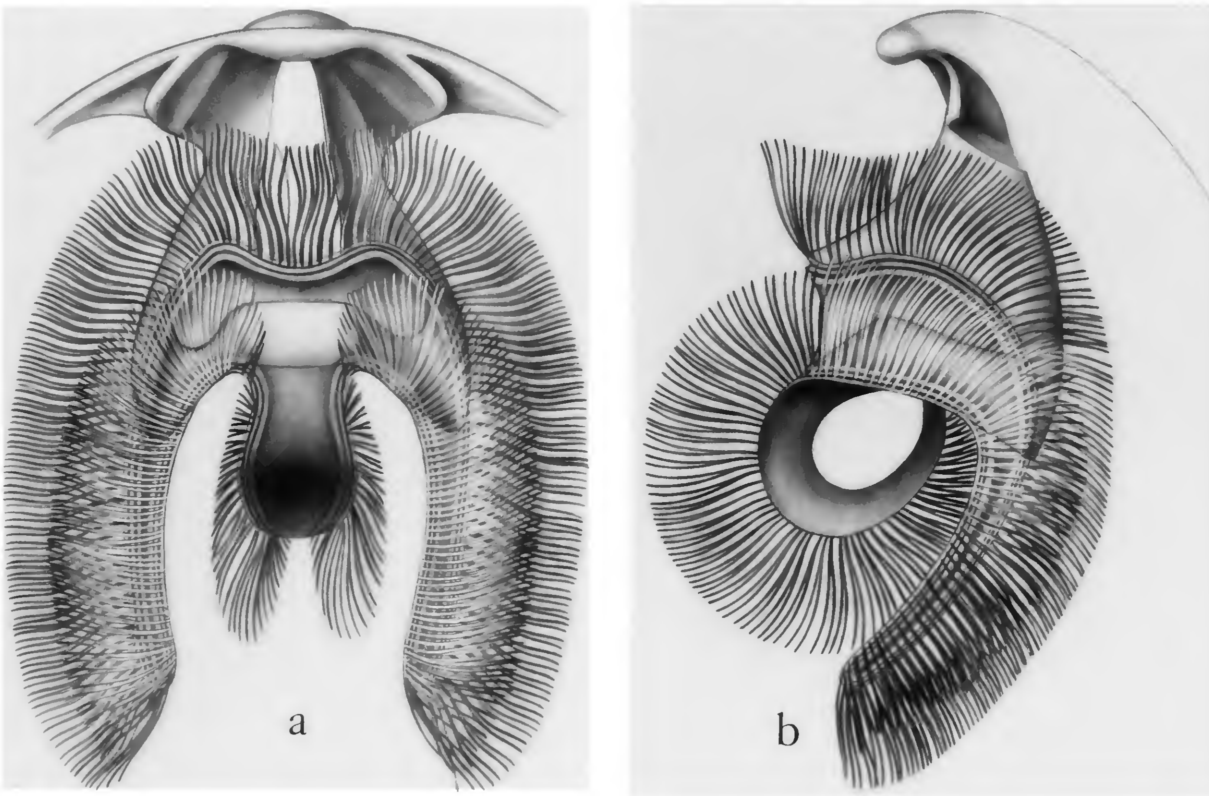


FIGURE 12.—Hypothetical lophophore of *Plectothyris*, a Jurassic genus with short terminal points: *a*, ventral view, ca. × 5.8, showing lophophore almost completely free anteriorly and with large median coil; *b*, side view of same, ca. × 5.8, showing long extension of free lateral arms anterior to terminal points (see Plate 44: figures 24, 25; Plate 73: figures 7, 8).

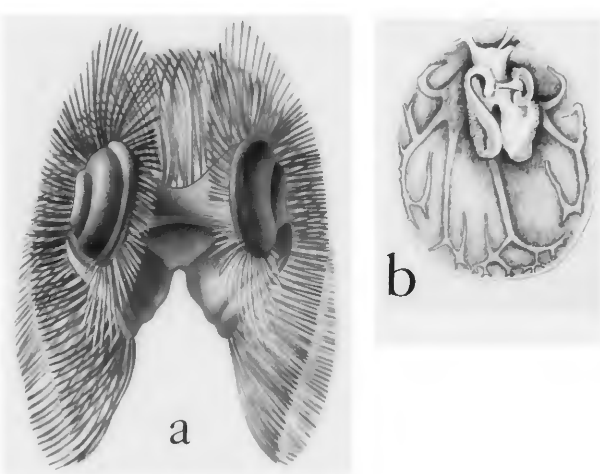


FIGURE 13.—Deep-water lophophores: *a*, dorsal view of tightly coiled lophophore of *Abyssothyris elongata* Cooper, showing median connecting band, ca. × 2.6 (Plate 16: figure 19); *b*, same view of lophophore of "*Liothyrina*" *winteri* Blochmann, showing median coil with its connecting band (reduced ½ from Helmcke, 1940:43).

the trough or web of the terminal point. When occupying the long branch of the loop, the membrane of attachment of the filament bands faced ventrally, but when it became partially or wholly free as the loop shortened through time it tended to alter position to face medially as in modern genera, with the filaments facing laterally toward the commissural opening. When attached to the long terminal point, filaments of the inside row of the lateral arm must have been longer and overlain those of the outside row to have been effective in creating the necessary feeding currents (Figures 10–12).

Brachiopods with extremely long terminal points on the loop are not common. More abundant are those of more modest dimensions, such as those of the Postepithyridinae, Lophrothyridinae, Lobothyridinae, and Rhombothyridinae. In these subfamilies, which were shortening their loops, the lateral arms probably extended anteriorly beyond the distal ends of the terminal points to hang partially free, perhaps stiffened to some extent by spicules. In these forms, which were evolving toward the more modern type, the median coil was probably well established; there was certainly ample room between the widely divergent branches of the loop as in *Epithyris*, *Charltonithyris*, and *Postepithyris* (Figure 11).

The loop of *Abyssothyris*, and possibly other genera with the transverse band directed anteriorly, the lophophore may have been modified. Zezina (1975:255–257) shows that the lophophore of some abyssal forms does not fill the mantle cavity. Such a lophophore was described by Helmcke (1940:257, fig. 20b) in "*Liothyrella*" *winteri* Blochmann and is illustrated herein (Figure 13*a,b*). The abbreviated lophophore of *Abyssothyris elongata* Cooper is illustrated on Plate 16: figure 19.

The Shell

Folding.—In defining genera among the Terebratulacea the type of folding has always been given great importance. Two genera may have similar or identical loops yet be unlike in folding. The loop of *Pseudoglossothyris* is similar in its statistics to that of *Plectothyris* but the former is sulcate and the latter rectimarginate with peripheral costae.

Buckman made much of folding. In his long experience with these brachiopods he described developments of folding that are difficult to follow. For example, the supposed *Centronella* stage or ventral carination and sulcation in the young cannot always be seen in the adult. The homeomorphic development of folding in many different stocks at the same or different times is confusing and limits the use of folding to a secondary role. It also makes identification on exterior characters alone suspect.

Sulciplication is the commonest type of folding in Jurassic shells. The widely identified species *Terebratula subsella* auct. is an example of a "species" that frequently has been placed in the wrong genera. Species misidentification may account for some of the discrepancies between reconstructed and excavated loops. Plate 31 illustrates two genera originally identified as this species that have different loops: *Habrobrochus* and *Xestosina*.

Sulcation is a character adopted by numerous stocks from Ordovician to Recent: *Brachymimulus* in the Ordovician and Silurian, *Stryxia* in the Devonian, *Sanjuania* in the Mississippian, *Cryptacanthia* in the Pennsylvanian, *Glossothyropsis* in the Permian, *Nucleatula* in the Triassic, *Nucleata* and *Linguithyris* in the Jurassic, and *Abyssothyris* in the Recent fauna. *Bothrothyris*, *Pseudoglossothyris*, and *Rhapidothyris* are Jurassic examples having a sulcate anterior commissure. The first is homeomorphic with a zeilleriid from the Jurassic of northeastern Africa identified as *Pseudoglossothyris* (Muir-Wood, 1935:121).

Although uniplication is the commonest form of folding in the Paleozoic, it is relatively rare in the Mesozoic. A few Jurassic genera such as *Lophrothyris*, *Tubithyris*, and *Glyphisaria*, new genus, are uniplicate. In some examples the uniplication may develop in late life to tentative or positive sulcation. *Cererithyris* is an example of feeble sulciplication and *Morrisithyris* is an opposite example. Sulciplication (biplication) is very rare in Recent terebratulacean brachiopods but does occur in a few Tertiary genera: *Terebratula*, *Oleneothyris*, *Pliothyrina*, *Rhytisoria*, and *Pycnobrochus*, new genus.

Homeomorphy.—Parallel development of different stocks producing like exterior forms is a challenging problem in the study of brachiopods. The brachiopod is a relatively simple animal and has only a limited evolutional repertoire, consequently there is repetition in form, folding, and other exterior characters. An excellent example is *Dallithyris* with its swollen ventral valve, concave lateral commissure, and strongly truncated beak. It resembles the Jurassic *Goniothyris* (sensu stricto), the Cretaceous *Sardope*, and Recent homeomorphs such as *Stenosarina*, *Stenobrochus*, and *Tichosina cubensis*. Another interesting series of homeomorphs consists of flattish shells with long, attenuated beak with symphytium completely exposed: *Juralina* and *Terebratula moravica* of the Jurassic; *Rec-*

tithyris and *Cyranoia* of the Cretaceous. Planoconvex form is often repeated: *Strongylobrochus*, *Rugithyris*, and *Petalothyris* in the Jurassic.

An example of homeomorphy is the remarkable resemblance of *Cheirothyropsis* to the terebratellacean *Cheirothyris* with its four angular folds. Another is the lamellose, concavo-convex *Rugithyris*, which resembles *R. anabarensis* Dagis (1968). Dagis species, however, has a convex dorsal valve that suggests that it is generically unlike *Rugithyris*.

COSTATION.—Wrinkling of the shell produces confusing homeomorphs and is often misleading as a generic character, an interesting case being that of *Parathyridina*, now proved to be a zeilleriid that occurs with a generically unnamed homeomorph. Costation may be developed over all or only part of the shell and appears sporadically in many stocks. Buckman and Rollier used the partial or marginal costation of the Jurassic *Terebratula fimbria* J. Sowerby to make the genus *Plectothyris* almost simultaneously. Buckman also used the fringe of costae to establish *Plectoidothyris*. He also mistakenly assigned *Terebratula plicata* J. Buckman to the latter genus, largely on the basis of peripheral costae. In the Cretaceous of Sweden a large terebratulacean suggesting *Cyranoia* is peripherally costate. Several genera in the Jurassic of Saudi Arabia developed marginal costae, as did *Mexicaria* in the Jurassic of Mexico. Dubar (1942) descibed many costate species from the Lias of Morocco, where they are homeomorphic contemporaries of costate zeilleriids. In the Eocene of the United States *Plicatoria* develops an elaborate and varied costation pattern varying from a few to many costate.

A costellate surface is another sporadic feature of the exterior. It is rare in the Jurassic of Israel, Saudi Arabia, and the Somali Republic in the form of *Striithyris*. In the Cretaceous several genera are finely capillate, e.g., *Capillithyris* and *Capillarina*, close homeomorphs. *Liramia* and *Arcuatothyris* occur together, the former capillate, the other with a radial teardrop ornament, making them at first glance very similar.

A subdued wavy capillation occurs in some Tertiary and modern genera, such as *Dyscolia*, *Mimorina*, and *Goniobrochus*, but all three differ in their loops. An obscure capillation, not to be confused with that of *Striithyris* or *Capillithyris*, may be seen on some terebratulaceans, such as *Liothyrella neozelanica* and *Tichosina*. In Recent forms the capillae appear only on the flanks or in protected parts of an anteriorly folded shell. In some, capillation appears only on shells with exfoliated outer layer. This is apparently the case with *Holcothyris* from Burma (Ovcharenko, 1963) described by Buckman on burned or roasted shells, a technique primarily developed to expose the dorsal adductor scars. Such capillation is not to be confused with that of *Striithyris*, as Ovcharenko (1967) has done.

Supra-Generic Classification of Terebratulacea

Previous Classification

Classification of the Brachiopoda has become more and more complicated since the appearance of Beecher's *Revision of the Families of Loop-bearing Brachiopoda* in 1893. At that time Beecher divided the Terebratulidae Gray into four subfamilies: Centronellinae, Stringocephalinae, Terebratulinae, and Discoliinae (sic; = Discoliidae Fischer and Oehlert, emended). The first two subfamilies are from the Paleozoic and are not considered here. Schuchert (1897) in modifying Beecher's classification recognized four subfamilies in the Terebratulidae: Stringocephalinae Dall, 1870; Megalanterinae Waagen, 1882; Terebratulinae Dall, 1870 (later referred to Gray, 1840); and

Discoliinae (sic) Beecher, 1893. In Zittel's *Textbook of Paleontology*, four families are again recognized by Schuchert (1913) who prepared the chapter on brachiopods. He divided the Terebratulidae into Megalanterinae Waagen, 1882; Dielasmatinae Schuchert; Terebratulinae Dall, 1870; and Dyscoliinae Beecher (properly spelled but not dated). The Stringocephalinae was dropped. Since 1913 several comprehensive classifications have appeared. These, together with changes in the *International Code of Zoological Nomenclature* requiring priority of family names, have led to numerous changes.

Schuchert, in Schuchert and Levene (1929b:22–24) elevated the former family to the Superfamily Terebratulacea Waagen, 1883 (now attributed to Gray) with six families, five of them embracing Paleozoic genera of no concern here. The Terebratulidae Gray was divided into three subfamilies: Terebratulinae Dall, 1870 (now Gray, 1840), Nucleatinae Schuchert, 1929 and Cancellothyrinae Thomson, 1926. The Dyscoliinae was abandoned. The Terebratulinae was informally divided into Triassic, Jurassic, and Later Forms, a confession of the lack of detailed information on these "short-looped" brachiopods.

Roger's (1952) treatment of the Brachiopoda was the first comprehensive treatment to appear since Schuchert, in Schuchert and LeVene, 1929b. This was not innovative in classification. The Terebratulacea was the highest category used for the brachiopods under discussion. The Terebratulidae was separated into three subfamilies: Gryphinae Sahni, 1929 [=Terebratulinae Dall, 1870], Nucleatinae, referred to Schuchert and LeVene, 1929, and Cancellothyrinae Thomson, 1926. The Gryphinae were separated into Recent, Upper Cretaceous, and Lower Cretaceous to Jurassic genera. The Nucleatinae included the unlikely placement of *Avonothyris* in this subfamily. The Gryphoidea Allan, 1940, was synomymized with Terebratulacea Waagen, 1883.

Licharev, Makridin, and Rzonsnitzkaya (1960:286–298; see Makridin, 1960), under the Order Terebratulida, recognized the Terebratulacea with seven families, most of them confined to the Paleozoic. The Terebratulidae was divided into three subfamilies, as in Schuchert and LeVene (1929b): Terebratulinae, with an amorphous lot of genera; Nucleatinae, including many unrelated forms, such as *Dictyothyris*, *Tegulithyris*, *Pseudoglossothyris*, *Avonothyris* and others; and Cancellothyrinae Thomson, 1926, which was raised to superfamily rank by Cooper (1973b). The last is only of marginal concern herein and, it will not be included in further discussions of classification but is considered later in this monograph.

Makridin (1964:204–269) recognized three new subfamilies in the Terebratulidae: Lobothyrinae, Loboidothyrinae, and Dictyothyrinae, (which predates Dictyothyrididae Muir-Wood, 1965: H801). The first subfamily was proposed to include those terebratulids having short flanges (terminal points) on the loop; the second was for terebratulids having long flanges (terminal points) on the loop. The third subfamily included *Dictyothyris*, *Tegulithyris*, and *Cheirothyropsis*.

Muir-Wood (1965:H773–H816) made an effort to classify the Terebratulacea by proposing several new families in addition to the Terebratulidae: Orthotomidae, Cheniothyrididae, Dictyothyrididae (preoccupied by Dictyothyrinae Makridin, 1964), Tegulithyrididae, and Pygopidae. Dyscoliidae Fischer and Oehlert (1891) was revived. An effort was made to subdivide the Terebratulidae by proposing six subfamilies based on geological occurrence as well as morphology: Terebratulinae consisted of Triassic to Recent genera; five new subfamilies, all of them Cretaceous: Sellithyridinae, Rectithyridinae, Gibbithyridinae, Carneithyridinae, and Inopinatarculinae. The Nucleatidae was abandoned in favor of Pygopidae for no apparent reason and without explanation.

Dagis (1968) used Makridin's subfamilies Lobothyrinae and Loboidothyrinae to divide the Terebratulidae, the former for genera having short-flanged loops and the latter long-flanged loops. The Lobothyrinae included some genera with long-flanged loops, such as *Oleneothyris* and *Juralina*, while the Loboidothyrinae included genera, such as *Epithyris* and *Wattonithyris*, with wide, short-flanged loops. At this time Dagis (1968:8–13) detailed the loop development of *Viligothyris*, a genus having a loop with long flanges and therefore placed by him in the Loboidothyridae. This loop development showed a complicated metamorphosis akin to that of the Dallinacea but without production of an initial, fixed median pillar or septum in the dorsal valve, and the ascending elements of the loop forming from a centronellid median plate. Dagis used the information derived from this loop development to establish the Loboidothyracea and distinguish it from the Terebratulacea.

Several other workers have also proposed suprageneric categories for the Terebratulacea. Askerov (1964:6) proposed the family Karabaghidae for *Karabaghia*, a nomen nudum.

In a comprehensive study of Late Jurassic brachiopods from Azerbaidjan, announced in an extensive abstract, Askerov (1965) discussed and evaluated the various characters of the Terebratulacea that are usually regarded as of taxonomic signifiance. He noted (1965:12) that the study of terebratulid crura has been neglected for use as criteria for family definition. To correct this deficiency he defined four types of crura:

1. Infulifer (band-like)–narrow bands, widening slightly in front, directed toward the pedicle from the inner extremities of the hinge plates. They are found in the majority of Mesozoic Terebratulacea. *Heimia*, *Praelongithyris*, *Lobothyris*, and *Postepithyris* are given as examples.

2. Falcifer (sickle-shaped)–like those of the Basiliolidae [Rhynchonellacea] and seen in zugmayerids [of no concern here].

3. Laminifer (lamellate)-freely hanging plates, supported along the center posteriorly by the hinge plates. These come in the new genus *Septocrurethyris* [sic], not defined.

4. Septifer (septum-like)–analogous to similar structures in the septorhynchids. They occur in the genus *Septocrurethyris* (sic). [The same genus is inadvertently used to illustrate two different types of crura. Later Askerov used *Karabachia* n. gen. (nomen nudum) to characterize laminiform crura.]

A fifth type (not numbered by Askerov) exists, in which crura may be absent.

In Chapter 6 Askerov (1964:16–20) briefly described and classified the late Jurassic brachiopods. The Terebratulidae were defined as follows:

> short-looped Terebratulacea with infulifer crura: *Heimia*, *Ptychtothyris*, *Goniothyris*, *Sphaeroidothyris*, *Cererithyris*, *Lobothyris*, *Holcothyris*, *Juralina*, *Azerithyris* n. gen. [with undescribed type-species] with short wide descending branches, wide trapezoidal transverse band and long flanges, *Caucasithyris* n. gen. [with undescribed type-species] short, wide, strongly diverging branches, wide triangular transverse band and long wide flanges.

Family Karabachidae: "short-looped Terebratulacea with laminiform crura. *Karabachia* n. gen. [with undescribed type-species] – short, wide, descending branches, a very wide triangular transverse band and complexly structured long flanges."

Family Zugmayeridae Dagis, 1963: of no concern here.

Family Septocrurethyridae Askerov, 1964: "short-looped Terebratulacea with septifer crura. *Septocrurethyris* n. gen. [with undescribed type-species]." No other genera noted.

Family Nucleatidae Schuchert, 1929, emended Askerov: "short looped Terebratulacea without crura." Beside *Nucleata* Askerov included *Dictyothyris* and *Tegulithyris*, both emended.

In another abstract on the systematics of Late Jurassic brachiopods, Askerov (1967:48–51) proposed to elevate the Nucleatinae Schuchert, 1929 to full family status [already accomplished in 1965]. He revised the classification of terebratulids on their crura. In addition to the types of crura noted above, a fifth category, prefalcifer (early falcifer), was added. This type occurs in the nucleatids [stated to have no crura above], *Nucleata* and *Dictyothyris*. The septifer type was clarified by noting that it is like the structure in the erymnids (Rhynchonellacea: *Erymnia* Cooper).

Tchorszhevsky (1971b) raised the rank of Lobodothyrinae to that of family and redefined it as having lobodothyral crura, well-developed outer hinger plates distinctly separated from the crural bases, a simple transverse band, and absence of inner hinge plates. At the same time he proposed new subfamilies or redefinition of old ones in the Loboidothyrididae based on undescribed genera:

Loboidothyrinae Makridin, 1964 characterized by crura of indulifera type and by carinae developed to a varying degree.

Snajnochiellinae Tchorszhevsky, 1971b, including genera with infulifera type crura and which do not possess carinae.

Karpatellinae Tchorszhevsky, 1971b, characterized by falcifer crura, rather rare among terebratulids.

Dragoviellinae Tchorszhevsky, 1971b, characterized by laminifer crura.

Family Goniothyrididae Tchorszhevsky, 1971b, characterized by a goniothyroid type of crura, including two new subfamilies, Goniothyridinae and Svaljavithyridinae, which are distinguished by the nominate crura that rest on the floor of the valve.

Phillipsithyrididae Tchorszhevsky, 1971b, distinguished by presence of relict structures of the loop and complete absence of loop flanges at the outer and inner hinge plates.

All of the above families are based on undefined genera and are, at present, of no use until the generic names are made available.

Tchorszhevsky (1972) produced another new family, Tchegemithyrididae, with *Tchegemithyris* and *Bejrutella*, both new and well described, and *Turkmenithyris* Prosorovskaya, 1962. This family consists of smooth-shelled forms, uniplicate to biplicate, with long-flanged loops ⅓ to ½ the dorsal valve length, high crural processes originating near the anterior margin or anterior third of the outer hinge plate. Keels not developed on crural base. The horizontal transverse band is perpendicular to the plane of the loop; no inner hinge plates or septa.

In 1972 Dagis outlined a classification of the Terebratulida (1972:50–53). Of interest here is his treatment of the Terebratulacea and Loboidothyracea, which are defined as follows.

Superfamily Terebratulacea Gray, 1840:

Dental plates, septum and septal plates not developed. Loop short consisting only of primary elements. Transverse band formed by resorption of echmidium and vertical plate in old representatives, and as the result of simple fusion of descending bands in younger forms. Triassic-Recent. Families: Terebratulidae Gray, 1840, Orthotomidae Muir-Wood, 1936, Cancellothyridae Thomson, 1926, Nucleatidae Schuchert and LeVene 1929 [should be Schuchert, 1929], = (Pygopidae Muir-Wood, 1965), Gibbithyrididae.

Superfamily Loboidothyracea Makridin, 1964:

Loop relatively long, often with protruding flanges [terminal points]. Transverse band formed of secondary elements which evolved in ontogeny on the ventral part of the vertical plate. Dental plates absent, cardinal process well developed. Septal plates may be present. Triassic – Cretaceous.

Families: Loboidothyridae Makridin, 1964, Dictothyridae Makridin, 1964, Boreiothyridae Dagis 1968 [this family is characterized by septal plates in the dorsal valve and is not considered in this study].

Dieni, Middlemiss, and Owen (1973:192–195[2]) emended the family Pygopidae Muir-Wood, 1965, as follows: "Terebratulacea lacking true crural bases. The hinge plates are horizontal, tapering or with rounded inner edges, and pass forward as horizontal structures to join the crura. The loop is short and the transverse band low arched." Two new subfamilies were proposed: Pygopinae (with *Nucleata*) and Platythyridinae. [Nothing is said about Nucleatidae or Nucleatinae, much older valid categories]. The subfamily Platythyridinae was defined as "Pygopidae with biconvex shells, without dorsal median sulcus or perforation [referring to *Pygope*]." The new subfamily Pygopinae was defined as "Pygopidae with deep median sulcus; shell may develop two lateral lobes which come into contact and fuse in adult stage, enclosing median perforation." *Nucleata* was placed here.

In his most recent classification Dagis (1974) continues the use of Lobothyrinae and notes the elevation of the Loboidothyrinae to superfamily rank. This superfamily is made to include ?Dictyothyridae Makridin, 1964, Boreiothyrididae

[2] The title page of this paper is dated 1973 but Middlemiss (1978) dates it as 1975. He also gives the new subfamily Platythyridinae to Dieni and Middlemiss, excluding Owen. I found no reason for this exclusion in the original paper. The 1973 paper is cited in the Zoological Record (volume 110, p. 2) as 1973.

Dagis, 1968 (not included in this study), ?Cheniothyrididae Muir-Wood, 1965, and Tegulothyrididae Muir-Wood, 1965. Dagis (1974:197) proposed the subfamily Plectoconchinae, noting its plicated exterior, lack of inner hinge plates, prefalcifer crura, and remnant of the *Centronella* loop stage. His reference is to Russian shells identified as *Plectoconcha* Cooper and is not based on the authentic American genus, the loop development of which is unknown.

Katz and Popov (1974a,b) proposed a new scheme of classification based on the layered structure of the shell. The superfamily Terebratuloidea (sensu Katz, 1971) (the superfamily ending "oidea" used by these authors is in accordance with ICZN article 29, recommendation 29A; = Terebratulacea of Muir-Wood, 1965) was divided into two groups: (1) brachiopods characterized by only primary and secondary (fibrous) shell layers: Terebratulidae, Cancellothyrididae, Dyscoliidae, Loboidothyrididae (Dictyothyrididae); (2) brachiopods having a third (prismatic) layer in addition to the two previously mentioned: Nucleatidae, Gibbithyridiae, Stringocephalidae, Goniothyrididae, Centronellidae, Notothyrididae, and Labaiidae. The first group (Terebratuloidea) may have sculptured and variously folded types, while the second lacks these features but frequently has crura carinate to crescentic and septa-like crura. These are grouped into the Superfamily Centronelloidea Waagen 1882 [=Centronellacea], which is defined as follows: "shells primary smooth, sometimes semicostate and capillate, with primary secondary and tertiary layers; anterior commissure variable with predominance of rectimarginate, inverted forms. Crura variable, carinate crescentic and septum like." It includes Centronellidae, Notothydidae, Labaiidae, Nucleatidae, Gibbithyrididae, and Goniothyrididae (Tchorszhevsky, 1971a).

The Goniothyrididae was defined as "Centronelloidea with long flanged brachidial loops which develop as a result of complex ontogenetic reorganization". A new subfamily Postepithyridinae Popov was created: "biconvex, elongate with a uniplicate or slightly biplicate anterior commissure. Crura slightly carinate. Genera: *Postepithyris* and *Nalivkinella*."

The Gibbithyrididae (from Gibbithyridinae Muir-Wood, 1965) have carinate crural bases, often with processes protruding into the dorsal apical cavity. Loop short, formed by simple transformation of the echmidium. Flanges weakly developed or absent. This includes the subfamilies Gibbithyridinae and Dallithyridinae. The Gibbithyridinae include an unlikely assemblage of genera: ?*Plectoconcha* Cooper, 1942; *Abichia* Askerov, 1965; *Iberithyris* Kvakhadze, 1972; *Concinnithyris* Sahni, 1929; *Ornatothyris* Sahni, 1929; *Gibbithyris* Sahni, 1925; *Gryphus* Megerle von Mühlfeldt, 1811; *Paracapillithyris* Katz and Popov, 1974a, and *Orientothyris* Katz and Popov, 1974a.

The Subfamily Dallithyridinae Katz and Popov, 1974a, includes another unlikely grouping: *Weberithyris* Smirnova, 1969a; *Dallithyris* Muir-Wood, 1959; *Najdinithyris* Makridin and Popov, 1964; and *Longithyris* Katz and Popov, 1974a.

In their second article Katz and Popov (1974b:33–42) applied their philosphy of classification to the entire Class Articulata, proposing two subclasses: Inferioarticulata, including brachiopods having a third layer: Pentamerida (crura and loop bearers), Stenoscismatida (crura bearer), Spiriferida (spire bearers), and Centronellida (loop bearers). The Superioarticulata includes brachiopods having only two layers: Orthida, Rhynchonellida, Athyridida (Athyridina, Delthyridina, Retziidina, Spiriferidina, Terebratulida, Strophomenida, Thecideidae) and Megathridida ordo nov. (punctate loop-bearing forms with a well developed pedicle). The superfamilies Centronelloidea and Stringocephaloidea were separated from Terebratulida and placed in an independent order Centonellida. "These orders originate from different ancestral taxa and were parallel in their evolution."

Katz and Popov postulated a water depth and temperature control for the development, or lack of development, of the third layer. In general the brachiopods having a third layer were shallow water forms whereas the deeper water brachiopods had only two layers. Ecological control of this layering casts doubt on the value of these characters for a major classification. Moreover, using a single shell feature for major classification throws into confusion other basic taxonomic characters.

Tchorszhevsky (1974) in describing five new genera proposed new family and subfamily names. A subfamily Psebajithyridinae was suggested under the family Gibbithyrididae for the valid genus *Psebajithyris*. Turkmenithyridinae was proposed to accomodate *Turkmenithyris* and was placed under the family Tchegemithyrididae along with the Tchegemithyridinae. He also proposed the family Postepithyridae[3] which was also later described by Popov in 1974a. The composition of this family according to Tchorszhevsky is: *Postepithyris* Makridin, 1960; *Inversithyris* Dagis, 1968; *Uralella* Makridin, 1960; *Peculneithyris* Smirnova, 1972a; *Mametothyris* Smirnova, 1969b; and *Penzhinothyris* Smirnova, 1969. Muirwoodellidae is another new family with two subfamilies: Muirwoodellinae and Karadagithyridinae. The former includes *Goniothyris* Buckman, 1918 (sic); *Lissajousithyris* Almeras, 1971; and *Muirwoodella*, Tchorszhevsky, 1974. Tchorszhevsky evidently forgot that he had proposed Goniothyridae in 1971b.

The Karadagithyridinae is composed of two tribes (a new complication in an already complicated nomenclature): Karadagellini with *Karadagella* and *Goniothyrella* "(in lit)"; Karadagithyridini including *Karadagithyris* Tchorszhevsky and *Svaljavithyris* described by comparison with *Karadagithyris* and with *Terebratula carpathica* Zittel as type-species. The latter genus was regarded as invalid by Barczyk (1979:211).

Pearson (1977:42) added the subfamily Triadithyridinae to the Terebratulidae to care for *Triadithyris* Dagis of the Triassic.

Proposed Classification

The development of a classification for the Terebratulacea must take into consideration the work of Dagis, who studied the loop development of various genera and proposed the Loboidothyridacea as a category equivalent to the Terebratulacea. The arrangement starts with Makridin (1964) who in his extensive studies of Jurassic brachiopods, proposed the subfamilies Lobothyrinae (p. 204) and Loboidothyrinae (p. 213). He based these subfamilies on the loops, those with short-flanged loops belonging to the Lobothyrinae and those with long-flanged loops belonging to the Loboidothyrinae. Without discussing the taxonomic value of flanges (= terminal points) in genus and species separation, it seems that Makiridin and later Dagis had a mistaken understanding of the loop of *Loboidothyris*. The definition of this family must therefore be revised and its status as a basis for the superfamily Loboidothyridacea doubted.

Makiridin (1964:204) placed *Ptychtothyris* Buckman, 1917, and *Lophrothyris* Buckman, 1917, in the family Lobothyridae, both with long flanges along with the short-flanged *Lobothyris*. Muir-Wood (1934), Dagis (1968), and Sučić-Protić (1971) have reconstructed the loop of *Lobothyris* as having short terminal points. The loop reconstructed by Sučić-Protić was based on a specimen from close to the type-locality. Dagis' reconstructions are based on immature specimens and depict the development of the loop that follows a pattern similar to that among other brachiopods having short-flanged loops, as *Chatwinothyris* (Steinich, 1965), *Gryphus*, or *Liothyrella* Foster, 1974.

Makridin figured reconstructions of two Russian specimens of *Ptychtothyris*, both with short-flanged loop. The reconstruction of *Lophrothyris*

[3] Tchorszhevsky's name probably has priority over Postepithyridinae Popov because Tchorszhevsky's paper is dated 1 January 1974.

placed in the Lobothyridae has a fairly long-flanged loop. The loop of type *Ptychtothyris* from England is long-flanged. These facts lead to the suspicion that the Russian shells do not belong to these genera.

The situation with the Loboidothyrinae is different because the loop of the type-species of *Loboidothyris* is unknown. The only information on the loop prior to this study is from the serial sections of a species similar to *L. latovalis* Buckman, the type-species, which show that the loop is short-flanged. Makridin (1964) evidently derived his conception of the loop from specimens misidentified as *Loboidothyris*. He described five species: *L. retrocarinata* (Nalivkin); *L. zieteni* (Loriol) now placed in *Moeschia* Boullier, but made the type of *Colosia*, new genus; *L. valfinensis* (Loriol); *L. subsella* (Leymerie); and *L. engeli* (Rollier). Makridin made a reconstruction of the loop of *L. retrocarinata* (1964:216, fig. 73) only, and does not mention the loop of the other species in his descriptions. The loops of *L. zieteni* and *L. subsella* are now known to have loops with short flanges (see *Colosia*, Plate 35 and *Habrobrochus*, Plate 31: figures 26–32). Makridin's idea that the loop of *Loboidothyris* has long terminal points must have been derived from the reconstruction of *L. retrocarinata* with long flanges (f/Ll = 0.47). Evidence now points to the fact that the loop of *Loboidothyris* has short terminal points.

Almeras (1971:182, pl. 17: fig. 16A–E) published a description and interior details by serial section of *Loboidothyris ingens* (Rollier), a large species similar to the type species, *L. latovalis* Buckman. This species has a short-flanged loop (f/Ll = 0.21, Almeras' figures). *Terebratula perovalis* (Sowerby) is related to, if not the same as, Buckman's type, and was included by him in the original description of *Loboidothyris*. Its loop has short terminal points (Plate 36: figures 25–27). Popov (in Katz and Popov, 1974a) renamed *L. retrocarinata* (Nalivkin) as type of a new genus *Nalivkinella*. The evidence indicates that the Loboidothyrinae should embrace terebratulids having loops with short terminal points (short-flanged). Makridin was consistent in including genera with long-flanged loops in his subfamily: *Postepithyris* Makridin, *Moiseevia* Makridin, *Rouillieria* Makridin, and *Uralella* Makridin. The loop of *Goniothyris*, placed here, had not been seen in its entirety and his named species *G. eggensis* (Rollier) is not congeneric with the type-species of *Goniothyris* sensu stricto.

Loboidothyrinae has been elevated to Loboidothyridacea by Dagis (1968), who believes that the complicated loop development justifies such a change. Unfortunately the genus yielding the information on its loop development is a long-flanged form, *Viligothyris*, and not in accordance with the short-flanged type of loop shown to be that of *Loboidothyris*.

Dagis (1974:194) defined the Lobothyridinae as follows: "Shell surface smooth or with infrequent sloping plicae. Inner hinge plates not developed. Crura infulifer or 'lobobothyroid.'" The length of the loop flanges was not mentioned and the family was ranked under the Terebratulidae.

The elevated Loboidothyridacea were defined: "Loop comparatively long, often with prominent flanges. Transverse band formed from secondary elements which emerge in ontogeny on the ventral part of the vertical plate. The loop passes through centronellid, prequasicampagiform, quasicampagiform, and dictyothyridiform stages. Dental plates absent. Cardinal process well developed. Septal plates may be present" (p. 194).

The Lobothyrididae were defined: "Shell surface smooth, anterior margin from smooth [rectimarginate] to biplicate. Septal plates absent." The assortment of species given by Dagis (1968:85) for the Lobothyridinae shows clearly the lack of information about the loop. Among a number of definite short-flanged forms, such as *Dallithyris* and *Liothyrella*, one finds genera with long terminal points on the loop: *Lophrothyris*, *Juralina*, *Oleneothyris*, *Stroudithyris*,[4] *Cyrtothyris*, *Praelongithyris*, and *Rhombothyris*.

---

[4] According to Dagis (1968:16), "Practically identical development of the brachial supports takes place in the genus *Stroudithyris* Buckman, which we studied on a series of specimens from the Middle Jurassic of the Southern Caucasus."

The list of Loboidothyrididae (Dagis 1968:89) includes genera with short-flanged loops: *Sphaeroidothyris* and *Cererithyris*. The problem of classifying with such illusory characters is to decide how long is a long-flanged loop.

Barczyk (1969:11) and Almeras (1971:119, 120) question the value of Makridin's adoption of long- and short-flanged loops as a basis of family classification. Almeras regarded the classification based on these characters as artificial because it did not take into account important details of the exterior. A major problem in connection with these taxa, Lobothyrididae and Loboidothyridacea, is the fact that the loops of both name-givers have loops unlike those on which the families were based. These categories must be revised.

The loop development of the Loboidothyridacea is based on that of *Viligothyris* Dagis (1968), a genus with long loop flanges (f/Ll = 0.42)[5] similar to those of the English *Stroudithyris*. The type of loop development shown by *Viligothyris* is assumed by Dagis to be characteristic of all long-flanged genera.

In classifying these terebratulaceans it is necessary to decide what length of loop flange or terminal point is important.[6] Genera having loops with f/Ll in excess of 0.30 are classified herein as having long terminal points. This judgement leaves borderline genera that are difficult to classify, but this is true of any scheme based on morphological characters. In this evaluation specimens with a broad longitudinal transverse band may have f/Ll in excess of 0.30 but have no terminal points but h/f may equal more than 0.50, thus nearly equal to, or equalling, the measure of f. Nearly all Cretaceous genera and all Recent genera have such broad transverse bands, only a few Cretaceous genera have long terminal points like those of the Jurassic-like genera of Smirnova: *Okathyris*, *Spasskothyris*, and *Atelithyris*.

Although Dagis has shown that one genus with long-flanged loop has a loop development more complicated than that of the short-flanged forms, it is now impossible to tell which of the numerous genera that he assigned to the Loboidothyridacea have this complicated loop development. Some of the genera assigned herein have loops intermediate between the short- and long-flanged forms. There is a large number of Jurassic genera, such as *Loboidothyris*, that have definite terminal points that cannot be termed long as interpreted herein and as described by Almeras. There are also genera with pronounced points but not long ones. The loop development of these intermediate forms is not known. It seems best therefore to put aside the Loboidothyridacea as a major group correlative with the Terebratulacea because of the uncertainty of the loop development of this large number of genera, and also because the type genus of Loboidothyridacea (family and superfamily) proves to have a short-flanged loop.

With this preliminary discussion the way is cleared for a conservative, practical attempt at classifying these brachiopods with emphasis on the loop, but also paying attention to important exterior details. In absence of knowledge of their developmental stages the arrangement will undoubtedly suffer from artificiality, but getting likes together is the first step in better understanding. Dagis (1974), who has done the most work recently to arrange this difficult group, recognizes the following divisions of the Terebratulida: Stringocephalacea King, 1850; Cranaenacea Cloud, 1942; Cryptonellacea Thomson, 1926; Loboidothyracea Makridin, 1964; Terebratellacea King, 1850; Dielasmatacea Schuchert, 1913; Dallinacea Beecher, 1893; and Terebratulacea Gray, 1840. To these may be added Cancellothyridacea

As shown herein (Plate 43: figures 17, 18) *Stroudithyris* has a long-flanged loop (f/Ll = 0.43). By analogy with those placed in the Loboidothyrididae, *Stroudithyris* belongs there rather than in the Lobothyrididae.

[5] All figures in this paragraph are based on Dagis' reconstruction of *Viligothyris* (1968:91, fig. 55; herein Plate 63: figure 15).

[6] Tchorszhevsky (1974:47) recommends that those flanges should be called very short that do not exceed ⅕ the length of the loop proper, and called short those that do not exceed ⅓ the length of the loop, and very long those that are more than half the length of the loop. He does not note the part of the loop from which the terminal points are measured.

Thomson, 1926. Only Terebratulacea and, to a small degree, Cancellothyridacea concern this monograph.

A number of the subfamilies proposed herein contain a single genus. These subfamilies are based on genera having unusual characters of the loop and exterior that make them unique and not readily placed in the more general categories. Some of the more recently proposed genera cannot be properly placed because of the vagueness of their descriptions and lack of illustration of the loop by dissection, serial section, or reconstruction.

Supra-Generic Hierarchy

- Terebratulacea Gray, 1840
  - Terebratulidae Gray, 1840
    - Terebratulinae Gray, 1840
    - Apletosiinae, new subfamily
    - Tichosininae, new subfamily
    - Plicatoriinae, new subfamily
    - Sellithyridinae Muir-Wood, 1965
    - Nerthebrochinae, new subfamily
    - Rectithyridinae Muir-Wood, 1965
    - Plectoconchinae Dagis, 1974 (emended)
    - Triadithyridinae Pearson, 1977
    - Gryphinae Sahni, 1929
    - Platythyridinae Dieni, Middlemiss, and Owen, 1973
  - Nucleatidae Schuchert (ex Nucleatinae Schuchert, 1929)
  - Pygopidae Muir-Wood, 1965 (emended)
    - Pygopinae Muir-Wood, 1965
  - Dyscoliidae Fischer and Oehlert, 1891
    - Dyscoliinae Fischer and Oehlert, 1891
    - Aenigmathyridinae, new subfamily
    - Eurysoriinae, new subfamily
  - Gibbithyrididae Muir-Wood, 1965
    - Gibbithyridinae Muir-Wood, 1965
    - Carneithyridinae Muir-Wood, 1965
    - Rhombariinae, new subfamily
    - Goniothyridinae Tchorszhevsky, 1971
    - Psebajithyridinae Tchorszhevsky, 1974
    - Capillithyridinae, new subfamily
    - Capillarininae, new subfamily
    - Heterobrochinae, new subfamily
  - Dictyothyrididae Makridin, 1964
  - Dienopidae, new family
  - Hesperithyrididae, new family
  - Muirwoodellidae Tchorszhevsky, 1974
    - Muirwoodellinae Tchorszhevsky, 1974
    - Karadagithyridinae Tchorszhevsky, 1974
  - Tchegemithyrididae Tchorszhevsky, 1972
    - Tchegemithyridinae Tchorszhevsky, 1972
    - Turkmenithyridinae Tchorszhevsky, 1974
    - Lissajousithyridinae, new subfamily
    - Spasskothyridinae Smirnova, 1977
    - Notosiinae, new subfamily
    - Postepithyridinae Tchorszhevsky, 1974
    - Lobothyridinae Makridin, 1964
    - Rhombothyridinae, new subfamily
    - Lophrothyridinae, new subfamily
    - Morrisithyridinae, new subfamily
    - Loboidothyridinae Makridin, 1964
    - Cererithyridinae, new subfamily
    - Bothrothyridinae, new subfamily
    - Oleneothyridinae, new subfamily
  - Tegulothyrididae Muir-Wood, 1965
  - Cheirothyropsidae, new family
  - Cheniothyrididae Muir-Wood, 1965
- Cancellothyridacea Thomson, 1926
  - Cnismatocentridae Cooper, 1973
    - Cnismatocentrinae Cooper, 1973
    - Arcuatothyridinae Katz, 1974 (ex Arcuatothyrididae Katz, 1974)
  - Inopinatarculidae Muir-Wood, 1965 (ex Inopinatarculinae, 1965)
    - Undefined Subfamily

Terebratulacea Gray, 1840

Small to large, rounded, subpentagonal, trigonal or longitudinally rostrate shells with variable foramen modified by deltidial plates, deltidium or symphytium; anterior commissure rectimarginate to paraplicate to episulcate, rarely sulcate. Dental plates absent. Cardinal process usually present, variable in size. Loop subdeltiform, varying from ⅕ to ⅗ of dorsal valve length, and ⅕ to ½ width of dorsal valve. Loop attached to socket ridges usually by outer hinge plates variable in length and width, occasionally absent; inner hinge plates secondarily formed, rare. Crural bases narrow or broad, attached to socket ridges directly or by outer hinge plates on their dorsal or ventral edge or in between. Crural processes variable from bluntly angular to needle sharp, forming a focal point in the loop. Length of descending lamellae variable. Transverse band variably arched, horizontal or posterventrally directed, narrow or broad (in a longitudinal direction). Anterolateral extremities of loop (terminal points, flanges of Makridin, 1964) variable from narrowly rounded to long and sharp. Dorsal median septum not developed; septoidium or myophragm present in dorsal valve of some genera. Crural props (mantle plates of Kvakhadze, 1972) present in some genera. Lophophore a plectolophe or modified plectolophe. Shell layered, inner layer endopunctate.

In classifying Terebratulacea, parts of the exterior are important: convexity of the values, outline, profiles, folding of the anterior and lateral commissures, beak characters as well as any superficial ornament such as capillae, costae, or plications. The loop is of great importance because it supports the lophophore and some of the muscles. The parts of the loop that are given most importance are its length and width relative to those measures of the dorsal valve, angle formed by the lateral branches, position of the crural processes, nature of the outer hinge plates and their attachment to the crural bases, whether dorsally or ventrally attached or in between. Of considerable importance is the dimension of the transverse band, the presence or absence of terminal points, and their length relative to the length of the loop. In using these numerous characters to establish families, it is hoped that the arrangement offered will prove useful and suggestive of relationships between the genera. Lack of knowledge of the loop development of the majority of the genera of the Terebratulacea prevents the establishment of a more natural classification based on ontogeny. One cannot assume that all genera with long terminal points had the same development of the loop as *Viligothyris*; to do so may lead to a chaotic classification. The large number of genera already described makes some attempt at orderly arrangement, even if artificial, necessary and desirable.

TEREBRATULIDAE Gray, 1840

Small to large unevenly biconvex, rarely planoconvex, dorsal valve less deep than the ventral one; rectimarginate to biplicate, rarely sulcate or sulciplicate. Smooth or radially capillate, occasionally peripherally costate or plicate. Loop variable, usually relatively short. Crural processes variable in position; outer hinge plates usually concave, more rarely nearly flat or not developed, variably attached, most commonly to the dorsal edge of the crural base. Transverse band variable; terminal points modestly developed when present, usually short or lacking. Inner hinge plates rarely developed. Triassic to Recent.

TEREBRATULINAE Gray, 1840

Anterior commissure rectimarginate to moderately biplicate. Loop more or less triangular, short to moderately long. Crural processes usually anterior of midloop. Transverse band narrow to broad. Anterolateral extremities of loop usually subangular, not extended or only slightly extended. Inner hinge plates rarely developed.

Terebratula Müller, 1776; *Maltaia*, new genus; *Pycnobrochus*, new genus; *Liothyrella* Thomson, 1916; *Acrobrochus*, new genus; *Mimorina*, new genus; *Rhytisoria*, new genus; *Pliothyrina* Van Roy, 1980. Eocene to Recent.

APLETOSIINAE, new subfamily

Large, moderately biplicate. Loop wide (Wl/Ll = 0.52), short. Crural processes long, needle-like, located opposite anterior end of socket ridge. Outer hinge plates greatly reduced or absent; inner hinge plates present. Terminal points moderately long.

Apletosia, new genus. Pliocene.

This rare genus deviates from the more common Terebratulinae in having excessively long crural processes and terminal points on the borderline of short and long as defined herein. The position of the crural processes is like that of *Liothyrella* near or at the distal end of the socket, thus eliminating a crus. *Apletosia* is probably an aberrant development from *Pliothyrina*.

TICHOSININAE, new subfamily

Small to large, anterior commissure rectimarginate to moderately uniplicate. Surface smooth, capillae usually obscure when present. Loop short (Ll/LD at or near 0.30) with nearly parallel sides. Transverse band usually broad (f/Ll = ca 0.20; h/f = 0.73), nearly horizontal to slightly arched medially. Anterolateral extremities of loop rounded to angular, not extended. Crural processes anterior of midloop. Outer hinge plates attached to crural bases dorsally. Crural props rare. Inner hinge plates not developed.

Tichosina Cooper, 1977; *Eurysina*, new genus; *Erymnia* Cooper, 1977; *Zygonaria*, new genus; *Stenosarina* Cooper, 1977; *Arctosia*, new genus; *Dysedrosia*, new genus. Eocene to present.

PLICATORIINAE, new subfamily

Usually large, rectimarginate to uniplicate, smooth or peripherally costate to plicate. Loop long with long outer hinge plates attached dorsally to the crural base (crus). Inner hinge plates rare, sporadic. Crural processes far anterior of midloop (a/Ll = 0.72–0.77) often overhanging broad transverse band.

Plicatoria, new genus; *Tanyoscapha*, new genus; *Embolosia*, new genus; *Dolichozygus*, new genus; ?*Dolichosina*, new genus. Eocene to Recent.

SELLITHYRIDINAE Muir-Wood, 1965

Small to medium, subpentagonal with sulciplicate anterior commissure. Loop triangular, moderately long. Outer hinge plates dorsally attached to crural bases. Crural processes near or anterior to midloop. Transverse band narrow to moderately broad.

Sellithyris Middlemiss, 1959; *Loriolithyris* Middlemiss, 1968; *Musculina* Schuchert and Levene, 1929(a). Cretaceous.

NERTHEBROCHINAE, new subfamily

Small to large, rectimarginate to biplicate, smooth or rarely capillate. Loop fairly short (Ll/LD = 0.21–0.36) with longitudinally broad transverse band. Outer hinge plates attached at or near dorsal edge of crural base. Inner hinge plates rare. Crural processes anterior of midloop. Terminal points small or lacking. Crural props rare.

Nerthebrochus, new genus; *Najdinothyris* Makridin and Katz, 1964; *Dilophosina*, new genus; *Liramia*, new genus; ?*Longithyris* Katz and Popov, 1974a; *Neoliothyrina* Sahni, 1925; *Iberithyris* Kvakhadze, 1972; *Hadrosia*, new genus; *Harmatosia*, new genus; *Boubeithyris* Cox and Middlemiss, 1978; ?*Lunpolaia* Ching and Ye, 1979; ?*Sardope* Dieni, Middlemiss, and Owen, 1973; *Paraboubeithyris* Middlemiss, 1980. All Cretaceous.

RECTITHYRIDINAE Muir-Wood, 1965

Large with flatly convex valves, beak elongate, exposing large convex symphytium. Loop widely triangular. Socket ridges extended or not. Crural processes anterior to midloop. Outer hinge plates dorsally attached to crural bases; inner hinge plates rare. Transverse band fairly broad.

Rectithyris Sahni, 1929; ?*Weberithyris* Smirnova, 1969a; *Cyranoia*, new genus. Cretaceous.

In the Jurassic *Juralina* is a homeomorph of *Rectithyris*.

PLECTOCONCHINAE Dagis, 1974 (emended)

Medium to large, semicostate. Beak labiate. Anterior commissure rectimarginate to uniplicate. Outer hinge plates dorsally attached to crural bases. Loop short (Ll/LD = 0.30), wide (Wl/Ll = 0.94). Crural processes opposite sockets.

Plectoconcha Cooper, 1942; ?*Merophricus*, new genus.

Dagis (1974:197) based this subfamily on Russian shells that seem quite different from the type-species from the United States. He stated that "inner hinge plates not developed. Crura prefalcifer type. Centronellid stage distinct." Inasmuch as the crural processes of the American type species are opposite the sockets, no crura can be determined as to type, at least not on the exposed loop. Youthful stages of the American species are unknown so that a centronellid stage cannot be verified.

TRIADITHYRIDINAE Pearson, 1977

"Smooth, biconvex terebratulids; anterior commissure plicate. Cardinal process prominent.

Crura ventrally curved; descending branches short, arising directly from the side of crura. Otherwise as in the family [Terebratulidae]" (Pearson 1977:44).

Triadithyris Dagis, 1963; *Pamirothyris* Dagis, 1974. Triassic. Pearson's reconstructed loop of *Triadithyris* is unlike the loop of any genus seen in this study.

GRYPHINAE Sahni, 1929

Small to large, smooth, rectimarginate to broadly uniplicate. Loop short, scooplike. Transverse band broad. Crura narrow. Outer hinge plate flattish, attached ventrally. Crural processes anterior of midloop.

Gryphus Megerle von Mühlfeldt, 1811; *Epacrosina*, new genus; *Dallithyris* Muir-Wood, 1959; *Stenobrochus*, new genus. Recent.

Sahni's (1929) subfamily was equated with the Terebratulinae after its proposal (Roger, 1952). Inasmuch as *Gryphus* is the name derivative for the subfamily it seems appropriate to use it for a group of shells sharing its charaters. The subfamily Dallithyridinae Katz and Popov (1974b) is a synonym of the Gryphinae as used herein, although some of the genera assigned to that taxon do not appear to belong. Katz and Popov included *Weberithyris* Smirnova and *Najdinothyris* Makridin and Katz in their subfamily. According to data herein these genera are not related to members of the Gryphinae.

PLATYTHYRIDINAE Dieni, Middlemiss, and Owen, 1973

Medium size, oval, uniplicate. Surface finely capillate. Loop long, narrow. Outer hinge plates gently concave, attached just below ventral edge of crural bases. Crural processes anterior of midloop. Transverse band broad. Anterolateral extremities without terminal points.

Platythyris (= *Aniabrochus*) Middlemiss, 1959. Cretaceous.

Serial sections of the loop prepared by Middlemiss (1978) suggested to him that a relationship exists between *Platythyris* (= *Aniabrochus*) and *Pygope*. The loop of *Pygope* has not yet been seen. Middlemiss' sections are of *Pygites* (not *Pygope*), which has a loop quite different from that of *Platythyris* (see Nekvasilova, 1980, pl. 5: fig. 1). The loop of *Pygope* is suggestive of that of *Nucleata*, short and wide, not long like that of *Platythyris* (= *Aniabrochus*, new name, necessitated because of prior use of *Platythyris* for a moth).

Sardope Dieni, Middlemiss, and Owen was included in the Platythyridinae. It is much differently shaped than *Platythyris* and suggests *Najdinothyris* Makridin and Katz, rather than having kinship with *Platythyris*. The outer hinge plates of *Platythyris* and *Pygites* seen in serial section belong to the horizontal type and are an important reason for Middlemiss' views.

NUCLEATIDAE Schuchert (ex NUCLEATINAE Schuchert, 1929)

Small to medium size, smooth, moderately to strongly sulcate. Loop short. Crural bases indistinct. Crural processes blunt, anterior to midloop. Outer hinge plates poorly defined. Transverse band anteriorly rounded, without terminal points.

Nucleata Quenstedt, 1868–1871; ?*Linguithyris* Buckman, 1917. Jurassic.

Nucleata has not been thoroughly studied. It is possible that the many sulcate forms in the Jurassic and Cretaceous may have different types of loops. Rothpletz (1886–1887, pl. 8) illustrates a number of sulcate species with sketchily drawn loops of different length, width, and aspect, different enough to suggest that all are not related. Askerov (1965) misplaced *Dictyothyris* and *Tegulithyris* in this family where they obviously do not belong.

PYGOPIDAE Muir-Wood, 1965 (emended)

"Terebratulacea lacking true crural base [?]. The hinge plates are horizontal [in serial section], tapering or with rounded inner edges, and pass forward as horizontal structures to join the crura. The loop is short and the transverse band low arched" (Dieni, Middlemiss, and Owen, 1973:192).

Muir-Wood and Dieni, Middlemiss, and Owen included *Nucleata* Quenstedt, 1868–1871 in the family Pygopidae. There is no explanation as to why Nucleatidae/Nucleatinae was dropped by Muir-Wood (1965). *Nucleata* is the name-giver to the family and has priority over Pygopidae in the making of a family name. The Nucleatidae is herein recognized as a family separate from the Pygopidae. That the familes are related is evident from the loops of the known members, that of *Pygites* being very similar to that of *Nucleata*. Separation into two families is justified on the bizarre growth developments of the Pygopidae.

PYGOPINAE Muir-Wood, 1965

"Pygopidae with deep dorsal median sulcus; shell may develop two lateral lobes which come into contact and fuse in adult stage, enclosing median perforation" (Dieni, Middlemiss, and Owen, 1973:192).

?*Pygope* Link, 1830; ?*Antinomia* Catullo, 1851; *Pygites* Buckman, 1906. Jurassic to Cretaceous.

This group is not considered herein because of insufficient specimens. I have not seen a loop of *Pygope* or *Antinomia* and therefore have questioned the family assignment. The loop of *Pygites* has been well figured by Nekvasilova (1980).

DYSCOLIIDAE Fischer and Oehlert, 1891

Small to large. Smooth or capillate, capillae often in zigzag. Loop short, variable usually with thin transverse band horizontal or directed anteriorly. Outer hinge plates often poorly defined as are crural basis posteriorly. Crural processes anterior of midloop. Eocene to Recent.

DYSCOLIINAE Fischer and Oehlert, 1891

Small to large; beak labiate, strongly truncated. Exterior with fine zigzag capillae. Loop short, scooplike, with poorly defined outer hinge plates. Crura narrow. Crural bases posteriorly obscure. Crural processes anterior of midloop. Transverse band nearly horizontal or directed anteriorly. Anterolateral extremities of loop usually rounded or subangular; no terminal points.

Dyscolia Fischer and Oehlert, 1890; *Goniobrochus*, new genus. Pliocene to Recent.

AENIGMATHYRIDINAE, new subfamily

Small to medium, rectimarginate to strongly sulcate. Smooth, lamellate, and obscurely capillate. Loop short. Outer hinge plates poorly defined. Crura usually narrow. Crural processes near or anterior to midloop. Transverse band directed anteriorly with narrow median fold.

Abyssothyris Thomson, 1927; *Aenigmathyris* Cooper, 1971; *Xenobrochus* Cooper, 1981; *Acrobelesia*, new genus; *Ceramisia*, new genus; *Faksethyris* Asgaard, 1971. Paleocene to Recent.

Faksethyris does not conform to the other members of this subfamily because its a/Ll = 0.44, whereas all the others have this relationship showing an anterior position of the crural processes. *Faksethyris* conforms well in the form of the loop and the anteriorly directed transverse band.

EURYSORIINAE, new subfamily

Small to medium, subpentagonal, smooth. Anterior commissure uniplicate. Loop short, squarish. Crural processes obtuse, anterior to midloop. Outer hinge plates, crural bases poorly defined. Transverse band slender, medially protuberant.

Eurysoria, new genus; ?*Aphragmus*, new genus.

GIBBITHYRIDIDAE Muir-Wood, 1965

Small to large, rectimarginate to uniplicate to sulciplicate. Foramen variable, often minute. Cardinal process variable, small to ponderous. Loop short. Crural bases broad. Outer hinge plates attached at or near ventral edge of crural bases. Crural processes anterior of midloop. Transverse band usually broad, variably arched.

GIBBITHYRIDINAE Muir-Wood, 1965

As for family but with small cardinal process.

Gibbithyris Sahni, 1925; *Concinnithyris* Sahni, 1929; *Biplicatoria*, new genus; *Ornatothyris* Sahni, 1929; *Atactosia*, new genus; *Magnithyris* Sahni, 1925; ?*Paracapillithyris* Katz and Popov, 1974a; *Hesperosia*, new genus; ?*Orientothyris* Katz and Popov, 1974. Cretaceous.

Katz and Popov (1974a) placed *Plectoconcha* in this family with a query. Its ventrally concave hinge plates and type of crural base are so unlike those of *Gibbithyris* that it is entirely out of place in this subfamily.

CARNEITHYRIDINAE Muir-Wood, 1965

Small to large round to oval, rectimarginate to uniplicate, rarely sulcate; smooth. Beak incurved, foramen usually small to minute. Loop short. Cardinal process large to ponderous, shafted. Outer hinge plates often swollen; crural processes anterior to midloop. Transverse band usually narrow, moderately arched.

Carneithyris Sahni, 1925; *Chatwinothyris* Sahni, 1925; *Ellipsothyris* Sahni, 1925; *Ornithothyris* Sahni, 1925; *Ogmusia*, new genus. Cretaceous to Paleocene.

RHOMBARIINAE, new subfamily

Small to medium, strongly inaequivalve. Smooth. Foramen small in elongate beak. Anterior commissure uniplicate. Loop moderately long, wide. Outer hinge plates narrow, ventrally attached to crural bases. Crural processes anterior to midloop. Transverse band thin, medially protuberant.

Rhombaria, new genus. Cretaceous.

GONIOTHYRIDINAE Tchorszhevsky, 1971

Medium to large; beak short, strongly truncated; dorsal valve strongly convex. Loop long. Outer hinge plates convex ventrally.

Goniothyris Buckman, 1917. Jurassic.

Tchorszhevsky (1971b) characterized his family as having "a goniothyroid type of crura." This type was not defined in his original work, nor was it clear then whether the author was referring to *Goniothyris* as typified by *G. gravida* (Szajnocha), the type named by Buckman (1917) or *G. phillipsi* (Morris) placed in *Goniothyris* by Buckman. The two species are very unlike, the latter large, strongly biplicate and with a long beak. Brachiopods of this type have been called *Goniothyris* by Barczyk (1969:27). The type species is very distinctive. Katz and Popov (1974a) referred the completely different genera *Postepithyris* and *Nalivkinella* as members of Popov's subfamily Postepithyridinae under the family Goniothyrididae.

Tchorszhevsky (1974) abandoned his family Goniothyrididae when he placed *Goniothyris* in the subfamily Muirwoodellinae along with *Lissajousithyris* and *Muirwoodella*, both of which, to judge by their cardinalia, are out of place with *Goniothyris*.

In this monograph Goniothyrididae is used for brachiopods having the exterior characters of *G. gravida* (Szajnocha). The species *G. poleymiensis* Almeras and *G. craneae* (Davidson) have the characteristic exterior of the genus. The loops of the two have been illustrated by serial section. Almeras' sections of *G. poleymiensis* unfortunately do not show the whole loop, because the transverse band was missing, but they do show the ventrally arched and ventrally attached outer hinge plates. Tchorszhevsky (1970) published serial sections of a specimen from Transcarpathia called *G. craneae* (Davidson). The serial sections indicate a long loop, rather narrow, with long terminal points. Tchorszhevsky's sections (1970:58, fig. 6, tenth and eleventh sections) show distinct, flatly concave outer hinge plates attached to the ventral edge of the crural base to make the pendent type of pattern. The loop of *G. gravida* (Szajnocha) has not yet been illustrated. A convex outer hinge plate is of sporadic occurrence in the Jurassic, suggesting its development in different, unrelated stocks. It is found in *Karadagella*, *Placothyris*, and *Heterobrochus*.

PSEBAJITHYRIDINAE Tchorszhevsky, 1974

Medium to large. Uniplicate to weakly sulciplicate. Loop narrow, about ⅓ dorsal valve length. Outer hinge plates attached to ventral edge of crural bases. Transverse band moderately broad, nearly horizontal.

Psebajithyris Tchorszhevsky, 1974; *Placothyris* Westphal, 1970. Jurassic.

CAPILLITHYRIDINAE, new subfamily

Subcircular, subequally biconvex, capillate. Loop short, wide. Outer hinge plates broad, ventrally attached to the crural bases. Crural processes anterior to midloop. Anterolateral extremities subangular, not extended.

Capillithyris Katz and Popov, 1974a. Cretaceous.

See discussion under Capillarininae.

CAPILLARININAE, new subfamily

Small to large, subcircular, rectimarginate, strongly radially capillate. Loop narrow, moderately long, crus long and narrow. Crural processes anterior to midloop. Transverse band broad. Anterolateral extremities of loop rounded. Socket ridges posteriorly extended.

Capillarina, new genus. Cretaceous.

Although *Capillarina* and *Capillithyris* are externally similar, there is a great difference in their cardinalia and loops. The socket ridges of *Capillarina* are so strongly extended posteriorly that they make a ridge with the cardinal process that extends slightly posterior of the posterior margin. This arrangement is similar to that seen in *Rectithyris*, and emphasized by Sahni for that genus. This feature is not seen in *Capillithyris*, nor are the loops alike, that of *Capillithyris* short and wide, that of *Capillarina* long and narrow, and the latter with long, rounded, narrow crura producing a scooplike loop.

HETEROBROCHINAE, new subfamily

Medium size, subpentagonal, anterior commissure biplicate, surface smooth. Loop wide-angled, moderately long. Crural processes posterior of midloop. Outer hinge plates ventrally attached to the crural bases. Transverse band broad, medially protuberant.

Heterobrochus, new genus. Jurassic.

DICTYOTHYRIDIDAE Makridin, 1964

Small to medium, anterior commissure antiplicate, surface marked by intersecting radial and concentric lines that create a papillose surface. Loop long. Crural processes anterior of midloop. Outer hinge plates attached to ventral edge of crural bases. Terminal points short.

Dictyothyris Douvillé, 1879. Jurassic.

There are numerous species referred to this genus that need close study. Makridin (1964:261, 262) described *D. gzeliensis* with exceptionally long terminal points according to his reconstruction, a loop unlike that of the dissected specimen depicted herein (Plate 37: figures 5–8). Although the loop of Makridin's species suggests that of *Dienope*, its external form is that of true *Dictyothyris*. The exterior of *Dictyothyris badensis* Rollier, figured by Makridin (1964; pl. 20: figs. 3, 4), is like that of *Dienope* but its interior is not figured. Early Cretaceous species referred to *Dictyothyris* by Nekvasilova (1980), with their long beak and long cardinal process, are unlike *Dictyothyris*.

DIENOPIDAE, new family

Medium size, elongate oval, surface marked by intersecting radial and concentric lines. Anterior commissure parasulcate. Loop very long, anteriorly webbed. Outer hinge plates attached to ventral edge of crural bases. Crural processes strongly posterior of midloop. Terminal points more than half loop length.

Dienope, new genus. Jurassic.

HESPERITHYRIDIDAE, new family

Medium to large, foramen large, anterior commissure uniplicate, surface smooth but shell folded into a few strong plications. Cardinal process prominent. Outer hinge plates narrow, ventrally attached to the crural bases.

Hesperithyris Dubar, 1942. Liassic.

MUIRWOODELLIDAE Tchorszhevsky, 1974

"Smooth, anterior commissure rectimarginate to biplicate. Outer hinge plates with processes well developed. Loop long-flanged, half of dorsal valve length. Union of outer hinge plates with crura – type III; transverse band – type III [Tchorszhevsky, 1974:51]."

MUIRWOODELLINAE Tchorszhevsky, 1974

"Crura of pseudoarculifer type [p. 51]."

Muirwoodella Tchorszhevsky, 1974. Jurrassic.

KARADAGITHYRIDINAE Tchorszhevsky, 1974

Crura of the Karadagithyrid type, may be supported by means of the processes of the outer hinge plates on the floor of the dorsal valve.

Tribe Karadagellini Tchorszhevsky – processes of the outer hinge plates do not rest on the floor of the dorsal valve.

Karadagella Babanova, 1965; *Goniothyrella* Tchorszhevsky, 1974. Description of the latter genus not seen.

Tribe Karadagithyridini Tchorszhevsky – the strongly developed processes of the outer hinge plates rest on the floor of the dorsal valve.

Karadagithyris Tchorszhevsky, 1974; *Svaljavithyris* Tchorszhevsky, 1974 (regarded as invalid by Barczyk, 1979:211).

TCHEGEMITHYRIDIDAE Tchorszhevsky, 1972

Small to large, smooth, rarely capillate, rarely peripherally costate. Rectimarginate to sulciplicate. Crural process at midloop or variably distant therefrom. Loop long (Ll/LD = 0.40 or greater). Terminal points variable. Outer hinge plates variably attached, usually dorsally, to the crural bases. Transverse band usually with narrow bridge, often protuberant. Loop metamorphosis complex?

TCHEGEMITHYRIDINAE Tchorszhevsky, 1972

Small to large, uniplicate to biplicate. Loop long. Crural processes anterior of midloop. Terminal points long. Loop development complex in *Viligothyris* (possibly in others.)

Bejrutella Tchorszhevsky, 1972; *Tchegemithyris* Tchorszhevsky, 1972; *Viligothyris* Dagis, 1968.

TURKMENITHYRIDINAE Tchorszhevsky, 1974

Crura of turkmenithyroid type. Loop short, with long flanges, extends ⅓ the length of the dorsal valve. Transverse band of loop differentiated.

Turkmenithyris Prosorovskaya, 1962. Jurassic.

LISSAJOUSITHYRIDINAE, new subfamily

Small to large, rectimarginate to sulciplicate, smooth. Loop long (Ll/LD = 0.40 or greater) and variable in width. Outer hinge plates dorsally attached to the crural bases. Crural processes posterior of midloop. Terminal points long (f/Ll = 0.40 or greater).

Apatecosia, new genus; *Arcelinithyris* Almeras, 1971; *Eristenosia*, new genus; *Lissajousithyris* Almeras, 1971; *Monsardithyris* Almeras, 1971; *Nalivkinella* Katz and Popov, 1974a [Makridin's *Loboidothyris*]; *Uralella* Makridin, 1960; *Stroudithyris* Buckman, 1917; *Rouillieria* Makridin, 1960; *Saucrobrochus*, new genus; *Dorsoplicathyris* Almeras, 1971; *Strongylobrochus*, new genus. All Jurassic.

SPASSKOTHYRIDINAE Smirnova, 1977

Medium to large, elongate oval, rectimarginate to uniplicate. Loop long (Ll/LD = 0.39–0.60) [based on Smirnova's reconstructions]. Crural processes posterior of midloop, broad. Terminal points long (f/Ll = 0.40–48). Inner hinge plates developed in *Spasskothyris.*

Atelithyris, *Spasskothyris*, *Okathyris*, all of Smirnova. Cretaceous.

The loop characters of these three genera are more like those of Jurassic genera than any Cretaceous genera described herein.

NOTOSIINAE, new subfamily

Medium to large, rectimarginate with long loop having long terminal points (f/Ll = 0.40–0.65). Crural processes posterior to midloop.

Notosia, new genus; *Exceptothyris* Sučić-Protić, 1971; ?*Senokosica* Sučić-Protić, 1971; *Serbiothyris* Sučić-Protić, 1971, *Pirotothyris* Sučić-Protić, 1971. All Liassic.

POSTEPITHYRIDINAE Tchorszhevsky, 1974

Rectimarginate to strongly biplicate, surface usually smooth, rarely capillate or peripherally costate. Loop long (Ll/LD = 0.35–0.60). Outer hinge plates dorsally attached to the crural bases. Crural processes at or posterior of midloop. Terminal points intermediate (f/Ll = 0.30–0.40).

Postepithyris Makridin, 1964; *Caryona*, new genus; *Conarothyris*, new genus; *Epithyris* Phillips, 1841; *Euidothyris* Buckman, 1917; *Ferrythyris* Almeras, 1971; *Galiennithyris* Rollet, 1966; ?*Gigantothyris* Seifert, 1963; *Glyphisaria*, new genus; *Gyrosina*, new genus; *Heimia* Haas, 1890; *Holcothyris* Buckman, 1917; *Juralina* Kiansep, 1961; *Lenothyris* Dagis, 1968; *Millythyris* Almeras, 1971; *Moeschia* Boullier, 1976; *Oligorhytisia*, new genus; *Perrierithyris* Almeras, 1971; *Petalothyris*, new genus; *Plectoidothyris* Buckman, 1917; *Systenothyris*, new genus; *Xestosina*, new genus; *Pachythyris* Boullier, 1976; *Arceythyris* Rollet, 1964. All Jurassic.

LOBOTHYRIDINAE Makridin, 1964

Rectimarginate shells with fairly long loop (Ll/LD = 0.40–0.50). Crural processes posterior of midloop. Terminal points moderately long (f/Ll = 0.24–0.35).

Inaequalis, *Mirisquamea*, *Pyraeneica*, *Squamiplana*, *Loboidothyropsis*, *L. (Bullothyris)* (all Sučić-Protić, 1971); *Lobothyris* Buckman, 1917. All Liassic.

RHOMBOTHYRIDINAE, new subfamily

Medium to large, narrowly to roundly oval, uniplicate to paraplicate, smooth, beak short, truncated. Symphytium short, fully exposed. Loop moderately long (Ll/LD = 0.36–0.40). Outer hinge plates attached dorsally to the crural bases. Crural process anterior of midloop. Terminal points short (f/Ll = less than 0.30).

Rhombothyris, *Praelongithyris*, *Cyrtothyris*, all of Middlemiss, 1959. All Cretaceous.

LOPHROTHYRIDINAE, new subfamily

About medium size, uniplicate to biplicate, smooth. Loop moderately long. Outer hinge plates dorsally attached to the crural bases. Crural processes anterior of midloop. Terminal points of intermediate length (f/Ll = 0.30–0.35).

Argovithyris Rollet, 1972; *Aromasithyris* Almeras, 1971; *Lophrothyris* Buckman, 1917; *Pentithyris*, new genus; *Pseudotubithyris* Almeras, 1971; *Pseudowattonithyris* Almeras, 1971; *Tubithyris* Buckman, 1917; *Odarovithyris* Tchorszhevsky, 1971. All Jurassic.

MORRISITHYRIDINAE, new subfamily

Large, strongly biplicate, beak long with exposed symphytium. Loop moderately long, narrow. Outer hinge plates dorsally attached to the crural bases. Crural processes near midloop. Transverse band with deep reentrant on posterior side; anterolateral extremities broad; bridge narrow.

Morrisithyris Almeras, 1971. Jurassic.

The loop of *Morrisithyris* with its broad anterolateral extremities and transverse band with deep posterior reentrant bounded by narrow prongs, is unique. Posterior prongs are seen spasmodically in other genera, as *Monsardithyris*.

LOBOIDOTHYRIDINAE Makridin, 1964

Small to large, rectimarginate to sulciplicate, mostly smooth, rarely capillate or costate. Loop length variable (Ll/LD = 0.30–0.50). Outer hinge plates dorsally attached to the crural bases. Crural processes near midloop or anterior of midloop. Terminal points short (f/Ll = 0.15–0.30) or not noticeably developed.

Loboidothyris Buckman, 1917; *Colosia*, new genus; *Pinaxiothyris* Dagis, 1968; *Pseudoglossothyris* Buckman, 1917; *Ptychtothyris* Buckman, 1917; *Sphaeroidothyris* Buckman, 1917; *Stiphrothyris* Buckman, 1917; *Striithyris* Muir-Wood, 1935; *Wattonithyris* Muir-Wood, 1936; *Pionothyris*, new genus; *Avonothyris* Buckman, 1917; ?*Bihenithyris* Muir-Wood, 1935; *Charltonithyris* Buckman, 1917; *Dolichobrochus*, new genus; *Stenogmus*, new genus. All Jurassic.

CERERITHYRIDINAE, new subfamily

As above but with loop having short terminal points (f/Ll = 0.24–0.29); crural processes posterior of midloop.

Cererithyris Buckman, 1917; *Animonithyris*, new genus; *Mexicaria*, new genus; *Plectothyris* Buckman, 1917; *Habrobrochus*, new genus; *Rocheithyris* Almeras, 1971. Jurassic.

BOTHROTHYRIDINAE, new subfamily

Large, roundly rhomboidal, anterior commissure sulcate, surface smooth. Loop triangular, moderately long (Ll/LD = 0.40). Outer hinge plates narrow. Crural processes anterior of midloop. Transverse band strongly arched. Anterolateral extremities narrowly rounded.

Bothrothyris, new genus. Jurassic.

OLENEOTHYRIDINAE, new subfamily

Large, elongate oval, biplicate, smooth. Loop moderately long. Crural processes posterior of midloop. Crural processes attached dorsally to crural bases. Terminal points long (f/Ll = 0.44); transverse band steeply inclined posteriorly, angular.

Oleneothyris Cooper, 1942.

TEGULOTHYRIDIDAE Muir-Wood, 1965

Medium to large, anterior commissure antiplicate. Loop long (Ll/LD = 0.51). Crural processes close to midloop. Outer hinge plates attached to dorsal edge of crural bases. Transverse band moderately broad, medially protuberant. Terminal points moderately long (f/Ll = 0.32).

Tegulithris Buckman, 1917. Jurassic.

CHEIROTHYROPSIDAE, new family

Medium size, oval to subpentagonal, both valves with four opposite ridgelike plications. Anterior commissure rectimarginate. Loop like that of *Tegulithyris* (as shown by Makridin's reconstruction, 1964:268, fig. 94).

Cheirothyropsis Makridin, 1964. Jurassic.

CHENIOTHYRIDIDAE Muir-Wood, 1965

Small, pentagonal, both valves lamellose and marked by median depression producing bilobed anterior margin. Anterior commissure rectimarginate. Loop not completely known.

Cheniothyris Buckman, 1917. Jurassic.

CANCELLOTHYRIDACEA Thomson, 1926

CNISMATOCENTRIDAE Cooper, 1973

Small to large, smooth to capillate; deltidial plates conjunct; cardinalia with socket ridges but no outer hinge plates, Loop short, wide; transverse band narrow; crural processes anterior. Musculature as in *Terebratulina* with dorsal pedicle muscles attached to floor of ventral valve.

CNISMATOCENTRINAE Cooper, 1973

Large capillate, rectimarginate; foramen large. Loop as for family.

Cnismatocentrum Dall, 1920. Recent.

ARCUATOTHYRIDINAE Katz, 1974 (ex ARCUATOTHYRIDIDAE Katz, 1974)

Small to medium, smooth or with radial teardrop ornament. Rectmarginate to slightly uniplicate or sulcate. Loop short, crural processes small and anterior.

Arcuatothyris Popiel-Barczyk, 1972; *Nucleatina* Katz, 1962. Cretaceous.

INOPINATARCULIDAE Muir-Wood, 1965 (ex INOPINATARCULINAE, 1965)

Small, costellate; foramen small; anterior commissure uniplicate; crural processes large; transverse band fairly broad longitudinally, moderately arched.

Inopinatarcula Elliott, 1952.

Undefined Subfamily

Subfamily Ptictothyrinae. This name is attributed to Makridin, 1964, by Kvakhadze (1971:26) in his announcement of the new genus *Iberithyris*. This genus is placed in this family (1971) but later Kvakhadze (1972) placed it in the Lobothyrinae. I have been unable to find Ptichtothyrinae in Makridin's work of 1964. The family name thus seems unavailable. *Iberithyris* is herein placed in the Loboidothyridinae.

Genera of Terebratulacea

Systematics

In the following pages genera that have yielded loops or especially well-revealed cardinalia are described. The emphasis is on the loop, which is described in detail. For each genus the type-species is cited, the number of specimens studied or literature used in lieu of specimens is cited, and the geologic and geographic occurrences given. These data for illustrated and described specimens are given in available detail in the plate legends and descriptions of new taxa. A short telegraphic description of the exterior of each genus is presented and illustrations of the important exterior details are furnished on the plates, usually dorsal, side, and anterior views. It is important to link loop to exterior.

The loop and cardinalia are discussed in detail and the various measurements of parts of the loop are recorded. These data are followed by explanatory, comparative, and informative remarks relating to the particular genus and related forms. Mention is also made of terebratulacean genera, the loops of which have been well described or illustrated but not in collections available to me. Photographs of the actual specimen dissected, or a cast of it are given, as a help to link exteriors to interiors. This could not be done for all genera.

Genera of which specimens were not available and the loops of which have been reconstructed are noted, often with abstracted or translated descriptions and with the illustration of the reconstructed loops. Statistics are presented on these reconstructions and from those of serial sections giving adequate detail and measurements such as those of Almeras (1971), and Sučić-Protić (1971).

Triassic TEREBRATULACEA

Triassic TEREBRATULIDAE

Not much is known of the Terebratulidae of the Triassic Period. Although brachiopods are numerous in some Triassic deposits, the short-looped forms lacking dental plates and septal supports of the crura appear to be rare. A few species have been named from the Alpine Cassian beds by Bittner (1890:59–62, 316). A figure of the short loop of *Terebratula cassiana* Bittner (p. 60) is given but it shows no details of the hinge plate.

The Triassic Terebratulidae, as shown by the work of Dagis, reveals the presence of large numbers of short-looped forms referrable to the Dielasmatacea, in which the crural bases are supported by septal plates. Dagis (1974) describes five genera, two representing the Lobothyridinae, one the Plectoconchinae, and two of Loboidothyrididae (sensu Dagis). Hoover (1979) described several genera, one of which, *Vex*, was referred to the Terebratulidae. This, however, proves to have a long loop.

This meager representation obviously does not include all of the Terebratulidae of the Triassic that would be a fruitful source of research. Two genera of short-looped forms are noted herein but are not named for lack of specimens well located in the stratigraphic sequence.

Laevithyris Dagis, 1974

Laevithyris Dagis, 1974:198.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Lobothyris rossachae* Dagis, 1965: 143, pl. 25: figs. 1–3.

Specimens Studied.—Literature only.

Geologic Occurrence.—Triassic (Carnic).

Localities.—Northeastern Russia, Primor, and possibly North America.

Diagnosis (Dagis, 1974).—Smooth, elongate-oval shells with a slightly uniplicate anterior commissure. Hinge plates low, but clearly defined from the socket ridges, crural bases high. Cardinal process not divided into lobes, low.

Description (Dagis, 1974).—Shells of medium size, quite clearly extended in length, oval in outline. Valve surfaces smooth, no plication developed. Anterior commissure faintly uniplicate. Beak short, thick, slightly curved with rounded ridges. Foramen round, permesothyridid.

Pedicle collar short. Cardinal process low, flattened, not divided into lobes. Hinge plates low, but clearly defined from socket ridges, lie in the plane of articulation of the valve. Crural bases high, directed ventrally, crura of infulifer type, wide. Loop extends for half the length of the shell, bears short but distinct flanges. Transverse band high drawn a little toward the hinge margin.

Observations and Comparison (Dagis, 1974).—Closest to this genus is the Liassic genus *Viligothyris* Dagis (1968:89), separate species of which are practically indistinguishable in external appearance from species of the present genus. In the genus *Laevithyris* there is no dissociated inner hinge plate which is characteristic of *Viligothyris*, as well as long loop flanges.

Development of brachial supports is wholly unstudied in the new genus. There are only isolated observations which make it possible to be convinced that the transverse band in the genus *Laevithyris* developed as a secondary structure of the loop. The latter reliably defines the position of the new genus within the family Loboidothyrididae.

To this genus, apparently, in addition to the Siberian species, belongs a form described by Smith (1927:127) as *Terebratula pyriformis* Suess from the Late Triassic of North America.

Note.—Statistics could not be prepared from the serial sections because the distance between sections was inadvertently omitted.

Lobothyroides Xu, 1978

Lobothyroides Xu, 1978:307.

Family.—Placement uncertain.

Type-Species.—*Lobothyroides striata* Xu, 1978: 307, pl. 101: figs. 11–13.

Specimens Studied.—Literature only.

Geologic Occurrence.—Upper Triassic.

Locality.—Sichuan Province, China.

The inadequate serial sections do not allow understanding of the interior details.

Pamirothyris Dagis, 1974

Pamirothyris Dagis, 1974:195 [not Ovcharenko, 1975].

Family.—Placement uncertain.

Type-Species.—*Lobothyris kushlini* Dagis, 1963: 184, pl. 27: figs. 1–10.

Geologic Occurrence.—Triassic (Norian and Rhaetic).

Locality.—Pamir.

Diagnosis.—Smooth shells, with equally convex valves and straight anterior commissure. Beak wide, curved, foramen mesothyridid to permesothyridid. Hinge plates lie in the plane of the valves. Crura infulifer.

Description (Dagis, 1974).—Small shells with valves moderately and equally convex. Plicae absent, anterior commissure straight. Beak wide, low, with rounded ridges, usually strongly curved. Foramen round, mesothyridid or permesothyridid. Symphytium low, wide.

In the ventral valve is a short pedicle collar. Cardinal process low, not divided into lobes, myophore dissected. Hinge plates thin, wide, lie in the plane of the valves. Crura narrow, infulifer type of structure, crural bases scarcely expressed. Loop with rounded extremities, short, extends ⅓ the length of the dorsal valve.

Comparison (Dagis, 1974).—From the similar genus *Lobothyris* this genus differs in its straight hinge plates and the character of the crura. By these same features, as well as the absence of a sulcus in the dorsal valve, the genus *Pamirothyris* differs from the Liassic genus *Rhapidothyris* Tuluweit (1965:72).

NOTE.—Statistics could not be prepared from the serial sections because distance between sections was inadvertently omitted, and no enlargement was given.

Plectoconcha Cooper, 1942

PLATE 59: FIGURES 11–14; PLATE 66: FIGURES 14, 15

Plectoconcha Cooper, 1942:233.—Hoover, 1979, pl. 2: figs. 6, 7 [not *Plectoconcha* Dagis, 1972].

SUBFAMILY.—Plectoconchinae Dagis, 1974.

TYPE-SPECIES.—*Rhynchonella aequiplicata* Gabb, 1864:35, pl. 6: fig. 37.

GEOLOGIC OCCURRENCE.—Upper Triassic.

LOCALITY.—Nevada.

DESCRIPTION.—Species of *Plectoconcha* are fairly common in Upper Triassic limestone of western United States. The genus consists of rounded, oval, elongate shells ranging from small to fairly large and characterized by an erect, labiate beak and peripheral costae occupying the anterior third to half of the valves. The posterior ⅓ to ½ is smooth. A single specimen with imperfectly preserved loop is known. The cardinal process is widely elliptical. The socket ridges are steeply inclined and bound narrow sockets. The fulcral plates are thin and recessed posterior to the socket ridge. The outer hinge plates are narrow and taper anteriorly to a point on the posterior side of the descending lamellae. The crural base is marginal and expands into the crural process just posterior of the open end of the socket. Thus the outer hinge plate and its taper include the crural process, an unusual condition in the Terebratulidae. The descending lamellae flare widely and are united by a thin, narrow, broadly arched transverse band. The anterolateral extremities of the loop are subangular and without terminal points.

LOOP STATISTICS (of figured specimen, USNM 242083).—$\angle = 55°$; Wl/Ll = 0.94; a/Ll = 0.53; b/Ll = 0.47; c/Ll = 0.50; d/Ll = 0.03; e/Ll = 0.26; f/Ll = 0.21; g/Wl = 0.94; h/f = 0.01; h/Ll = 0.03.

USNM 242083: Upper Triassic, Keyhole Canyon, Pershing County, Nevada.

DISCUSSION.—The exterior of *Plectoconcha* is like that of *Merophricus* from the Lias of Morocco which is a semicostate brachiopod but the loops of the two are different in detail. In *Merophricus* the outer hinge plates are broader, the crural processes are shorter and farther forward, and the lateral extremities of the loop are rounded rather than subangular.

Dagis (1974:197) figures serial sections of a Russian brachiopod identified as *Plectoconcha*. Although it is difficult to compare an actual loop with serial sections, it seems evident that Dagis is not dealing with genuine *Plectoconcha*. The illustrated specimen of the Russian shell is much smaller than the American one and the sections, which do not clearly depict the crural processes, indicate a loop narrower than that of the American form and one with fairly long, broad, slightly crescentic descending lamellae with a narrow transverse band. The crural processes, if this Russian shell were truly *Plectoconcha*, should appear before the descending lamellae become evident.

Dagis (1974:26–28) shows figures of the loop development of *Plectoconcha variabilis* Dagis having stages of development like those of *Dielasma*, in which the median ridge of the centronellid loop divides and the transverse band grows laterally to unite the descending branches. The final stage depicted, which is not that of an adult (Dagis, 1974, fig. 5) shows a fairly long, narrow loop with moderate terminal points unlike the loop of the American *Plectoconcha*, the loop of which is short and wide and without terminal points. The Russian shells belong to a stock different from the American one even though they are externally similar.

Indications from the Dagis serial sections of an adult (1974:197, fig. 143) suggest a loop much narrower than that of American *Plectoconcha*. The Russian *Plectoconcha* is from the Lower and Middle Triassic. Although the exterior of *Vex semisimplex* (White) is similar to that of the Russian "*Plectoconcha*," its loop is long and completely different from the loops of the Russian and American shells.

Triadithyris Dagis, 1963

PLATE 66: FIGURES 11, 12

Triadithyris Dagis, 1963:118.—Pearson, 1977:44.

SUBFAMILY.—Triadithyridinae Pearson, 1977.

TYPE-SPECIES.—*Terebratula gregariaeformis* Zugmayer, 1880:13, pl. 1: figs. 22, 26–29. Pearson, 1977:44, figs. 14–16; pl. 7: figs. 11–14.

GEOLOGIC OCCURRENCE.—Upper Triassic.

LOCALITIES.—Alps, Carpathians, Crimea, Caucasus, and Pamir.

DESCRIPTION (from Dagis, 1963).—Biplicate shells with outline approaching pentagonal, beak short, low rounded beak ridges. Foramen of not large size, rounded in outline, permesothyridid.

Pedicle collar not large, tubular. Hinge plates in the dorsal valve are thin, narrow, rather distinctly marked off from the massive inner socket ridges. Hinge plates do not bear crural bases. Cardinal process of not large size, thickened, bifid.

Loop with long wide crural processes, short descending bands and strongly ventrally curved transverse band. Muscle field in dorsal valve has a pear-shaped outline.

COMPARISON.—Buckman (1914, 1917) erected a whole series of Middle Jurassic terebratulid genera possessing a biplicate margin and having rather similar shells to *Triadithyris*. *Charltonithyris*, *Cererithyris*, *Loboidothyris*, *Kutchithyris*, and *Goniothyris* have a foramen to some extent similar.

Unfortunately the internal structure of three of these Jurassic genera, *Loboidothyris*, *Kutchithyris*, and *Goniothyris*, is not completely known, and the small differences in external structure on the basis of which Buckman created these genera are for the most part difficult to see. This impedes the task of carrying out an exhaustive comparison of *Triadithyris* on the one hand with the Jurassic genera on the other. However, even on the basis of the little data available for the Jurassic genera, a rather precise limitation of *Triadithyris* may be drawn. Thus, from *Charltonithyris* it differs in its smaller foramen, the difference of its location, the smooth shoulders, narrower loop, and absence of a septoidum; from *Cererithyris* it differs in the character of the beak, the permesothyridid foramen, the shorter and less diverging muscle tracks; from *Loboidothyris* it differs in the same features as from *Cererithyris* and in the absence of a septoidum: from *Goniothyris* it differs in the longer beak and smaller foramen, the different position of the foramen relative to the beak ridges, and also in the arrangement of the muscle tracks of the dorsal valve. In addition, in distinction from all the genera mentioned, there is a much more strongly developed plication of the anterior margin.

A similar appearing genus, which is difficult to distinguish from its external features, is the Jurassic *Kutchithyris* from which *Triadithyris* differs in its smaller foramen, absence of septoidum, different arrangement of muscle tracks and loop.

LOOP STATISTICS.—See Table 2.

DISCUSSION.—Pearson (1977:44) describes *Triadithyris* and illustrates its interior by serial sections and a reconstruction of the loop. His description and diagnosis indicate a large cardinal process whereas Dagis regarded this structure as "not large." Statistics from the serial sections following the pattern used herein, do not conform with those made from Pearson's reconstruction. The restored loop is short, shorter than the 45%

TABLE 2.—Loop statistics for the genus *Triadithyris*

Proportions	Serial sections (Dagis, 1974, fig. 144)	Serial sections (Pearson, 1977, fig. 15)	Reconstruction (Pearson, 1977, fig. 16)
∠	?	27°	17°
Wl/Ll	?	0.54	0.64
Ll/LD	?	0.41	0.36
WL/WD	?	0.24	0.25
a/Ll	0.66	0.53	0.74
b/Ll	0.34	0.47	0.26
c/Ll	0.42	0.28	0.40
d/Ll	0.24	0.25	0.34
e/Ll	0.17	0.29	0.12
f/Ll	0.17	0.29	0.14
g/WD	?	0.30	0.30
g/Wl	?	1.25	1.19
h/f	?	0.10	0.21
WD/LD	?	0.91	0.92

of specimen length indicated in Pearson's description. The descending lamellae are restored as very short but in text figure 15 the loop is said to continue to 8.3 mm but only 4.35 mm of loop are shown in the serial sections. The restoration of the loop shows an odd transverse band with a wide reentrant on the anterior side bounded by two sharp points. The sections do not seem to indicate such a loop structure, unless all of the sections are not illustrated. The reconstruction of the loop profile shows a loop about 30% of the dorsal valve length and considerably shorter than full dorsal view of the loop.

In the reconstruction the crural processes are strongly bent toward the middle of the valve. This is probably in accordance with the statement (p. 44) that the crural processes are directed dorsally. The serial sections (fig. 14, 15, section 1.25) do not indicate such sharp "dorsally directed crural processes."

Statistics of the loop taken from Dagis serial sections (1974:144) do not agree with those from Pearson's serial sections. Dagis does not give shell measurements, consequently only the loop could be measured for statistical purposes.

Specimens described below under the heading "Genus and Species Undetermined" have the external aspect of *Triadithyris* but the loop is entirely different from that reconstructed by Pearson.

Vex Hoover, 1979

PLATE 61: FIGURES 16–20

Vex Hoover, 1979:9.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Terebratula semisimplex* (White), 1879:108; 1883:108, pl. 31: fig. 3a–c.

GEOLOGIC OCCURRENCE.—Lower Triassic.

LOCALITY.—Southeastern Idaho.

DISCUSSION.—The exterior of this genus suggests that of *Plectoconcha* but the loop and cardinalia are so different from those of the Upper Triassic *Plectoconcha* that *Vex* must be removed from the subfamily Plectoconchinae. *Plectoconcha* is a fairly large brachiopod from the Upper Triassic (Luning formation) that has a wide, short loop with crural processes opposite the distal openings of the sockets. The crural processes of *Vex* are anterior of the distal opening of the socket and the descending lamellae are long and thin attaining at least ⅔ the dorsal valve length (USNM 242069, Plate 61), quite unlike the short loop of *Plectoconcha*. No specimens of *Vex* in the collection show the full length of the loop and none preserves the ascending branches. Obviously the loop is not that of a terebratulid. There is no median septum in the dorsal valve of *Vex*.

The socket ridges of *Vex* are thin and overhang the sockets and are overlain by the flatly convex or slightly concave outer hinge plates which conceal the crural bases. The crural processes are short but needle-sharp and are located anterior to the outer hinge plates and sockets. The fulcral plates are moderately thick and extend laterally as short shelves.

A single specimen (USNM 551157) shows the transverse band indistinctly and part of the ascending branches but no connection with the descending element was established. The transverse piece makes an angle slightly greater than 90° facing the beak. The angle is located 0.40 mm of the length of the dorsal valve from its beak. This suggests a free loop that is definitely not terebratulid.

The ventral valve has a long excavate pedicle collar and dental plates are lacking. No trace of dental plates was seen in young specimens.

The cardinalia of *Vex* are similar to those of *Portneufia* Hoover (1979) also from the Lower Triassic (Thaynes Formation – Portneuf Member). The socket ridges of *Portneufia* are thin and overhang the sockets and the gently concave outer hinge plates overlie the socket ridges. The fulcral plates are prominent but less extended than those of *Vex*. The loop is long but its transverse band is unknown. A major distinction from *Vex* is the presence of well developed dental plates in the ventral valve. There is no dorsal median septum in *Portneufia*.

Hoover (1979:7) placed *Portneufia* in the Zugmayeriinae where it does not seem at home. Although *Portneufia* has dental plates which are a characteristic of the subfamily, it is lacking in dorsal septal plates and has a long loop unlike that of *Zugmayeria*. Lack of septal plates excludes *Portneufia* from the Dielasmatacea. Its lack of a median septum excludes it from the Aulacothyroideidae which, beside a long loop, has septal plates and a median septum. At present no home seems to exist for *Portneufia*. A similar situation exists for *Vex*.

Although the exterior of *Vex* suggests *Plectoconcha* the loop and cardinalia exclude it from the Plectoconchinae. The loop, which suggests that of *Zeilleria*, is unlike the typically terebratulid loop of *Plectoconcha*. *Vex* has no median septum or dental plates and cannot be assigned to the zeilleriids. At present there is no family to accept it.

Triassic Genus and Species Undetermined 1

PLATE 18: FIGURES 13–15

FAMILY.—Placement uncertain.

SPECIMENS STUDIED.—Three, one with loop.

GEOLOGIC OCCURRENCE.—Upper Triassic.

LOCALITY.—Alaska.

EXTERIOR.—Medium size, nearly circular, unequally biconvex, ventral valve deeper than moderately convex dorsal valve. Sides and anterior margins strongly rounded. Lateral commissure straight; anterior commissure with narrow, gentle uniplication. Beak short, narrow, with strong beak ridges. Foramen moderately large, submesothyridid. Surface smooth; ocasional narrow radial color bands.

INTERIOR.—Pedicle collar not developed. Other details of ventral valve not seen.

Cardinalia and Loop: The cardinal process is narrowly elliptical, moderately elevated, with flattened myophore surface. The socket ridges are thin and inclined; the outer hinge plates are short and concave, narrow and attached to the crural base at its dorsal edge. A high partition is formed by the crural base bounding the inside edge of the outer hinge plate. The crural processes are short but taper rapidly to needle-sharp points and are located at not quite midvalve. The descending lamellae are short and thin. The transverse band is broadly and fairly strongly arched with nicely rounded crest. The terminal points are moderately long.

LOOP STATISTICS.—USNM 551163: ∠ = 44°; Wl/Ll = 0.81; Ll/LD = 0.40; Wl/WD = 0.30; a/Ll = 0.47; b/Ll = 0.53; c/Ll = 0.33; d/Ll = 0.14; e/Ll = 0.24; f/Ll = 0.29; g/WD = 0.18; g/Wl = 0.59; h/f = 0.17; h/Ll = 0.05; WD/LD = 1.04.

USNM 551163: Triassic, Cape Kekurnoi, Cold and Alinchak Bays, Alaska.

DISCUSSION.—The loop of this brachiopod is most suggestive of some Jurassic species with only moderate terminal points. It is suggestive of *Laevithyris* Dagis (1974) but is rounder. The sections of *Laevithyris* were inadequate for preparation of comparative statistics. These indicate a fairly wide loop with modest terminal points. Dagis records the loop of *Laevithyris* as extending one-half the dorsal valve length and with short but distinct flanges (terminal points).

Triassic Genus and Species Undetermined 2

PLATE 61: FIGURES 6–9

FAMILY.—Placement uncertain.

SPECIMENS STUDIED.—Fifteen, one with fair loop.

GEOLOGIC OCCURRENCE.—Upper Triassic.

LOCALITY.—Nevada.

EXTERIOR.—Small, biconvex, subpentagonal with maximum width anterior to midvalve. Ventral valve more convex than dorsal one. Sides rounded. Lateral commissure convex toward ventral side. Anterior commissure sulciplicate; plicae narrow and short, confined to anterior third. Beak suberect; foramen large, mesothyridid. Symphytium visible. Surface smooth.

INTERIOR.—Ventral interior with short pedicle collar; without dental plates.

Cardinalia and Loop: Cardinal process is wide and short. The socket ridges are narrow, erect and the sockets wide. The outer hinge plates are narrow and extended anteriorly along the dorsal edge of the crural base to the cardinal process. The crural bases are moderately elevated along the inner edge of the outer hinge plates. The crural processes are stout and pointed. The transverse band is strongly and fairly evenly arched. The terminal points are short.

LOOP STATISTICS.—USNM 551160a-c: ∠ = 38°; Wl/Ll = 0.82; a/Ll = 0.45; b/Ll = 0.55; c/Ll = 0.45; d/Ll = 0.00; e/Ll = 0.36; f/Ll = 0.19; h/f = 0.05; h/Ll = 0.09; WD/LD = 0.92.

USNM 551160a-c: Upper Triassic, Table Mountain, E of Luning, Hawthorne quadrangle, Nevada.

DISCUSSION.—The specimens on which the above description is based were referred by Muller and Ferguson (1939:1599) to *Terebratula julica* Bittner. Bittner's species is provided with dental plates and thus not related to the Nevada form (Bittner, 1890:125, fig. on 126).

Jurassic TEREBRATULACEA

Animonithyris, new genus

PLATE 34: FIGURES 20-35; PLATE 70: FIGURES 15, 16

SUBFAMILY.—Cererithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula dorenbergi* Felix, 1891:176, pl. 27: fig. 8-8b.

DIAGNOSIS.—Medium sized terbratulaceans with wide loop; length of loop about 2/5 dorsal valve length and width; crural processes at mid-loop.

SPECIMENS STUDIED.—Seventy-five, eight with silicified loops.

GEOLOGIC OCCURRENCE.—Jurassic (Oxfordian).

LOCALITY.—Southern Mexico.

EXTERIOR.—Medium size, subcircular, inequivalve, ventral valve fairly strongly convex, dorsal valve almost flat. Lateral commissure nearly straight; anterior commissure rectimarginate to sulciplicate in adult. Beak short, suberect to erect; beak ridges short, angular; foramen large, mesothyridid to submesothyridid. Deltidial plates small, barely and narrowly conjunct. Surface smooth, some radial lines where decorticated.

TABLE 3.—Loop statistics for the genus *Animonithyris*

Proportions	USNM 550999a	USNM 550999b	USNM 550999c	USNM 550999d	USNM 550999e
∠	49°	52°	52°	58°	50°
Wl/Ll	0.93	0.93	0.91	1.00	0.88
Ll/LD	0.40	0.29	0.37	0.37	0.36
Wl/WD	0.38	0.39	0.38	0.32	0.38
a/Ll	0.50	0.50	0.55	0.50	0.46
b/Ll	0.50	0.50	0.45	0.50	0.54
c/Ll	0.36	0.43	0.37	0.39	0.38
d/Ll	0.14	0.07	0.18	0.11	0.08
e/Ll	0.21	0.21	0.18	0.25	0.23
f/Ll	0.29	0.29	0.27	0.25	0.31
g/WD	0.26	0.33	0.27	0.27	0.33
g/Wl	0.69	0.77	0.78	0.71	0.87
h/f	0.52	0.20	0.37	0.28	0.35
h/Ll	0.15	0.06	0.10	0.07	0.10
WD/LD	0.97	0.92	0.87	1.05	0.83

USNM 550999a-e: *Animonithyris dorenbergi* (Felix), Jurassic (Oxfordian), 5 km W of Tlaxiaco, Oaxaca, southern Mexico.

INTERIOR.—Ventral valve interior with short, excavated pedicle collar. Other details obscure.

Loop and Cardinalia: The loop is widely triangular, nearly as wide as long and occupies two-fifths of the length and almost the same of the width of the dorsal valve. The cardinal process is wide, flattened, forming a half ellipse, slightly bilobed with concave myophore that faces posteriorly. The fulcral plates are well individualized and slightly extended laterally. The socket ridges are slender, inclined laterally and bound narrow sockets. The outer hinge plates are narrow, concave and end abruptly at the fulcral plate, occasionally with a short low anterior rib. The crural bases are strongly elevated and form a high rim along the inside edge of the outer hinge plates, to form with the socket ridges, a narrowly U-shaped trough. The crus is broad, flat, and short. The crural processes are sharp anteromedially directed points. They are located just anterior to the junction of the fulcral plates and outer hinge plates. The descending lamellae are short, moderately broad ribbons, gently bowed laterally and support a fairly wide transverse band, which is flattened medially for about one-third the width of the loop. The terminal points are short and subangular with short webs.

Loop Statistics.—See Table 3.

Discussion.—The loops of *Animonithyris* and *Mexicaria* are similar but the strong costation of the latter is a significant generic difference. The loop is similar to that of *Habrobrochus* from the Kimmeridgian of Germany but is somewhat narrower with less bulging sides and stouter transverse band. Externally the Mexican shells are rounder and with barely conjunct deltidial plates.

Etymology.—From the Greek *aneimon* (naked).

Apatecosia, new genus

Plate 32: figures 18–23, 28, 29; Plate 41: figures 22–27; Plate 71: figures 1, 2

Subfamily.—Lissajousithyridinae, new subfamily.

Type-species.—*Cererithyris nutiensis* Bague, 1955: 219, pl., fig. 2a–c.

Diagnosis.—Medium sized, oval, moderately sulciplicate; beak elongate, narrow, labiate; foramen mesothyridid; loop not reaching midvalve, crural processes posterior of midloop; transverse band narrowly arched, moderately protuberant.

Table 4.—Loop statistics for the genus *Apatecosia*

Proportions	USNM 550987a	USNM 550991b	USNM 551006b
∠	41°	36°	41°
Wl/Ll	0.74	0.67	0.75
Ll/LD	0.44	0.44	0.45
Wl/WD	0.39	0.32	0.35
a/Ll	0.44	0.43	0.44
b/Ll	0.56	0.57	0.56
c/Ll	0.37	0.39	0.35
d/Ll	0.07	0.04	0.09
e/Ll	0.15	0.11	0.13
f/Ll	0.41	0.46	0.43
g/WD	0.39	0.29	0.31
g/Wl	0.91	0.90	0.88
h/f	0.27	0.24	0.25
h/Ll	0.11	0.11	0.11
WD/LD	0.85	0.92	0.96

USNM 550987a: *Apatecosia nutiensis* (Bague), Jurassic (Callovian - *Macrocephalites macrocephalus* Zone), quarry at La Cude near Velars, on route La Cude-Cocelles, Côte d'Or, France.

USNM 550991b and 551006b: Same as above.

Specimens Studied.—Seventeen, three excavated to show loop, one with cardinalia only.

Geologic Occurrence.—Jurassic (Callovian).

Locality.—France.

Exterior.—Medium size, subtriangular to subpentagonal, maximum width near or anterior to midvalve. Unequally convex, ventral valve having greater convexity and depth. Anterolateral margins rounded, posterolateral margins long, oblique and forming an acute angle. Lateral commissure nearly straight, narrowly convex toward the ventral side in the anterior quarter; anterior commissure sulciplicate to episulcate, the plication confined to the anterior third. Beak moderately long, suberect to erect, labiate, with poorly defined beak ridges. Foramen medium size, mesothyridid to permesothyridid. Symphytium partially visible. Surface smooth.

Interior.—Ventral valve interior not seen.

Loop and Cardinalia: The cardinal process is a small half elliptical shelf with myophore directed posteroventrally. The socket ridges are erect, thin plates bounding narrow sockets. The fulcral plate was not clearly seen but must be small and narrow without conspicuous development of a lateral ridge. The outer hinge plates are short and narrow and attach to the dorsal edge of the wide crural base. This latter plate forms a conspicuous wall along the inner margin of the outer hinge plates, and with the socket ridge, forms a short narrow U or wide V-shaped trough. The dorsal surface of the outer hinge plates is situated close to the valve floor, forming a shallow umbonal chamber. The crural processes are posterior to midloop and are drawn into long sharp points. The descending lamellae are moderately long and slightly bowed. The terminal points are long and widely webbed, producing a wide transverse ribbon where the band and descending lamellae meet. The transverse band is a narrow arch, nearly vertically sided where it is wide, then narrows on the flattened crest or bridge which occupies about a quarter of the loop width.

Loop Statistics.—See Table 4.

Discussion.—This genus differs from *Cererithyris* in its exterior and interior details. The exterior folding is much stronger and the loop differently proportioned, the crural processes are slightly farther posteriorly, the transverse band is wider with its crest nearer the crural processes and the terminal points longer than *Cererithyris*. The transverse band is less protuberant and directed at a higher angle from the horizontal than that of *Cererithyris*. Almeras (1971:406) gives a long and detailed comparison of the interior details of "*C.*" *nutiensis* Bague with specimens assigned by him to *Cererithyris* based on serial sections. He concludes that "*C.*" *nutiensis* cannot be referred to *Cererithyris*.

ETYMOLOGY.—From the Greek *apate* (deceit).

Arcelinithyris Almeras, 1971

PLATE 28: FIGURE 23; PLATE 45: FIGURE 25; PLATE 46: FIGURES 12–15; PLATE 54: FIGURE 27; PLATE 71: FIGURES 17, 18

Arcelinithyris Almeras, 1971:173.

SUBFAMILY.—Lissajousithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula arcelini* Lissajous, in Arcelin and Roché, 1936:83, pl. 6: figs. 1–6; pl. 14: figs. 11, 12. Almeras, 1971:175, pl. 1: figs. 1–3; pl. 2A–B; pl. 3A–B; pl. 4A–B.

SPECIMENS STUDIED.—Five including three with silicified loops.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITY.—France.

EXTERIOR.—About medium size, elongate oval with gently rounded sides and rounded anterior margin; unequally biconvex, ventral valve with more convexity than dorsal one. Lateral commissure nearly straight; anterior commissure rectimarginate. Beak suberect, labiate. Foramen large, permesothyridid. Symphytium visible. Surface smooth.

INTERIOR.—Ventral valve interior with narrow elongate teeth and short pedicle collar. Other details not visible.

Loop and Cardinalia: The loop is elongate triangular like that of *Lissajousithyris*. It is nearly twice as long as wide and occupies half the length and a third the width of the dorsal valve. The cardinal process is small, narrowly elliptical and has the myophore facing posteroventrally. The socket ridges are thin and incline slightly laterally to bound long narrow sockets. The fulcral plates are stout and are continued laterally for a short distance. The outer hinge plates are triangular, moderately wide, nearly flat and are continued anteriorly as a narrow ridge along the dorsal edge of the crural base to terminate at the base of the crural processes. The crural bases are broad and flat and make a wall along the inside margin of the outer hinge plates to form short U-shaped troughs. The crural processes are located posterior to the middle of the loop and are narrow and extended into short, sharp points. The descending lamellae are thin, flat ribbons of moderate length and are produced into long, webbed terminal points. The transverse band is a high arch, medially flattened for about a third the width of the loop. The attachment of the descending branch is a long narrow web. The terminal points are sharply angular.

LOOP STATISTICS.—See Table 5.

TABLE 5.—Loop statistics for the genus *Arcelinithyris*

Proportions	USNM 551038a	Arcelin and Roché 1936	Almeras 1971
∠	27°	25°	26°
Wl/Ll	0.43	0.47	0.35
Ll/LD	0.45	0.52	0.52
Wl/WD	0.31	0.35	0.33
a/Ll	0.40	0.40	0.38
b/Ll	0.60	0.60	0.62
c/Ll	0.33	0.27	0.23
d/Ll	0.07	0.13	0.15
e/Ll	0.17	0.20	0.19
f/Ll	0.43	0.40	0.43
g/WD	0.28	0.30	0.27
g/Wl	0.92	0.86	0.89
h/f	0.23	0.18	?
h/Ll	0.10	0.07	?
WD/LD	0.64	0.70	0.74

551038a: *Arcelinithyris arcelini* (Lissajous), Jurassic (Bajocian), quarry La Roche-Vineuse, Monsard, Saône-et-Loire, France.

Arcelin and Roché (1936, pl. 41: fig. 11) and serial sections by Almeras (1971, pl. 4A) from same place as above.

DISCUSSION.—The loop of *Arcelinithyris* is similar to that of *Lissajousithyris* with which it occurs. The loop of the latter however is longer and wider and with longer terminal points. In exterior details *Lissajousithyris* differs from *Arcelinithyris* in having a uniplicate to sulciplicate anterior commissure. The loop of *Arcelinithyris* resembles the loop of *Inaequalis* Sučić-Protić but differs in having much longer terminal points and a somewhat wider angle.

Arceythyris Rollet, 1964

PLATE 63: FIGURE 8

Arceythyris Rollet, 1964:38.—Contini and Rollet, 1970:40–42.—Almeras, 1971:382.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula diptycha* Oppel, 1856–58:496, Number 91.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian-Callovian).

LOCALITY.—France, Germany, and Switzerland.

EXTERIOR.—Abstracted from Almeras (1971:384) revised generic description. Small to medium, biconvex, subpentagonal beak feebly or not laterally carinated, short, gently recurved. Symphytium hidden. Foramen permesothyridid, circular, small to medium. Lateral commissure oblique, recurving toward dorsal valve anteriorly. Anterior commissure uniplicate in young, a short sulciplicate stage not preceded by uniplication and rapidly followed by a well developed episulcate stage producing a more or less marked anterior ventral tongue. Dorsal lateral plications often close set and prominent. Muscle imprints filiform and feebly divergent under the beak, anteriorly enlarged and divergent. Euseptoidum present.

INTERIOR.—Collar peduncular. Cardinal process plano-convex, grooved or not posteriorly, prominent, smooth, plano-convex or grooved or well elevated and grooved anteriorly. Hinge plates club-shaped, then a shallow V, poorly differentiated from the socket ridges. Crural bases little elevated. Plane of articulation well marked; denticles without accessory cavities. Crural processes more often vertical and with carinate bases. Presence of a euseptoidum not constant, always reduced. Transverse band horizontal. Length of brachidium 0.40–0.50.

LOOP STATISTICS.—See Table 6.

DISCUSSION.—Almeras places *Terebratula lingui-fera* Davidson in this genus. The same species is claimed as an example of *Neumayrothyris* by Tokuyama (1958b). These assignments are based on exterior details only. See *Stenogmus* for further comparisons).

TABLE 6.—Loop statistics for species of *Arceythyris*

Proportions	Almeras, 1971	Contini and Rollet, 1970
∠	37°	42°
Wl/Ll	0.74	0.78
Ll/LD	0.44	?
Wl/WD	0.36	?
a/Ll	0.42	0.49
b/Ll	0.58	0.51
c/Ll	0.24	0.39
d/Ll	0.18	0.10
e/Ll	0.25	0.22
f/Ll	0.33	0.29
g/WD	0.32	?
g/Wl	1.50	0.51
h/Ll	?	0.02
h/f	?	0.07
WD/LD	0.98	?

Almeras (1971, pl. 70A, B serial sections): *Arceythyris pseudoglobata* (Muir-Wood) Jurassic (Middle Bathonian – zone with *subconractus*, zone with *morrisi*), Trept, Isere, France.

Contini and Rollet (1970:40, fig. 3 – reconstruction): *Arceythyris diptycha* (Oppel); Jurassic (Callovian Varians Beds), Arcey, Doubs, France.

Argovithyris Rollet, 1972

PLATE 63: FIGURES 14, 17

Argovithyris Rollet, 1972:95.—Boullier, 1976:314–316.

SUBFAMILY.—Lophrothyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula birmensdorfensis* Moesch, 1867:312, pl. 6: fig. 5a–f.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Callovian and Oxfordian).

LOCALITIES.—France, Germany, and Switzerland.

DIAGNOSIS (Rollet, 1972).—Biconvex, of small size; beak strongly incurved, in contact or nearly so with the dorsal umbo. Foramen small, epithyridid, often labiate. Anterior commissure rectimarginate, then uniplicate to feebly sulciplicate.

Pedicle collar present. Cardinal process poorly developed, low, short, generally with smooth surface. Hinge plates thin and flat, with internal margin sharp and carinate. Crura arched in the form of a parenthesis, less elevated (height compared to thickness (e) of the shell, cr/e = 0.10–0.13). Jugum [j = transverse band] straight laterally, long from the posterior toward the anterior, with summit very low (relative height j/e = 0.04–0.07). Points [crural processes] curved, subparallel with external lateral margins almost nil.

TABLE 7.—Loop statistics for *Argovithyris birmensdorfensis* (Moesch)

Proportions	Rollet, 1972, fig. 7	Rollet, 1972, fig. 8	Boullier, 1976
∠	26°	26°	18°
Wl/Ll	0.37	0.50	0.33
Ll/LD	0.31	0.29	?
Wl/WD	0.17	0.17	?
a/Ll	0.56	0.45	0.54
b/Ll	0.44	0.55	0.46
c/Ll	0.40	0.38	0.34
d/Ll	0.16	0.07	0.20
e/Ll	0.11	0.23	0.21
f/Ll	0.33	0.32	0.25
g/WD	0.27	0.21	?
g/Wl	1.54	1.27	?
h/f	0.33	0.41	?
h/Ll	0.11	0.13	?
WD/LD	0.67	0.88	?

Rollet (1972, fig. 7 – reconstruction): Jurassic (Callovian), Birmensdorf, Argovie, Switzerland.

Rollet (1972, fig. 8 – reconstruction): Jurassic (Callovian), Indrieux, near Arandas, Ain, France.

Boullier (1976:316, fig. 170b – reconstruction): Jurassic (Callovian), Birmensdorf, Argovie, Switzerland.

Length of the brachidium: 0.35–0.40 of the dorsal valve [length].

LOOP STATISTICS.—See Table 7.

DISCUSSIONS.—The reconstructions were made on serial sections of three different appearing specimens, the first and last topotypes from Birmensdorf, Switzerland, the second from Arandas, France. The first is more oval than the Arandas specimen which is rather triangular. Although the two loops are similar in aspect their details are different, especially the position of the crural processes. The transverse band is unusually broad in all three reconstructions, an unusual condition in the Jurassic.

For comparison of the loop of *Argovithyris* with that of *Dolichobrochus*, new genus, and *Karadagella* Babanova, see below.

Aromasithyris Almeras, 1971

PLATE 46: FIGURES 1–10; PLATE 71: FIGURES 15, 16

Aromosithyris Almeras, 1971:544.—Boullier, 1976:172–180.

SUBFAMILY.—Lophrothyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula balinensis* Szajnocha, 1879:203, pl. 2: figs. 1–6.

SPECIMENS STUDIED.—Forty-five, two excavated to show loop.

GEOLOGIC OCCURRENCE.—Jurassic (Callovian).

LOCALITIES.—France, Poland, Germany, Portugal, and Russia.

DISCUSSION.—Boullier (1976:172) points out that Almeras (1971) endeavored to make a neotype of one of his specimens from France, because of failure to locate Szajnocha's types, which came from Poland. This citation of a neotype was invalid because choice of a neotype (ICZN, 1961, Article 75) requires, among other stipulations, that the author of the neotype must make certain of the loss of the original type and must select a topotype or a specimen from as close to the type locality and formation as possible. Boullier (1976) discovered Szajnocha's types, thus making Almeras' selection unnecessary.

Boullier (1976, pl. 5: figs. 1–5) figures Szajno-

TABLE 8.—Loop statistics for the genus *Aromasithyris*

Proportions	USNM 75952b	USNM 551042b	Almeras, 1971	*Boullier, 1976, fig. 85	Boullier, 1976; fig. 98
∠	28°	26°	30°	30°	32°
Wl/Ll	0.55	0.48	0.47	0.59	0.48
Ll/LD	0.51	0.54	0.44	?	0.59
Wl/WD	0.26	0.28	0.26	?	0.32
a/Ll	0.41	0.52	0.46	0.47	0.44
b/Ll	0.59	0.48	0.54	0.53	0.56
c/Ll	0.41	0.52	0.22	0.30	0.24
d/Ll	0.00	0.00	0.24	0.17	0.20
e/Ll	0.14	0.13	0.24	0.18	0.15
f/Ll	0.45	0.35	0.30	0.35	0.41
g/WD	0.27	0.28	0.24	?	0.28
g/Wl	1.17	1.00	0.91	?	0.75
h/f	0.15	0.14	0.13?	?	0.12
h/Li	0.07	0.05	0.04?	?	0.05
WD/LD	0.87	0.76	0.91	?	0.76

* Measurements of specimen not given.

USNM 75952b: *Aromasithyris balinensis* (Szajnocha), Jurassic (Callovian), Balin, near Cracow, Poland.

USNM 551042b: *Aromasithyris balinensis* sensu Almeras [not Szajnocha] (= *A. almerasi* Boullier), Jurassic (Callovian – *koenigi* Zone), Vercra, near Marchampt, Ain, France.

Almeras, 1971:552, pl. 198: Same as above.

Boullier (1976:174, fig. 85): *Aromasithyris balinensis* (Szajnocha), Jurassic (Callovian), Balin, near Cracow, Poland.

Boullier (1976:195, fig. 98): *Aromasithyris haasi* Boullier, Jurassic (Lower Oxfordian), Renggeri Marl of Pont-au-Diable, Ste. Anne, Doubs, France.

cha's syntypes of *T. balinensis* from Balin. She recommended that Almeras' specimen, misidentified as *A. balinensis* (Almeras, 1971:548, pl. 190: fig. 4) be renamed *A. almerasi* Boullier. Statistical studies by Boullier showed that variation exists between the Polish and French specimens, also shown here by study of the loops. Sufficient similarities also exist that led her to believe that a widened definition of *Aromasithyris* would embrace the deviations shown from Early Callovian to Early Oxfordian. In the list of species assigned to *Aromasithyris*, however, Boullier fails to list *A. balinensis* (Szajnocha).

Boullier's emended diagnosis of *Aromasithyris* follows: Shell of medium size, of pentagonal to subpentagonal outline with valves generally slightly swollen. Beak medium, recurved at a right angle, more or less completely hiding deltidium. Foramen circular or oval, may be crested or labiate, permesothyridid. Anterior commissure low, uniplicate to feebly sulciplicate to paraplicate; plications sharp or rounded, diverging, separated by a more or less wide and deep depression; plication marks the edge of the valves which is more or less sharp.

Pedicle collar present. Cardinal process low and short, denticulate, sometimes a little elevated at front. Umbonal cavity facultative. Hinge plates often flat and thin with small crural bases slightly developed, sharp, may be carinate anteriorly, socket ridges a little prominent. Crural processes parallel to subparallel with carinate bases thickened or flattened ventrally. Loop 30%–40% of dorsal valve length.

In my study a specimen from Vercra, France and one from Balin, Poland were excavated to show the loop. The specimen from Vercra and statistics from one of the French specimens sectioned by Almeras (1971:552, pl. 197: fig. 1), has the loop occupying nearly 50% of the dorsal valve length and not quite a third of its width. The crural processes are located posterior of midloop. Taper of the outer hinge plate along the dorsal edge of the crural base extends to the crural processes. The terminal points are long.

The specimen from Balin, Poland (USNM 75952b) deviates slightly in loop dimensions from that of Vercra. The loop angle is somewhat less and the loop proportion Wl/Ll is less. The crural processes are slightly anterior to midloop rather than posterior as in the Vercra specimen. There is a long taper of the outer hinge plates along the dorsal edge of the crural bases to the crural processes. The terminal points of the Balin specimen are slightly shorter than those of the excavated Vercra specimen.

LOOP STATISTICS.—See Table 8.

COMMENTS.—*Aromasithyris* strongly resembles *Dorsoplicathyris*, especially the Vercra specimens which are closer internally to that genus than the Balin specimen. Similarities appear in the shallow umbonal cavity, hinge plates and more bulging loop. Externally the excavated specimen from Vercra is more like *Aromasithyris* from Balin in its paraplicate anterior commissure. See discussion of *Dorsoplicathyris*. Boullier (1976:173) suggests a possible affinity of *Aromasithyris* to *Perrierithyris* Almeras (1971). The loop statistics of the two are not in complete accordance.

In summary, Boullier's discovery of the syntypes of *Terebratula balinensis* Szajnocha makes Almeras' attempt at fixing a type for the species unnecessary. Almeras' naming of Szajnocha's species from Balin is regarded as having fixed the type species of *Aromasithyris*.

Avonothyris Buckman, 1917

PLATE 39: FIGURES 7–15; PLATE 48: FIGURES 1–10; PLATE 74: FIGURES 13, 14

Avonothyris Buckman, 1917:102.—Muir-Wood, 1965:H777.

SUBFAMILY.—Loboidothyridinae Makridin, 1964.

TYPE-SPECIES.—*Avonothyris plicatina* Buckman, 1917:102, pl. 21: fig. 9a–c.

SPECIMENS STUDIED.—Forty-three specimens of three species, two with complete loop, one of them the type species, two with cardinalia only.

GEOLOGIC OCCURRENCE.—Jurassic (Bathonian).

LOCALITY.—Great Britain.

EXTERIOR.—Small to fairly large, subtriangular to subpentagonal. Maximum width at or near midvalve; inequivalve, ventral valve having greater convexity. Dorsal umbo in type species narrowly sulcate. Lateral commissure straight except for anterior third where it is narrowly convex ventrally. Anterior commissure sulciplicate. Beak short, suberect. Foramen large, permesothyridid; symphytium partially visible. Dorsal umbonal chamber shallow. Surface with concentric growth lines and radial capillae where exfoliated.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The cardinal process is a small semi-elliptical shelf facing posteriorly. The

TABLE 9.—Loop statistics for the genus *Avonothyris*

Proportions	USNM 129176a	USNM 551013a	USNM 551115
∠	40°	42°	46°
Wl/Ll	0.87	0.83	0.92
Ll/LD	0.46	0.40	0.41
Wl/WD	0.47	0.37	0.37
a/Ll	0.58	0.63	0.63
b/Ll	0.42	0.37	0.37
c/Ll	0.48	0.50?	0.50
d/Ll	0.10	0.13?	0.13
e plus f/Ll	0.42	0.37	0.37
e/Ll	?	0.14	0.10
f/Ll	?	0.23	0.27
g/WD	0.37	0.28	0.30
g/Wl	0.78	1.04	0.82
h/f	?	0.43	0.15
h/Ll	?	0.10	0.04
WD/LD	0.87	0.90	1.00

USNM 129176a: *Avonothyris langtonensis* (Davidson), Jurassic (Bathonian – Great Oolite), Langton Herring, Dorsetshire, England.

USNM 551013a: *A. bradfordensis* (Davidson), same as above.

USNM 551115: *A. plicatina* Buckman, Jurassic (Bradfordian), Bradford-on-Avon, Wiltshire, England.

socket ridges are thin, curved, erect and bound narrow sockets. The fulcral plates are thin. The outer hinge plates are close to the valve floor, very narrow and attached to the dorsal edge of the crural bases, and with the socket ridges they form deep V-shaped troughs. The outer hinge plates taper almost to the crural processes. The crural bases form a high ridge along the inside edge of the outer hinge plates. The crural bases expand into moderately broad crural processes that are drawn into needle-like points (lost in USNM 551013a, but present in 551015b and 551115) that are directed anteroventrally and slightly medially. The descending lamellae are fairly broad, short and straight to slightly bowed. The transverse band is a low arch with narrowly to moderately broad ribbon. The sides of the arch are moderately steep and the median portion for about ¼ the loop width is flattened and protuberant. The transverse band is nearly horizontal in side view. The terminal points are short and acute.

LOOP STATISTICS.—See Table 9.

DISCUSSION.—The preparation of the loop of *A. bradfordensis* (Davidson) (USNM 551013a) is imperfect in the outer hinge plates but the form of the loop is intact. The outer hinge plates are very thin and close to the valve floor and were mostly lost in the preparation. The hinge plates are well shown in the preparation of *A. langtonensis* (Davidson) (USNM 129176a) which exhibits their long taper. The preparation of *A. plicatina* Buckman (USNM 551115) shows not only the well-developed outer hinge plates, but also the very long, needle-sharp crural processes. These were lost in the preparation of specimens from Langton Herring. The loop of *A. plicatina* has more laterally bowed descending lamellae than those of *A. bradfordensis*.

Almeras (1971:409) noted similarity of *Avonothyris* to *Cererithyris* in comparing a French specimen (pl. 84: fig. 4) with *A. plicatina*. One difference in the exterior noted is the presence in *A. plicatina* of a narrow sulcus in its dorsal umbo, which is lacking in *Cererithyris*. Almeras (p. 409) says that "*Avonothyris plicatina* Buckman only differs from [*Cererithyris*] *intermedia* (Sow.) by the existence of a groove on the dorsal umbo corresponding to an initial sinuate stage, absence of an intermediate uniplicate stage in the course of the ontogeny of the anterior commissure, and in a dorsal median sulcus in a deeper V (compare Buckman (1917, pl. 20: fig. 9c, and Almeras 1971, pl. 84: fig. 4). The other morphological characters are common. The internal structures do not present, in our existing knowledge, very clear differences."

When the exposed loops of *Avonothyris* and *Cererithyris* are compared significant differences can be seen in shape, crural processes, and transverse band. The loop angles differ, that of *Avonothyris* being the greater and forming a triangle. The loop of *Cererithyris* is bowed laterally and has only a vaguely triangular shape. The crural processes of *Avonothyris* are located more anteriorly than those of *Cererithyris* and they are drawn into needle-like points that face anteromedially. The crural processes of *Cererithyris* are acute but are not drawn into needle-like points. The transverse band of *Cererithyris* is medially more protuberant than that of *Avonothyris* and extends to the ends of the crural processes. The crural processes of *Avonothyris* protrude beyond the transverse band.

Stroudithyris Buckman (1917) resembles *Avonothyris* in its exterior and folding but differs in having a less erect beak and large foramen in a beak that conceals the symphytium. The loops are similar in form with loop dimensions close but the crural processes of *Avonothyris* are farther anterior in the loop than those of *Stroudithyris*, and are much more attenuated. This arrangement makes for much longer terminal points in *Stroudithyris*.

Ovcharenko (1967) doubts the independent status of *Avonothyris* and implies close relationship to *Kutchithyris*.

Bejrutella Tchorszhevsky, 1972

Bejrutella Tchorszhevsky, 1972:40.

SUBFAMILY.—Tchegemithyridinae Tchorszhevsky, 1972.

TYPE-SPECIES.—*Bejrutella bejrutica* Tchorszhevsky, 1972:40, fig. 2.

GEOLOGIC OCCURRENCE.—Jurassic (Oxfordian).

LOCALITY.—Lebanon and Syria.

DESCRIPTION (Tchorszhevsky, 1972).—Biconvex, oblong-pentagonal, with sharply biplicate anterior commissure. Beak long, thick, and rather curved, touching the surface of the dorsal valve. Outer hinge plates of medium width, equal in cross-section. Their orientation changes from horizontal in the apex of the valve to convergent [?] ventrally toward the anterior margin. Crural processes are high, long, originate near the anterior margin of the hinge plates. Their lower halves are located vertically and the upper are separated (fig. p. 39). The loop extends ⅖ of the length of the dorsal valve; the loop flanges are long, rounded terminations. The transverse band is narrow, arranged perpendicularly to the growth plane of the loop.

COMPARISON (Tchorszhevsky, 1972).—From the similarly internally structured genus *Turkmenithyris*, it is distinguished by a sharply biplicate anterior commissure, somewhat elongate loop, equal but differently oriented outer hinge plates. From the genus *Tchegemithyris* it is distinguished by a shorter loop and its flanges equal, but differently oriented hinge plates, simple transverse band and sharply bifurcate anterior margin.

COMMENT.—Tchorszhevsky's serial sections show an incomplete loop.

Bihenithyris Muir-Wood, 1935

PLATE 31: FIGURES 17–23; PLATE 45: FIGURES 19–24; PLATE 53: FIGURES 26–31; PLATE 73: FIGURES 19, 20

Bihenithyris Muir-Wood, 1935:110; 1965:H777.

SUBFAMILY.—Loboidothyridinae Makridin, 1964.

TYPE-SPECIES.—*Bihenithyris barringtoni* Muir-Wood, 1935:111, figs. 12, 13 pl. 12: fig. 7a-c; (serial sections extend only to crural processes. No distance between sections given.)

SPECIMENS STUDIED.—Sixteen, three loops prepared. All specimens from Israel.

GEOLOGIC OCCURRENCE.—Jurassic (Callovian).

LOCALITY.—Somali Republic and Israel.

TABLE 10.—Loop statistics of the genus *Bihenithyris*

Proportions	USNM 550985b	USNM 551058b	USNM 551117a
∠	36°	30°	34°
Wl/Ll	0.68	0.62	0.66
Ll/LD	0.44	0.46	0.40?
Wl/WD	0.36	0.34	0.32
a/Ll	0.58	0.57	0.47
b/Ll	0.42	0.43	0.53
c/Ll	0.58	0.57	0.47
d/Ll	0.00	0.00	0.00
e/Ll	0.14	0.19	0.21
f/Ll	0.28	0.24	0.32
g/WD	0.39	0.37	0.32
g/Wl	1.08	1.08	1.04
h/f	?	0.25	?
h/Ll	?	0.06	?
WD/LD	0.83	0.85	0.84?

USNM 550985b: *Bihenithyris* sp., Jurassic (Callovian Zohar Shale, near base), NW side of Hamektesh, Hagadol, southern Israel.

USNM 551058b: *B. weiri* Muir-Wood, Jurassic (Middle Callovian – *Eligmus* Beds) Mahktesh, Hathira, Kurnub, Israel.

USNM 551117a: *B.* aff. *B. barringtoni* Muir-Wood, Jurassic (Callovian subunit 23, unit III – *Eligmus* – *Erymnoceras* Beds, 40 m above base), same as above.

EXTERIOR.—Medium size, biconvex, ventral valve deeper than dorsal valve; elongate pentagonal; maximum width near or slighly anterior to midvalve. Lateral margins oblique posteriorly, curved toward dorsal valve at anterior. Anterior commissure strongly sulciplicate. Beak suberect, truncated, labiate, without beak ridges. Foramen large, round, permesothyridid. Symphytium partially exposed. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is moderately long and narrow, occupying nearly half the dorsal valve length and slightly more than a third its width. The cardinal process is wide laterally but short in the longitudinal direction. The socket ridges are thin and erect and bound narrow sockets. The outer hinge plates are moderately wide and have a long taper almost to the crural processes and are attached to the dorsal edge of the crural base. This forms a wall along the inside edge of the outer hinge plate and with the socket ridge makes a deep U-shaped trough. The crural processes are broad, erect and drawn to sharp points (broken off in one excavated specimen). The descending lamellae are short, narrow and slightly bowed. The transverse band is a narrow arch, wide at its base, narrowing rapidly to the crest or bridge. The transverse band is directed ventrally at a low angle from the horizontal.

Loop Statistics.—See Table 10.

Discussion.—Specimens received from Israel are herein referred to *Bihenithyris* although the specimens are smaller than Muir-Wood's types. One lot conforms to the type, *Bihenithyris barringtoni*, in its strong biplication and in the large pedicle opening in an erect or semierect beak that reveals the symphytium. Muir-Wood's (1935:112, fig. 13) serial sections do not reveal the nature of the transverse band because they were taken only as far as the probable crural processes. The sections show slender inclined socket ridges and outer hinge plates flat proximally that become concave anteriorly. The loop is said to be short, less than half the dorsal valve length, a feature not shown by the serial sections. The Israeli specimens show the loop reaching nearly to midvalve.

The chief feature of the loops of the three Israeli specimens is the nearly horizontal transverse band and fairly short terminal points. The three specimens placed here are variable: USNM 551117a has the crural processes located slightly posterior to the others. The terminal points of USNM 550985b and 551058b are shorter than those of the other. There is fair agreement in the loop angle and the proportional width to length of the loop. The proportions of the various parts of the loop to loop length are in fair agreement.

The loop of *Bihenithyris* as shown by these Israeli shells is like that of *Apatecosia* but that genus has a loop with narrower angle. The loop of *Striithyris*, with its nearly horizontal transverse band, is similar to that of *Bihenithyris*, but its loop angle is smaller, the crural processes are more posterior and the outer hinge plates are shorter. There is a resemblance to the loop of *Stiphrothyris* but that genus has a wider loop angle and more anterior crural processes than those of the Israeli *Bihenithyris*.

Bothrothyris, new genus

Plate 37: figures 25–27; Plate 60: figure 1; Plate 69: figures 14, 15

Subfamily.—Bothrothyridinae, new subfamily.

Type-Species.—*Bothrothyris curiosa*, new species.

Diagnosis.—Large concavo-convex, sulcate terebratulacean suggesting *Pseudoglossothyris* externally but with broad-ribboned loop having round, solid crural bases and thick-shafted, bilobed cardinal process and strong median ridge.

Specimens Studied.—One silicified specimen revealing the loop.

Geologic Occurrence.—Jurassic (Callovian).

Locality.—Egypt.

Exterior.—Roundly rhomboidal, maximum width at midvalve; valves unequal in depth; dorsal valve gently concave, ventral valve subcarinate; anterior profile concavo-convex. Lateral commissure nearly straight; anterior commissure broadly sulcate. Dorsal valve with broad median sulcus, deepening anteriorly. Beak short, incurved; foramen small, mesothyridid; deltidial plates vestigial (?). Surface smooth.

Interior.—No dental plates.

Loop and Cardinalia: The loop is narrowly triangular and occupies about 40% of the length and a third the width of the dorsal valve. The cardinal process is thick bilobed and with short shaft tapering anteriorly. The socket ridges, are short, thick, inclined; the fulcral plates are thick but obsolescent by deposition of adventitious shell on their surfaces. The outer hinge plates are short, narrow and gently concave. The crural bases are partly covered by the cardinal process. The crura are long, narrow, rounded with a depression in their ventrad surface that extends almost to the crural processes. These are narrow and drawn into long needle-sharp points directed anteromedially. The descending lamellae are long, thin, rotating from vertical to horizontal anteriorly.

The transverse band is a broad, narrowly rounded arch with narrow crest. The transverse band is deflected about 30° from the vertical. The terminal points are rounded, not strongly extended and form an angle of about 50° with the side of the loop.

LOOP STATISTICS.—USNM 551007: ∠ = 34°; Wl/Ll = 0.79; Ll/LD = 0.40; Wl/WD = 0.30; a/Ll = 0.55; b/Ll = 0.45; c/Ll = 0.32; d/Ll = 0.23; e/Ll = 0.14; f/Ll = 0.31; g/WD = 0.20; g/Wl = 0.59; h/f = 0.32; h/Ll = 0.09; WD/LD = 0.93.

USNM 551007: *Bothrothyris curiosa*, new species, Jurassic (Callovian), 30°40′N, 32°22′E, Gebel Maghara, northern Sinai, Egypt.

DISCUSSION.—The loop of *Bothrothyris* is unusual in its crural bases that attach the loop to the hinge plate. These are very narrow and can be divided into an outer ridge representing the anterior extension of the hinge plate and an inner ridge representing the crural base. The loop of *Pseudoglossothyris* is unlike that of *Bothrothyris* in having broad crural bases, more widely bowed descending lamellae, stronger terminal points and a more protuberant transverse ribbon with prominent median flattening. The loop of *Bothrothyris* is unlike any described in this monograph.

ETYMOLOGY.—From the Greek *bothros* (a trench) plus *thyris* (opening).

Bothrothyris curiosa, new species

PLATE 37: FIGURES 25–27

DIAGNOSIS.—Large terbratulacean having the form and outline of *Pseudoglossothyris* but differing in having smaller foramen, less development of deltidial plates, strong median ridge and completely different loop.

DESCRIPTION.—Exterior as for the genus. Ventral valve subcarinate, umbonal region narrowly subcarinate, angularity continued anteriorly, widening to broad fold with anterior shallow reentrant at anterior margin. Sides sloping steeply to margins. Interior without dental plates.

Dorsal valve sulcus broad, shallow, widening anteriorly as it deepens. Posterolateral flanks gently rounded; anterior forming short rounded tongue to fit ventral valve reentrant. Muscle scars not preserved; median ridge strong. Interior as for genus.

MEASUREMENTS (in mm).—Holotype: length 60; dorsal valve length 54; width at midvalve 50; thickness about 25; apical angle 85°.

OCCURRENCE.—as for genus.

HOLOTYPE.—USNM 551007.

DISCUSSION.—This species suggests *Pseudoglossothyris? sulcata* Muir-Wood (1935:121, pl. 13: fig. 6a–c) from the Somali Republic in its general appearance. The species in question is smaller, has a deeper sulcus and a completely different interior from that of *Bothrothyris*. A specimen in the National Museum of Natural History of *P.? sulcata* from 6 miles north of Dire Daua, Abyssinia with silicified shell reveals a thick median septum and undivided hinge plate attached to it indicating that *P.? sulcata* is a zeillerid, as suspected by Muir-Wood (1935:122). It is therefore not comparable to *Bothrothyris*.

Caryona, new genus

PLATE 56: FIGURES 9–14; PLATE 74: FIGURES 9–14

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula saemani* Oppel, 1857:272.

DIAGNOSIS.—Small, uniplicate with long loop with crural bases at midloop.

SPECIMENS STUDIED.—Nine, one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Callovian).

LOCALITY.—France.

EXTERIOR.—Small, pentagonal; longer than wide, sides rounded, anterior margin somewhat truncated. Posterolateral margins forming large acute angle. Lateral commissure slightly oblique posteriorly, curved toward ventral side anteriorly. Anterior commissure rectimarginate. Beak short, slightly labiate, beak ridges rounded. Foramen large, permesothyridid. Symphytium partially to wholly visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

TABLE 11.—Loop statistics for *Caryona saemani* and *Lophrothyris subequestris*

Proportions	USNM 75092	Almeras, 1971
∠	35°	30°
Wl/Ll	0.63	0.68
Ll/LD	0.50	0.54
Wl/WD	0.33	0.35
a/Ll	0.50	0.45
b/Ll	0.50	0.55
c/Ll	0.50	0.33
d/Ll	0.00	0.12
e/Ll	0.17	0.28
f/Ll	0.33	0.27
g/WD	0.29	0.35
g/Wl	0.87	0.77
h/f	0.24	0.26
h/Ll	0.08	0.07
WD/LD	0.93	1.06

USNM 75092: *Caryona saemani* (Oppel), Jurassic (Callovian - Kelloway Rock), Pizieu, France.

Almeras (1971:364, pl. 64: fig. 15; pl. 67A,B): *Lophrothyris subequestris* (Rollier), Jurassic (Upper Bathonian - *retrocostatum* Zone), S of Molards, Davayé, Saône-et-Loire, France.

Loop and Cardinalia: The loop is fairly long and triangular and occupies half the length and a third the width of the dorsal valve. The cardinal process is a small, wide, half ellipse with myophore facing posteriorly. The socket ridges are curved, thin and laterally inclined over narrow sockets. The outer hinge plates are short and deeply concave and have a narrow taper to the crural processes. They are attached to the dorsal edge of the crural bases which form a high ridge along their inner margin. There are no measurable crura. The crural processes are short and bluntly acute, not drawn into needle-like points. The descending lamellae are thin, short, slightly bowed laterally and form a margin to the struts of the transverse band. The struts of the arch are broad at the base and thin toward the bridge which is the narrowest part of the band. The arch is slightly posterior of the horizontal in profile. The bridge occupies about a third of the loop width. The crest of the arch is slightly protuberant and the posterior side of the bridge is concave. The terminal points are short and stout.

LOOP STATISTICS.—See Table 11.

DISCUSSION.—Almeras (1971:357) considers *Terebratula subequestris* Rollier to belong to *Lophrothyris*.

The loop of *Lophrothyris lophus* Buckman is much wider than that of *Terebratula subequestris* or *T. saemani* but only slightly wider than that of *Tubithyris wrighti* (Plate 43: figures 10, 11) which differs in morphology from *Lophrothyris* while being similar to *Caryona*.

Tubithyris and *Caryona* are close homeomorphs but their loops differ, that of *Tubithyris* is proportionately wider and has a greater loop angle and the crural processes are slightly more anterior. The transverse band of *C. saemani* is slightly more protuberant and the crural bases narrower than those of *Tubithyris*.

ETYMOLOGY.—From the Greek *karyon* (a nut).

Cererithyris Buckman, 1917

PLATE 41: FIGURES 1-7; PLATE 45: FIGURES 26-33; PLATE 70: FIGURES 9, 10, 23, 24; PLATE 76, FIGURE 2

Cererithyris Buckman, 1917:109.—Almeras, 1971:404.

SUBFAMILY.—Cererithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula intermedia* J. Sowerby, 1812-1815:38.

SPECIMENS STUDIED.—Twenty-eight, four excavated, two complete loops, two cardinalia only.

GEOLOGIC OCCURRENCE.—Jurassic (Upper Bathonian).

LOCALITY.—Great Britain and France.

EXTERIOR.—Medium to large, widely oval to subpentagonal; dorsal valve slightly shallower than ventral one; lateral commissure nearly straight, anterior commissure slightly to moderately sulciplicate in adult. Umbonal cavity shallow. Beak short, suberect to erect; beak ridges short. Foramen large, permesothyridid. Symphytium partially visible or hidden. Surface marked only by concentric growth lines.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is widely triangular with the length greater than the width. The cardinal process is small, a narrow shelf-like struc-

TABLE 12.—Loop statistics of the genus *Cererithyris*

Proportions	USNM 551096a	Davidson, 1851–1852	Tchoumachenko, 1976–1977	Almeras, 1971
∠	36°	50°	28°	39°
Wl/Ll	0.69	0.72	0.55	0.70
Ll/LD	0.48	0.46	0.47	0.40
Wl/WD	0.32	0.36	0.32	0.30
a/Ll	0.48	0.56	0.55	0.53
b/Ll	0.52	0.44	0.45	0.47
c/Ll	0.48	0.28	0.45	0.33
d/Ll	0.00	0.28	0.10	0.20
e/Ll	0.29	0.16	0.14	0.26
f/Ll	0.23	0.28	0.31	0.21
g/WD	0.39	0.28	0.45	0.29
g/Wl	0.98	0.77	1.41	1.00
h/f	0.13	0.43	0.29	?
h/Ll	0.03	0.12	0.09	?
WD/LD	1.04	0.93	0.79	0.96

USNM 551096a: *Cererithyris intermedia* (J. Sowerby), Jurassic (Bathonian – Cornbrash), excavation for petrol tanks at Islip Railway Station, near Oxford, Oxfordshire, England.

Davidson (1851–1852, pl. 11: fig. 5): Jurassic, Cornbrash, England.

Tchoumatchenko (1976–1977, fig. 15 – reconstruction): *Cererithyris intermedia* (J. Sowerby), Jurassic (Bathonian Dessivich Formation Zone with *Acanthothiris spinosa*), coarse oolite horizon, right bank of River Lom, near village of Dolni Lom, Vidin District, NW Bulgaria.

Almeras (1971, pl. 80): *Cererithyris fleischeri* (Oppel), Jurassic (Bathonian = upper Zone with *retrocostatum*), S of Molards, Davaye, Saône-et-Loire, France.

ture with myophore shallowly concave and facing posteroventrally. The socket ridges are thin and curved, and slightly erect bounding narrow sockets. The fulcral plates are thin and laterally extended. The outer hinge plates are short, narrowly triangular, and are extended as a ridge along the dorsal edge of the crural base, with which, and the socket ridges, they form short narrow V- or U-shaped troughs. The crural bases are broad and form a high wall along the inner margin of the outer hinge plates. Anteriorly they soon expand into the crural processes that are located just anterior to midloop. The crural processes are drawn into long acute points. The descending lamellae are narrow, thin ribbons laterally and moderately to widely bowed. The transverse band forms a steep sided arch medially flattened for two-fifths to a half the loop width. The junction of the transverse band and the descending lamellae is a narrow curve with modest webs. The steep sides of the band narrow in ascending to the flattened bridge. The transverse band protrudes ventrally to a point about equal to the distal ends of the crural processes. The transverse band in lateral view at a low angle from the horizontal.

LOOP STATISTICS.—See Table 12.

DISCUSSION.—Except for the loop angle the Davidson drawing of the loop of *Terebratula intermedia* is in fair agreement with the excavated loop shown here. Davidson's drawing shows the short, outer hinge plates, a larger cardinal process, and crural processes slightly farther forward than in the excavated specimen. The arch of the transverse band is not the same but the proportions show the Davidson loop to be similar to that of the prepared specimen. The transverse band is much too wide in the drawing and is not narrowed at the crest as in the preparation. The Davidson drawing is evidently a composite because Davidson says in his legend to pl. 11: fig. 5: "Interior, from specimens in the British Museum."

A specimen in the British Museum (BM 30453) from the Cornbrash of Chippenham, England, reveals a wide calcite-covered loop with protuberant, transverse band resembling that of *Epithyris*.

Sowerby's type lot of *T. intermedia* consists of five specimens. The two small ones with fine-grained matrix are thought to be from the White Limestone of the Great Oolite and are probably young *Epithyris* (B61583 and B61584). The three larger specimens are filled with coarser matrix like that of the Cornbrash.

Specimen B61582, Sowerby's figured specimen, is subpentagonal in outline with moderately wide sulciplication, 33.5 mm long by 30.1 mm wide. The matrix is yellowish with greenish granules characteristic of the Cornbrash. The shell outline is similar to that of *Epithyris*.

Almeras (1971:405) gives an extensive diagnosis of *Cererithyris* based on other species than the type, and finds some disagreement with the generic diagnosis in Muir-Wood (1965:H777). The diagnosis in the Treatise agrees fairly well with information derived from the dissected specimen illustrated herein, even though the serial sections (fig. 637) are incomplete. The loop occupies nearly 50% of the valve length and the outer hinge plates deepen and widen anteriorly where they appear U-shaped with the bounding socket ridge and elevated crural base. The transverse band is high arched as stated in the Treatise.

Almeras (1971, pl. 84) did not section a specimen of the type species from Oxfordshire and his figure of *C. intermedia* is not in accordance with the size or exterior of the British species. The French specimen is wider anteriorly and has much more pronounced folding than that seen on the average British specimen. Statistics prepared from Almeras' sections of *C. fleischeri* agree with the loop of the British species in loop angle but disagree in the position of the crural processes and the length of e–f/Ll. For comparison with *Apatecosia* see above.

Tchoumatchenko (1976/1977:217, 219, figs. 13, 15) reconstructed the loops of two species of *Cererithyris*, *C. dorsetensis* Douglas and Arkell and *C. intermedia* (J. Sowerby). The former has an angle and general loop dimensions near those of the specimen from Oxfordshire figured herein but the hinge plates, transverse band, terminal points and crus are not in accordance with the dissected *Cererithyris*. The loop of *C. intermedia* restored by Tchoumatchenko has a much narrower angle, occupies more than half the dorsal valve length, has concave lateral branches and a lower, more narrowly folded but broader transverse band that is deflected strongly posteroventrally rather than having a low angle from the horizontal and the bridge narrower than that of the dissected specimen.

These reconstructions are so different from reality that one can only conclude that they are faulty or the species are misidentified. Ovcharenko (1967) questions the "independent status" of *Cererithyris* and implies that it has close relationship to *Kutchithyris*.

Charltonithyris Buckman, 1917

PLATE 34: FIGURES 7–13; PLATE 75: FIGURES 13, 14

Charltonithyris Buckman, 1917:106.—Muir-Wood, 1965: H777.

SUBFAMILY.—Loboidothyridinae Makridin, 1964.

TYPE-SPECIES.—*Terebratula uptoni* Buckman, 1895:455.

SPECIMENS STUDIED.—Two, one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITY.—Great Britain.

EXTERIOR.—Large to medium size, roundly rhomboidal; ventral valve deeper than dorsal valve. Lateral commissure straight; anterior commissure rectimarginate to gently uniplicate. Beak short, suberect, truncated by a large permesothyridid foramen. Symphytium not visible. Surface marked only by concentric lines of growth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is widely triangular, its length and width nearly equal. It occupies nearly two-fifths the length and slightly more than a third the width of the dorsal valve. The cardinal process is small, a semi-elliptical shelf at the apex with depressed myophore facing posteroventrally. The socket ridges are fairly stout, erect and bound a fairly wide socket supported by thick fulcral plates. The latter are not extended laterally. The outer hinge plates are short, narrowly triangular and concave, forming with the moderately elevated crural bases narrow, V-shaped troughs. The inner edge of the outer hinge plates is continued anteriorly along the dorsal margin of the crural base as a strong ridge. This extends anteriorly nearly to a point directly dorsad of the cardinal processes. There are no definable crura because the crural bases expand into the crural processes just beyond the junction with the outer hinge plates. The crural processes are acute and drawn into fine points. They are slightly approximate and extend slightly anterior to the horizontal when viewed from the side. The descending lamellae are short and narrow, slightly bowed laterally. The transverse band is broad, laterally flattened and extends as an arch nearly parallel to the horizontal. The arch is narrowed and flattened medially, the flattening equal to more than a quarter of the loop width. There is a posterior reentrant on the flattened part or bridge, exaggerated by imperfect excavation.

LOOP STATISTICS.—USNM 551000b: ∠ = 50°; Wl/Ll = 0.92; Ll/LD = 0.40; Wl/WD = 0.36; a/Ll = 0.54; b/Ll = 0.46; C/Ll = 0.54; d/Ll = 0.00; e/Ll = 0.19?; f/Ll = 0.27; g/WD = 0.24; g/Wl = 0.62; h/f = 0.52?; h/Ll = 0.14?; WD/LD = 1.03.

USNM 551000b: *Charltonithyris uptoni* (S. S. Buckman), Jurassic (Bajocian – Middle Inferior Oolite – *buckmani* Grit), Witlington, Andoversford, Gloucestershire, England.

DISCUSSION.—The preparation of this loop may be defective in the posterior projections and reentrant at the crest of the transverse band. It is likely also that a slight anterior portion of the protuberant flattened bridge may have been lost in opening the specimen.

The proportion f/Ll = 0.27 suggests a loop with fairly prominent terminal points but this is not the case. The proportion comes about due to the breadth of the transverse band and its proximity to the crural processes. The actual terminal points are not drawn out.

Almeras (1971:185) regards *Charltonithyris* as a subgenus of *Loboidothyris* and defines it as follows: "Initial stage plano-convex preceding the late appearance of a gentle uni- or sulciplication. Lateral beak ridges acute and very extended. Muscle imprints rather short and divergent. Transverse band a high arch, medially horizontal. Hinge plates terminating in a V, crural bases carinate."

The sections of *C. uptoni* (Muir-Wood, 1965:H777, fig. 637) show the V-shaped trough made by the socket ridge, outer hinge plate and high crural base. The loop in the sections is strongly elevated and medially flattened. The only comparable sections of *Loboidothyris*, those of *L. ingens* by Almeras (1971, pl. 16A–C) are not in accordance with those in Muir-Wood, 1965. The hinge plates are different, the crural processes are longer and the transverse band of the loop rounded. The statistics show the *Loboidothyris* loop to be much narrower than that of *Charltonithyris*. The loop of *Charltonithyris* is too different from that of *Loboidothyris*, as shown by *L. ingens* or *L. perovalis*, to be regarded as a subgenus of *Loboidothyris*.

The loop of *Charltonithyris* is similar to that of *Gigantothyris* Seifert (1963) from the Bajocian of Germany. *Gigantothyris* is unevenly biconvex and uniplicate to sulciplicate in late adulthood. It has a wider angle and Wl/Ll = 1.00, its loop occupies more of the length and width of the dorsal valve, and the crural processes are slightly posterior of midvalve. These are minor differences from the loop of *Charltonithyris*, otherwise they are close.

The true relationship of *Charltonithyris* to *Loboidothyris* cannot be settled until the loop of the type species is established beyond doubt. Present evidence indicates that the loop of *Loboidothyris* has short terminal points, not long ones as Makridin (1964) postulated.

Cheirothyropsis Makridin, 1964

PLATE 63; FIGURE 5

Cheirothyropsis Makridin, 1964:267.

FAMILY.—Cheirothyropsidae, new family.

TYPE-SPECIES.—*Terebratula pseudotrigonella* Trautschold, 1877:102, pl. 9: fig. 27. Makridin, 1964:268, fig. 94, pl. 20: fig. 7.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Middle Callovian).

LOCALITY.—Central Russian Platform, Crimea, and western Europe.

EXTERIOR (Makridin, 1964).—Medium size, biconvex, pentagonal. Four opposite radial ribs projecting anteriorly on each valve. Surface reticulated by intersecting radial and concentric lines. Anterior commissure rectimarginate. Beak short, slightly curved. Foramen large, symphytium visible.

INTERIOR (Makridin, 1964).—Pedicle collar small. Cardinal process bilobed or trilobed. Loop long flanged [long terminal points], extending somewhat more than half the length of the dorsal valve [not so in the reconstruction Ll/LD = 0.46]. Transverse band curved trapezoidally. Median septum absent; euseptoidum occasionally present.

LOOP STATISTICS (from Makridin reconstruction, fig. 94).—$\angle$ = 38°; Wl/Ll; = 0.74; Ll/LD = 0.46; Wl/WD = 0.34; a/Ll = 0.48; b/Ll = 0.52; c/Ll = 0.29; d/Ll = 0.19; e/Ll = 0.23; f/Ll = 0.29; g/WD = 0.18; g/Wl = 0.54; h/f = 0.38; h/Ll = 0.11; WD/LD = 1.00.

DISCUSSION.—This is a remarkable homeomorph of *Cheirothyris* Rollier, which has a long zeilleriid loop. The loop statistics of *Cheirothyropsis* are most like those of *Tegulithyris*. Because of the ribbing and reticulate pattern Makridin placed his genus in the Dictyothyrididae proposed by him in 1964. The loop character suggests placement in the Tegulithyrididae Muir-Wood, 1965, rather than in Makridin's family or a separate family, as suggested herein, called for by the aberrant exterior.

Colosia, new genus

PLATE 35: FIGURES 1–21; PLATE 36: FIGURES 16–21; PLATE 70: FIGURES 11, 12

Loboidothyris.—Felix 1967:135, pl. 16, left column [not Buckman, 1917].

SUBFAMILY.—Loboidothyridinae Makridin, 1964.

TYPE-SPECIES.—*Terebratula zieteni* Loriol, 1876–1877:168, pl. 23: figs. 8–12.

DIAGNOSIS.—Elongate oval terebratulaceans of small to medium size having rectimarginate, uniplicate to sulciplicate shells provided with a short, wide loop with broad transverse band and crural processes well anterior of midloop.

SPECIMENS STUDIED.—Forty, eleven with silicified loops.

GEOLOGIC OCCURRENCE.—Jurassic (Kimmeridgian).

LOCALITY.—Switzerland and Germany.

EXTERIOR.—Medium to large, elongate elliptical to elongate pentagonal; unequally biconvex, ventral valve deeper and more convex than dorsal one. Lateral commissure curved toward ventral side in anterior third. Anterior commissure variable from uniplicate in young to moderately sulciplicate in adults. Beak moderately long, erect, curved over dorsal umbo, slightly labiate. Foramen large, mesothyridid. Sympthytium short, partially visible. Surface smooth.

INTERIOR.—Teeth of ventral valve small, somewhat triangular; pedicle collar short. Other details not revealed.

Loop and Cardinalia: The loop is stout, short, wide, variable, and occupies a third or slightly more of the length and somewhat more than a fifth of the width of the dorsal valve. The socket plates are moderately thick, slightly inclined laterally and bound wide sockets. The fulcral plates are stout and are extended laterally as strong ridges. The outer hinge plates are fairly wide, short, and abruptly join the dorsal edge of the crural base just anterior to the distal end of the fulcral plate. The outer hinge plates are tapered anteriorly along the dorsal edge of the crural bases to just posterior of the expanding crural process (Plate 35: figure 15). The variability of the taper accounts for the variation in the statistic d/Ll or crus. The crural base is broad, inclined and extends posteriorly along the inside margin of the outer hinge plates as an elevated ridge. In old specimens (USNM 551002e) the outer hinge plate with the elevated crural base and the thick-

TABLE 13.—Loop statistics for the genus *Colosia*

Proportions	USNM 551002a	USNM 551002b	USNM 551002e	USNM 551002j	USNM 551002n	USNM 551002o	USNM 551002p	Boullier, 1976
∠	41°	34°	36°	38°	35°	37°	38°	42°
Wl/Ll	0.80	0.70	0.71	0.65	0.72	0.78	0.72	0.73
Ll/LD	0.42	0.31	0.33	0.31	0.31	0.27	0.29	0.29
Wl/WD	0.33	0.22	0.26	0.22	0.25	0.27	0.27	0.24
a/Ll	0.56	0.60	0.54	0.59	0.57	0.56	0.61	0.56
b/Ll	0.44	0.40	0.46	0.41	0.43	0.44	0.39	0.44
c/Ll	0.56	0.60	0.54	0.47	0.52	0.44	0.44	0.32
d/Ll	0.00	0.00	0.00	0.12	0.05	0.12	0.17	0.24
e/Ll	0.20	0.23	0.17	0.15	0.14	0.17	0.17	0.12
f/Ll	0.24	0.27	0.29	0.26	0.29	0.27	0.22	0.32
g/WD	0.30	0.25	0.28	0.26	0.28	0.31	0.29	0.18
g/Wl	1.00	1.14	1.54	1.18	1.13	1.14	1.08	0.83
h/f	0.83	0.39	0.41	0.50	0.41	0.41	0.55	0.50
h/Ll	0.20	0.11	0.12	0.13	0.12	0.11	0.12	0.16
WD/LD	0.85	0.97	0.90	0.93	0.88	0.78	0.77	0.88

USNM 551002a,b,e,j,n,o,p: *Colosia zieteni* (Loriol), Jurassic (Kimmeridgian – Badnerschichten), Mellikon, Switzerland.

Boullier (1976, fig. 194): *C. zieteni* (Loriol), Jurassic (Late Oxfordian – Couches de Baden), Rümikon, Argovie, Switzerland.

ened anterior margin of the outer hinge plate forms a deep, cuplike ensemble that would make a broad U in serial section. The crural processes are short, acute and more or less strongly inclined toward the middle. The descending lamellae are very short because the transverse band is attached to the anterior slope of the crural processes. The transverse band is broad (h/f = 0.39–0.83), and forms a moderately strong, broadly elevated arch with subangular crest. The posterodorsal edge of the median crest of the transverse band is usually indented by a shallow notch. The terminal points are variable but mostly short.

LOOP STATISTICS.—See Table 13.

DISCUSSION.—The exterior and interior characters of this genus set it apart from *Loboidothyris* to which it had been hitherto referred. The outer form is elongate elliptical with the maximum width at midvalve. In contrast *Loboidothyris* is elongate in outline with the maximum width anterior to midvalve. The loop of *Loboidothyris* is fairly long and has modest terminal points whereas that of *Colosia* is short and has a stout, broad transverse band and short terminal points.

The specimens from Mellikon illustrated herein show some variation, as is true when any series of loops can be obtained. Young specimens do not have as strongly extended a ridge from the fulcral plates as older specimens. The transverse band of the young specimens is narrower than that of the older ones and the band is not posteromedially notched as in older specimens. In the latter the crural processes are closer to the transverse band than in young ones.

Felix (1967) figures a series of silicified specimens of "*Loboidothyris*" identified with *T. zieteni* which exhibit the same loop as the Swiss specimen described herein (Series A of Felix). Some of the German specimens exhibit strongly angular and divergent terminal points similar to the loop shown on Plate 35: figure 14. Series B of Felix may now be referred to *Placothyris*.

Boullier (1976:360) places *Terebratula zieteni* in her genus *Moeschia*. Although she gives serial sections of *T. zieteni* (1976:363, 364, figs. 193, 194) she does not reconstruct the loop as she did for *Moeschia alata* Boullier, the type species. Statistics from one of her serial sections (fig. 194) of *T.*

zieteni are in substantial agreement with those of the silicified specimens. The loop of the silicified specimens, however, does not agree with the serial sections and the reconstructed loop of *Moeschia alata*, type species. That loop has the same stylized appearance that characterize the Rollet-Boullier reconstructions. There are no details in the outer hinge plates of *M. alata* and the terminal points are long with broad webs and with a thin and very narrow transverse band. This combination is utterly unlike that of the same features seen in the loops of silicified *Colosia zieteni* which cannot be admitted to *Moeschia* (for Boullier's reconstruction of *Moeschia*, see Plate 63: figure 13).

ETYMOLOGY.—From the Greek *kolos* (short), in allusion to the short loop.

Conarothyris, new genus

PLATE 45: FIGURES 1–6; PLATE 50: FIGURES 7–12; PLATE 57: FIGURES 19–29; PLATE 62: FIGURE 17; PLATE 72: FIGURES 3, 4, 7, 8, 13, 14

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Conarothyris opima*, new species (= *Terebratula eudesi*, sensu Davidson, 1852–1855, pl. 12: fig. 4, from Dundry, England; not Oppel, 1858).

COMPOSITION.—*Terebratula eudesi* Oppel, 1858; *Conarothyris opima*, new species.

DIAGNOSIS.—Medium-sized, strongly biconvex terebratulaceans with long, wide loop having crural processes at or near midloop.

SPECIMENS STUDIED.—Twenty, two cardinalia and five loops excavated.

GEOLOGIC OCURRENCE.—Jurassic (Bajocian - Inferior Oolite).

LOCALITY.—Great Britain, Germany, and France.

EXTERIOR.—Medium size, roundly oval, valves strongly swollen, subequally biconvex; sides rounded; anterior margin narrowly rounded to subnasute. Lateral commissure oblique posteriorly, narrowly rounded to subacute at anterior. Anterior commissure paraplicate. Beak moderately protuberant, erect, slightly labiate; foramen medium size, round to oval, permesothyridid. Symphytium concealed. Surface smooth except for concentric lines of growth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is long and occupies about a half the length and more than a third the width of the dorsal valve. The socket ridges are slender, inclined slightly and bound narrow sockets. The fulcral plates are slender and extended laterally. The outer hinge plates are variable and fairly broad but short and with a fairly long taper along the median part of the crural base. The taper terminates at the posterior slope of the crural process. The taper may occur close to the ventral edge of the crural base, or may descend toward the middle of the crural base, so that part of the crural base forms a low margin dorsad of the outer hinge plate edge. The crural bases are either not elevated along the inner margin of the outer hinge plates or are very slightly elevated. The crural processes are short and acutely pointed. The descending lamellae are moderately long, nearly straight or slightly bowed. The transverse band is moderately broad and forms a steeply inclined arch, medially angulated and with wide lateral slopes. The terminal points are moderately long.

LOOP STATISTICS.—See Table 14.

DISCUSSION.—The loops of specimens USNM 551129, 551103 from Sherborne and Burton Bradstock differ slightly statistically from the specimens from Dundry in being proportionately wider. In other details of the loop the two are fairly close but the exterior of the Sherborne specimen is also different in having a wider and shallower sulcus bounded by narrower folds of the dorsal valve. A slight distortion of the loop may account for the difference in the loop statistics, except for the position of the crural processes. There is a slight distortion of the specimen from Burton Bradstock (USNM 551103) that may account for the high figure of Wl/Ll. All of the other statistics except a/Ll are fairly close to those from Dundry. Specimens 551127 and 551103 have the crural processes more posterior than the others. Specimen USNM 551127 is smaller than

TABLE 14.—Loop statistics for genera *Conarothyris*, *Ferrythyris*, and *Millythyris*

Proportions	*Conarothyris*						*Ferrythyris ferryi* (Deslongchamps) (serial sections from Almeras, 1971, pl. 28A,B)	*Millythyris millyensis* Almeras (from Almeras serial sections, 1971, pl. 38A,B
	USNM 551103	USNM 551125a	USNM 551127	USNM 551129a	USNM 551130	Deslongchamps 1862–1885		
∠	36°	32°	33°	35°	34°	40°	32°	32°
Wl/Ll	0.76	0.65	0.68	0.76	0.60	0.73	0.58	0.51
Ll/LD	0.51	0.45	0.51	0.44	0.53	0.47	0.52	0.51
Wl/WD	0.38	0.33	0.33	0.32	0.33	0.32	0.31	0.36
a/Ll	0.41	0.53	0.46	0.50	0.50	0.53	0.47	0.43
b/Ll	0.58	0.47	0.54	0.50	0.50	0.47	0.53	0.57
c/Ll	0.38	0.41	0.40	0.45	0.40	0.27	0.25	0.24
d/Ll	0.03	0.12	0.06	0.05	0.10	0.26	0.22	0.19
e/Ll	0.20	0.12	0.16	0.17	0.15	0.13	0.20	0.26
f/Ll	0.39	0.35	0.38	0.33	0.35	0.34	0.33	0.31
g/WD	0.34	0.30	0.35	0.32	0.30	0.18	0.28	0.30
g/Wl	0.77	0.91	1.07	1.00	0.92	0.55	0.91	0.92
h/f	0.23	0.26	0.37	0.18	0.14	0.15	?	?
h/Ll	0.09	0.09	0.14	0.06	0.05	0.05	?	?
WD/LD	1.03	0.88	1.04	0.91	0.95	1.06	0.96	0.90

USNM 551103: *Conarothyris opima*, new species, Jurassic (Bajocian – Inferior Oolite), Burton Bradstock, England.

USNM 551125a: *Conarothyris opima*, new species, Jurassic (Bajocian – Inferior Oolite – *concavi* Zone), Dundry, Somerset, England.

USNM 551127: *Conarothyris opima*, new species, Jurassic (Bajocian – Inferior Oolite) Dundry, Somerset, England.

USNM 551129a: *Conarothyris opima*, new species, Jurassic (Bajocian – Inferior Oolite – *concavi* Zone), Corton Denham, Sherborne, Dorset, England.

USNM 551130: *Conarothyris opima*, new species, Jurassic (Bajocian Inferior Oolite – *discites* Zone), Dundry, Somerset, England (this specimen imperfect on right side, not figured).

Deslongchamps (1862–1885, pl. 109: fig. 6): *C. eudesi* (Oppel), Jurassic, Saône-et-Loire, France.

the other specimens and may be a young individual but more probably a different species.

Deslongchamps (1862–1885:375, pl. 109: figs. 6, 7) illustrates the loop of *C. eudesi* (Oppel) at approximately × 2. The loop is shown as a more slender structure than the excavated loops of the English specimens. The silicified loop is said to have been prepared by Munier-Chalmas. Its statistics are similar to those of the dissected specimens (Plate 62: figure 17).

Conarothyris shares statistical similarity with *Ferrythyris* and *Millithyris*, both of Almeras (1971), and *Pachythyris* Boullier (1976). The two former genera are folded like *Conarothyris*. *Ferrythyris* is said to be thicker than *Millithyris* and its symphytium is covered. There are slight statistical loop differences between *Millithyris* and *Ferrythyris* that are not apparent in their external form (Almeras, 1971:246, 250). *Conarothyris*, with a loop like the others, is distinguished externally by the greatly swollen valves and great thickness. Statistics of a species each of *Ferrythyris* and *Millithyris* are introduced for comparison with those of *Conarothyris*.

Conarothyris is readily distinguished from *Pachythyris* Boullier (1976) by the stronger anterior folding and the great depth of the dorsal sulcus. The loop of *Conarothyris* appears to be somewhat longer than that of *Pachythyris* (40% of dorsal valve length in *Pachythyris*; 44%–45% in *Conarothyris*). There is discrepancy between the two genera in c and d/Ll, *Pachythyris* having much longer crura. This discrepancy may be due to poor interpretation of the serial sections of *Pachythyris*. It is difficult in most serial sections to detect the anterior taper of the outer hinge plates along the crural bases. In some serial sections I have studied, the crura seem exceptionally long. The interpretation of the crus in serial sections also involves more accurate identification of the crural processes than is possible in most series of serial sections.

ETYMOLOGY.—From the Greek *konaros* (well-fed), in allusion to the strong convexity of the valves.

Conarothyris opima, new species

Terebratula eudesi.—Davidson, 1852–1855. pl. 12: fig. 4 [not Oppel, 1858].

DIAGNOSIS.—See generic account above.

Dictyothyris Douvillé, 1879

PLATE 37: FIGURES 1–8; PLATE 61: FIGURE 26; PLATE 63: FIGURES 1, 2; PLATE 69: FIGURES 16, 17

Dictyothyris Douvillé, 1879:267.—Deslongchamps, 1862–1884:142, 168, 169; 1862–1885:411–422.—Buckman, 1917:129.—Muir-Wood, 1965:H801.

FAMILY.—Dictyothyrididae Makridin, 1964.

TYPE-SPECIES.—*Terebratula coarctatus* Parkinson, 1811:299.

SPECIMENS STUDIED.—Sixty, one excavated to show loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bathonian).

LOCALITIES.—Great Britain, France, and Russia.

EXTERIOR.—Small to medium size, shoulders posterior of midvalve; valves unequally biconvex, ventral valve more convex than dorsal valve. Lateral commissure narrowly concave toward the dorsal side in anterior half; anterior commissure intraplicate. Beak long, erect, beak ridges strong; foramen large, mesothyridid. Symphytium visible. Surface covered by capillae made nodose by concentric capillae.

TABLE 15.—Loop statistics for the genus *Dictyothyris*

Proportions	USNM 31338a	Davidson, 1851–1852	Makridin, 1964
∠	52°	53°	20°
Wl/Ll	0.94	1.00	0.39
Ll/LD	0.46	0.43	0.66
Wl/WD	0.40	0.37	0.22
a/Ll	0.56	0.58	0.26
b/Ll	0.44	0.42	0.74
c/Ll	0.39	0.33	0.22
d/Ll	0.17	0.25	0.04
e/Ll	0.22	0.17	0.21
f/Ll	0.22	0.25	0.53
g/WD	0.36	0.22	0.47
g/Wl	0.88	0.58	1.28
h/f	0.64	0.64	0.15
h/Ll	0.14	0.16	0.08
WD/LD	1.07	1.14	1.10

USNM 31338a: *Dicyothyris coarctata* (Parkinson), Jurassic (Bathonian), Renville, Caen, Calvados, France.

Davidson (1851–1852) pl. 13: fig. 13, 13a): Jurassic (Great Oolite), Bath, England.

Makridin (1964, fig. 90 – reconstruction): *"Dictyothyris" gzheliensis* (Gerassimov), Jurassic (Middle Kelloway Rock), Krasnopresnensk ore quarry in Kamushka, Moscow Oblast, Russia. Introduced for comparison with *Dictyothyris coarctata* and *Dienope* (see below).

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The cardinal process is a large thick half ellipse with upturned edge and concave myophore facing posteroventrally. A short medium ridge divides the myophore. The socket ridges are thick and bound fairly wide sockets which are proximally roofed by shell tissue. The fulcral plates are thick. The outer hinge plates are small, triangular, thick and flattened. They join the crural bases at their ventral edge. The crural base is marginal to and flush with the inner margin of the outer hinge plates. The crura are short and develop immediately into the crural processes which bear long, slender points that are directed ventrally and slightly anteromedially. The descending lamellae are moderately broad ribbons, bowed laterally and extended into short, webbed terminal points. The transverse band is fairly broad and forms a high, medially flattened arch with steep sides. The flattened median portion of the arch is protuberant and extends ventrally to just beyond the distal ends of the crural processes. The flattened bridge of the transverse band occupies about ⅗ of the loop width. The flattened middle part of the loop bears a deep reentrant on its posterodorsad side.

Loop Statistics.—See Table 15.

Discussion.—The loop figured by Davidson (1851–1852, pl. 13: figs. 13, 13a) is more generalized than that of the excavated specimen. The two differ in details of the hinge plates and socket ridges, features that are seldom well differentiated in drawings. The Davidson loop is in complete agreement with the loop angle, length and width relationships compared to the length and width of the dorsal valve. The outer hinge plates of the drawing are recessed below (dorsad) the crural bases, an important deviation from the excavated loop. The form of the transverse band is essentially correct but its profile fails to bring out the flattened and protuberant form of that structure.

Davidson' figure of the loop was redrawn by Deslongchamps (1862–1884, pl. 6: fig. 8) who claims that in grinding specimens, the branches of the loop should be longer, like those of "*Dictyothyris*" *trigeri* which is similar to the loop of *Macandrevia* (see *Dienope*, pg. 72).

Makridin (1964:262; this monograph, Plate 63: figures 1, 2) illustrates the internal structure of *Dictyothyris gzheliensis* (Gerassimov) by serial section and reconstruction of the loop. The sections show the thickness of the outer hinge plates but their structure is not clear in either sections or reconstruction. The loop angle, loop proportions and relation of the loop to valve length are completely different from those of *Dictyothyris coarctata* figured herein and drawn by Davidson. The loop is shown with exceptionally long terminal points like those of *Dienope trigeri* (Deslongchamps), now placed in the genus *Dienope*. In side view the loop is depicted with a broad ascending transverse band. These differences, along with the aberrant folding and ornament suggest that this species may not belong to *Dictyothyris*. See *Tegulithyris* for comparison of its loop with that of *Dictyothyris*.

Olga Nekvasilova (1980:68–77) described two species of Lower Cretaceous brachiopods as *Dictyothyris* that do not conform to the type species. Her figures show specimens with a long beak and visible symphytium. The serial sections indicate exceptionally long cardinal process, socket ridges without outer hinge plates and narrow loop. These details are unlike those features of *Dictyothyris*. The exterior of her specimens suggest *Dienope* but the interiors are not in agreement with those of that genus.

Dienope, new genus

Plate 61: figures 1–5

Family.—Dienopidae, new family.

Type-Species.—*Terebratula trigeri* Deslongchamps, 1856:97; 1860:23, pl. 11: figs. 7–10, 12–14; 1862–1884:142–144, pl. 20: fig. 2; 1862–1885: 415, 416. Couffon, 1917:114, fig. 8.

Diagnosis.—Elongate, medium size shells having parasulcate anterior commissure, ventrally convex outer hinge plates and long terebratulid loop.

Specimens Studied.—Three, one excavated for loop.

Geologic Occurrence.—Jurassic (Callovian).

Locality.—France.

Exterior.—Medium size, unequally biconvex, ventral valve moderately convex, dorsal valve flatly convex; elongate pentagonal, tapering anteriorly. Maximum width somewhat posterior of midvalve. Lateral commissure concave toward ventral side; anterior commissure parasulcate. Beak suberect, truncated; foramen large, mesothyridid. Surface marked by fine elevated radial lines crossed by fine concentric threads.

Interior.—Ventral valve interior not seen. Neither Deslongchamps nor Couffon mention the presence of dental plates, and none were seen in this study.

Loop and Cardinalia: The loop occupies about ¾ the length of the dorsal valve. The cardinal process is protuberant, moderately bilobed and with fairly deep pit for muscle insertion. The sockets are very narrow and elongated, the teeth long and narrow, the outer hinge plates are moderately convex toward the ventral valve and are so welded to the socket ridge as to obscure that structure. The crural processes in the specimen studied are moderately wide and sharply pointed. The descending lamellae are narrow and slender and unite anteriorly with much wider ascending lamellae that expand into a fairly wide bridge or transverse band.

LOOP STATISTICS.—USNM 551152: ∠ = 14°; Wl/Ll = 0.21; Ll/LD = 0.74; Wl/WD = 0.15; a/Ll = 0.26; b/Ll = 0.74; c/Ll = 0.18; d/Ll = 0.08; e/Ll = 0.18; f/Ll = 0.56; g/WD = 0.33; g/Wl = 2.20; h/f = 0.05; h/Ll = 0.03; WD/LD = 1.00.

USNM 551152: *Dienope trigeri* (Deslongchamps), Jurassic (Callovian), Deux, Deux-Sevres, France.

DISCUSSION.—In 1859 Deslongchamps (pl. 2: fig. 11) figured a loop purported to be that of *Terebratula trigeri.* This loop as depicted occupied about 40% of the dorsal valve length, had parallel sides and a narrowly folded, moderately wide transverse band. As usual with illustrations of the hinge there is little definite detail. In 1884 Deslongchamps, without mentioning this figure, illustrated a silicified specimen displaying the loop. The figure (Deslongchamps, 1882–1885, pl. 20: figs. 2, 3) is twice natural size and shows a long and slender loop with laterally bowed, narrow descending branches and slightly wider ascending branches and a narrow transverse band. The ascending and descending branches are united anteriorly by a narrow web (fig. 3). The crural processes are somewhat approximate, long and needle-like. The hinge plates are shown as slightly concave but without a separation from the socket ridge. A bilobed cuplike cardinal process is depicted and a short median ridge (euseptoidum).

Deslongchamps remarks on how long this loop is compared to that figured by Davidson (1851–1852, pl. 13: fig. 13, 13a) of *Dictyothyris coarctata.* Nevertheless Deslongchamps regards *T. trigeri* as a terebratulacean because of its lack of a median septum despite the great length of the loop. Deslongchamp's figure of the long loop of *T. trigeri* shows the ascending and descending branches soldered by a narrow web. Delance and Tintant (1965:129) mention this feature of the soldering of the anterior parts of the loop although their somewhat disordered sections (plate B, sections 12–18), do not show this part of the loop. Although the loop of *Dienope* is suggestive of that of the Zeilleriacea, its webbed anterior and divided hinge plate, together with the lack of dental plates in the ventral valve, a well-formed median septum, all argue for relationship to the Terebratulacea. *Dictyothyris gzheliensis* (Gerassimov), described by Makridin (1964:261) with reconstructed loop (Plate 63: figures 1, 2) and with its long terminal points is suggestive of *Dienope* but its exterior is more like that of *Dictyothyris.* The Lower Cretaceous specimens described by Nekvasilova (1980) are externally suggestive of *Dienope* but the cardinal process and other features are not those of the Jurassic genus.

ETYMOLOGY.—From the Greek *di* (apart) plus *ope* (opening).

Dolichobrochus, new genus

PLATE 31; FIGURES 1–6; PLATE 75: FIGURES 3, 4

SUBFAMILY.—Loboidothyridinae, Makridin, 1964.

TYPE-SPECIES.—*Terebratula excavata* Deslongchamps, 1856:97; 1859:20, pl. 2: figs. 3, 4. Rollier, 1918:208.

DIAGNOSIS.—Medium size, sulciplicate terebratulacea with long, narrow loop having long crura and short terminal points.

SPECIMENS STUDIED.—Three, one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Callovian).

LOCALITY.—France.

EXTERIOR.—Small, subcircular to subpentagonal, maximum width anterior of midvalve; valves unequal in convexity, ventral valve deeper and more convex. Lateral commissure oblique in posterior, strongly convex toward ventral valve in anterior third. Anterior commissure broadly and gently sulciplicate, plication confined to anterior third. Beak short, suberect. Foramen of medium size, permesothyridid. Smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is longer than wide, narrowly triangular and occupies a half the length and not quite a third the width of the dorsal valve. The cardinal process is a half ellipse with the myophore directed posteroventrally. The socket ridges are thin and erect and bound narrow sockets. The outer hinge plates are triangular, narrow, and short, tapering onto the dorsal edge of the crural bases, the taper ending well posterior of the crural processes. The fulcral plates are small. The crural bases form a high wall on the inside edge of the outer hinge plates to form short, deeply concave, narrow U-shaped troughs. The crura are unusually long and broad, flat, widening to the crural processes which are bluntly acute, and located far toward the anterior. The descending lamellae are short. The transverse band is fairly wide, is strongly and subangularly arched, widest at its lateral extremities, and thins toward the crest or bridge. The terminal points are moderately long, forming an angle of about 45° with the side of the loop. The transverse band is inclined about 30° from the horizontal.

LOOP STATISTICS.—USNM 550982b: ∠ = 27°; Wl/Ll = 0.54; Ll/LD = 0.46; Wl/WD = 0.27; a/LI = 0.60; b/LI = 0.40; c/Ll = 0.24; d/Ll = 0.36; e/Ll = 0.15; f/Ll = 0.25; g/WD = 0.29; g/Wl = 1.00; h/f = 0.24; h/Ll = 0.06; WD/LD = 0.95.

USNM 550982b: *Dolichobrochus excavata* (Deslongchamps), Jurassic (Callovian), Le Chalet, at U. S. Army Depot, on north side of Route N761, 14 km southeast of Montreuil-Bellay, Maine-et-Loire, France.

DISCUSSION.—This brachiopod hitherto has been identified as *Terebratula subsella* but its loop is unlike that of other specimens referred to that species (see Plate 31: figures 26–32) especially the similar appearing specimens herein referred to *Habrobrochus*, new genus. The loop of *Dolichobrochus* is unusual for the great development of the crura, a feature often not readily identifiable. The loop is unusually long for such a small shell and the terminal points are short. No other Jurassic loop figured herein, except that of *Karadagella* Babanova is like this one. Of the Jurassic species referred to *Sellithyris* by Barczyk (1969:47–55) none has a long loop like that of *Dolichobrochus*.

The loop of *Karadagella* is long and narrow like that of *Dolichobrochus* but its outer hinge plates are attached to the ventral side of the crural bases, not the dorsal side as in *Dolichobrochus*.

Although the loop of *Dolichobrochus* suggests that of *Argovithyris* as reconstructed by Rollet (1972) the two differ in important details. The dimensions of the loop of *Dolichobrochus* (Wl/Ll = 0.54) are larger than those of *Argovithyris*. One reconstruction of *Argovithyris* (Rollet, 1972, fig. 7) has the crural processes far anterior, the other (fig. 8) does not. The loop of *Dolichobrochus* is proportionately much longer than that of *Argovithyris*. The crura of *Dolichobrochus* are longer than those of *Argovithyris*. The terminal points of the latter are longer than those of *Dolichobrochus*. The transverse band of *Dolichobrochus* is not so broad as the Rollet reconstructions and is a much broader arch, not pinched medially as the reconstructed band of *Argovithyris*.

According to Almeras (1971:427) there is exterior similarity of *T. excavata* to *Perrierithyris* especially in the flattened dorsal umbo and the form of the beak. These distinguish the two and also serve to separate *T. excavata* from *Dorsoplicathyris dorsoplicata*. Comparison of the loop statistics of *Perrierithyris* and *Dolichobrochus* shows important differences. The loop angles are similar but the crural processes are far anterior in the latter but well posterior in *Perrierithyris*. The terminal points of *Perrierithyris* are much longer than those of *Dolichobrochus*.

ETYMOLOGY.—From the Greek *dolichos* (long) plus *brochos* (noose or loop).

Dorsoplicathyris Almeras, 1971

PLATE 33: FIGURES 1–14; PLATE 72: FIGURES 1, 2

Dorsoplicathyris Almeras, 1971:437.—Boullier 1976:235–238.

SUBFAMILY.—Lissajousithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula dorsoplicata* Suess,

TABLE 16.—Loop statistics for the genus *Dorsoplicathyris*

Proportions	USNM 550997b	USNM 550997c	USNM 550998a	USNM 550998b	Almeras, 1971
∠	33°	33°	32°	31°	35°
Wl/Ll	0.61	0.57	0.67	0.54	0.63
Ll/LD	0.46	0.42	0.43	0.40	0.46
Wl/WD	0.35	0.31	0.32	0.29	0.37
a/Ll	0.48	0.53	0.43	0.50	0.43
b/Ll	0.52	0.47	0.57	0.50	0.57
c/Ll	0.48	0.53	0.43	0.50	0.26
d/Ll	0.00?	0.00?	0.00?	0.00?	0.17
e/Ll	0.13	0.10	0.19	0.14	0.25
f/Ll	0.39	0.37	0.38	0.36	0.32
g/WD	0.33	0.33	0.32	0.32	0.33
g/Wl	0.93	1.35	1.00	1.16	0.94
h/f	0.10	0.19	0.13	0.14	?
h/Ll	0.04	0.07	0.05	0.05	?
WD/LD	0.90	0.78	0.90	0.88	0.82

USNM 550997b,c: *Dorsoplicathyris dorsoplicata* (Suess), Jurassic (Callovian – *koenigi* Zone), Vercra, near Marchampt, Ain, France.

USNM 550998a,b: *D. dorsoplicata* (Suess), Jurassic (Callovian – *jasoni* Zone), same as above.

Almeras (1971, pl. 173 A,B): *D. dorsoplicata* (Suess), Jurassic (Callovian *jasoni* Zone), Cuvergnat, Aromas, Jura, France.

1855, in Deslongchamps, 1856:97.

SPECIMENS STUDIED.—About 100, 4 excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Callovian).

LOCALITY.—France.

EXTERIOR.—About medium size to moderately large; elongate oval; sides rounded; posterolateral extremities acutely angular. Valves unequally convex, ventral valve with greater convexity and depth. Lateral commissure curved ventrally in anterior third; anterior commissure uniplicate to incipiently and broadly sulciplicate. Beak short, erect, slightly labiate; foramen large, permesothyridid. Symphytium mostly hidden. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is an elongated triangle, longer than wide, occupying about ⅖ the length and about ⅓ the width of the dorsal valve. The cardinal process is small, a half elliptical shelf. The socket ridges are thin and erect and bound narrow sockets. The fulcral plates were not seen. The outer hinge plates are moderately long and taper anteriorly along the dorsal edge of the crural bases to a point just below or slightly posterior of the crural processes. The crural bases with the outer hinge plates and socket ridges form deep, narrow troughs. The outer hinge plates are almost in contact with the valve floor at the posterior. The crural processes are located at about midloop or slightly posterior thereto, and are produced into slender points directed ventrally. The descending branches are long, flat ribbons, straight or slightly bowed and diminishing in height anteriorly where they bound the long web that forms the base of the transverse band. The arch of the transverse band is narrow, inclined at a steep angle (more than 40°) from the horizontal and not protruding beyond the points of the crural processes. The flattened crest of the transverse band (bridge) takes up about a quarter of the loop width. The terminal points are long and narrow.

LOOP STATISTICS.—See Table 16.

DISCUSSION.—Preparation of this loop was difficult and none of the loops are perfect. The outer hinge plates are so close to the valve floor and so thin that it was difficult to expose them without scraping all or part of them away. The taper of the outer hinge plates was also difficult to obtain without damage and were successfully exposed on only one side of the loop of USNM 550997b. In excavating the terminal points the webs between the descending lamellae and the ascending part of the transverse band formed a surface of weakness so that the thinned ends of the descending branches or terminal points partially flaked away. Nevertheless the loop and its length are well exhibited.

The serial sections of *Dorsoplicathyris* show the very shallow umbonal cavity characteristic of the genus. The hinge plates are shown in the serial sections as rather flattish and broadly U-shaped, but the U is quite misshapen. The dissected specimens indicate a narrower U.

Dorsoplicathyris is similar to *Aromasithyris* in its exterior and loop. Externally it differs from *Aromasithyris* in its more elongate form, longer beak, its less developed anterior commissure and less development of a median sulcus on the dorsal valve. Internally the loops are similar but that of *Dorsoplicathyris* is slightly wider. The differences between the two genera are subtle (see Almeras 1971 and discussion of *Aromasithyris* herein).

Reconstructions of the loop of *Dorsoplicathyris* have appeared in several publications. Boullier restored the loop of *D. prolifica* Boullier (1976, figs. 151, 152). The proportions of the loop are not quite the same as those of the dissected loops. These reconstructions show a long, slender loop with long terminal points: $\angle = 30°$; Wl/Ll = 0.54; $\angle = 27°$, Wl/Ll = 0.48; crural processes posterior of midloop. Rollier (1911, pl. 1: fig. 18) gives a drawing of the loop of *T. dorsoplicata* which shows a short, wide loop with relatively short terminal points, unlike the Boullier reconstructions or the dissections. Makridin (1964:208) assigned *T. dorsoplicata* to *Ptychtothyris*.

The statistics show modest variation in the loop angles and more in the position of the crural processes which are near midloop, slightly anterior or slightly posterior except in the Boullier reconstructions in which they are posterior of midloop. The terminal points are long in all specimens in which the loop is known but Boullier's reconstructed specimens show e/Ll to be greater than that in the dissected specimens.

Epithyris Phillips, 1841

PLATE 39: FIGURES 22–28; PLATE 41: FIGURES 11–14; PLATE 42: FIGURES 1–17; PLATE 63: FIGURE 6; PLATE 73: FIGURES 5, 6, 21, 22

Epithyris Phillips, 1841:55.—Buckman, 1906:322; 1917: 118.—Arkell, 1931:598.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula maxillata* J. deC. Sowerby, 1821–1825:52. Muir-Wood, 1936:68.

SPECIMENS STUDIED.—Seventy-five specimens of three species, five with loop excavated, four with damaged loops.

GEOLOGIC OCCURRENCE.—Jurassic (Upper Bathonian).

LOCALITIES.—Great Britain and France.

EXTERIOR.—Large, subpentagonal, length and width nearly equal but variable; maximum width at about midvalve; posterolateral extremities obtuse. Anterior third of lateral commissure ventrally concave; anterior commisssure uniplicate to quadriplicate. Beak short, suberect to erect, usually appressed to dorsal umbo. Foramen large, often anteriorly excavated, mesothyridid. Symphytium partially visible or concealed. Surface marked only by concentric lines of growth.

INTERIOR.—Ventral interior not seen.

Loop and Cardinalia: The loop is widely triangular with width equal to or exceeding length, occupying about ⅖ length and nearly the same of dorsal valve width. The cardinal process in the young is a small, narrow half ellipse with sunken myophore and elevated lateral margins. In large or old specimens it is greatly thickened and extended in a ventral direction. In this thickened form the myophore is deeply sunken and surrounded by a prominent ridge, medially notched to give the structure a bilobed outline. The socket ridges are thick and bound a narrow socket that is proximally roofed. The fulcral plates are thick but not laterally extended. The outer hinge plates are triangular, short, thick, concave and usually notched at their distal margin. They attach to the dorsal edge of the short crural base. The outer hinge plates in some specimens are so thickened as to appear flat. The crural base is only slightly elevated along the inner margin of the outer hinge plates. The crural processes are located near midloop and are acutely pointed, in some specimens needle-sharp. The crural processes are located close to the outer hinge plates and thus a crus is difficult of definition and measurement. The descending lamellae are widely bowed thin bands. They join the transverse band to form moderately long webbed terminal points. The transverse band is a moderately wide ribbon, strongly arched with steep lateral slopes and flattened median bridge approximating half the loop width. The flattened crest or bridge is protruded ventrally beyond the distal ends of the crural

TABLE 17.—Loop statistics for the genus *Epithyris*

Proportions	USNM 32137a	USNM 64419a	USNM 104706a	USNM 123738a	USNM 551004a	USNM 551012a	USNM 551022a	USNM 551023b	Davidson, 1851–1852
∠	50°	50°	48°	48°	41°	48°	51°	53°	66°
Wl/Ll	0.93	0.87	0.89	1.05	0.82	0.90	0.91	0.94	1.22
Ll/LD	0.44	0.41	0.44	0.33	0.42	0.41	0.37	0.46	0.37
Wl/WD	0.42	0.39	0.46	0.34	0.36	0.32	0.34	0.39	0.36
a/Ll	0.50	0.48	0.37	0.62	0.46	0.52	0.45	0.44	0.55
b/Ll	0.50	0.52	0.63	0.38	0.54	0.48	0.55	0.56	0.45
c/Ll	0.29	0.48	0.37	0.50?	0.36	0.41	0.45	0.44	0.55
d/Ll	0.21	0.00	0.00	0.12?	0.10	0.00	0.00	0.00	0.00
e/Ll	0.21	0.22	0.20?	0.19	0.27	0.17	0.27	0.25	0.00
f/Ll	0.29	0.30	0.43?	0.19	0.27	0.31	0.28	0.31	0.33
g/WD	0.29	0.38	0.37	0.32	0.29	0.26	0.39	0.31	0.23
g/Wl	0.72	0.70	0.81	0.94	0.83	0.81	0.90	0.80	0.64
h/f	0.27	0.10	?	0.31	0.18	0.22	0.25	0.22	0.33
h/Ll	0.08	0.03	?	0.06	0.05	0.07	0.07	0.07	0.11
WD/LD	1.03	0.93	1.02	1.04	0.98	1.17	1.00	1.11	1.27

USNM 32137a: *Epithyris* sp., Jurassic (Bathonian), Boulonais, France.

USNM 64419a: *E. maxillata* (J. de C. Sowerby), Jurassic (Bathonian – Bradford Clay), Bradford-on-Avon, England. (Great Oolite), Boulogne-sur-Mer, Pas de Calais, France.

UNSM 104706a: (= *E. oxonica* Arkell), Jurassic (Great Oolite), Boulogne-sur-Mer, Pas de Calais, France.

USNM 123738a: *E. oxonica* Arkell, Jurassic (Upper Bathonian Great Oolite), railway cutting near Chedworth, Gloucestershire, England.

USNM 551004a: *E. oxonica* Arkell, Jurassic (Bathonian – White Limestone), Kiddington, Oxfordshire, England.

USNM 551012a: *E.? submaxillata* (Morris), Jurassic (Inferior Oolite), Leckhampton Hill, Gloucestershire, England.

USNM 551022a: *E. oxonica* Arkell, Jurassic (Bathonian – Great Oolie), Kirtlington, Oxfordshire, England.

USNM 551023b: *E. oxonica* Arkell, Jurassic (Upper Bathonian – White Limestone Woodeaton Pit, Route A40 at the Elfield Road Turnoff, Woodeaton, Oxfordshire, England.

Davidson (1851–1852, pl. 9: fig. 9): *Terebratula maxillata* J. de C. Sowerby, a small specimen, location not given. Also illustrated by Deslongchamps, 1862–1884:351, pl. 102: fig. 4.

processes. The ribbon of the crest is usually narrower than that of the sides and has a deep posterior indentation.

LOOP STATISTICS.—See Table 17.

DISCUSSION.—The loop drawn by Davidson (1851–1852, pl. 9: fig. 9) is of a small specimen not yet having developed its folding. No enlargement is given. The loop is figured as wider than any of the excavated specimens and the protuberant median crest of the transverse band is too broad. In all specimens excavated to show the loop the crest of the transverse band is narrowed rather than broadened. The position of the crural processes in relation to the crest of the transverse band is shown as too close; the crural processes of Davidson's drawing almost overhang the transverse band.

Barczyk (1969:18–25) assigns several species from the Late Jurassic of Poland to *Epithyris* and furnishes reconstructions based on serial sections. His *Epithyris bauchini* [sic] Etallon (now referred to *Juralina*) is depicted with a loop completely unlike that of *Epithyris*. His other reconstructions show the wide loop characteristic of *Epithyris*, but none shows the protuberant median crest of the transverse band. *Epithyris rollieri* (Haas) described by

Barczyk is now placed in *Placothyris* by Westphal (1970:38), the narrow loop of which is exhibited in a silicified specimen. It is unlike that of Barczyk's reconstruction because the outer hinge plates of *Placothyris* are ventrally convex, suggesting the condition of the outer hinge plates in *Gibbithyris* of the Cretaceous or *Karadagella* of the Jurassic. *Epithyris cincta* Barczyk (not Cotteau) is figured with a short loop, whereas the specimen from Bourges, France, figured herein (Plate 56: figures 5–8A), has a long loop with long terminal points. Makridin established *Postepithyris* on *Terebratula cincta* Cotteau and from his serial sections reconstructed a narrow loop with long terminal points. Its loop is entirely different from that *Epithyris.*

A young excavated specimen of *E. oxonica* (USNM 123738a) shows a loop wider than in most adults and with the crural processes more anterior than in the excavated adults. This is like Davidson's drawing discussed above. Furthermore the terminal points are not as long as in older specimens. The young excavated specimen imperfectly shows the attachment of the outer hinge plates to the crural bases, making the measurements of c and d/Ll questionable.

The excavated loop of *E.? submaxillata* (Morris), not of Sowerby from the Bajocian, is wide and stout; the bridge of the transverse band is not as thin as that of *E. oxonica* nor are the terminal points as long. The ensemble of loop characteristics is similar to that of *Epithyris*; the exterior however is not so strongly folded anteriorly.

A specimen (USNM 32138a) identified as *Terebratula* [*Cererithyris*] *intermedia* Sowerby on excavation proved to have the loop of *Epithyris.* The specimen is evidently a young one (Plate 42: figures 7, 8, 17).

The loop dimensions of *Epithyris* are close to those of *Gigantothyris* but that genus has a flattened dorsal valve and uniplicate to modestly sulciplicate folding. The loop of *Euidothyris* is similar to that of *Epithyris* according to its statistics but its transverse band is not protuberant and is stouter than that of *Epithyris.* Although the loop of *Charltonithyris* is very wide, its transverse band is broad and not protuberant like that of *Epithyris.* Moreover, the exterior with its flattened dorsal valve and gently folded anterior commissure is unlike these features of *Epithyris.*

Dzik (1979:478, fig. 3, pls. 11, 12) illustrates the loop of specimens identified as *Epithyris "subsella"* (Leymerie) that are neither *Epithyris* or *subsella.* The specimens are large, strongly labiate and oval in outline, quite unlike the size and form of the specimen figured by Leymerie (1846). The loop displayed by four silicified specimens is narrower and longer than that of *Epithyris* and the transverse band is a broad arch, not flattened and protuberant medially as in *Epithyris.* Dzik's specimens seem to be a stock different from *Epithyris.*

Loop Statistics (Dzik's pl. 12: fig. 1).—∠ = 39°; Wl/Ll = 0.72; Ll/LD = 0.53; Wl/WD = 0.38; a/Ll = 0.34; b/Ll = 0.66; c/Ll = 0.34; d/Ll = 0.00; e/Ll = 0.31; f/Ll = 0.35; g/WD = 0.34; g/Wl = 0.91; h/f = 0.11; h/Ll = 0.04; WD/LD = 1.02.

Eristenosia, new genus

Plate 57: figures 1–7; Plate 72: figures 19, 20

Subfamily.—Lissajousithyridinae, new subfamily.

Type-Species.—*Eristenosia circularis*, new species.

Diagnosis.—Small circular terebratulaceans with long, narrow loop having long terminal points.

Specimens Studied.—Three, two excavated for loop, one complete, one hinge plates only.

Geologic Occurrence.—Jurassic (Kimmeridgian).

Locality.—France.

Exterior.—Small, nearly circular, all sides and anterior rounded; posterolateral margins obtuse. Biconvex, ventral valve deeper than dorsal. Lateral commissure straight; anterior commissure rectimarginate. Beak short, erect, beak ridges moderately strong. Foramen small, permesothyridid. Surface smooth.

Interior.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is long and narrow and occupies about ⅖ the length and ⅕ the width of the dorsal valve. The socket ridges are erect and thin and bound narrow sockets. The fulcral plates are thin and extend laterally as thin struts. The outer hinge plates are short and narrow, dorsally attached, and taper as a thin line to a point posterior of the crural processes. They are deeply concave and are bounded by the strongly elevated and flattened crural base. The crural processes are short, obtusely pointed and are located posterior to midloop. The descending lamellae are tapered anteriorly, nearly straight and fairly long. The transverse band is a very narrow, angular arch with long webbed attachment to the descending lamellae. The crest of the arch forms a narrow angle that reaches almost to the crural processes, so high is its inclination to the posterior. The terminal points are long.

LOOP STATISTICS.— USNM 30902a: $\angle = 19°$; Wl/Ll = 0.45; Ll/LD = 0.44; Wl/WD = 0.18; a/Ll = 0.41; b/Ll = 0.59; c/Ll = 0.31; d/Ll = 0.10; e/Ll = 0.11; f/Ll = 0.48; g/WD = 0.22; g/Wl = 1.23; h/f = 0.08; h/Ll = 0.04; WL/LD = 1.08.

USNM 30902a: *Eristenosia circularis*, new species, Jurassic (Kimmeridgian), Tonnere, Yonne, France.

DISCUSSION.—The loop of *Eristenosia* is unique among the Jurassic brachidia seen in this study. In its elongate, narrow form, it is most like the loops of Cretaceous *Najdinothyris* and Recent *Stenobrocus* and *Stenosarina.* It is remarkable for its slenderness in a shell having the width greater than the length. The loops of *Najdinothyris* and *Stenosarina* are narrow in narrow shells whereas the loop of *Eristenosia* is very narrow in a wide shell. Another unusual feature is the angular and posteriorly directed transverse band somewhat reminiscent of the loop of adult *Oleneothyris* but even more exaggerated than the transverse band of the Paleocene genus.

ETYMOLOGY.—From the Greek *eri* (very) plus *stenos* (narrow).

Eristenosia circularis, new species

PLATE 57: FIGURES 1–7

?*Terebratula cincta.*—Loriol, 1893:160–161, pl. 11: fig. 15 [not Cotteau, 1857].

DIAGNOSIS.—As for the genus above.

EXTERIOR.—As for the genus. Ventral valve moderately and fairly evenly convex in lateral profile, fairly strongly domed in anterior view. Median region inflated. All slopes steep.

Dorsal valve gently convex in lateral view, slightly more convex in anterior profile. Median region inflated. All slopes moderately steep.

MEASUREMENTS (in mm).—USNM 30902b: length 19.8; width 17.4; thickness 11.7; apical angle 97°.

OCCURRENCE.—Same as for genus.

TYPES.—Holotype: USNM 30902a; paratype: USNM 30902b.

DISCUSSION.—No other species is like this one in its round outline and long narrow loop. *Karadagella moisseevi* Babanova has a long narrow loop but its proportions are unlike those of *Eristenosia* and the exterior is elongate oval. The round unplicated specimen figured by Loriol cited above is similar externally to *Eristenosia circularis.*

Euidothyris Buckman, 1917

PLATE 40: FIGURES 19–24; PLATE 73: FIGURES 11, 12

Euidothyris Buckman, 1917:101.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Euidothyris extensa* Buckman, 1917:101, pl. 20: fig. 30.

SPECIMENS STUDIED.—Four, one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITY.—Great Britain and France.

EXTERIOR.—Large, rounded, subpentagonal; maximum width at about midvalve; sides rounded; apical angle obtuse; biconvex. Lateral commissure oblique in posterior three-quarters, anterior quarter bent ventrally. Anterior commissure sulciplicate. Beak short, erect. Foramen large, permesothyridid. Surface marked only by concentric lines of growth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is widely triangular with the sides well bowed laterally. The loop is almost as wide as long and occupies almost half the length and nearly 40% of the width of the dorsal valve. The cardinal process is a small half ellipse facing posteriorly. The socket ridges are thin and erect and bound narrow sockets. The outer hinge plates are short, concave, and make V-shaped troughs with the high marginal crural base and socket ridges. The outer hinge plates are attached to the dorsal margin of the crural bases. There are no definable crura because the crural processes appear at the junction of the hinge plates and crural base. The crural processes are narrow and acute, almost needle-like. The descending branches are thin, strongly bowed ribbons. The transverse band forms an arch with broad lateral struts and a flattened median crest that is about one-quarter the width of the loop. The posterior margin of the flattened crest is concave. The terminal points are narrowly rounded and short, making an angle of about 40°.

LOOP STATISTICS.—USNM 551017b: ∠ = 46°; Wl/Ll = 0.92; Ll/LD = 0.48; Wl/WD = 0.38; a/Ll = 0.48; b/Ll = 0.52; c/Ll = 0.32; d/Ll = 0.16; e/Ll = 0.18; f/Ll = 0.34; g/WD = 0.27; g/Wl = 0.78; h/f = 0.23; h/Ll = 0.08; WD/LD = 1.15.

USNM 551017b: *Euidothyris euides* Buckman, Jurassic (Bajocian - Inferior Oolite - Pea Grit), Crickley Hill, Cheltenham, Gloucestershire, England.

DISCUSSION.—The loop of this genus is similar to that of *Charltonithyris* but differs in having bulging descending lamellae, more posteriorly located crural processes, and moderately long terminal points. Its loop is also like that of *Epithyris* in general appearance and wide angle, but it has a different transverse band, the bridge of which is narrower and less protuberant. It is also different from *Epithyris* in the character of the anterior commissure. The loop of *Euidothyris* resembles that of *Gigantothyris* in dimensions but the loop of the latter is more lightly built and has a narrower transverse band.

The serial sections of *Euidothyris* figured in Muir-Wood (1965:H780, fig. 641a–g) are incomplete because they show only a portion of the posterior part of the shell and then, with a considerable gap a single section is given that may show the crural processes. The transverse band and terminal points are not shown.

Prosorovskaya (1968:95, fig. 66) reconstructed the loop of *Euidothyris bordgakliensis* (Moiseev) which is depicted with definite crural processes and fairly long terminal points, slightly shorter than those of the English species. The loop of *E. euides* is much wider than the reconstructed loop of the Russian species.

Exceptothyris Sučić-Protić, 1971

PLATE 77: FIGURE 11

Exceptothyris Sučić-Protić, 1971:37.

SUBFAMILY.—Notosiinae, new subfamily.

TYPE-SPECIES.—*E. expressa* Sučić-Protić, 1971: 37, pl. 15: figs. 1–3; pl. 34: fig. 1; pl. 40: fig. 6 (reconstruction of loop).

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Lower-Middle Lias).

LOCALITY.—Lower Lias, France and Italy. Middle Lias, Yugoslavia.

DIAGNOSIS. (Sučić-Protić, 1971:31).—"Five-sided shells. The beak is narrow and low. The foramen is big. There is a low fold on the dorsal valve. Crural processes are developed in the area of the hinge plates. Flanks are very long."

MORPHOLOGICAL DESCRIPTION (Sučić-Protić, 1971:37).—"Specimens of only one species of this genus are five-sided, with a low fold developed on the dorsal valve. Internal structure: inner pedicle collar, small cardinal process, crural processes developed in the area of hinge plates, very long flanks [flanges] of the brachidium."

LOOP STATISTICS.—See Table 22.

COMMENT.—This genus has a most remarkable loop; only one other genus from the Late Jurassic is known with such a long loop (*Rouillieria* Makridin). The extreme posterior position of the crural processes is also unusual. The reconstruction of *Exceptothyris* is similar to that of *Rouillieria michalkowi* (Fahrenkohl) figured by Makridin (1964:251, fig. 84).

Ferrythyris Almeras, 1971

Ferrythyris Almeras, 1971:218.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula ferryi* Deslongchamps, 1862–1884:27, pl. 5: figs. 1–4.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITY.—France, England, and Switzerland.

ORIGINAL DIAGNOSIS (from Almeras, 1971: 218).—Small to medium. Contour rounded triangular to rounded pentagonal and elongate. More or less globulose. Beak large, straight, almost touching the dorsal umbo, truncated more or less obliquely by a large circular foramen, labiate, permesothyridid to epithyridid. Symphytium not exposed. Beak ridges short and rounded. Lateral commissures very oblique posteriorly, then incurving strongly but regularly toward the dorsal valve on its anterior half. Anterior commissure angularly paraplicate without previous sinuate stage; sometimes simple or multiple intraplication. Dorsal muscle imprints elongate, straight, more or less divergent.

Pedicle collar fairly long. Deltidial plates thick and welded. Umbonal cavity more or less developed to the level of the anterior half of the cardinal process. The latter is very long to long, elevated and in general deeply grooved. Hinge plates in the form of a club, then of a moderate deep groove. Hinge teeth having the aspect of rectangular tongues very short in the rear and becoming more or less massive or like a hammer toward the front. Sockets deep. Plane of articulation and denticles expanded. Length of brachidium compared to that of the dorsal valve is included between 0.49 and 0.57. No euseptoidum.

For statistics and comparisons of the loop with those of other genera see discussion under *Conarothyris*.

Galliennithyris Rollet, 1966

PLATE 32: FIGURES 24–27; PLATE 55: FIGURE 14; PLATE 63: FIGURE 25

Galliennithyris Rollet, 1966:304; 1968:137.—Boullier, 1976: 97.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula galliennei* d'Orbigny, 1847:377, number 476 (figured by Cottreau, 1928, pl. 6: figs. 31–35).

SPECIMENS STUDIED.—Many totally silicified specimens, one with longitudinal half of loop exposed from the dorsal side, one with cardinalia only (Boullier, 1976).

GEOLOGIC OCCURRENCE.—Jurassic (Oxfordian).

LOCALITY.—France, Switzerland.

EXTERIOR.—Elongate oval, medium size, sides rounded, anterior margin narrowly convex. Valves strongly convex, ventral valve usually more so than dorsal valve. Lateral commissure convex ventrally in anterior third, oblique in posterior two-thirds. Anterior commissure rectimarginate to gently sulciplicate. Beak short, suberect, beak ridges rounded. Foramen small, permesothyridid. Symphytium short, visible. Surface smooth.

INTERIOR.—Ventral valve interior with small teeth and pedicle collar. Muscle field not seen.

Loop and Cardinalia: The loop is long, occupying nearly a half the length and a third the width of the dorsal valve. The cardinal process is a thin, narrow half ellipse medially indented and with concave myophore divided in the middle by a low ridge. The socket ridges are stout, thickened on their distal margin and inclined to bound a moderately wide socket. The fulcral plates are thick and are extended laterally as a short ridge along the inside shell wall. The outer hinge plates are flatly concave, narrowly triangular and attach to the dorsal edge of the crural bases; they are not tapered to the crural processes. The trough made by the socket ridges, outer hinge plates and high marginal crural bases is flat-floored and forms a broad U. The crural processes originate slightly posterior of midloop and are drawn into sharp slightly approximate points. The descending lamellae are fairly long and terminate in a long webbed extension to which the transverse

TABLE 18.—Loop statistics for the genus *Galliennithyris*

Proportions	Serial sections (Boullier, 1976, fig. 52)	Reconstruction (Boullier, 1976, fig. 53)
∠	36°	35°
Wl/Ll	0.65	0.64
Ll/LD	0.42	0.38
Wl/WD	0.33	0.28
a/Ll	0.45	0.43
b/Ll	0.55	0.57
c/Ll	0.22	0.28
d/Ll	0.23	0.15
e/Ll	0.21	0.24
f/Ll	0.34	0.33
g/WD	0.36	0.28
g/Wl	1.10	1.03
h/Ll	0.03	0.03
WD/LD	0.85	0.85

Boullier (figs. 52, 53): *Galliennithyris galliennei* (d'Orbigny), Jurassic (Oxfordian - Zone with *Plicatilis*), Besancon, Doubs, France.

band is attached. The transverse band is narrow and forms a high arch with steep sides and flattened bridge. The terminal points are long, nearly ⅖ of loop length.

LOOP STATISTICS.—USNM 31335a: ∠ = 33°; Wl/Ll = 0.57; Ll/LD = 0.48; Wl/WD = 0.33; a/Ll = 0.43; b/Ll = 0.57; c/Ll = 0.24; d/Ll = 0.19; e/Ll = 0.19; f/Ll = 0.38; g/WD = 0.28; g/Wl = 0.83; h/f = 0.26; h/Ll = 0.10; WD/LD = 0.82.

USNM 31335a: *Galliennithyris galliennei* (d'Orbigny), Jurassic (Oxfordian), Parrentruy, Old St. Remi, Launcy, Switzerland. Also see Table 18.

DISCUSSION.—The loop description above and that of the hinge plates is a composite of a specimen showing a longitudinal half of a complete loop from the dorsal side and another specimen (USNM 31335b) showing the hinge plates only.

Boullier (1976, figs. 52, 53) gives serial sections and a reconstruction of the loop of *G. galliennei* based on serial sections. The statistics prepared from these accord well with those of the prepared loop. The terminal points of the excavated loop are somewhat longer than those of the sections and reconstruction. In the reconstruction (fig. 53) the length of the terminal points is uncertain.

Boullier (1976:97–99) distinguishes *Galliennithyris* from *Dorsoplicathyris* by its more pentagonal form, stocky to subcircular or more or less elongate oval; by greater gibbosity; by its generally shorter beak, its anterior commissure being sulciplicate. Internally the cardinal process of *Galliennithyris* is more flattened, less protruding in front, is overhanging the umbonal cavity; hinge plates with less elevated crural bases with socket ridges less developed, and the brachidium shorter than average.

Gigantothyris Seifert, 1963

PLATE 28: FIGURE 31; PLATE 46: FIGURE 11; PLATE 62: FIGURES 19, 21, 24

Gigantothyris Seifert, 1963:180.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Gigantothyris gigantea* Seifert, 1963:180, figs. 9, 31; pl. 12; fig. 1.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian - Dogger - *humphriesi* Oolite).

LOCALITY.—Germany.

EXTERIOR (Information from Seifert, (1963), Quenstedt (1858), and Almeras (1971)).—Medium to large, rounded pentagonal, plano-convex to unequally biconvex. Anterior commissure uniplicate to gently sulciplicate in late development. Beak erect to suberect, without beak ridges. Foramen large, permesothyridid?. Symphytium hidden. Surface smooth.

INTERIOR.—Ventral valve interior poorly known.

Loop and Cardinalia: The loop is figured by Seifert, fig. 9e, and Quenstedt, 1858, pl. 57: 25 (herein Plate 46: figure 11; Plate 63: figure 21). Both figures show a wide loop that occupies about ⅖ the length and width of the dorsal valve. The outer hinge plates are short. Other details are not apparent. The incomplete serial sections of *G. gigantea* show a very low umbonal chamber with shallowly concave outer hinge plates with poorly differentiated and low socket ridges. The descending lamellae are nearly straight and produce short terminal points. The transverse band is fairly broad, fairly strongly arched and medially flattened for ¼ the loop width. The distance e, between the crural processes and the crest of the transverse band, is short. Statistics based on the loop figured by Seifert are not precise because some of the structures are not clearly depicted.

LOOP STATISTICS (Seifert, 1963, fig. 9e).—∠ = 54°; W1/L1 = 1.00; L1/LD = 0.42; W1/WD = 0.43; a/L1 = 0.50; b/L1 = 0.50; c/L1 = 0.30; d/L1 = 0.20; e/L1 = 0.20; f/L1 = 0.30; g/WD = 0.32; g/W1 = 0.75; h/f = 0.43; h/L1 = 0.13; WD/LD = 0.98.

Seifert 1963: *Gigantothyris gigantea* Seifert, Jurassic (Bajocian – *humphriesianum* Oolite), Stuifen, Germany.

Seifert (1963) assigns Quenstedt's (1858, fig. 25; herein Plate 62: figure 21) figure of *Terebratula intermedia* Zieten (not J. Sowerby, 1812–1815) to her *Gigantothyris* species.

DISCUSSION.—Seifert (1963:180) compares *Gigantothyris* to *Wattonithyris* Muir-Wood but the two are completely different in exterior characters and details of the loop. Although the statistics are close as to loop angle and proportions, the crural processes of *Wattonithyris fullonica* are considerably farther anterior in position and they are closer to the transverse band.

Seifert renamed the original of Quenstedt's *Terebratula intermedia* Zieten (not J. Sowerby) *Gigantothyris gigantea*, a specimen in the Geological Institute of Tübingen which is figured by Quenstedt (1868–1871:406, pl. 49: fig. 101). Another specimen called *G. luculenta* Seifert is figured by Quenstedt (1858:419, pl. 57: fig. 26). Accompanying this figure is another showing a loop (fig. 25) which is not assigned by Seifert but belongs with *Gigantothyris* because Quenstedt calls it *T. intermedia*. Seifert names as species of *Gigantothyris* two specimens referred by Quenstedt to *Terebratula omalogastyr* Zieten. These are *G. blanda*, a large specimen and the smaller *G. dorsoplanata*. The serial sections of these species are inadequate and present some differences in the hinge plates to those of *G. gigantea*, especially in the umbonal chamber of the dorsal valve. The loop is not shown in the sections so that comparison with the loop of *T. omalogastyr*, here called *Strongylobrochus*, from the *humphriesianum* Zone at Auerbach, Germany, cannot be compared.

Dagis (1968) figures a reconstruction from serial sections of a loop of *Gigantothyris ochoticus* Dagis, a stylized rendering that does not accord with Seifert's figure of the loop. Dagis' loop has W1/L1 = 0.84 and is thus a little longer than that of *G. gigantea*. Dagis notes the similarity of shell outline and unfolded anterior of two specimens referred to *T. omalogastyr* Zieten, by Arcelin and Roché (1936:90, fig. 24, pl. 9: fig. 1; pl. 12: fig. 6). Dagis believes it likely that these French specimens belong to *Gigantothyris*. Arcelin and Roché's specimen with loop (Plate 62: figure 24) has the following statistics: L = 40°; Wl/Ll = 0.77; Ll/LD = 0.43; Wl/WD = 0.31; a/Ll = 0.41; b/Ll = 0.59; c/Ll = 0.41; d/Ll = 0.00; e/Ll = 0.26; f/Ll = 0.33; g/WD = 0.21; g/Wl = 0.69; h/f = 0.27; h/Ll = 0.09; WD/LD = 1.05. Jurassic (Bajocian), Monsard, Saône-et-Loire, France.

The loop of this specimen has the transverse band set off on the posterior side of two small points directed posteriorly. This feature is shared by *Monsardithyris* and *Morrisithyris* from the same place. This loop differs from that of the type species of *Gigantothyris* in being longer and narrower, the crural processes more posterior and the outer hinge plates more tapering. This French specimen has the exterior of *T. omalogastyr* with its flattened dorsal valve, but the loop is different from that of *T. omalogastyr* (= *Strongylobrochus*).

Almeras (1971:187) regards *Gigantothyris* as a subgenus of *Loboidothyris* along with *Charltonithyris*. The exterior and loop statistics of the latter are close to those of *Gigantothyris* figured by Seifert but not to *Loboidothyris*.

Glyphisaria, new genus

PLATE 52: FIGURES 18–23; PLATE 74: FIGURES 15, 16

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Glyphisaria uniplicata*, new species.

DIAGNOSIS.—Large, strongly uniplicate terebratulacean with loop having short, anteriorly notched outer hinge plates and a strongly elevated, arched transverse band.

SPECIMENS STUDIED.—Three, one with complete loop.

GEOLOGIC OCCURRENCE.—Jurassic (Sequanian).

LOCALITY.—France.

EXTERIOR.—Large, widely oval to subpentagonal; unequally biconvex, dorsal valve gently convex, ventral valve strongly convex; maximum width slightly anterior to midvalve. Sides rounded, posterolateral margins forming an angle near 80°. Anterior margin gently rounded. Lateral commissure slightly oblique, narrowly bent ventrally in the anterior quarter. Anterior commissure broadly and strongly uniplicate. Beak moderately long, erect, beak ridges short. Foramen medium size, permesothyridid. Symphytium visible. Surface smooth.

INTERIOR.—Interior of ventral valve not seen.

Loop and Cardinalia: The loop is fairly widely triangular and occupies about 40% of the length and a third of the width of the dorsal valve. The cardinal process is small, narrowly elliptical with slightly concave myophore. The socket plates are thin, erect, slightly curved and bound narrow sockets. The fulcral plates are broad, shelf-like and extended laterally. The outer hinge plates are very narrow because the steep socket ridges and crural bases unite dorsally to form short V-shaped troughs which are notched at the anterior junction with the crural bases. The crural bases are broad and form a high wall along the inside edge of the outer hinge plates. The crural processes are located at about midloop, are broad and terminate in sharp points. The descending lamellae are narrow and gently bowed laterally. The transverse band is narrow, widest at its contact with the descending lamellae where there are short terminal points. The arch of the transverse band is steep-sided and narrow, forming a very narrow bridge or crest which measures about a fifth of the loop width. The transverse band deviates slightly from the horizontal and is protuberant.

LOOP STATISTICS.—$\angle = 40°$; Wl/Ll = 0, 81; Ll/LD = 0.39; Wl/WD = 0.32; a/Ll = 0.50; b/Ll = 0.50; c/Ll = 0.27; d/Ll = 0.23; e/Ll = 0.19; f/Ll = 0.31; g/WD = 0.31; g/Wl = 0.90; h/f = 0.26; h/Ll = 0.08; WD/LD = 0.98.

USNM 551085: *Glyphisaria uniplicata*, new species, Jurassic (Sequanian), Bourges, Cher, France.

DISCUSSION.—This genus is characterized by the strongly uniplicate anterior commissure, not a common feature of Jurassic brachiopods, by the anteriorly notched hinge plates, the strongly arched and protuberant transverse band with its narrow flattened bridge and the modest terminal points.

Terebratula formosa Suess, *T. castillensis* Douvillé, and *T. cotteaui* Douvillé are all similar externally to *Glyphisaria uniplicata* in having a strongly and broadly uniplicate anterior commissure. The loops of these species are unknown, consequently it is not possible to regard them as congeneric with *Glyphisaria*.

Turkmenithyris Prosorovskaya is similar externally to *Glyphisaria* as it has a strongly uniplicate anterior commissure. The loop (see Muir-Wood, 1965:H790, fig. 654:4d) is short and wide with long terminal points, longer than those of *Glyphisaria*. The transverse bands of the two genera are different, that of *Turkmenithyris* being a very slender, unflattened high arch, while that of *Glyphisaria* is broad-looped but a rather low arch with narrow bridge.

ETYMOLOGY.—From the Greek *glyphis* (a notch).

Glyphisaria uniplicata, new species

PLATE 52: FIGURES 18–23

DIAGNOSIS.—Large *Glyphisaria* with broad anterior fold and notched outer hinge plates.

DESCRIPTION.—Exterior as for the genus.

Ventral valve strongly convex in lateral profile, with maximum swelling at midvalve; broadly, strongly domed in anterior profile. Umbonal region subcarinate, carination broadening and disappearing at midvalve. Sulcus broad, shallow, occupying almost half valve width.

Dorsal valve gently convex, maximum convexity at umbo, maximum flattening in anterior half. Anterior profile broadly, moderately convex. Umbonal region gently swollen. Median and anterior flattened to form low fold, well defined in anterior third. Anterolateral flanks deflected and steep.

Interiors as for genus.

MEASUREMENTS (in mm).—USNM 551085: length 38.6; dorsal valve length 32.7; width 32.0; thickness 23.3; apical angle 81°.

TYPE.—Holotype: USNM 551085.

OCCURRENCE.—Jurassic (Sequanian), Bourges, Cher, France.

DISCUSSION.—A number of described species from the Jurassic resemble *G. uniplicata*. These are described and noted by Douvillé (1886, pl. 2). Four of these are uniplicate: *Terebratula castillensis* Douvillé is about the same size as *G. uniplicata* but has a narrower profile and narrower fold and sulcus. *T. cotteaui* Douvillé has a more abrupt and stronger median fold. *Glyphisaria uniplicata* is not as wide as *T. formosa* Suess, 1855 (the *T. formosa* figured by Douvillé is not the same as that of Suess which has bulging sides and is very wide). *T. cincta* Cotteau as figured by Douvillé is folded differently and is smaller than *G. uniplicata*, and has a different loop (see *Postepithyris*, Plate 56: figures 5–8A). Whether the first three discussed above, which are all uniplicate, have the same type of loop as *Glyphisaria* must await dissection or sectioning of authentic specimens. The matrix of the specimens from Bourges are amenable to dissection.

Goniothyris Buckman, 1917

Goniothyris Buckman, 1917:117.

SUBFAMILY.—Goniothyridinae Tchorszhevsky, 1971.

TYPE-SPECIES.—*Terebratula gravida* Szajnocha, 1881:74, pl. 2: fig. 3a–d.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITY.—England, Austria and Hungary.

COMPLETE DIAGNOSIS.—(from Almeras, 1971: 126, 127; based on *G. polymiensis* Almeras).—Medium to large. Rounded triangular. Dorsal valve strongly convex near the umbo, ventral valve convex or very carinate. Anterior commissure rectimarginate. Lateral commissures dorsally convex in their posterior half and incurved in a pronounced fashion in their anterior half. Beak almost straight, short, truncated obliquely, scarcely touching the brachial valve. Foramen circular, large, epithyridid to permesothyridid. Beak ridges slightly pronounced. Symphytium straight, low.

Pedicle collar very short. Cardinal process very short and slightly expressed. Hinge teeth hammer-shaped. Denticulum present. Hinge plates strongly convex ventrally, carinate and directed dorsally. Length of brachidium equal to 0.40 of that of the dorsal valve. Crural processes delicate, inclined at 20° and expanded to the maximum of their vertical extension, about 0.20 of the height of the shell. No euseptoidum. Muscle impressions very close, nearly parallel.

Distinguished from all other genera by the character of the beak, the commissures, as well as its internal structure.

COMMENT.—The exterior of *Goniothyris* is convergent to that of *Stenosarina*, *Dallithyris*, and *Stenobrochus* of the Recent fauna and *Najdinothyris* of the Cretaceous. The ventrad convexity of the outer hinge plates is like that of *Gibbithyris*, *Karadagella* and *Muirwoodella*. The loop of the specimen sectioned by Almeras unfortunately was incomplete. Buckman's placement of *T. phillipsi* Morris so unlike his type in the genus, has been a source of continuing confusion.

Buckman (1917:117) defined *Goniothyris* as follows: "Epithyrid (beak very short, apical, resting on umbo, foramen circular); morphogeny, cuneiform, to cuneiform uniplicate to cuneiform sulciplicate; muscle tracks very approximate, almost parallel."

"Special characters.—Posterior acumination with lateral pinching; beak very short with foramen apical."

In his list of species Buckman included *Terebratula phillipsi* Morris, a species externally and internally completely unlike *G. gravida* (Szajnocha), his named type. The latter has a strongly truncated, short beak and rounded contours as well as swollen valves. *Terebratula phillipsi*, on the other hand, has a long beak, and angular, pentagonal valves of low convexity and strong sulciplication. Reference of *T. phillipsi* to *Goniothyris* has led to the use of the name for many species unlike the type.

Seifert (1963:185) describes three new species of *Goniothyris*, all of which have exterior characters like those of *T. phillipsi*. Barczyk (1969) refers two species, including one of Seifert's to *Goniothyris*, both of which have an exterior like that of *T. phillipsi*. W. Barczyk's reconstruction of "*Goniothyris*" *amoena* Seifert shows a short, wide loop unlike that of *T. phillipsi* which is now the type of *Morrisithyris* Almeras (1971).

Tchorszhevsky (1970:57–59) sectioned a specimen of *Goniothyris craneae* (Davidson) which conforms to the exterior details of the type species. His sections show a moderately long narrow loop with fairly broad transverse band, crural processes near midloop and fairly long terminal points. The length of the dorsal valve is not recorded, making it impossible to tell how long the terminal points are in relation to the dorsal valve length. The outer hinge plates are shown as gently concave and attach near the ventral edge of the crural bases. They are not conspicuously convex as are those figured in Almeras' sections of *G. polymiensis* Almeras (1971, pl. 18A,B). Full knowledge of the loop of *Goniothyris* must await sectioning or excavation of the loop of the type-species.

Gyrosina, new genus

PLATE 32: FIGURES 1–6; PLATE 74: FIGURES 3, 4

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Gyrosina rotunda*, new species.

DIAGNOSIS.—Subcircular, sulciplicate; loop long, crural processes median in loop; transverse band broad, moderately protuberant.

SPECIMENS STUDIED.—Twelve, one excavated to show loop.

GEOLOGIC OCCURRENCE.—Jurassic (Callovian).

LOCALITY.—France.

EXTERIOR.—Subcircular, slightly wider than long; sides rounded; maximum width slightly anterior to midvalve. Valves unequally convex, ventral valve having greater convexity and depth. Lateral commissure slightly oblique posteriorly, abruptly convex toward ventral valve anteriorly. Anterior commissure narrowly sulciplicate in anterior fifth. Beak short, suberect, beak ridges narrowly rounded. Foramen large, submesothyridid to permesothyridid. Symphytium visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is widely triangular and occupies nearly a half the length and a third the width of the dorsal valve. The cardinal process is small and semielliptical with myophore facing posteroventrally. The socket ridges are thin and erect and bound narrow sockets. The outer hinge plates are short, narrow and deeply concave medially. They taper anteriorly onto the dorsal side of the crural bases to a point just dorsad of the crural processes. The crural bases form a wall along the inner margin of the outer hinge plates to form with them, and the socket ridges, short U-shaped troughs. The crural processes are located at midloop and are drawn into fine, slightly approximate points. The descending lamellae are thin, short and bowed laterally. The transverse band is broad and forms a high, narrow arch with moderately steep sides and flattened medially for about a quarter of the loop width. The median part of the band is moderately protuberant and approximates the distal ends of the crural processes. The transverse band is inclined from the horizontal by about 25°. The terminal points are fairly short.

LOOP STATISTICS.—USNM 550992b: $\angle = 39°$; Wl/Ll = 0.74; Ll/LD = 0.44; Wl/WD = 0.30; a/Ll = 0.50; b/Ll = 0.50; c/Ll = 0.50; d/Ll = 0.00; e/Ll = 0.20; f/Ll = 0.30; g/WD = 0.32; g/Wl = 1.09; h/f = 0.43; h/Ll = 0.13; WD/LD = 1.09.

USNM 550992b: *Gyrosina rotunda*, new species, Jurassic (Callovian - *Macrocephalites macrocephalus* Zone), Nuits St. George, Cote d'Or, France.

DISCUSSION.—This brachiopod is suggestive of *Apatecosia* because its loop is close to that of *A. nutiensis* (Bague). There is a difference in the position of the crural processes, at midloop in *Gyrosina*, slightly posterior in *Apatecosia*. The terminal points of *Gyrosina* are much shorter than those of *Apatecosia*.

ETYMOLOGY.—From the Greek *gyros* (round).

Gyrosina rotunda, new species

PLATE 32, FIGURES 1–6

DIAGNOSIS.—Small, rounded, narrowly sulciplicate shells having long loop with crural processes at midloop.

DESCRIPTION.—Exterior and interior as for genus.

Ventral valve moderately convex in lateral view, somewhat narrowly convex in anterior profile; umbonal region subcarinate, carination continuing to midvalve, extending as narrow fold to anterior margin. Anterior fold narrowly convex, set off by deep furrows. Lateral plications short, rounded. Lateral slopes steep.

Dorsal valve gently convex in lateral profile, broadly domed in anterior view, doming more even than that of ventral valve; median region swollen. Anterior folds in anterior fifth narrowly rounded, short. Lateral slopes steep.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
550992a	24.1	21.1	21.8	13.8	98°
550992c	23.4	20.5	22.4	14.0	100°
550992d	23.3	20.6	20.5	13.0	93°
550992e	19.6	17.6	18.7	10.0	98°

TYPES.—Holotype: USNM 550992a; paratypes: USNM 550992c–e.

OCCURRENCE.—Jurassic (Callovian - *M. macrocephalus* Zone), Nuits St. George; old quarries on road from La Cude to Corcelles, La Cude near Velors; Cote d'Or, France.

DISCUSSION.—This species is smaller and rounder than *Apatecosia nutiensis* (Bague) but has similar folding. The loop of *Gyrosina* has shorter terminal points and the crural processes are at midloop rather than posterior to midloop as in *A. nutiensis*. The exterior of *Gyrosina* resembles that of some species of *Pseudotubithyris* but its anterior commissure is more sharply and narrowly folded.

Habrobrochus, new genus

PLATE 31: FIGURES 26–32; PLATE 70: FIGURES 19, 20

SUBFAMILY.— Cererithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula subsella* Leymerie, 1846, atlas, pl. 10: fig. 5.

DIAGNOSIS.—Medium size, gently sulciplicate terebratulaceans with wide loop having a narrow transverse band.

SPECIMENS STUDIED.—Three, one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Kimmeridgian).

LOCALITIES.—Germany and France.

EXTERIOR.—Subselliform, rounded subpentagonal, maximum width at about midvalve; inequivalve, ventral valve with greater convexity and depth. Lateral commissure nearly straight posteriorly, convex toward ventral side at anterior. Anterior commissure incipiently sulciplicate, plication subdued and confined to anterior third. Beak short, erect, overhanging dorsal umbo. Foramen large, permesothyridid. Symphytium partially visible. Surface marked only by lines of growth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop forms a short, wide triangle. The cardinal process is a half ellipse in outline, thin, slightly bilobed and with the myophore facing posteriorly. The socket ridges are thin and delicate, curved and bound narrow sockets. The fulcral plates were not seen. The outer hinge plates are narrowly triangular, short, deeply concave and close to the valve floor indicating a shallow umbonal chamber. The outer hinge plates attach to the dorsal part of the crural bases where they end posterior of the crural processes. The crural bases are strongly elevated along the inner margin of the outer hinge plates and form with them, narrow U-shaped troughs. The crural processes are acutely angular and are located near midloop. The descending lamellae are laterally bowed and moderately long. The transverse band is a narrow, thin ribbon that forms a moderately strong arch almost parallel to the horizontal. It is flattened medially, the flattened part slightly protuberant and taking up about a third of the loop width. The terminal points are only moderately produced and form an angle of about 50° with the sides of the loop.

LOOP STATISTICS.—USNM 550984a: ∠ = 47°; Wl/Ll = 0.83; Ll/LD = 0.41; Wl/WD = 0.39; a /Ll = 0.53; b/Ll = 0.47; c/Ll = 0.33; d/Ll = 0.20; e/Ll = 0.23; f/Ll = 0.24; g/WD = 0.34; g/Wl = 1.00; h/f = 0.17; h/Ll = 0.04; WD/LD = 1.02.

USNM 550984a: *Habrobrochus subsella* (Leymerie), Jurassic (Kimmeridgian), Lindnerberg, Linden, near Hanover, West Germany.

DISCUSSION.—The brachidium purported to be that of *T. subsella* restored from serial sections by Barczyk (1969:52), shows a loop similar in shape to that of the Lindnerberg specimen but with much larger cardinal process and much longer terminal points. The side view shows a transverse band nearly horizontal, like that of the German specimen. The outer hinge plates of the Polish specimen are very short but no idea of their concavity can be gained from the reconstruction. The other species referred to "*Sellithyris*" have essentially the same plan as that of the German specimen described herein but vary considerably in width, thickness of the transverse band and length of the terminal points.

The loop of *Habrobrochus* differs markedly from that of *Xestosina*, hitherto referred to *T. subsella*, in its more delicate construction, thinner, less elevated transverse band, more anterior position of the crural processes and shorter terminal points. Its greater width and lesser length distinguish the loop of *Habrobrochus* from that of *Dolichobrochus* which was previously referred to *T. subsella*.

Statistically the loops of *Sellithyris sella* (Sowerby) of the lower Cretaceous and *Habrobrochus subsella* (Leymerie), are similar, the crural processes of both are at about midloop, the loop angles are close. There are however, small differences in the proportions of the distance of the transverse band from the crural processes and the terminal points. The external differences between the two are important and consist of stronger folding and straight beak completely exhibiting the symphytium of *Sellithyris*.

ETYMOLOGY.—From the Greek *habros* (dainty) plus *brochos* (noose or loop).

Heimia Haas, 1890

Heimia Haas, 1890:87, pl. 10: figs. 10, 11.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula mayeri* Choffat, 1883:254.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITIES.—England, France, and Switzerland.

EXTERIOR.—Small, subtriangular, greatest width near midvalve. Lateral margins rounded, posterolateral margins nearly straight forming a wide acute angle. Anterior margin with broad median reentrant. Valves unequally convex, ventral valve deeper and more convex. Lateral commissures convex toward the dorsal valve. Anterior commissure gently sulcate. Beak moderately long, subcarinate, suberect. Foramen medium size. Symphytium hidden. Surface smooth.

INTERIOR.—The loop, hitherto unknown, has been partially restored by Singeisen-Schneider (1976) in a study on interpretation and reconstruction of loops from serial sections. Singeisen-Schneider (1976:104, fig. 6) compares the reconstructed loops of *T. perovalis* (Sowerby), *Heimia mayeri* Choffat and *T. omalogastyr* Hehl seen in side view. This figure shows the loop of *Heimia* to be short occupying about 40% of the dorsal valve length, with a high transverse band extending beyond the ends of the crural processes. The latter are wide-angled without tapered or extended points. The outer hinge plates are short. The transverse band shown in section is strongly arched and has a broad, flattened bridge occupying about a half the loop width. The terminal points as seen in profile are moderately long. Unfortunately no ventral view was reconstructed.

One value of Singeisen-Schneider's work is the first indication of the nature of the loop of *Heimia*. Other statistics derived from Singeisen's reconstruction are: Ll/LD = 0.39; a/Ll = 0.41; b/Ll = 0.59; c/Ll = 0.26; d/Ll = 0.15; e/Ll = 0.22; f/Ll = 0.37; h/f = 0.02; h/Ll = 0.07. The loop is thus characterized by having the crural processes in a posterior position.

Prosorovskaya (1968:64, fig. 40) gives a reconstruction of the loop of a specimen identified as *Heimia planiconvexa* (Kitchin). Her specimens appear to be uniplicate and are oval in outline, quite unlike the type specimen *H. mayeri* (Choffat) which is somewhat triangular and moderately sulcate. Prosorovkaya's loop of *Heimia* cannot be taken as authentic for the genus until the loop of the type species has been made known.

Hesperithyris Dubar, 1942

PLATE 45: FIGURES 16–18; PLATE 54: FIGURES 22–24

Hesperithyris Dubar, 1942:78.

FAMILY.—Hesperithyrididae, new family.

TYPE-SPECIES.—*Terebratula renierii* var. *sinuosa* Dubar, 1942, pl. 9: fig. 6.

SPECIMENS STUDIED.—Thirty, none with loop.

GEOLOGIC OCCURRENCE.—Jurassic (Lias – Domerian).

LOCALITY.—Morocco.

DISCUSSION.—This name was proposed for strongly plicated terebratulaceans from the Lias of Morocco. The valves are convex, the ventral valve having the greater convexity. The folding is complicated, the flanks having one to three costae or plications and the ventral valve having a median fold bounded by strong plications that define a median sulcus within the fold, and a strong median plication. The dorsal valve has a broad median sulcus with two strong plications medially placed that oppose the sulci of the ventral valve. The young stage is initially uniplicate. The beak is long, protuberant, and is truncated by a large foramen. The symphytium is visible.

Although some of the specimens in the National Collection (kindness of Dr. G. Dubar) are silicified, not one preserves the loop, but the cardinalia are well preserved and unusual. The cardinal process is large and wide, a half ellipse, anteriorly bilobed and with marginal rim in some specimens. The fulcral plates are well individualized and extended laterally to the shell margin. The socket ridges are stout and steeply inclined over the socket. The outer hinge plates and crural bases are so grown together as to be difficult to separate. In any event the outer hinge plates are much reduced. This ensemble faces fairly strongly ventrally and posteriorly. The crural processes are moderately curved. This combination of structures is unlike any seen in this study except for *Merophricus*, which has some similarities but has definitely definable hinge plates. Dubar (1942, pl. 7: fig. 7) illustrates the cardinalia of *Terebratula termieri* Dubar, which have a hinge plate arrangement like that of *Hesperithyris*. In his text-figure 37 of *Terebratula hebbriensis* Dubar shows similar cardinalia and a small cardinal process.

The dorsal adductor marks of *Hesperithyris* are narrowly triangular and the left and right pairs are separated by a wide thickening of the median part of the shell.

Heterobrochus, new genus

PLATE 41: FIGURES 15–21; PLATE 69: FIGURES 12, 13

SUBFAMILY.—Heterobrochinae, new subfamily.

TYPE-SPECIES.—*Heterobrochus incultus*, new species, as figured herein.

DIAGNOSIS.—Transversely oval to subrhomboidal terebratulacean with wide loop having posteriorly situated crural processes, wide outer hinge plates attached to ventral edge of crural bases; terminal points moderately long.

SPECIMENS STUDIED.—Three, one excavated to show loop.

GEOLOGIC OCCURRENCE.—Jurassic (Kimmeridgian).

LOCALITY.—Germany.

EXTERIOR.—Medium to large; roundly subpentagonal, sides rounded, maximum width at midvalve, anterior margin broadly rounded; posterolateral margins near 90°. Lateral commissure nearly straight, convex toward ventral valve at anterior. Anterior commissure gently sulciplicate. Beak short, beak ridges short, beak erect. Foramen large, oval, permesothyridid. Symphytium partly visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The cardinal process is small, semielliptical, bilobed and its myophore is concave and faces posteriorly. The umbonal chamber is shallow. The socket ridges are thin, erect and bound narrow sockets. The fulcral plates are small. The outer hinge plates are small, triangular, flattened to slightly concave, are attached to the ventral edge of the crural bases, and are tapered onto the crural processes. The bases are flush with the inner edge of the outer hinge plates. The crural processes are acutely pointed and are located well posterior of midloop. They are not strongly extended and are moderately approximate. The descending lamellae are narrow, widely bowed laterally. The transverse band is moderately wide and forms a high, steep-sided arch with medially flattened crest. The latter is protuberant to about the distal end of the crural processes. The anterior margin of the median crest or bridge is slighly reentrant. The transverse band deviates from the horizontal by about 15° The terminal points are angular and moderately long.

LOOP STATISTICS.—USNM 30901c: $\angle = 51°$; Wl/Ll = 0.94; Ll/LD = 0.39; Wl/WD = 0.35; a/Ll = 0.36; b/Ll = 0.64; c/Ll = 0.33; d/Ll = 0.03; e/Ll = 0.28; f/Ll = 0.36; g/WD = 0.29; g/Wl = 0.82; h/f = 0.22; h/Ll = 0.08; WD/LD = 1.04.

USNM 30901c: *Heterobrochus incultus*, new species, Jurassic (Kimmeridgian), Fritzow, near Kammin, Pomerania, Germany.

DISCUSSION.—The important features of the loop of *Heterobrochus* are its width and the attachment of the outer hinge plates to the ventral edge of the crural bases. The ensemble, except for the great width of the loop, is similar to *Gibbithyris* of the Cretaceous and *Placothyris* of the Jurassic. The loop of *Karadagella* Babanova also has the outer hinge plates attached to the ventral side of the crural bases. Its loop, like that of *Placothyris*, is very narrow.

ETYMOLOGY.—From the Greek *heteros* (different) plus *brochos* (noose or loop).

Heterobrochus incultus, new species

PLATE 41: FIGURES 15–21

DIAGNOSIS.—As for genus.

DESCRIPTION.—Exterior and interior as for genus.

Ventral valve fairly strongly convex in lateral profile, most convex in umbonal region. Anterior profile narrowly and strongly convex with steeply sloping sides. Umbonal region narrowly swollen, swelling continuing to anterior margin where it forms low fold separated from flanks by shallow sulci. Median sulcus short, shallow mostly occupied by low fold. Flanks separated from sulcus by low fold on each side.

Dorsal valve gently convex in lateral profile, most convex just posterior of midvalve; anterior profile broadly and flatly convex with short steep flanks. Umbonal region slightly convex; median region moderately swollen; sulcus shallow, originating anterior to midvalve, bounded by short, low plications which bound an obscure, slightly protuberant fold. Flanks separated from fold by shallow sulci.

MEASUREMENTS (in mm).—USNM 30901b: length 32.0; dorsal valve length 28.0; width 29.6; thickness 17.5; apical angle 90°.

OCCURRENCE.—Jurassic (Kimmeridgian), Fritzow, near Kamin, Pomerania, Germany.

TYPES.—Holotype: USNM 30901b; paratypes: USNM 30901a, c.

DISCUSSION.—The specimens on which this species is based were identified as *Terebratula bauhini*

Etallon, which is said to be a common species at Fritzow, Germany. The Fritzow specimens called *T. bauhini* identified by Schmidt (1905, pl 2: figs. 1–4) are large and have a broadly uniplicate anterior commissure unlike the biplicate specimens under consideration. The latter resemble *T.* cf. *subsella* Schmidt (not Leymerie). They are unlike any of the commonly identified specimens of "*subsella*" in the literature, which are usually triangular in outline, rather small and sulciplicate. In absence of information on their loops it is not possible to make further comparison of *Heterobrochus*.

Placothyris and *Karadagella* have outer hinge plates attached like those of *Heterobrochus*; the former is a large, long, narrow brachiopod while the latter is large and narrowly elliptical with a short beak.

Holcothyris Buckman, 1917

Holcothyris Buckman, 1917:125 [= *Kutchithyris* in sensu Ovcharenko, 1967].

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Holcothyris angulata* Buckman, 1917:192, pl. 10: figs. 1–4.

SPECIMENS STUDIED.—One, and literature.

GEOLOGIC OCCURRENCE.—Jurassic (Bathonian).

LOCALITIES.—Burma and France?

EXTERIOR.—Elongate triangular; unequally biconex, ventral valve deeper than dorsal; dorsal valve flatly convex; maximum width anterior to midvalve. Posterolateral extremities forming an acute angle; lateral commissure broadly concave on ventral side; anterior commissure narrowly paraplicate, plications subangular, confined to anterior third. Beak suberect. Foramen large, permesothyridid? Symphytium partially visible. Surface smooth?, radially capillate where exfoliated.

INTERIOR.—Poorly known, loop not yet illustrated.

DISCUSSION.—The loop and other details of the Burma type species are not known. No serial sections are given in Muir-Wood, 1965. Almeras (1971:326–332) gives a detailed account of the interior of French specimens identified as *Holcothyris.* A difference in the anterior folding of the French specimens from that of the Burmese ones suggests separate origins. Almeras (1971:326) describes the interior of the French *Holcothyris angulata* as follows:

Pedicle collar fairly long. Deltidial plates thick, united or not in a single piece. Cardinal process long, plano-convex, grooved or not in its posterior half; at the front it becomes elevated only in forms with swollen dorsal umbo and it then takes a bilobed aspect, being somewhat depressed in its median part; it appears fairly visible at the generic level and I consider it a criterion of specific discrimination. The umbonal cavity well exposed in the type species, is more or less developed following the swelling of the dorsal umbo; it is lacking in *H. depressa* [Sahni], a species flattened in the posterior region of the dorsal valve. Hinge plates occasionally thick, gently concave ventrally, club-shaped posteriorly, a shallow V toward the front, slightly inclined dorsally, are not always well separated from the socket ridges; their length, compared to that of the brachidium varies from 0.12–0.13. Elevated crural bases are well differentiated. Hinge teeth are massive; dental sockets more or less deep; denticles are little marked; plane of articulation short (0.2–0.3) and fails in *H. rotunda* [Sahni], which shows wide, shallow sockets. No accessory cavities. Crural processes strongly oblique, their bases not carinate, are elevated and occupy at the maximum of their vertical extension (situated between the posterior third and almost a half of the brachidium a/b including between 0.64 and 0.79) between a quarter and a third the height of the shell. The transverse band is gently convex ventrally. A long median euseptoidum is present, well marked, or more precisely a median crest, called myophragm, issuing from the shell between the muscles and in which the length does not exceed that of the muscle impressions. The length of the brachidium compared to that of the dorsal valve, varies between 0.48 and 0.50.

LOOP STATISTICS (French specimen of *H. angulata* from Almeras, 1971:331, table 29, column 1: $\angle = 31°$; Wl/Ll = 0.55; Ll/LD = 0.48; Wl/WD = 0.32; a/Ll = 0.42; b/Ll = 0.58; c/Ll = 0.25; d/Ll = 0.17; e/Ll = 0.24; f/Ll = 0.34; g/WD = 0.28; g/Wl = 1.10; h/f = 0.12; h/Ll = 0.04; WD/LD = 0.93.

Almeras (1971:331, pl. 59A,B): *Holcothyris angulata* Buckman, Jurassic-Lower (Bathonian – *zigzag* zone), Prémeyzel, Ain, France.

DISCUSSION.—Ovcharenko (1967) claims that

H. angulata Buckman is a subspecies of *Kutchithyris acutiplicata* (Kitchin) because of similar exterior characters including presence of radial capillae in both. "From all the above [capillation of the two] it follows that the names *Kutchithyris* and *Holcothyris* are simultaneously proposed synonyms based on different subspecies of one species, of which the former according to priority of the type should be regarded as the older" [*Kutchithyris* has page priority over *Holcothyris*]. The ultimate test of this point of view rests on either exposing the loop of the Burmese type, *H. angulata*, or by means of adequate serial sections. The serial sections of *Kutchithyris* in Muir-Wood (1965:H783, figs. 645: 2a–k) are inadequate because they do not show the transverse band, making it impossible to gain any idea of the loop length or of the terminal points.

Inaequalis Sučić-Protić, 1971

PLATE 77: FIGURE 3

Inaequalis Sučić-Protić, 1971:12.

SUBFAMILY.—Inaequaliinae, new subfamily.

TYPE-SPECIES.—*Inaequalis dubari* Sučić-Protić, 1971:12, pl. 3: figs. 4–7; pl 23: fig. 1; pl 37: fig. 7 (reconstruction).

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Lias).

LOCALITIES.—France, Germany, Yugoslavia, and England.

DIAGNOSIS (SUČIĆ-PROTIĆ, 1971:12).—Elongated five-sided assymmetrical [sic] shells. The beak is long. The foramen is big. The cardinal process is wide. Hinge-plates are long. Flanks [terminal points] are medium-sized and pointed."

MORPHOLOGICAL DESCRIPTION (Sučić-Protić, 1971:12).—

The main characteristic of shells is assymmetry [sic]. All species are elongated-oval. Growth lines are expressed. The beak is characteristic: it is narrow, high and curved. It is not supported by the umbo of the dorsal valve so that the symphytium remains uncovered. The foramen is big, round to oval. The internal structure is characterized by a well developed cardinal process, elongated hinge-plates and a narrow brachidium. Its descending branches have a developed crural process. Flanks [terminal points] gradually curve towards the axis of symmetry and end in a peak.

LOOP STATISTICS.—See Table 22.

COMMENT.—Although diagnosed as pentagonal ("five-sided"), the figures of this genus on Sučić-Protić's pls. 3–5 are distinctly elongate elliptical in outline. The reconstructed outlines of *I. dubari*, *I. iniqua*, and *I. longiuscula*, all Sučić-Protić (pl. 37: respectively figs. 7, 9, and 10) have a shouldered outline, widest posteriorly, narrowing anteriorly quite unlike the figures of the actual specimens on Sučić-Protić's pls. 3–5. The loop of *I. rotundata* (Tuluweit) is suggestive of that of the dissected British specimen identified as *Lobothyris punctata* (Sowerby), which proves to have a fairly long loop (herein Plate 52: figures 1–6.

Inversithyris Dagis, 1968

Inversithyris Dagis, 1968:92.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Inversithyris rhomboidalis* Dagis, 1968:93, pl. 10: figs. 4, 5.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Kelloway Rock).

LOCALITY.—Northeastern SSSR (Chukotka).

DESCRIPTION (Dagis, 1968).—Medium size, moderately and weakly convex shells with poorly developed sinus [sulcus] in the dorsal valve. Lateral commissure straight, anterior [commissure] with a not large ventral curve [sulcate]. Beak short, slightly curved, foramen rounded, mesothyridid.

Pedicle collar short, teeth thick. Cardinal process transversely oval, not divided into lobes. Hinge plates wide, lying in the plane of commissure or slightly sloping. Umbonal cavity small, crural bases separate, perpendicular to the hinge plates, jutting out in the anterior region somewhat into the umbonal cavity. Crural processes wide. Loop with diverging branches and a high transverse band, not much thickened on the band. Flanges of the loop sharp, of medium length. Total length of arm supports equal to almost half the length of the dorsal valve.

LOOP STATISTICS.—Partial statistics from Dagis (1968:94, fig. 56): a/Ll = 0.42; b/Ll = 0.58; c/Ll = 0.22; d/Ll = 0.20; e/lL = 0.32; f/Ll = 0.26.

COMPARISON (Dagis, 1968).—A shell of very similar appearance to the new genus is *Rhapidothyris* Tuluweit (1965:72) described from the Liassic deposits of Europe. From the latter, *Inversithyris* is distinguished by the structure of the cardinalia, namely the more massive cardinal process, the considerably thicker hinge plates with perpendicular orientation to the crural bases.

A similar structure of the cardinalia and sinus [sulcus] in the dorsal valve is seen in the genus *Pseudoglossothyris* Buckman; the internal structure of this genus was studied by Muir-Wood (1965). From this genus *Inversithyris* differs in the absence of a keel on the ventral valve, the beak characters and the poorly developed sinus [sulcus] which appears as a not large thickening only near the anterior end.

Juralina Kiansep, 1961

PLATE 49: FIGURES 1–5, 6–8; PLATE 62: FIGURE 22; PLATE 63: FIGURE 23; PLATE 73: FIGURES 13, 14

Juralina Kiansep, 1961:29.—Boullier, 1976:367–369.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Juralina procerus* Kiansep, 1961: 29, fig. 8, pl. 1: figs. 2a,b, 3a,b, 36.

SPECIMENS STUDIED.—Fifteen specimens of two species, two with good loops, two with hinge plates and descending lamellae only.

GEOLOGIC OCCURRENCE.—Jurassic (Upper).

LOCALITIES.—Germany, France, Switzerland, and Russia.

EXTERIOR.—Noncontemporaneous homeomorph of *Rectithyris* of the Cretaceous. Fairly large, elongate oval, rhomboidal or subpentagonal with much elongated posterior. Sides rounded, anterior margin narrowly rounded, maximum width anterior to midvalve. Lateral commissure straight. Anterior commissure rectimarginate to moderately uniplicate. Beak elongated, straight to suberect, Foramen large, permesothyridid. Symphytium long, rounded and completely visible. Surface marked by concentric growth lines only.

INTERIOR.—Ventral valve interior details uncertain.

Loop and Cardinalia: The loop as revealed by *Juralina cervicula* (Rollier) is fairly long and fairly widely triangular and occupies almost ⅖ the length and a third the width of the dorsal valve. The cardinal process is large, semielliptical, shelflike and has the myophore facing posteriorly. The socket ridges are low and strongly inclined toward the narrow sockets. The fulcral plates are thick and are extended laterally as ridges nearly to the shell margin. The outer hinge plate is triangular, short, fairly wide and is extended anteriorly for a short distance slightly above the dorsal edge of the crural base to which it is attached. The crural base is extended posteriorly along the inner margin of the outer hinge plate as a strong wall to complete a fairly broad U-shaped trough. The crural processes are slender points directed anteroventrally and medially. The descending lamellae are long, bowed and thin. The transverse band is a strong arch, flattened medially and protuberant medially to reach about the height of the distal ends of the crural processes. The median flattening or bridge occupies about a third of the width of the transverse band. The terminal points are moderately extended and form an angle of 20° with the side of the loop.

LOOP STATISTICS.—USNM 551047: ∠ = 39°; Wl/Ll = 0.77; Ll/LD = 0.39; Wl/WD = 0.37; a/Ll = 0.47; b/Ll = 0.53; c/Ll = 0.29; d/Ll = 0.18; e/Ll = 0.23; f/Ll = 0.30; g/WD = 0.23; g/Wl = 0.61; h/f = 0.26; h/Ll = 0.08; WD/LD = 0.79.

USNM 551047: *Juralina cervicula* (Rollier), Jurassic (White Jura - Zeta), Schnaitheim, Germany.

DISCUSSION.—The loop of *Juralina insignis* was figured by Quenstedt (1868–1871, atlas, pl. 48: fig. 14) and Barczyk (1969:31, fig. 25) but each differs from that figured herein. Quenstedt's figure indicates a loop having much longer outer hinge plates (c/Ll = 0.50) but the loops conform in width and the terminal points are similar. Barczyk's loop is a reconstruction from serial sections and lacks detail of the hinge plates. His loop is figured as somewhat wider than that of the German specimen figured herein, the crura are longer, the crural bases crudely correct but the terminal points inaccurate. Furthermore the transverse band is not drawn with the median flattening that exists in the German specimen and the transverse band is narrow and more divergent from the horizontal.

Two other species were unsuccessfully prepared, *J. immanis* (Zeuschner) from the Oxfordian of Lodz, Poland, preserved only the hinge plates, crural processes and part of the descending lamellae. A specimen of *J. repelliana* (d'Orbigny) has short but extremely narrow outer hinge plates. The descending lamellae are widely divergent. Neither of these may truly belong to *Juralina* even though their exteriors conform to that of the type species.

Makridin (1964:236, fig. 79) gives serial sections and a reconstruction of the loop of a specimen identified as *T. bauchini* (sic) Etallon but referred to *Postepithyris*. The reconstruction shows a loop with long terminal points. The crural processes are uncertain. The specimens figured on Makridin's plate 15 have a more incurved beak than the Rauracian *J. bauhini* from Switzerland. Barczyk (1969) also figures specimens referred to *Epithyris bauhini* not *Juralina*. These are small and do not have an elongated beak. His reconstruction shows a narrow loop with narrow transverse band and divergent broad terminal points. This loop has a gross resemblance to that figured by Boullier (1976), but is different in detail, especially the transverse band. It is definitely not the loop of a *Juralina*.

Boullier (1976:367) discusses *Juralina* and its species *J. bauhini* (Etallon) and gives a stylized reconstruction of its loop based on serial sections of a specimen from the Middle Oxfordian of Switzerland. Statistics from the sections and reconstructed loop follow, the sections first, the reconstruction in parentheses: ∠ = 44° (40°); Wl/Ll = 0.75 (0.83); Ll/LD = 0.37 (0.44); Wl/WD = 0.30 (0.34); a/Ll = 0.49 (0.51); b/Ll = 0.51 (0.49); c/Ll = 0.37 (0.36); d/Ll = 0.12 (0.15); e/Ll = 0.24 (0.22); f/Ll = 0.27 (0.27); g/WD = 0.18 (0.16); g/Wl = 0.60 (0.46); h/f = 0.22 (0.15); h/Ll = 0.06 (0.04); WD/LD = 0.93 (0.93).

These figures do not accord with those taken from the Rauracian specimen figured herein (see below, and Plate 49: figures 1–5) which has the crural processes far forward in the loop and a much shorter anterior portion. They are in a closer agreement with the statistics of the German specimen (see above) a species not included in Boullier's list of species assigned to *Juralina*. *Terebratula bauhini* Etallon is a Rauracian species, not Oxfordian, and is probably not conspecific with Boullier's specimens.

Juralina? bauhini (Etallon)

Plate 49: figures 1–5; Plate 73: figures 13, 14

Terebratula bauhini Etallon, 1859–1862:258, pl. 41: fig. 6.

Discussion.—Specimens referrable to *T. bauhini* from Switzerland have the characteristic exterior of *Juralina* with its elongated beak and exposed symphytium. Most of the specimens, which occurred in a soft white limestone, are somewhat distorted and the one loop successfully exposed has suffered some damage. The loop varies from that described for the German species *J. cervicula* (see above).

Although this species has the exterior of *Juralina*, the extreme anterior position of the crural processes and brevity of the terminal points suggest a possible collateral branch rather than the main line development of *Juralina*.

Other species with the exterior of *Juralina*, *T. moravica* Glocker, *T. repelliana* d'Orbigny, and *T. immanis* Zeuschner, may belong here but the interiors are not well known. Barczyk (1969) places the latter in *Juralina* but his reconstructed loop has no resemblance to that of the German species. The interior of the two former species is not known. Smirnova (1975b) places *T. immanis* in her *Tropeothyris*, and *T. moravica* in *Weberithyris*.

LOOP STATISTICS.—USNM 551048: ∠ = 36°; Wl/Ll = 0.70; Ll/LD = 0.34; Wl/WD = 0.24; a/Ll = 0.65; b/Ll = 0.35; c/Ll = 0.35; d/Ll = 0.30; e/Ll = 0.10; f/Ll = 0.25; g/WD = 0.24; g/Wl = 0.85; h/f = 0.40; h/Ll = 0.10; WD/LD = 1.00.

USNM 551048: *Juralina? bauhini* (Etallon), Jurassic (Upper Rauracian), Bois du Treuil, Sayhièrs Switzerland.

Karadagella Babanova, 1965

Karadagella Babanova, 1965:95.

SUBFAMILY.—Karadagithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Karadagella moisseievi* Babanova, 1965:96, figs. 1–3.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Upper Bajocian).

Locality.—Eastern Crimea.

DIAGNOSIS (Babanova, 1965).—Shells, smooth, strongly biconvex. Beak thick, curved; foramen apical. Crural plates attached to hinge plate by ventral ends and in early stages of development they rest on the bottom of the dorsal valve, and in later stages hang free. Brachial [dorsal] loop with long flanges [terminal points].

COMPARISON (Babanova, 1965).—The genus considered is characterized by dorsally directed crural plates, with respect to the hinge plates and outer hinge plates attached on the ventral edge of the crural base. In all other features of external shell structure it corresponds with the genera belonging to the subfamily Loboidothyrinae which also permits its inclusion in the present subfamily. The genus most like *Karadagella* is *Postepithyris* Makridin. The similarity consists of the oval shell outline, the presence of a long flanged loop, slightly drooping in *Postepithyris* in the dorsally directed crural plates, which are attached to the hinge plate in the central region. In addition to the orientation of the crural plates, there is the distinction in the presence in *Postepithyris* of a dorsal septum and cardinal process (Makridin, 1960; Kiansep, 1961).

REMARKS (Babanova, 1965).—An arrangement of crural plates analogous with that in *Karadagella* is seen in *Adygelloides* (Dagis, 1963) and *Najdinothyris* Makridin and Katz from the Upper Cretaceous deposits of the southern SSSR. However, the absence of dental plates in *Karadagella* and the long-flanged brachial loop precludes their being genetically close.

LOOP STATISTICS (from reconstruction by Babanova, 1965:96, fig. 3).—∠ = 16°; Wl/Ll = 0.32; Ll/LD = 0.44; Wl/WD = 0.15; a/Ll = 0.53; b/Ll = 0.47; c/Ll = 0.35; d/Ll = 0.18; e/Ll = 0.21; f/Ll = 0.26; g/WD = 0.18?; g/Wl = 1.27?; h/f = 0.19; h/Ll = 0.05; WD/LD = 0.85.

COMMENT.—The narrowess of the loop is unlike that of *Postepithyris* and the dorsad extensions from the hinge plates are suggestive of *Gibbithyris* and possibly *Placothyris*. The loops of these two genera have only a slight development of the terminal points although there are extensions from the inner edge of the hinge plates. The terminal points of *Karadgella* are at the low end of standard set for loops with long terminal points.

Ovcharenko (1971) regards *Karadagella* as a junior synonym of *Goniothyris* Buckman. The exterior of *Karadagella* resembles that of "*Goniothyris*" *phillipsi* (Morris) now placed in *Morrisithyris* by Almeras (1971). This, and *Karadagella* are externally unlike type *Goniothyris gravida* (Szajnocha).

Tchorszhevsky (1974) places *Karadagella* in the tribe Karadagellini in the subfamily Karadagathyridinae.

Karadagithyris Tchorszhevsky, 1974

Karadagithyris Tchorszhevsky, 1974:54.
Svaljavithyris Tchorszhevsky, 1974:55.

SUBFAMILY.—Karadagithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Karadagithyris babanovae* Tchorszhevsky, 1974:55, figs. 8, 9.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Upper Bajocian).

LOCALITY.—Southeastern part of Gorno Crimea (Karadag Mountains).

BRIEF DESCRIPTION (Tchorszhevsky, 1974).—Shells have a moderately or strongly curved beak with a small apical or permesothyrid foramen. Symphytium short and narrow. Cardinal process well developed, oval, high, undivided. Outer hinge plates wide, thin, curved acutely toward the dorsal side. At the point of attachment of the crura they form a narrow ventrally directed curvature semicircular in cross-section. Crura and crural processes are thick, wide, slightly convergent ventrally. Processes of the outer hinge plates are well developed, extend to the level of the transverse band of the loop, but rest upon the floor of the dorsal valve only in its apical part.

In addition to the type species, the genus includes *Terebratula gerda* Oppel (1860, pl. 1: fig. 3) and, apparently, *T. margarita* Oppel (1860, pl. 2: fig. 3).

COMPARISON (Tchorszhevsky, 1974).—Similar in internal and external structure, the present genus differs from *Svaljavithyris* Tch. n. gen. for which "*T.*" *carpathica* Zittel, occurring widely in the Tithonian of the Low Tatra in Czechoslovakia, Switzerland, southern Poland, Transcarpathia, is proposed as the type species, in a shorter and more weakly curved beak with a larger, slightly permesothyrid foramen, wider and differently curved outer hinge plates, less wide and thicker processes of the outer hinge plate.

LOOP STATISTICS (from Tchorszhevsky, 1974:56, fig. 8, dimensions of sectioned specimen not given).—$\angle$ = 21°; Wl/Ll = 0.35?; a/Ll = 0.47; b/Ll = 0.53; c/Ll = 0.14; d/Ll = 0.33; e/Ll = 0.20; f/Ll = 0.33.

COMMENT.—Barczyk (1979), in his discussion of *Karadagithyris carpathica* (Zittel) notes that Tchorszhevsky (1973) originally placed this species in *Karadagithyris* but failed to validate his genus with a description. Later Tchorszhevsky (1974) made *T. carpathica* Zittel type of a new genus *Svaljavithyris*, again without formal description but with a comparison to *Karadagithyris*. Smirnova (1975b) assigns *T. carpathica* Zittel to her genus *Tropeothyris*. Barczyk (1979) regards her species identifications as incorrect and believes her specimens and Tchorszhevsky's all have the generic characters of *Karadagithyris*.

Kutchithyris Buckman, 1917

Kutchithyris Buckman, 1917:113.—Mitra and Ghosh, 1973:181.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Terebratula acutiplicata* Kitchin, 1897:9; 1900:6, pl. 1: figs. 1–7. Buckman, 1917: 113, pl. 20: fig. 17a.

SPECIMENS STUDIED.—Two specimens of the type species; literature, no loop.

GEOLOGIC OCCURRENCE.—Jurassic (Upper Bathonian to Callovian).

LOCALITIES.—Burma, Pamirs, and Russia.

DISCUSSION.—The only information on the loop of *Kutchithyris* is the inadequate serial sections in Muir-Wood, 1965:H783, figs. 645-2a-k, and the reconstruction by Ovcharenko, based on serial sections (1969:59, 60, figs. 1–3) of specimens from the Pamirs. The sections in Muir-Wood are not like those of Ovcharenko because they indicate a much shallower umbonal chamber. These serial sections are incomplete because there is no indication of the transverse band or any information on the terminal points. The text in Muir-Wood, 1965, indicates a loop one-third the dorsal valve length. The Ovcharenko reconstruction and sections show a loop of much greater length and with fairly long terminal points.

LOOP STATISTICS (based on the Ovcharenko (1969, fig. 3) reconstruction of *K. acutiplicata*).—$\angle$ = 40°; Wl/Ll = 0.81; a/Ll = 0.50; b/Ll = 0.50; c/Ll = 0.25?; d/Ll = 0.25?; e/Ll = 0.19; f/Ll = 0.31; h/Ll = 0.03; h/f = 0.10.

Statistics prepared from Ovcharenko's sections indicate a loop with longer terminal points than shown in the reconstruction, f/Ll = 0.41. The serial sections do not clearly show the position of the crural processes so that the sections and reconstruction do not produce figures that are close. Where to classify *Kutchithyris* is thus a problem. The specimens sectioned by Ovcharenko are from the Pamirs, not from Burma, from which the type comes.

Ovcharenko (1967) also noted the presence of radial capillation on *Kutchithyris* shells, corroborated by specimens in the collection of the National Museum of Natural History. These capillae along with other characters, led him to believe that *Kutchithyris* and *Holcothyris* Buckman are synonyms.

Mitra and Ghosh (1973, 181) give an emended description of *Kutchithyris* which includes serial sections. Although their sections are more complete than those of Muir-Wood (1965), they still leave uncertainty as to the true nature of the loop. The latter is said to occupy a third the length of the dorsal valve. No dimensions of the specimen sectioned are given making it impossible to determine the true length of the loop. The sections indicate a loop length of 13.7 mm. If the sectioned specimen were of the size of the one figured (fig. 4K) by Mitra and Ghosh, which has a dorsal valve of 31 mm length, the loop in such a case would equal almost half the dorsal valve length (0.44). This is more in accordance with Ovcharenko's findings. Loop statistics from the Mitra-Ghosh sections are: Wl/Ll = 0.74; a/Ll = 0.36; b/Ll = 0.64; c/Ll = 0.24; d/Ll = 0.12; e/Ll = 0.18; f/Ll = 0.46; h/Ll = 0.06. These figures indicate a loop with crural processes posterior of midloop and long terminal points. These figures, of course, depend on the accuracy of recognition of the parts of the loop shown in the sections.

Middlemiss (1980) places some Moroccan species from the lower Cretaceous in *Kutchithyris*, the exterior details of which are quite unlike those of *Kutchithyris*. *K. brivesi* (Roch) (Middlemiss, 1980, pl. 58: figs. 7–9) have strong external resemblance to *Sphaeroidothyris* rather than to strongly biplicate *Kutchithyris*. The assignment of these Cretaceous species to this Jurassic genus seems an unlikely choice.

Lenothyris Dagis, 1968

PLATE 62: FIGURE 18

Lenothyris Dagis, 1968:100.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Lenothyris perflexus* Dagis, 1968: 101, figs. 60, 61, pl. 11: figs. 1, 2.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Lower Volgian).

LOCALITY.—Northern Siberia.

EXTERIOR (Dagis, 1968).—Moderate size, rounded or oval; young specimens thin with a thickened dorsal valve. Adults rarely curved towards the plane of the commissure, through an angle approaching a right angle [anterior rapid growth]. Plicae not developed. Commissures straight. Beak short, moderately curved. Beak ridges rounded. Foramen not large, rounded or transversely oval, permesothyridid.

INTERIOR (Dagis, 1968).—Pedicle collar short. Cardinalia massive. Cardinal process thickened, not divided into lobes. Hinge plates approaching the floor of the valve, umbonal cavity small. Crural bases separate, sometimes also developed on the dorsal part of the hinge plates. Septalial ridge low. Both valves thickened in beak region. Loop long, reaching more than half the length of the dorsal valve. Crural processes high, transverse band strongly bent ventrally. Loop flanges [terminal points] long. Adductor impressions long, half the dorsal valve length, narrow, rather strongly diverging. Ovarian impressions deep.

LOOP STATISTICS (Dagis' reconstruction, 1968, fig. 61).—$\angle = 37°$; Wl/Ll = 0.70; Ll/LD = 0.54; Wl/WD = 0.41; a/Ll = 0.47; b/Ll = 0.53; c/Ll = 0.43; d/Ll = 0.04; e/Ll = 0.15; f/Ll = 0.38; g/WD = 0.34; g/Wl = 0.83; h/f = 0.05; h/Ll = 0.02; WD/LD = 0.93.

Dagis Reconstruction: *Lenothyris perflexus* Dagis, Jurassic (Volgian Stage), Lena River, Central Taimyr, Russia.

COMPARISON (Dagis, 1968).—*Lenothyris* differs from all known genera of terebratulids in its unique bicyclical growth. In internal structure it is perhaps similar to *Uralella*, owing to the massive cardinalia and long loop. In addition to the sharp bending of the shell *Lenothyris* differs from *Uralella* in the shorter and more weakly curved beak, the small size and also the character of the adductor impressions in the dorsal valve.

It should be mentioned that a more or less sharp change in the direction of shell growth is known in many species of different genera of terebratulids, for example, *Lobothyris edwardsi* Davidson, 1851–1852: pl. 6: figs. 13, 14; *"Terebratula" dallasi* Walker sensu Davidson, 1874–1882, pl. 3: figs. 1–5 and others, where in the majority of cases they have characteristics usually connected with the ephebic growth stages. In the Arctic species bicyclical growth is a stable feature (intermediate forms are not known) and is well expressed in time and space, which makes it possible to isolate them in an independent genus.

As has already been mentioned, *Lenothyris* is most like *Uralella*, the parent genus of the described genus, or these two may have come from a common ancestor.

COMMENT.—*Lenothyris* was placed by Dagis in his Loboidothyrididae.

Lissajousithyris Almeras, 1971

FIGURE 10; PLATE 46: FIGURES 16–22; PLATE 71: FIGURES 19, 20

Lissajousithyris Almeras, 1971:164.

SUBFAMILY.—Lissajousithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula matisconensis* Lissajous, in Arcelin and Roché, 1936:80, pl. 5: figs. 1–7; pl. 14: figs. 9, 10.

SPECIMENS STUDIED.—Five, two with complete silicified loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITY.—France.

EXTERIOR.—Medium size, elongate oval; ventral valve slightly deeper than dorsal one. Lateral commissure posteriorly oblique, convex toward ventral side at anterior. Anterior commissure uniplicate to sulciplicate. Dorsal sulcus wide. Beak short, suberect, moderately labiate. Foramen medium size, mesothyridid to permesothyridid; symphytium wide, visible. Surface smooth.

INTERIOR.—Ventral valve interior with thick and massive teeth; pedicle collar short. Muscle field not well impressed.

Loop and Cardinalia: The loop is unusually long and occupies more than half the length and more than a third the width of the dorsal valve. The cardinal process is small, somewhat rectangular shelf with myophore facing almost ventrally. The socket ridges are erect, thin, with rounded distal edges, gently curved and bound wide sockets. The fulcral plates are thick and are laterally extended as short ridges. The outer hinge plates are short, triangular with narrow tapered edge along the lower or dorsal margin of the crural base ending under the crural process. One specimen (USNM 551036c) is notched at the junction of the hinge plates and crural bases as in *Monsardithyris*. An elevated rim is formed by the crural bases along the inner margin of the outer hinge plates. This, with the outer hinge plate and socket ridge, forms a narrow U-shaped trough. In serial section (Almeras, 1971, pl. 5A,B) this ensemble is seen as a V-shaped trough with carina on the crural base. The crural processes are acute, located posterior to midloop, gently approximate, and not drawn into long points. The descending lamellae are

TABLE 19.—Loop Statistics for the genus *Lissajousithyris*

Proportions	USNM 551036c	USNM 551036d	Arcelin and Roché, 1936	Almeras, 1971
∠	23°	28°	30°	40°
Wl/Ll	0.43	0.58	0.55	0.72
Ll/LD	0.66	0.52	0.58	0.43
Wl/WD	0.30	0.39	0.38	0.40
a/Ll	0.40	0.33	0.39	0.40
b/Ll	0.60	0.67	0.61	0.60
c/Ll	0.29	0.20	0.28	0.30
d/Ll	0.11	0.13	0.11	0.07 (0.10)
e/Ll	0.11	0.17	0.11	0.25
f/Ll	0.49	0.50	0.50	0.35
g/WD	0.32	0.33	0.31	0.25
g/Wl	1.05	0.83	0.80	0.74
h/f	0.10	0.10	0.06	0.23?
h/Ll	0.05	0.05	0.03	0.08?
WD/LD	0.88	0.79	0.84	0.85

USNM 551036c, d: *Lissajousithyris matisconensis* (Lissajous), Jurassic (Bajocian), quarry La Roche-Vineuse, Monsard, Saône-et-Loire, France.

Arcelin and Roché (1936, pl. 14: fig. 9) and specimen sectioned by Almeras (1971, pl. 6A,B): same locality.

moderately long ribbons, straight or gently bowed. The transverse band is a high, narrow arch flattened medially and strongly webbed where it is attached to the descending lamellae. The median flattening or bridge in width is equal to about a fifth the width of the loop. The flattened part is narrowly notched on the posterior side with the sides of the notch bounded by short points or barbs. The terminal points are long and take up about half the loop length.

LOOP STATISTICS.—See Table 19.

DISCUSSION.—The loop of this genus appears to be variable as shown by specimens and figures of *L. matisconensis* (Lissajous) and the above statistics. The two loops figured by Arcelin and Roché (1936, pl. 14: figs. 9, 10) differ in length and width and both are flat-sided. Neither of these specimens shows the notched character of the outer hinge plate seen in one of the specimens belonging to the collection of the National Museum of Natural History (USNM 551036d). The two National Museum specimens, beside the notching, vary from those figured by Arcelin and Roché in having distinctly bowed lateral lamellae. The loops also vary in length and width but both specimens exhibit the anterior folding characteristic of *Lissajousithyris*. The loop of fig. 10 of Arcelin and Roché is possibly that of a young *Monsardithyris*.

The loop of *Lissajousithyris* is similar to that of *Monsardithyris* but the exterior features are different, especially in shell proportions and folding. In its great length this loop resembles that of two of the reconstructed loops of Liassic genera illustrated by Sučić-Protić: *Pirotothyris* and *Exceptothyris*.

Loboidothyris Buckman, 1917

PLATE 36: FIGURES 22–28; PLATE 70: FIGURES 17, 18

Loboidothyris Buckman, 1917:112.—Muir-Wood, 1965:H784 [part].—Almeras, 1971:182.

Dundrythyris Almeras, 1971:118. [Type-species *Terebratula perovalis* Sowerby, 1821–1825 (lectotype by Almeras, 1971)].

Not *Loboidothyris* Buckman.—Makridin, 1964:213.—Muir-Wood, 1965:H782, fig. 643: 5d [= *Morrisithyris*].—Rouselle, 1965b:82.

SUBFAMILY.—Loboidothyridinae Makridin, 1964.

TYPE-SPECIES.—*Loboidothyris latovalis* Buckman, 1917:112, pl. 20: fig. 25a. Davidson 1851–1852, pl. 10: figs. 1, 2.

SPECIMENS STUDIED.—Two, one with complete loop, one with cardinalia only. Literature.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITIES.—Great Britain, France, and Germany.

DISCUSSION.—*Loboidothyris* is a widely misidentified genus of the Jurassic. The type species is from the lower part of the Middle Jurassic but the genus has been identified widely in the Upper Jurassic, especially in Europe. Felix (1967) identified it in the Upper Jurassic of Germany and referred to it a species that has a loop unlike that of specimens from the Middle Jurassic, which are exactly like that of *Colosia*, new genus (Plate 35). Almeras (1971:187) noted that Felix's specimens were unlike *Loboidothyris*, Barczyk (1969), following the lead of Makridin, referred several species from the Upper Jurassic of Poland to *Loboidothyris*. Among them is *Terebratula zieteni* Loriol, which Boullier (1976) places in *Moeschia* but is called *Colosia* in this monograph. The three Polish species referred to *Loboidothyris* by Barczyk differ strongly in the structure of their loops as he has reconstructed them: *L. valfinensis* (Loriol) has a loop with long terminal points; *"L." undosa* Schmidt and *"L." zieteni* (Loriol) have short terminal points. *Terebratula subsella* (Leymerie) of the Upper Jurassic is often referred to *Loboidothyris* but Barczyk regards it as a species of the Cretaceous *Sellithyris*. Makridin (1964, as noted below) referred several Russian species erroneously to *Loboidothyris*.

Prosorovskaya (1968:70–91) identifies several species of Moissiev and several others, among them *L. zieteni* (Loriol), herein described as *Colosia*. The loops of five of these species are reconstructed but no two of them are alike, and all have fairly long terminal points. The loop of *"L." tchegemensis* (Moissiev) has long terminal points (f/Ll = 0.42). This species was later made the type of *Tchegemithyris* by Tchorszhevsky (1972) and is the name giver to his family Tchegemithyrididae (= Loboidothyridae). None of Prosorovskaya's reconstructions are like the loop of *Loboidothyris perovalis* (Sowerby), nor are they in accordance with Almeras' statistics of *L. ingens* (Rollier).

Because Buckman's description of *Loboidothyris* is based wholly on the exterior, except for an allusion to the dorsal adductor scars, no good information on the loop of the type species has been published. Muir-Wood (1965:H784) gives a diagnosis but the information on the loop appears to be erroneous. A figure of a loop and serial sections are attributed to *"Loboidothyris" perovalis* (J. de C. Sowerby) (Muir-Wood 1965:H782, fig. 643-5d; and H783, fig. 645: 1). The first figure identified as *L. perovalis* with loop proves to be that of the loop of *Morrisithyris* sent to the British Museum by Roché, a fact corroborated by Dr. Ellis Owen (in litt., March 1976). The serial sections (Muir-Wood, 1965, fig. 645: la-i) are said to belong to *L. perovalis*. They show keeled hinge plates unlike those figured by Almeras (1971, pl. 15A-C). These sections differ so strongly from sections of *Loboidothyris ingens* (Rollier) that Almeras proposed a new genus, *Dundrythyris*, for them. Neither of the sectioned specimens are topotypes, thus the loop characters of *Loboidothyris* are still not known.

Almeras, using the information derived from *Loboidothyris ingens*, a species very close to *L. latovalis*, if not identical, gives a redefinition of *Loboidothyris*. He notes (1971:184) that the external similarities of *Loboidothyris*, *Charltonithyris*, and *Gigantothyris* are so strong that he regards them as subgenera of *Loboidothyris*. He also points out that Rollier (1918:231) refers a specimen to *Terebratula ingens*, which Quenstedt (1868–1871:406, pl. 40: fig. 101) figures from the Brown Jura (delta) from Stuifen, Germany and incorrectly called *Terebratula intermedia*, but is now identified as *Gigantothyris gigantea*, type species of *Gigantothyris* Seifert (1963).

Almeras (1971:188) redefined *Loboidothyris* (based on *L. ingens*) as follows:

Medium to large, circular, planoconvex to biconvex. Valves unequally swollen. Beak massive, slightly to strongly recurved, provided with lateral carinae, generally long and strong. Symphytium not visible. Foramen large, circular, commonly labiate or attrite, permomesothyridid. Lateral commissures nearly vertical scarcely righting themselves dorsally at the front. Anterior commissure rectimarginate and later gently uniplicate or sulciplicate in old individuals. Muscle imprints wide, slightly divergent.

Pedicle collar short. Deltidial plates thick, welded. No umbonal cavity. Cardinal process long, lobed and low. Hinge plates club-shaped [in section], then [forming] a distinct U, not carinated, very distinct from the socket ridges. Teeth long an elongate rectangular tongue. Dental sockets very deep. Denticulum present. Euseptoidum slightly elevated and short. Transverse band ventrally convex. Length of brachidium 0.4.

Almeras notes that the diagnosis of the anatomical characters of *Loboidothyris* is based on observations of Muir-Wood, Buckman, and his own serial sections. It is odd that Almeras accepts Muir-Wood's (1965) figures (Almeras 1971:182; synonymy of *Loboidothyris*) when it is clear that the figure is that of *Morrisithyris*, Almeras' genus.

Loop statistics confirm *Loboidothyris*, as shown by *L. ingens* and *L. perovalis*, as having a fairly narrow loop with moderate terminal points. Compared to *Charltonithyris*, the terminal points are shorter and the loop narrower. The loop of *Gigantothyris* is much wider than that of *L. ingens* and *L. perovalis* and the terminal points are longer. The loops of *Gigantothyris* and *Charltonithyris* appear to be so different that subgeneric relationship to *Loboidothyris* seems unlikely.

Dependent on certain knowledge of the loop of *L. latovalis* from topotypes, *Loboidothyris* remains uncertain unless its true relationship to *T. perovalis* is satisfactorily established.

Rouselle (1965b:87) regards *Loboidothyris latovalis* Buckman as synonymous with *Terebratula perovalis*. However, her Moroccan specimens, which she identifies with a query, seem to be not in accordance with the excavated specimen of *T. perovalis* from Dundry figured herein (Plate 36: figures 22–28). The loop of the Moroccan form illustrated by Rouselle has very long terminal points suggestive of *Monsardithyris* or *Lissajousithyris* rather than *T. perovalis*. The anterior of the Moroccan shell is rather more strongly plicated than the French genera mentioned above, suggesting a new group or stock related to *Monsardithyris*.

The lectotype of *Terebratula ingens* Rollier by

Almeras (1971:189) is *Terebratula perovalis* Davidson (not J. de C. Sowerby) 1851–1852, pl. 10: fig. 5). Rouselle (1965b:82) regards *T. ingens* = *T. latovalis* = *T. perovalis*.

Buckman (1917:112) listed *T. perovalis* J. deC. Sowerby as a species of *Loboidothyris*.

Makridin (1964:213) cites the type of *Loboidothyris* as *Terebratula perovalis* Davidson, 1878 (sic) [*Loboidothyris latovalis* Buckman, 1917] evidently regarding these two species as one and the same, as does Rouselle. In his diagnosis, however, Makridin uses information from other species not congeneric with the cited types. He thus erroneously believed that the loop of *Loboidothyris* had long terminal points. His reconstructed figure of a loop, that of "*Loboidothyris*" *retrocarinata* Nalivkin (not Rothpletz) has very long terminal points and is now named *Nalivkinella nalivkini* Popov (in Katz and Popov, 1974a). For further understanding of *Loboidothyris* a dissected specimen from Dundry, England is described below.

Loboidothyris perovalis (J. de C. Sowerby)

Plate 36: figures 22–28

Exterior.—Medium to large, elongate oval, sides rounded, greatest width anterior to midvalve. Posterolateral extremities forming an angle of 75°–80° Lateral commissure nearly straight posteriorly, bent ventrally at anterior. Anterior commissure uniplicate in young stages, sulciplicate in adults. Beak erect, labiate, without beak ridges. Foramen round, large, permesothyridid. Symphytium mostly covered. Surface smooth.

Interior.—Ventral valve interior not seen.

Loop and Cardinalia: The loop occupies slightly more than a third of the length and width of the dorsal valve. The cardinal process is a small half ellipse. The socket ridges are slender, erect, and bound narrow sockets. The fulcral plates are thin. The outer hinge plates are short, narrowly triangular and thickened against the socket ridges. There is only a short taper which terminates posterior of the crural processes. The outer hinge plates are attached along the dorsal edge of the crural bases, which form high walls along their inside margin. The crural processes are located anterior to midloop, are sharply pointed and are directed anteroventrally and slightly medially. The descending lamellae are short and slightly bowed. The transverse band is a low arch at a small angle to the horizontal. It is widest at its base and thins to form a bridge which occupied almost half the loop width. The terminal points are short.

Loop Statistics.—See Table 20.

Discussion.—Davidson (1851–1852, pl. 10: fig. 6; Rollier, 1918:231 places this figure in his *T. ingens*) presents a drawing of a loop purported to be that of *T. perovalis* (copied by Deslongchamps, 1862–1885, pl. 52: fig. 3; pl. 53: fig. 1) which is defective in the same details as that of his rendering of *T. intermedia*, which it strongly resembles. The outer hinge plates are inaccurate compared to those of the excavated specimen and suggest a concave hinge plate. The crura are too narrow. Davidson's loop has nearly correct proportions but the transverse band has a rounded crest rather than a flattened bridge as shown by the prepared specimen. The terminal points, which are incorrectly rounded, are shown as open loops and disagree in length with those of the excavated specimen. I do not know of any short-looped brachiopod that has open loops as its terminal points; they are normally webbed.

The loop of *T. perovalis* prepared for this study does not conform to that of the Cheltenham, England, specimen sectioned by Almeras (1971, pl. 15A-C, see loop statistics). There is a striking difference in the loop dimensions: $\angle = 52°$, Wl/Ll = 0.98 for the Cheltenham specimen: $\angle = 39°$, Wl/Ll = 0.68 for *L. perovalis* from Dundry. The crural processes of the Dundry specimen are well anterior of midloop while those of the Cheltenham specimen are at about midloop. These facts suggest that the Cheltenham specimen is not *T. perovalis* J. de C. Sowerby even though their exteriors are similar. As *Dundrythyris* is typified by *T. perovalis* from Dundry, not Cheltenham, its generic definition must conform to the characters of the type species. That Almeras wanted *T. perovalis* from Dundry, England as type species of his genus is clearly implied in the name he gave

TABLE 20.—Loop statistics for the genus *Loboidothyris*, including those of *L. ingens* and *Dundrythyris* for comparison with *L. perovalis*

Proportions	USNM 551092	Almeras, 1971 Pl. 16A-E *L. ingens*	Davidson 1851-1852 *L. perovalis*	Almeras, 1971 Pl. 15A-C *Dundrythyris*
∠	39°	35°	38°	52°
Wl/Ll	0.68	0.68	0.70	0.98
Ll/LD	0.35	0.38	0.47	0.44
Wl/WD	0.32	0.28	0.33	0.49
a/Ll	0.56	0.53	0.55	0.49
b/Ll	0.44	0.47	0.45	0.51
c/Ll	0.34	0.39	0.25	0.27
d/Ll	0.22	0.14	0.30	0.22
e/Ll	0.20	0.26	0.10	0.34
f/Ll	0.24	0.21	0.35	0.17
g/WD	0.26	0.19	0.21	0.24
g/Wl	0.81	0.75	0.64	0.51
h/f	0.21	0.33?	0.28	0.29?
h/Ll	0.05	0.07?	0.10	0.05?
WD/LD	0.76	1.09	0.98	1.00

USNM 551092: *Loboidothyris perovalis* (J. deC. Sowerby), Jurassic (Bajocian - Inferior Oolite), Dundry, Somerset, England.

Almeras (1971, pl. 16A–E): *Loboidothyris ingens* (Rollier), Jurassic (Aalénien Supérieur), Cherveux, Deux-Sèvres, France.

Davidson (1851–1852, pl. 10: fig. 6) *Loboidothyris perovalis* (J. deC. Sowerby), no specific locality given.

Almeras (1971, pl. 15A–C); *Dundrythyris "perovalis"* sensu Almeras (not J. deC. Sowerby), Jurassic (Bajocian Inferior Oolite), Cheltenham, Gloucestershire, England.

the genus and his selection of a specimen from Dundry as lectotype.

The statistics of Almeras' sections of *L. ingens* (Rollier) are so close to those of the dissected specimen of *L. perovalis* that their generic identity seems a certainty. The loop proportions are the same, the length and width proportions of the two are similar, and the position of the crural processes is anterior to midloop in both. Rouselle (1965b:82) equates *T. perovalis* J. de C. Sowerby with *Loboidothyris latovalis* Buckman, type species of *Loboidothyris*, and also regards Davidson's figure (1851–1852, pl. 10: fig. 3, 3a,b only) *perovalis* = *latovalis*, the same figure that Almeras (1971:202) regards as *Monsardithyris ventricosa* (Hartmann-Zieten). The similarity of the loops of the Dundry specimen and *L. ingens* tends to lend credence to Rouselle's synonymy.

The loop of *Dundrythyris* from Cheltenham appears to be so different from that of *T. perovalis* that it should receive a new name. The Dundry *T. perovalis* is herein regarded as a subjective synonym of *L. latovalis*, with precedence over Buckman's species.

Almeras and Peybernès (1979:70) identify *Dundrythyris perovalis* in the Pyrenees.

Loboidothyropsis Sučić-Protić, 1971

PLATE 77: FIGURE 7

Loboidothyropsis (Loboidothyropsis) Sučić-Protić, 1971:16, 17.

SUBFAMILY.—Lobothyridinae Makridin, 1964.

TYPE-SPECIES.—*L. (Loboidothyropsis) tipica* Sučić-Protić, 1971:17, pl. 5: figs. 3–6; pl. 25: fig. 1; pl. 38: fig. 1 (reconstruction of loop).

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Middle Lias).

LOCALITIES.—Germany, Romania, France, Spain, and Yugoslavia.

DIAGNOSIS (Sučić-Protić, 1971:16).—Elongated, usually flattened shells. The posterior part is pointed while the anterior part is flat and rounded. The beak is curved. The foramen is big. The inner pedicle collar is developed. The cardinal process is wide. Flanks [terminal points] are medium sized, disjoined, curved on ends. [Rectimarginate].

MORPHOLOGICAL DESCRIPTION (Sučić-Protić, 1971:16).—"Shells are elongated-oval, convex to biconvex. The anterior part of the shells is always narrow. All species have well expressed growth lines. The inner pedicle collar is developed. The maximum width of the brachidium is in the flanks [terminal points] area. Flanks are medium-sized and wide. They are rounded at their ends."

LOOP STATISTICS.—See table 22.

COMMENT.—The reconstructions show blunt crural processes (poorly depicted in the type) close to the distal ends of the outer hinge plates and the terminal points are unusually bowed, as they are in the reconstructions of the other assigned species. The name seems inapt because *Loboidothyris* elsewhere is shown to have a loop with short terminal points and its shells are often distinctly folded at the anterior.

Loboidothyropsis (Bullothyris) Sučić-Protić, 1971

PLATE 77: FIGURE 8

Loboidothyropsis (Bullothyris) Sučić-Protić, 1971:21.

SUBFAMILY.—Lobothyridinae Makridin, 1964.

TYPE-SPECIES.—*Terebratula subpunctata* var. *crassa* Dubar, 1925:290, pl. 2: figs. 1–6; pl. 7: figs. 10, 11 (no lectotype established).

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Middle Lias).

LOCALITIES.—France, Romania, and Yugoslavia.

DIAGNOSIS (Sučić-Protić, 1971:22).—"Elongated-oval shells with inflated valves and a wide very much curved beak [Rectimarginate]."

LOOP STATISTICS.—See Table 22.

COMMENT.—Sučić-Protić does not describe the loop but serial sections and a reconstruction of a Yugoslavian specimen are presented. The chief characteristic of this subgenus is the strong inflation of the valves, the dorsal valve more convex than the ventral valve in some examples. The loop is said to be distinctive.

Sučić-Protić cites *Terebratula subpunctata* var *crassa* Dubar, 1925:290, pl. 2: figs. 1–6. The legend to Dubar's pl. 2: fig. 6 is given as *Terebratula subpunctata* var *gibbosa* nov. var. There is no text for this new variety and the page reference on the legend is to *T. s.* var. *crassa*. Specimens figured as *T. s.* var. *crassa* Dubar (pl. 7–9) are cited as examples of *Pirotothyris ampla* Sučić-Protić.

Lobothyris Buckman, 1917

PLATE 52: FIGURE 7; PLATE 77: FIGURE 1

Lobothyris Buckman, 1917:107.—Muir-Wood, 1934:539.—Almeras, 1971:180.—Sučić-Protić, 1971:5.

SUBFAMILY.—Lobothyridinae Makridin, 1964.

TYPE-SPECIES.—*Terebratula punctata* J. Sowerby, 1812–1815:46. Muir-Wood, 1934, pl. 62: fig. 28a–c (lectotype). (Not Buckman, 1917, pl. 20: fig. 7.)

SPECIMENS STUDIED.—Many, in several species and genera. Two British specimens excavated for loop, one complete, one a shadow in calcite. Silicified specimens from France with loop.

GEOLOGIC OCCURRENCE.—Jurassic (Lias).

LOCALITIES.—Great Britain, France, Spain, Germany, Sicily, Yugoslavia, and Romania.

PRELIMINARY DISCUSSION.—This discussion includes several genera that are related to or have been identified as *Lobothyris*. The structure of the holotype is not certainly known. Muir-Wood's study (1934) indicated a genus with moderately long loop (Ll/LD = 0.30), short terminal points and crural processes anterior to midloop. These data seem not to be correct for *Lobothyris*.

The internal characters of the genus have been described by several authors with conflicting data: Deslongchamps (1862–1884), Dubar (1925), Dagis (1968), and Sučić-Protić (1971). Their discussions and illustrations indicate ambiguity in the internal characters, some indicating a genus with a long loop with long terminal points (the first two), the others having a shorter loop with more modest terminal points. Davidson (1851–1852, pl. 6: fig. 3 from Sowerby's type lot) shows a long loop with long terminal points that are unwebbed, a broadly rounded transverse band, and septal plates attached to a fairly strong medium septum. This ensemble suggests a zeilleriid and can be dismissed from consideration. Davidson (1876–1878, pl. 16: fig. 8) figures a loop different from the preceding with crural processes anterior of midloop and transverse band broadly arched. This is the figure repudiated by Deslongchamps (1862–1885:374, pl. 40: fig. 1). Deslongchamps (1862–1885, pl. 109: figs. 1, 2) figures the loop of a silicified specimen from France with long loop and crural processes posterior of midloop.

Muir-Wood (1934) studied Sowerby's types and other British specimens and designated as lectotype one of Sowerby's original specimens from the Middle Lias from Horton Stone Quarry, Oxfordshire. In his description of *Terebratula punctata* Sowerby (1812–1815:46) states, "Abundant in the same dark limestone, sent me by Lady Aylesford, with number 2 [pl. 15, called *Terebratula subrotunda*], at a place called Horton stone quarry." On page 45 Sowerby states that the shell depicted as figure 2 came "from a limestone quarry near Warwick."

Muir-Wood (1934:540) illustrates 28 sections of a specimen 31.5 mm long from the Middle Lias at Tilton, Leicestershire, England, not the type-locality. The dorsal umbo appeared in the sections at 2.4 mm from the beak, leaving a dorsal valve of 29.1 mm. The 28th section terminates the series and shows two long dashes marked dl (= descending branch of loop, p. 256). This section ends at 5.2 mm of loop. The large dashes in section 28 suggest the crural processes, at least part of them, rather than descending lamellae. If this be true most of the loop has not been sampled or at any rate not figured. The transverse band and terminal points are not figured or recorded. These sections represent Ll/LD of only 0.18, about four-fifths of the loop are missing, yet the description of the genus states that the loop is approximately one-third the length of the dorsal valve. Evidence from specimens in the Sowerby type lot indicate a loop length of about Ll/LD = 0.40. Another specimen from Middle Lias, Halstead, Leicestershire, England was sectioned longitudinally and the loop excavated in the last section to show its full length (Muir-Wood, 1934:541, fig. 6). The dimensions of the specimen are not given. The loop as revealed by the final section is about 9 mm long and the crural processes are shown posterior to midloop (a/Ll = 0.47).

The reconstruction of the loop (Muir-Wood 1934, pl. 63: fig. 37; herein Plate 52: figure 7) is based on these horizontal and longitudinal sections and shows a fairly wide, short loop (∠ = 39°) and Ll/LD = 0.37 more than a third of valve length. It also shows unwebbed terminal points, an unlikely condition in terebratulid brachiopods.

Loop Statistics (Muir-Wood reconstruction, specimen B65240).—∠ = 39°; Wl/Ll = 0.63; Ll/LD = 0.37; Wl/WD = 0.27; a/Ll = 0.53; b/Ll = 0.47; c/Ll = 31; d/Ll = 0.22; e/Ll = 0.22; f/Ll = 0.25; g/WD = 0.27; g/Wl = 1.00; h/f = 0.12; h/Ll = 0.03; WD/LD = 0.88.

Muir-Wood reconstruction: *Lobothyris punctata* (Sowerby), middle Liassic, Tilton, Leicestershire, England.

Muir-Wood (1934:542) states, "Sowerby figures [1812–1815, pl. 15: fig. 2, called *T. subrotunda* by Sowerby] a young specimen of *Terebratula punctata* having a brachial [dorsal] valve 21 mm in length (Ll/LD = 0.40]. Another specimen from the same locality [presumably the type-locality] and collection, but not figured by Sowerby, has a brachial [dorsal] valve 23 mm in length and a loop 9 mm in length [Ll/LD = 0.39]." These figures suggest that specimens from the type lot have a loop 40% of the length of the dorsal valve, not one-third as stated.

Sučić-Protić (1971) in a study of the Middle Liassic brachiopods of Yugoslavia, describes 11 genera and illustrates their interiors by serial section and reconstructions. The latter seem de-

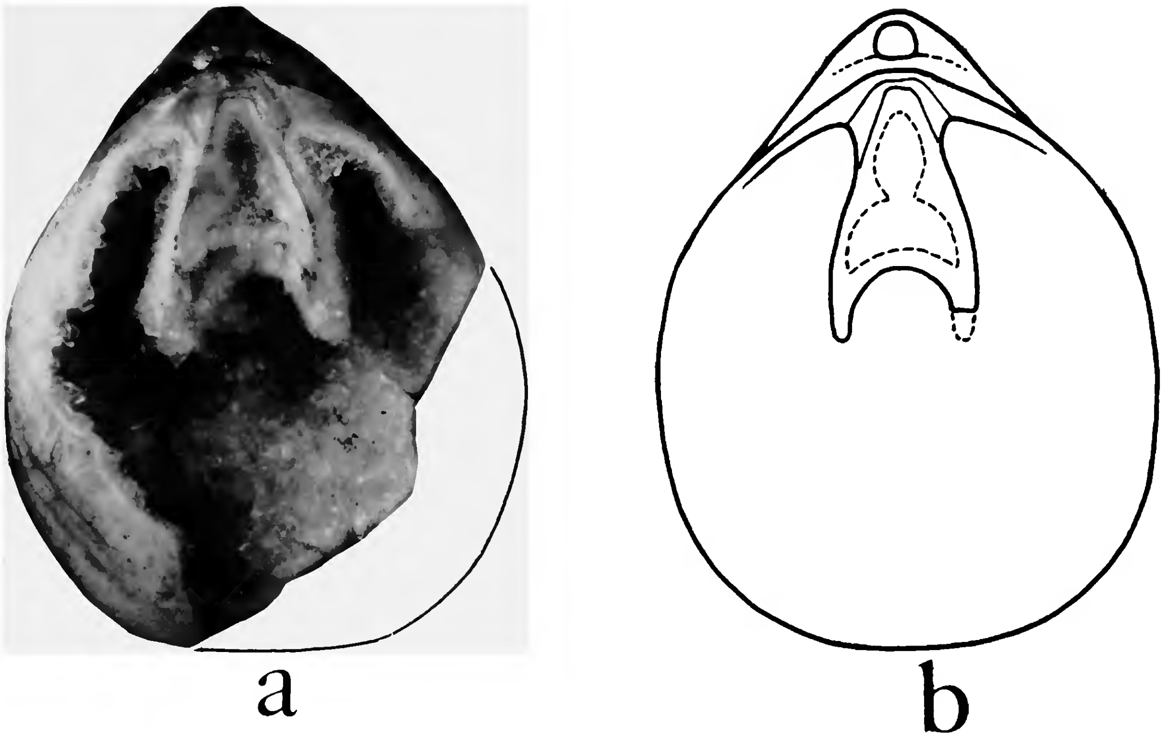


FIGURE 14.—*Lobothyris punctata* (J. deC. Sowerby), Middle Lias, Bodicote, near Banbury, Oxfordshire, England: *a*, specimen USNM 551165a, showing shadow of loop in crystalline calcite coating, crural process on left side of 25 mm anterior of ventral beak; *b*, drawing of same showing length of terminal points and position of crural process.

fective in the depiction of the hinge plates, crural bases and especially the crural processes, a defect common in most reconstructions from serial sections.

Among the 11 genera is *Lobothyris*, represented by two species, and said to be the only genus in the study that has a loop with short terminal points. For comparison with these and other lobothyrid-like brachiopods, Sučić-Protić sectioned a specimen of *L. punctata* from the Middle Lias, Banbury, Oxfordshire, England. It measures (dimensions taken from pl. 2: fig. 1) in mm: length 25.0, width 22.0, thickness 13 (WD/LD = 0.88). The loop reconstructed by Sučić-Protić (pl. 37: fig. 3; herein Plate 77: figure 1) has a loop angle of 34° and shows moderate webbed terminal points (f/Ll = 0.25), a more correct illustration than that of the Muir-Wood reconstruction. Unlike a dissected specimen from England (USNM 551041a, described below) the Sučić-Protić specimen has the crural processes anterior to midloop, like the Muir-Wood reconstruction. The last (22nd) section of the Sučić-Protić series of sections shows fairly large segments of the terminal points suggesting that the sectioning may not have been carried to the extreme end of the loop, as no distance from the previous section is given and the transverse band is not shown. The two Yugoslavian species assigned to *Lobothyris* (*L. sinemurensis* (Oppel) and *L. amoena* Sučić-Protić) have loops as reconstructed with scarcely any development of terminal points.

LOOP STATISTICS.—See Table 22.

A specimen from Bodicote, near Banbury, Oxfordshire, England (USNM 551165a) similar to Sowerby's type was prepared by grinding away the crystalline calcite covering the loop, giving a shadow of the loop and its important parts. The crural processes are located posterior of midloop (a/Ll = 0.47) and the terminal points are moderately long (f/Ll = 0.33). This loop does not agree with the two reconstructions. It was pointed out above that the data on the loops shown by the reconstructions are not complete. Only a fifth of the loop is shown in Muir-Wood's sections which ended at the crural processes; addition of the remaining part of the loop would indicate that the crural processes are posterior of midloop, not anterior. An addition of about 1.5 mm on the loop of Sučić-Protić's would make the crural processes posterior of midloop and the statistics would be very close to those of the specimen from Bodicote.

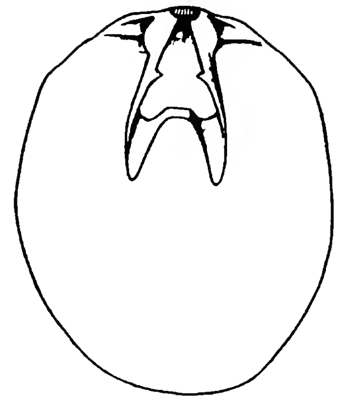


FIGURE 15.—Reconstruction of *Inaequalis rotunda* (Tuluweit) introduced for comparison with the British specimen of "*Lobothyris*" from Cheltenham (Plate 52: figure 6), after Sučić-Protić, 1971, pl. 37: fig. 8.

"*Lobothyris*" SPECIES

PLATE 52: FIGURES 1–6, 8–17; PLATE 62: FIGURES 1, 2; PLATE 71: FIGURES 5, 6

Specimens from England and France that have been identified as *L. punctata* have loops with long terminal points and are referrable to some of the genera proposed by Sučić-Protić. All of these are generalized forms having a rectimarginate anterior commissure. The Sučić-Protić genera are similar externally and their claim to generic identity must be based largely on the character of the loop. The long-flanged "*Lobothyris*" described below are represented by an excavated specimen from England and silicified examples from France.

DISSECTED SPECIMEN FROM ENGLAND (Plate 52: figures 1–6; Plate 71: figures 5, 6).—The specimen comes from the Middle Lias, near Cheltenham, Gloucestershire, obtained from the British Museum (Natural History) (USNM 551041a), measures in mm: length 29.0; width 20.5; thickness 15.5 (WD/LD = 0.71) and is like the specimen figured by Davidson (1851–1852, pl. 6: fig. 6). It is almond-shaped as it tapers anteriorly and posteriorly; is unequally biconvex with dorsal valve gently convex and the ventral one strongly convex. The lateral commissure is straight and the anterior commissure is rectimarginate. The surface is marked by well-defined growth lines. The beak is erect and the foramen fairly large. The symphytium is hidden.

On excavation the loop appears unlike the reconstruction of Muir-Wood or Sučić-Protić in most respects. It is long and narrow with long terminal points. The socket ridges are slender erect plates that bound narrow sockets. The fulcral plates are small and not extended laterally. The outer hinge plates are fairly wide, shallowly concave with their inner edge tapered anteriorly to join the dorsal edge of the crural base and terminate posterior of the crural processes. The crura are broad and flat in section. The crural base forms a ridge along the inside edge of the outer hinge plate. The crural processes, which are posterior of midloop, as they are in all the Sučić-Protić genera, and form short acute points. The descending lamellae are thin, very slightly bowed and join the transverse band on the outside of a long web. The transverse band is a narrow arch extending posteroventrally nearly vertically from the horizontal. The bridge is narrow and measures about a quarter of the loop width. The terminal points are long, reminiscent of those of *Arcelinithyris* and *Lissajousithyris*.

Loop Statistics: See Table 22.

Remarks on the Excavated Specimen: The shape of this specimen is not in accordance with that of

L. punctata from the type-locality, which is wider and not tapered anteriorly but its loop relationship to the dorsal valve agrees better with that of the loop mentioned by Muir-Wood (1934:542) in Sowerby's collection. The loop has little similarity to that figured by Dagis (1968) or to the reconstruction by Muir-Wood and Sučić-Protić, but is like that of French specimens discussed below.

SILICIFIED SPECIMENS FROM FRANCE (Plate 52: figures 8–17; Plate 62: figures 1, 2).—Several specimens from the Middle Lias north-northwest of Les Granges, Indre, France exhibit the cardinalia and loop to perfection. A specimen (USNM 551040a) measures in mm: length 31, width 27, thickness 14, WD/LD = 0.87. The valves are nearly equally convex. The species is not the same as the type specimens from England but the loop is like that of the excavated specimen from Cheltenham. In two of the specimens the loop is slightly wider than that of the English specimen and its relationship to the length and width of the dorsal valve is about the same. The fulcral plates are well developed and have lateral extensions. The outer hinge plates are wider than those of the English specimen but they have the same taper along the dorsal edge of the crural bases and terminate posterior of the crural processes which are acutely pointed and located posterior of midloop. The transverse band is steeply inclined, is narrowly arched and has a flattened crest or bridge occupying a quarter of the loop width. The terminal points are webbed and amount in length to half the loop length.

Deslongchamps (1862–1885, pl. 109: figs. 1, 2; herein Plate 62: figures 1, 2) figures a loop of silicified "*Lobothyris*" *punctata* which is very close

TABLE 21.—Loop statistics for French specimens described by Deslongchamps and Dubar

Proportions	USNM 551040a	Deslongchamps 1862–1885	Dubar 1925, pl. 6: fig. 18	Dubar 1925, pl. 6: fig. 20	Dubar 1925, pl. 6: fig. 22	Dubar 1925, pl. 7: fig. 6	fig. 8
∠	33°	32°	35°	35°	31°	31°	32°
Wl/Ll	0.58	0.58	0.62	0.57	0.57	0.57	0.54
Ll/LD	0.44	0.45	0.50	0.43	0.50	0.47	0.54
Wl/WD	0.27	0.36	0.39	0.32	0.37	0.39	0.36
a/Ll	0.34	0.38	0.34	0.31	0.33	0.33	0.36
b/Ll	0.66	0.62	0.66	0.69	0.67	0.67	0.64
c/Ll	0.32	0.30	0.31	0.31	0.27	0.27	0.36
d/Ll	0.02	0.08	0.03	0.00	0.06	0.06	0.00
e/Ll	0.21	0.20	0.16	0.15	0.14	0.17	0.14
f/Ll	0.45	0.42	0.50	0.54	0.53	0.50	0.50
g/WD	0.24	0.20	0.29	0.32	0.33	0.35	0.32
g/Wl	0.91	0.55	0.50	0.64	0.89	0.89	0.88
h/f	0.07	0.14	0.08	0.11	0.06	0.08	0.02
h/Ll	0.03	0.06	0.04	0.06	0.03	0.04	0.01
WD/LD	0.96	0.86	0.88	0.83	0.80	0.72	0.84

USNM 551040a: *Pirotothyris?*, Middle Lias, NNW of Les Granges, Indre, France.

Deslongchamps (1862–1885, pl. 109: fig. 1): *Pirotothyris?*, location unknown.

Dubar (1925, pl. 6: fig. 18): *Lobothyris punctata pentagonalis* Dubar (= *Inaequalis dubari* Sučić-Protić), Middle Lias, Jean Germa, near Foix, French Pyrenees.

Dubar (1925, pl. 6: fig. 20): *L. punctata pentagonalis* Dubar (= *Inaequalis dubari* Sučić-Protić), Middle Lias, S of Pech St. Sauveus, French, Pyrenees.

Dubar (1925, pl. 6: fig. 22): *L. subpunctata* Davidson (= *Pirotothyris*), Middle Lias, N of Cos, French Pyrenees.

Dubar (1925, pl. 7: figs. 6, 8): *L. subpunctata crassa* Dubar (= *Pirotothyris*), Middle Lias, St. Sauveur, French Pyrenees.

to that of the specimens from Les Granges. Statistics of these two loops are given in table 21.

The loop of the specimens from Les Granges accord best statistically with the statistics of *Pirotothyris* Sučić-Protić, although the shape of the exteriors do not conform well (see Table 22).

Dubar (1925) in making a study of the Liassic in the French Pyrenees discovered quantities of silicified "*Lobothyris*" that he identified with *L. punctata*, *L. subpunctata* Davidson, and *L. davidsoni* (Haime). Dubar described varieties of the first two species depending on their exterior form. All of the specimens referred to the first two species and their varieties have similar loops that closely resemble the loop of the silicified specimens from Les Granges and that figured by Deslongchamps. The loop of *L. davidsoni* is also like the other French species but the anterior commissure is sulcate and must be excluded from *Lobothyris*. Statistics of the loops of representative specimens described by Dubar are given on Table 21 for comparison with the loops of Deslongchamps and Les Granges. Dubar's work and figures are discussed below in connection with Sučić-Protić's study of Liassic brachiopods of Yugoslavia.

The loop of young "*Lobothyris*," according to Dubar, has shorter terminal points than the adult (f/Ll = 0.36–0.40) but rather long nevertheless. Dubar discusses the variability of the loop and mentions that in 40 examples, 22 had the end of the loop at midvalve (Ll/LD = 0.50), 10 were greater than this (0.53) and 8 reached only 0.47. There are also variations in the bowing of the descending lamellae and in the width and degree of flattening of the bridge of the transverse band. Dubar concludes that "the extreme variety of these forms of brachial apparatus of which the peculiarities seem independent of the form of the shell and other internal characters, do not permit one to draw more general observations."

Vialli and Cantaluppi (1967:92–97) describe species of *Lobothyris* from the Lias of Gozzano and illustrate their interiors by serial sections. The sections of all the species, *L. jauberti* (Deslongchamps), *L. paumardi* (Deslongchamps), *L. perforata* (Piette), *L. sarthacensis* (d'Orbigny) show the transverse band. Of the first three species the one section given of the terminal points anterior to the transverse band ranges from ½ to 1 mm. That section of *L. sarthacensis* is 2.3 mm anterior to the transverse band suggesting a loop with long terminal points. The other either had short terminal points or the sections are not complete.

The Sučić-Protić Genera

These have a sameness of external characters. In outline they vary in ellipticity from narrow in *Mirisquamea* to round in *Pyraeneica ariegensis*. Some are rather more ovate than elliptical, but withal, there is a general similarity in outline for most of the species figured. All of the genera are rectimarginate and most have a short, erect beak with variable foramen even within a genus. In profile the dorsal valve is generally flatly convex in some genera, becoming strongly convex to equal or greater than the convexity of the ventral valve. Generic differences based on the exterior are subtle and difficult, making the loop vital in generic determination. There is close similarity in the loops of a number of the genera. Most of the loops vary between 27° (*Mirisquamea*) and 42° (*Loboidothyropsis*). The widest is 57° of *Pyraeneica numerosa*. Most loops have a narrow bridge of the transverse band and all have webbed terminal points. The terminal points of all the genera, except *Lobothyris* are greater than f/Ll = 0.30.

The loops can be divided into four types: (1) wide and relatively short (slightly less than Ll/LD = 0.50 and f/Ll = 0.35 or less), including *Squamiplana*, *Pyraeneica*. *Loboidothyropsis (Loboidothyropsis)*, and *L. (Bullothyris)*; (2) long loop with long terminal points (f/Ll = 0.32–0.51) usually a narrow bridge and moderately wide angle (27°–38°), includes *Inaequalis*, *Serbiothyris*, *Senokosica* and *Pirotothyris*; (3) long loop (Ll/LD = 0.62) with moderate terminal points (f/Ll = 0.34) includes *Mirisquamea*; (4) with very long terminal points (f/Ll = 0.65, includes *Exceptothyris*.

The loops of *Mirisquamea* and *Exceptothyris* are outstandingly different from all the others. The reconstruction of the latter is very similar to that of *Rouillieria* Makridin (1964:251, fig. 84). *Pyraeneica* has an unusually wide loop with moderate terminal points. The loops of the second group resemble that of the excavated British specimen, the French silicified specimens figured herein, and the loops figured by Dubar (1925). Although the loop angles and Wl/Ll are variable, all have the crural processes posterior of midloop, the bridge narrowly flattened, the loop close to a half or slightly more than the dorsal valve length and moderately long, to long, terminal points. Most of the loops figured by Dubar are of the same type with narrow bridge, long terminal points and crural processes posterior of midloop. Sučić-Protić (p. 12) places *Terebratula subpunctata* var. *pentagonalis* Dubar in her genus and species *Inaequalis dubari*. She does not cite any other of the figured loops of Dubar (1925, pl. 6: figs. 18, 20) as belonging to this genus. None of Dubar's figures of loops conform well with that of *Inaequalis*, although they are similar in appearance, but have longer terminal points.

The French silicified specimen from Les Granges and Deslongchamps' loop (1862–1885, pl. 109: fig. 1) seem to conform best with the Dubar specimens showing loops and may be assigned tentatively to *Pirotothyris*, although the exteriors from Les Granges do not conform.

The four genera, *Inaequalis*, *Serbiothyris*, *Senokosica*, and *Pirotothyris* are close statistically and might be regarded as congeneric. The second and third have a somewhat wider angle and all have the terminal points ranging from f/Ll = 0.32–0.50. All are close in exterior details. The Sučić-Protić genera are summarized in Table 22.

Notes on Table 22. (Sučić-Protić genera).—In studying the sections and reconstructions figured by Sučić-Protić some inconsistencies were encountered. Sučić-Protić gives the dimensions of each of the sectioned specimens, which makes it possible to derive statistics from the serial sections as well as the reconstruction. Unfortunately the two do not always agree. The distance between the last section of a series and the one preceding it is not given, consequently the loop length measured from the sections is usually slightly less than that of the reconstructions. Furthermore the length and width of the outlines defining the shell margins in the reconstructions do not always agree with the given measurements. The outlines are not always consistent with the text figures of the specimens. Examples are *Inaequalis iniqua* and *I. dubari*, both Sučić-Protić (pl. 3: figs. 4–7; pl. 4: figs. 4–6) showing widely elliptical shells but the outline of the sectioned specimens (pl. 37: fig. 9) is drawn with a shouldered form, widest posteriorly and tapering anteriorly. Actually there are no specimens with this shouldered outline figured on pls. 1–15. All of the reconstructions are given as × 2, but several of them are actually at × 1.5 when compared with the given measurements of the sectioned specimens. An example is the reconstruction of *Exceptothyris*: the dimensions of the sectioned specimen given on legend to pl. 34: fig. 1 are (in mm): length 35.2; width 28.7. From this must be subtracted 3.4 mm representing the length of the beak of the ventral valve to the dorsal umbo. This gives the dorsal valve length as 31.8 mm. The length of the dorsal valve outline of the reconstruction is 47.5 mm which indicates an enlargement of × 1.5, not × 2 as stated in the plate legend. The serial sections of *Exceptothyris* give a recorded length of loop of 17.8 mm but the reconstruction shows a loop of 27.5 mm showing the enlargement to be × 1.5. Another example is the reconstruction of *Mirisquamea* (pl. 40: fig. 7) in which the loop measure derived from the sections is at × 2.5 in an outline correct at × 2.

Discussion of *Lobothyris* Loop

The problem now arises as to what is the loop structure of *Lobothyris*. Buckman used a French specimen to illustrate his new genus without giving any information on interior details. He stated in preliminary remarks (Buckman, 1917:23) that the specimens figured as "genotype" were to be the reference for his genera, not the named type. Inconsistently he used the expression "type" in citing the selected species, hence "Type, *L. punctata*, J. Sowerby species" for *Lobothyris*. Inasmuch as the term "genotype" is not recognized as a

TABLE 22.—Loop statistics of the Sučić-Protić genera and *Lobothyris* from England

Proportions	*Squamiplana piroidea*	*Inaequalis dubari*	*Loboidothyropsis (L.) tipica*	*L. (Bullothyris) subpunctata crassa*	*Pyraeneica numerosa*	*Serbiothyris medioliassica*	*Senokosica matura*	*Pirotothyris fortis*
∠∠	40°	27°	28°	42°	62°	36°	38°	28°
Wl/Ll	0.70	0.48	0.43	0.45	0.94	0.57	0.54	0.48
Ll/LD	0.44	0.47	0.44	0.47	0.40	0.50	0.54	0.50
Wl/WD	0.31	0.28	0.23	0.39	0.42	0.39	0.34	0.35
a/Ll	0.45	0.43	0.40	0.44	0.36	0.44	0.29	0.39
b/Ll	0.55	0.57	0.60	0.56	0.64	0.56	0.71	0.61
c/Ll	0.39	0.41	0.27	0.28	0.31	0.29	0.25	0.26
d/Ll	0.06	0.02	0.13	0.16	0.05	0.15	0.04	0.13
e/Ll	0.20	0.25	0.25	0.24	0.32	0.16	?	0.15
f/Ll	0.35	0.32	0.35	0.32	0.32	0.40	?	0.46
g/WD	0.25	0.30	0.28	0.32	0.25	0.27	0.38	0.26
g/Wl	0.81	0.85	1.10	0.86	0.60	0.67	0.67	0.73
h/f	0.23	0.25	?	0.13	?	?	?	0.04
h/Ll	0.08	0.08	?	0.04	?	?	?	0.02
WD/LD	0.96	0.81	0.81	0.83	0.96	0.74	0.85	0.78

Squamiplana piroidea Sučić-Protić: Middle Liassic, Senokos, Yugoslav Carpatho Balkanids, Sučić-Protić, 1971, pl. 37: fig. 4.

Inaequalis dubari Sučić-Protić: Middle Liassic, Lukanja, Yugoslav Carpatho Balkanids, Sučić-Protić, 1971, pl. 37: fig. 7.

Loboidothyropsis (Loboidothyropsis) tipica Sučić-Protić: Middle Liassic, same as above, Sučić-Protić, pl. 38: fig. 1.

Loboidothyropsis (Bullothryis) subpunctata crassa Sučić-Protić: Middle Liassic, Sonokos, Yugoslav Carpatho Balkanids, Sučić-Protić, 1971, pl. 38: fig. 5.

Pyraenica numerosa Sučić-Protić: Middle Liassic, Lukanja, Yugoslav Carpatho Balkanids, Sučić-Protić, 1971, pl. 38: fig. 6.

Serbiothyris medioliassica Sučić-Protić: Middle Liassic, same as above, Sučić-Protić, 1971, pl. 39: fig. 1.

Senokosica matura Sučić-Protić: Middle Liassic, same as above, Sučić-Protić, 1971, pl. 38: fig. 3.

Pirotothyris fortis Sučić-Protić: Middle Liassic, Senokos, Yugoslav Carpatho Balkanids, Sučić-Protić, 1971, pl. 40: fig. 1.

type designation, subsequent authors have regarded Sowerby's species as the type and Sowerby's specimens as syntypes from which Muir-Wood selected as type the specimen illustrated by Sowerby (1812–1815, pl. 15: fig. 1). Buckman's French "genotype," which is like the French specimens illustrated herein (Plate 52), probably has the long loop like that of specimens illustrated by Dubar and Deslongchamps. Muir-Wood's sections and composite reconstructions are not derived from specimens from the type-locality although she mentions a fairly long loop in two of Sowerby's specimens. Sučić-Protić's sectioned and reconstructed loop from the same general area as Sowerby's types suggests a short-looped brachiopod. However, the suspicion is strong that the whole loop was not sampled.

The specimen with shadowy loop preserved in

TABLE 22.—Continued

Proportions	*Exceptothyris expressa*	*Mirisquamea punctata clevelandensis* (Ager)	*Lobothyris punctata* (Sowerby) reconstruction by Sučić-Protić	USNM 551165a *L. punctata* (Sowerby) excavated loop	USNM 551041a *L. punctata* (Sowerby) excavated loop	*Lobothyris punctata* (Sowerby) Muir-Wood reconstruction	*Inaequalis rotundata* Sučić-Protić
∠L	30°	32°	34°	31°	26°	39°	27°
Wl/Ll	0.52	0.45	0.61	0.50	0.46	0.63	0.46
Ll/LD	0.60	0.62	0.36	0.41	0.47	0.37	0.46
Wl/WD	0.35	0.36	0.24	0.26	0.30	0.27	0.27
a/Ll	0.21	0.45	0.53	0.47	0.46	0.53	0.37
b/Ll	0.79	0.55	0.47	0.53	0.54	0.47	0.63
c/Ll	0.21	0.43	0.39	0.35	0.31	0.31	0.29
d/Ll	0.00	0.02	0.14	0.12	0.11	0.22	0.08
e/Ll	0.14	0.21	0.22	0.20	0.12	0.22	0.21
f/Ll	0.65	0.34	0.25	0.33	0.46	0.25	0.42
g/WD	0.26	0.41	0.33	0.27	0.38	0.27	0.23
g/Wl	0.76	0.76	1.09	0.91	1.08	1.00	1.05
h/f	0.05	0.21	0.14	0.19	?	0.12	0.12
h/Ll	0.03	0.07	0.04	0.06	?	0.03	0.05
WD/LD	0.89	0.75	0.79*	0.86	0.73	0.87	0.79

* Does not agree with WD/LD taken from specimen measurements

Exceptothyris expressa Sučić-Protić: Middle Liassic, Lukanja, Yugoslav Carpatho Balkanids, Sučić-Protić, 1971, pl. 40: fig. 6.

Mirisquamea punctata clevelandensis (Ager): Middle Liassic, Rosomaca, Yugoslav Carpatho Balkanids, Sučić-Protić, 1971, pl. 40: fig. 7.

Lobothyris punctata (Sowerby): Middle Liassic, Bambury (sic), Oxfordshire, England, Sučić-Protić, 1971, pl. 37: fig. 3.

Lobothyris punctata (Sowerby), USNM 551165a: Middle Liassic, Bodicote, near Banbury, Oxfordshire, England.

Lobothyris punctata (Sowerby), USNM 551041a: Middle Liassic, Tilton, Leicestershire, England. Muir-Wood Reconstruction (1934, pl. 63: fig. 37).

Lobothyris punctata (Sowerby): Middle Liassic, near Cheltenham, Gloucestershire, England. Excavated specimen.

Inaequalis rotundata (Sučić-Protić): Middle Liassic, Lukanja, Yugoslav Carpatho Balkanids, Sučić-Protić, pl. 37: fig. 8.

calcite from Bodicote, near Banbury, England, gives a correct position of the crural processes in the loop and shows moderately long terminal points. Its Ll/Ld = 0.41 conforms to that of the loops in Sowerby's type lot mentioned by Muir-Wood.

The specimen from Cheltenham, excavated for loop and illustrated herein (Plate 52: figures 5, 6), is not a topotype, is narrower than the type species, has long terminal points, and the crural processes posterior to midloop. The loop does not conform in angle, or W/L relationship with any of the Sučić-Protić species except *Inaequalis rotundata*, which has narrow and fairly long terminal points. I am therefore placing the English specimen tentatively in *Inaequalis*.

The evidence in the foregoing pages indicates that *Lobothyris* has a loop with moderately long terminal points and crural processes posterior of midloop. Externally it has biconvex valves with rectimarginate anterior commissure.

SPECIES ERRONEOUSLY ASSIGNED TO *Lobothyris*

Herein are noted one specimen from Les Granges and two species described by Arcelin and Roché (1936). The first, USNM 551056, is subcircular, has a dorsal valve with length and width equal and has a rectimarginate anterior commissure. The loop is wide, Wl/Ll = 0.56, and its length in relation to that of the dorsal valve is Ll/LD = 0.41. The outer hinge plates are drawn along the dorsad side of the crural base. The terminal points are webbed and the crural processes posterior of midloop. Its statistics are: ∠ = 42°; Wl/Ll = 0.56; Ll/LD = 0.41; Wl/WD = 0.44; a/Ll = 0.42; b/Ll = 0.58; c/Ll = 0.42; d/Ll = 0.00; e/Ll = 0.17; f/Ll = 0.41; g/WD = 0.26; g/Wl = 0.87; h/Ll = 0.02; WD/LD = 1.00. Statistically this specimen is referable to *Senokosica* Sučić-Protić.

Almeras (1971:181) referred two specimens described by Arcelin and Roché (1936) to *Lobothyris*: *Terebratula pseudocrithea* and *T. romani*. The loop of the first resembles that of *Lobothyris* of Muir-Wood but is also suggestive of the loop of young *Monsardithyris* figured on the same plate (Arcelin and Roché, 1936, pl. 14: fig. 4). The loop has an angle of 37°; Wl/Ll = 0.67; Ll/LD = 0. 0.40; Wl/WD = 0.32; a/Ll = 0.33; and f/Ll = 0.43. The loop is in best accordance with that of *Senokosica* Sučić-Protić.

"*Lobothyris*" *romani* is still more aberrant in having a loop angle of 48° and Wl/Ll = 0.96, loop length and width nearly equal. The crural processes are located far posteriorly in the loop (a/Ll = 0.36), and the terminal points are fairly long. The loop accords best with that of *Pyraeneica* Sučić-Protić.

Lophrothyris Buckman, 1917

PLATE 44: FIGURES 12–17; PLATE 45: FIGURES 8–15; PLATE 74: FIGURES 1, 2; PLATE 75: FIGURES 7, 8

Lophrothyris Buckman, 1917:114.—Almeras, 1971:356.

SUBFAMILY.—Lophrothyridinae, new subfamily.

TYPE-SPECIES.—*Lophrothyris lophus* Buckman, 1917:114, pl. 21: fig. 15.

SPECIMENS STUDIED.—Ten (of two species), two excavated with good loop, one with cardinalia only.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITY.—Great Britain and France.

EXTERIOR.—Small to medium size, round to roundly pentagonal; sides rounded; anterior margin rounded to truncated. Valves unequally biconvex, ventral valve more so than dorsal. Lateral commissure straight to oblique; anterior commissure rectimarginate to uniplicate. Beak erect to suberect. Foramen large, submesothyridid. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is stout and widely triangular, longer than wide, occupying about half the length and more than a third of the width of the dorsal valve. The cardinal process is a small half ellipse, with the myophore facing posteriorly and slightly ventrally. The socket ridges are thin, erect and bound narrow sockets. The fulcral plates are small and laterally extended. The outer hinge plates are short, narrow, dorsally attached and taper to the crural processes. The crural base forms a high ridge along the inside margin of the outer hinge plate and with the hinge plate and socket ridge forms a narrow U-shaped trough. The crural processes are narrow and extended into long, sharp points extending nearly directly ventrally. The descending lamellae are short and slightly bowed. The transverse band is fairly broad, wide laterally but narrowing slightly on the crest of the arch. The bridge forms about half the loop width. The web is moderately wide; the terminal points moderately long.

LOOP STATISTICS.—See Table 23.

DISCUSSION.—The loop of the type-species is characterized by a wide angle, nearly equal length and width and occupies nearly a half the shell length, having the crural processes well forward of midloop and fairly long terminal points.

TABLE 23.—Loop statistics for the genus *Lophrothyris*

Proportions	USNM 551033a	USNM 551100a
∠	41°	38°
Wl/Ll	0.82	0.83
Ll/LD	0.39	0.48
Wl/WD	0.36	0.42
a/Ll	0.50	0.56
b/Ll	0.50	0.44
c/Ll	0.29	0.39
d/Ll	0.21	0.17
e/Ll	0.11	0.11
f/Ll	0.39	0.33
g/WD	0.26	0.37
g/Wl	0.72	0.87
h/f	0.28	0.30
h/Ll	0.11	0.11
WD/LD	1.04	0.94

USNM 551033a: ?*Lophothyris whitakeri* (Walker-Davidson), Jurassic (Bajocian – Pea Grit), Crickley Hill, Cheltenham, England.

USNM 551100a: *L. lophus* Buckman, Jurassic (Bajocian Inferior Oolite – under Pea Grit), Leckhampton, Gloucestershire, England.

Specimens called ?*Lophrothyris whitakeri* (Walker-Davidson) are doubtfully placed under *Lophrothyris*. These specimens from Crickley Hill (USNM 551033) are broadly uniplicate but do not accord closely to the details of the loop of the type-species. The crural processes are not so far forward and the terminal points are somewhat longer, representing variation between different species.

The exterior characters of *Tubithyris* are too different from those of *Lophrothyris* to be placed in the synonymy of *Lophrothyris* even though the loops are statistically similar and the two are uniplicate.

Prosorovskaya (1968:61, fig. 37) reconstructs the loop of a specimen identified as *Lophrothyris euryptycha* (Kitchin), which is entirely unlike that of the specimen described and figured herein. The reconstructed loop is long and narrow with subparallel sides whereas the loop of the English specimen is fairly widely triangular.

Magharithyris Farag and Gatinaud, 1960

Magharithyris Farag and Gatinaud, 1960:78.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Magharithyris triplicata* Farag and Gatinaud, 1960:78, pl. 1: fig. 1a–c.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Bathonian).

LOCALITY.—Maghara Massif, Sinai, Egypt.

DIAGNOSIS (Farag and Gatinaud, 1960).—Beak more or less closely applied on the summit of the dorsal valve, foramen elliptical, shape elongated, morphogeny uniplicate to parasulcate to triplicate to quadriplicate to multiplicate.

COMPARISON (Farag and Gatinaud, 1960).—This genus relates most to *Parathyridina* Sch[uchert] and L[eVene].

Differences with *Parathyridina* Schuchert and LeVene (1929): beak narrower, foramen elliptical instead of being circular, shape elongated instead of globulose, triplicate or quadriplicate stage not existing in *Parathyridina*.

Differences with *Plectothyris* Buckman (1917) and *Plectoidothyris* Buckman (1917): morphogeny beginning with a uniplicate stage instead of beginning with a plano-convex or concavo-convex stage.

This is a monotypic genus.

COMMENT.—According to measurements given, this genus is of about medium size (mm): length = 29, width = 22.8 and thickness = 15.7. No information is given on the internal characters.

Merophricus, new genus

PLATE 54: FIGURES 14, 15; PLATE 55: FIGURES 1–5; PLATE 66: FIGURE 13

SUBFAMILY.—Plectoconchinae Dagis, 1974.

TYPE-SPECIES.—*Merophricus dubari*, new species (= *Terebratula* cf. *semiarata* Dubar, 1942:63, pl. 3: fig. 26a–e).

COMPOSITION.—*Terebratula semiarata* Dubar (1942), *T. moreti* Dubar (1942), *Merophricus dubari* Cooper, new species.

DIAGNOSIS.—Partially costate Terebratulacea having a short, wide loop with widely bowed descending lamellae and a narrow transverse band.

SPECIMENS STUDIED.—Five specimens and literature.

GEOLOGIC OCCURRENCE.—Jurassic (Lias).

LOCALITY.—High Atlas, Morocco.

EXTERIOR.—Subcircular to ovate, sides rounded, maximum width at midvalve; valves subequally convex, ventral valve slightly deeper and more convex. Lateral commissure straight; anterior commissure rectimarginate to uniplicate. Beak short, suberect to erect. Foramen large, incomplete; deltidium short, hidden. Surface of anterior half to three-quarters radially costate.

INTERIOR.—No dental plates in ventral valve.

Loop and Cardinalia: The loop is short and wide, and occupies nearly a third the length and width of the dorsal valve. The socket ridges are low, stout and define fairly wide sockets. The fulcral plates are thick and are extended laterally. The outer hinge plates are flatly concave and end abruptly at the crural processes without narrow taper. There are no crura. The descending lamellae are given off in a dorsal direction from the anterior end of the crural processes and bow strongly laterally to pass into the transverse band, not completely preserved in the specimen figured by Dubar (1942, pl. 3: fig. 26c).

LOOP STATISTICS (Dubar, 1942, pl. 3: fig. 26).—$\angle = 51°$; Wl/Ll = 1.00; Ll/LD = 0.27; Wl/WD = 0.28; a/Ll = 0.65; b/Ll = 0.35; c/Ll = 0.60; d/Ll = 0.05; e plus f/Ll = 0.35; g/WD = 0.26; g/Wl = 0.95; h/f = ?; h/Ll = ?; WD/LD = 0.96.

Dubar (1942, pl. 3: fig. 26): *Merophricus* cf. *M. semiarata* (Dubar). Jurassic (Lower Lias), Oued Derdourah, Ari-bou-Larfa (Sud de Timhadit), Moyen Atlas, Morocco.

DISCUSSION.—This loop is unlike any described herein except that of *Plectoconcha* in the wide bowing of the descending lamellae, the broad outer hinge plates, reduced crural processes and ill-defined crural base. The transverse band of Dubar's specimen was only partially preserved but indications are that it was slender.

ETYMOLOGY.—From the Greek *meros* (part) plus *phricos* (ruffling of a smooth surface).

Merophricus dubari, new species

Terebratula cf. *semiarata* Dubar, 1942:63, pl. 3: fig. 26a–e.

DIAGNOSIS.—See generic account above.

Mexicaria, new genus

PLATE 34: FIGURES 1–6

SUBFAMILY.—Cererithyridinae, new subfamily.

TYPE-SPECIES.—*Parathyridina mexicana* Ochoterena, 1960:24, pl. 1: fig. 2a–d (= *P. mexicana triplicata* Ochoterena).

DIAGNOSIS.—Small, anteriorly strongly costate terebratulaceans with wide loop (Wl/Ll = 0.72).

SPECIMENS STUDIED.—Twelve specimens, no loop excavated. Information and figure of loop from Ochoterena (1960, pls. 3, 4).

GEOLOGIC OCCURRENCE.—Jurassic (Oxfordian).

LOCALITY.—Southern Mexico.

EXTERIOR.—Small, roundly pentagonal, sides and anterior margin rounded. Ventral valve more convex than dorsal one. Lateral commissure straight; anterior commissure uniplicate, the plication complicated by strong peripheral costae. Beak suberect, short. Foramen large, mesothyridid; anterior part of beak and symphytium worn off in some specimens. Plication variable.

INTERIOR.—Ventral valve interior with small elongate teeth; no other details seen.

Loop and Cardinalia: The loop as illustrated by Ochoterena (1960, pl. 3) is widely triangular like that of *Animonithyris* and occupies a half the length and more than ⅖ of the width of the dorsal valve. The socket ridges are thin and inclined laterally to bound a moderately wide socket, floored by a thin fulcral plate with thin lateral extension. The outer hinge plates are narrowly triangular and tapered onto the dorsal edge of the crural bases. The crus is short, broad and flattened. The crural bases are continued along the inner margin of the outer hinge plates to form a high border and with those plates and the socket ridges to make V-shaped troughs that widen anteriorly to become U-shaped. The crural processes are located at about midloop, are narrow and prolonged into needle-like points. The descending branches are thin ribbons, moderately long and outwardly bowed. The transverse band is a high arch flattened medially for two-fifths of the loop width. The ribbon of the median flattening is thin and slightly concave toward the posterior. The terminal points are moderately long, only slightly webbed, and form an angle of 24° with the side of the loop.

LOOP STATISTICS (Ochoterena, 1960, pl. 3: fig. 2a).—∠ = 41°; Wl/Ll = 0.72; Ll/LD = 0.49; Wl/WD = 0.35; a/Ll = 0.52; b/Ll = 0.48; c/Ll = 0.39; d/Ll = 0.13; f/Ll = 0.29; g/WD = 0.35; g/Wl = 0.79; h/f = 0.10; h/Ll = 0.03; WD/LD = 1.00.

Ochoterena (1960, pl. 3: fig. 2a): *Mexicaria mexicana* (Ochoterena), Jurassic (Oxfordian), Rancho Pacheco, northwest Oaxaca, Mexico.

DISCUSSION.—The statistics of Ochoterena's illustrated loop and those of *Animonithyris* are similar. The loop of *Mexicaria* is longer than that of *Animonithyris* and wider in relation to the width of the dorsal valve. The loop of *Mexicaria* is more slender than that of *Animonithyris*.

ETYMOLOGY.—Named for Mexico.

Millythyris Almeras, 1971

Millythyris Almeras, 1971:245.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Millythyris millyensis* Almeras, 1971:251, pl. 43: figs. 6–11; pl. 27: fig. 8; pl. 37.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Upper Bajocian).

LOCALITY.—France.

ORIGINAL DIAGNOSIS (Almeras, 1971:245).—Small to medium. Oval to rounded pentagonal, more or less broad. Valves moderately swollen. Beak nearly straight to straight, not touching the dorsal umbo, without lateral ridges. Symphytium low and narrow. Foramen circular, permesothyridid, labiate. Lateral commissures slightly deviating toward the ventral valve posteriorly, regularly deflected toward the dorsal valve in the anterior region. Anterior commissure paraplicate without an initial sinuate stage and not followed by intraplication. Dorsal median sulcus U-shaped or in a V always less deep than in *Ferrythyris*. Dorsal muscle imprints long, more or less divergent, with widened anterior terminations.

Pedicle collar fairly long. Cardinal process plano-concave, then generally elevated toward the front, not pedunculate, grooved or not. Umbonal cavity at least present at the level of the anterior half of the cardinal process. Hinge plates in the form of a club, then of V, well separated from the socket ridges. Hinge teeth and sockets as in *Ferrythyris*. Plane of articulation and denticles enlarged. Length of brachidium 0.47–0.55. No euseptoidum.

COMMENT.—The loop statistics, like the exteriors of *Ferrythyris* and *Millythyris*, are very close. For loop statistics and comparison of loops with *Ferrythyris* and *Conarothyris*, see *Conarothyris*.

Mirisquamea Sučić-Protić, 1971

PLATE 77: FIGURE 10

Mirisquamea Sučić-Protić, 1971:38.

SUBFAMILY.—Lobothyridinae Makridin, 1964.

TYPE-SPECIES.—*Lobothyris punctata clevelandensis* Ager, 1956:2, pl. 1: figs. 1–5.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Middle Lias).

LOCALITIES.—England and Yugoslavia.

DIAGNOSIS (Sučić-Protić, 1971:38).—"Elongated, fairly convex shells. The beak is narrow and long. The foramen is big. There is no developed inner pedicle collar. Hinge plates and brachidium are very long" [rectimarginate].

MORPHOLOGICAL DESCRIPTION (Sučić-Protić, 1971:38).—

Elongated-oval shells. The posterior part is elongated and narrow while the anterior part is rounded. Growth lines are expressed. The beak is narrow, low, and curved. The foramen is big; it is not supported by the umbo of the dorsal valve. The inner pedicle collar is not developed. The uncovered symphytium is narrow and low. Internal structure: small and low cardinal process, very long hinge plates which almost reach the crural processes. The long brachidium is one half of the shell's length. This is due to very long descending branches and not to flanks [terminal points] as with other Liassic genera. The crural process is clearly expressed and the flanks themselves are medium-sized, parallel, rounded on the ends.

LOOP STATISTICS.—See Table 22.

REMARKS.—This is another extremely long loop but its terminal points are relatively short (f/Ll = 0.34). The outer hinge plates are also extremely long for a Jurassic brachiopod.

Moeschia Boullier, 1976

PLATE 63: FIGURE 13

Moeschia Boullier, 1976:333.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula alata* Rollet, 1972: 24, pl. 1: figs. 2–10; pl. 2: figs. 1–3 (= *Terebratula rollieri* auct. pars).

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Upper Jurassic.

LOCALITIES.—France, Switzerland, Poland, and Romania.

ORIGINAL DIAGNOSIS (Boullier, 1976:334).—Large, plano-convex to biconvex. Dorsal valve always less swollen than the ventral. Beak short, most often strongly incurved, foramen permesothyridid, rounded or oblong, marginate, rarely crested. Deltidium slightly or not exposed. Anterior commissure uniplicate, elevated to feebly sulciplicate. Adductor muscle impressions long, spatulate, scarcely divergent.

Pedicle collar present. Cardinal process fairly prominent, flat and low posteriorly, more projecting anteriorly, with roughened surface. Hinge plates wide, flat to fairly concave, thin, carinate anteriorly, provided with a high horizontal socket plate, not always clearly differentiated from the rest of the [hinge] plate. Crural processes parallel, slightly convergent, often thickened or carinate at the base, variable in position. Jugum [transverse band] narrow laterally, flat or convex, less elevated than the crura. Wings [terminal points] well developed in species from the Middle Oxfordian, shorter in those from the Upper Oxfordian, Brachidium occupying 30%–39% of the length of the dorsal valve. The internal structure of this genus seems to undergo a certain evolution in the course of time.

TABLE 24.—Loop statistics for the genus *Moeschia**

Proportions	Boullier, 1976, fig. 182	Boullier, 1976, fig. 186	Boullier, 1976, fig. 184
∠	30°	33°	31°
Wl/Ll	0.57	0.60	0.58
Ll/LD	0.36	0.35	0.42?
Wl/WD	0.22	0.23	0.27?
a/Ll	0.47	0.42	0.49
b/Ll	0.53	0.58	0.51
c/Ll	0.30	0.31	0.28
d/Ll	0.17	0.11	0.21
e/Ll	0.21	0.23	0.20
f/Ll	0.32	0.35	0.31
g/WD	0.22	0.23	0.27?
g/WL	1.00	1.39	1.00
h/f	0.12	0.11	0.54?
h/Ll	0.04	0.04	0.14?
WD/LD	0.90	0.90	0.90?

* The length of the dorsal valve was not given in the text for these sections and the reconstruction. Approximation of the dorsal valve length and width were taken from the means for the species given by Boullier (1976:337) and the percentage occupied by the beak of the ventral valve average from the figures of *M. alata* on pl. 11. The figures for Ll/LD, Wl/WD, g/WD, and WD/LD are not accurate but are reasonable. The figures of the loop proper are fairly accurate, as accurate as one can identify the various unlabelled loop parts in serial sections.

Boullier (1976, fig. 182 – serial sections): *Moeschia alata* (Rollet), Middle Oxfordian (Transversarium Zone), Birmensdorf Beds, Indrieux, near Arandas, Ain, France.

Boullier (1976, fig. 186 – reconstruction): *Moeschia alata* (Rollet), same location as above.

Boullier (1976, fig. 184 serial sections): *Moeschia alata* (Rollet), Middle Oxfordian (Transversarium Zone), Sponge Beds, Chatillon-sur-Seine, Cote d'Or, France.

LOOP STATISTICS.—See Table 24.

DISCUSSION.—Boullier distinguishes *Moeschia* from *Rouillieria* Makridin (1964) by the excessive length of the loop of the latter. She notes similarity to *Turkmenithyris* Prosorovskaya (1962) but *Moeschia* is less lozen-shaped, has a more elevated cardinal process, less developed crural bases, and short terminal points [ailes]. *Moeschia* differs from *Postepithyris* Makridin (1960) in its external outline, which is never subcircular or rounded pentagonal, less regular sulciplication, non-trilobate cardinal process, flat hinge plates, crural processes less convergent toward the center and a transverse band which is neither wide nor elevated. Although there is some resemblance to *Dorsoplicathyris* Almeras (1971) in general aspect, *Moeschia* differs in having a less-developed cardinal process, thinner hinge plates, with slender flat and arcuate crural bases, slightly inclined to parallel crural processes, less high, by its laterally narrower transverse band of pointed appearance and less elevated, by its wider, longer and more divergent terminal points (at least in some species), and by a shorter brachidium.

Among other species Boullier includes *Terebratula zieteni* Loriol in *Moeschia*, a species here given the name *Colosia*, new genus. This species has never had a safe home, having been placed in *Loboidothyris* by Makridin (1964) and by Felix (1967). Comparison of silicified loops of *T. zieteni* from Mellikon, Switzerland, with the reconstruction of the loop of *Moeschia* by Boullier (1976, fig. 186) shows very marked differences. The loop of *Moeschia*, as depicted, has long terminal points and a transverse band that is fairly strongly folded and medially very narrow. The loop of *Colosia* (*T. zieteni*) has poorly developed terminal points and a low, broad transverse band. The sections of *T. zieteni* illustrated by Boullier (1976, fig. 194) show a reverse relationship of a/Ll and b/Ll, that of *Moeschia* being larger while that of *T. zieteni* is smaller. The loops of these two genera are so different that their type-species cannot be congeneric.

Moisseevia Makridin, 1964

Moisseevia Makridin, 1964:243.—Rothpletz, 1886-1887:75 [part].

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Moisseevia sokolovi* Makridin, 1964:244, pl. 16: figs. 3, 4.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Late Oxfordian).

LOCALITY.—Russian Platform, Caucasus, Crimea, and western Europe.

DESCRIPTION (Makridin, 1964).—Elongate-oval shells with slightly swollen, frequently depressed dorsal valves. Anterior margin with a wide, usually faintly developed fold. Beak strongly curved, overhanging the dorsal valve. Foramen round or somewhat oval. There is a well developed pedicle collar. Loop extends more than ⅓ the length of the dorsal valve. Cardinal process short. Dorsal septum thin and fairly short. Traces of attachment of adductor muscles in this valve expand gradually anteriorly, almost parallel to the septum for a considerable distance, diverging from it at the extremities.

GENERAL OBSERVATIONS AND COMPARISON (Makridin, 1964).—This new genus corresponds in general terms to features of the group Grandis-Sippe Rothpletz, with such genera as *Loboidothyris* Buckman and *Rouillieria* Makridin affiliated. However, *Moisseevia*, new genus, is separated quite clearly from *Loboidothyris* Buckman by the presence of a clearly expressed median septum and relatively wider adductor muscle impressions which are parallel to the septum for a great distance. It is possible that the Late Jurassic representatives of *Loboidothyris* Buckman that belong to *L. zieteni* (Loriol) group [= *Colosia*, new genus herein] gave rise to the genus *Moisseevia*.

The more delicate and strongly incurved beak with rather weakly developed ridges, the less distinctly apical position of the foramen, narrow traces of attachment of the adductors, the somewhat sharper expression of the median septum all serve to distinguish this genus from *Rouillieria* Makridin. I believe that *Moisseevia*, new genus, can be regarded as an ancestral genus of *Rouillieria* Makridin.

COMMENT.—The interior of *Moisseevia* has not been illustrated by serial sections or otherwise. A long-flanged loop is ready separation from Upper Jurassic *Loboidothyris* (= *L. zieteni* (Loriol) = *Colosia*), which has only modest terminal points.

Monsardithyris Almeras, 1971

PLATE 29: FIGURES 16–21; PLATE 38: FIGURE 14; PLATE 47: FIGURES 1–15; PLATE 71: FIGURES 3, 4, 11, 12

Monsardithyris Almeras, 1971:198.

SUBFAMILY.—Lissajousithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula ventricosa* Zieten, 1830:52, pl. 40: fig. 2. Arcelin and Roché, 1936:73, pl. 4: figs. 1–11; pl. 5: fig. 12; pl. 6: fig. 10; pl. 14: figs. 1–4, 6, 7 (loops). Almeras, 1971:202, pl. 7: figs. 1, 2; pl. 12: fig. 1; pls. 8A, 9.

SPECIMENS STUDIED.—Fifty, 21 silicified specimens with loop.

GEOLOGIC OCCURRENCE.—Middle Jurassic.

LOCALITIES.—Great Britain, France, and Germany.

EXTERIOR.—Large, elongate oval, sides and anterior margin rounded; posterolateral extremities near 90°. Nearly equally biconvex, ventral valve slightly deeper than dorsal valve. Lateral commissure straight; anterior commissure rectimarginate to broadly uniplicate to sulciplicate. Beak short, suberect, moderately labiate; foramen large, permesothyridid. Surface smooth except for lines and varices of growth.

INTERIOR.—Teeth long and narrow, separated from shell margin by narrow groove. Pedicle collar short, excavated. Other details of ventral valve uncertain.

Loop and Cardinalia: The loop is a long triangle with length greater than width, occupying about half the length and nearly ⅖ the width of the dorsal valve. The sides of the loop are slightly bowed laterally. The cardinal process is a small, thin, slightly concave shelf-like half ellipse with myophore directed posteriorly, and often with upturned rim. The socket ridges are curved, thin, high and only slightly tilted laterally. They bound long, narrow sockets proximally covered by shell. The fulcral plates are thin and are slightly extended laterally as a horizontal ridge. The outer hinge plates are short, narrow and triangular, steeply inclined, moderately concave, and often notched anteriorly (Plate 47: figure 15). They are tapered anteriorly for a short distance along their contact with the dorsal edge of the crural bases which are elevated along their inside edge. The

TABLE 25.—Loop statistics for the genus *Monsardithyris*

Proportions	USNM 551020a	USNM 551020b	USNM 551020c	USNM 551020d	USNM 551020e	USNM 551020f	USNM 551035a	USNM 551039	Almeras 1971
∠	31°	31°	35°	31°	33°	31°	37°	36°	39°
Wl/Ll	0.55	0.55	0.64	0.59	0.58	0.62	0.71	0.69	0.70
Ll/LD	0.47	0.51	0.46	0.51	0.49	0.48	0.53	0.47	0.47
WL/WD	0.36	0.35	0.35	0.37	0.35	0.36	0.38	0.40	0.37
a/Ll	0.33	0.45	0.32	0.45	0.42	0.44	0.38	0.46	0.42
b/Ll	0.67	0.55	0.68	0.55	0.58	0.56	0.62	0.54	0.58
c/Ll	0.29	0.18	0.28	0.27	0.21	0.25	0.18	0.34	0.20
d/Ll	0.04	0.19	0.04	0.18	0.21	0.19	0.20	0.12	0.22
e/Ll	0.16	0.14	0.24	0.09	0.15	0.19	0.22	0.12	0.18
f/Ll	0.51	0.41	0.44	0.46	0.43	0.37	0.40	0.42	0.40
g/WD	0.28	0.32	0.40	0.26	0.28	0.27	0.26	0.29	0.25
g/Wl	0.78	0.92	0.63	0.70	0.82	0.90	0.69	0.72	0.89
h/f	0.10	0.10	0.09	0.11	0.10	0.13	0.20	0.19	0.22
h/Ll	0.05	0.04	0.04	0.05	0.04	0.05	0.08	0.08	0.09
WD/LD	0.71	0.79	0.67	0.81	0.79	0.82	0.88	0.80	0.82

USNM 551020a–f: *Monsardithyris ventricosa* (Zieten), Jurassic (Bajocian), quarry La Roche-Vineuse, Monsard, Saône-et-Loire, France.

USNM 551035a: *M. buckmaniana* (Walker), Jurassic (Bajocian – Pea Grit), Crickley Hill, Cheltenham, Gloucestershire, England.

USNM 551039: *M.? buckmani* (Davidson), Jurassic (Bajocian – Inferior Oolite), Cleave Hill, Cheltenham, Gloucestershire, England.

Almeras (1971, pl. 8A,B): *Monsardithyris ventricosa* (Zieten), Jurassic (Bajocian), quarry La Roche-Vineuse, Monsard, Saône-et-Loire, France.

socket ridges, outer hinge plates and crural bases make narrowly U-shaped troughs. In serial section (Almeras, 1971, pls. 8A, 9) this ensemble appears to be broadly V-shaped. The crura are short, flat, and broad representing the extension of the crural bases to the crural processes which are located posterior to midloop. No carinae are present in serial section. The cardinal processes vary from bluntly acute to drawn into short needle-like points. These extend anteroventrally. In profile they end at about the same extent as the protuberant transverse band. The descending lamellae are moderately long, narrow ribbons, tapering from the anterior side of the crural processes to the long terminal points. The transverse band is strongly elevated and diverges from the horizontal at an angle of about 70°. The terminal points are long and widely webbed. The transverse band is based on their posterior part, fairly wide but tapering posteroventrally to the crest of the loop or bridge which is narrow, protuberant and flattened, the flattening approximating 20%–25% of the loop width. In some specimens a short barb extends dorsally from each edge of the flattened bridge (Plate 38: figure 14). The webbed part of the terminal points occupies about ⅖ the length of the loop.

LOOP STATISTICS.—See Table 25.

DISCUSSION.—The loop of this genus is distinguished by the brevity of its outer hinge plates and the rounding of their distal margins which makes a more or less deep reentrant at the anterior junction of the outer hinge plate with the crural base. Although there is some taper of the plates along the dorsal edge of the crural processes, there is often a fairly generous measure of crus. The terminal points are uniformly long but the bridge or flattened crest of the transverse band is variable. In some specimens (Plate 47: figure 10) it is very narrow, but in figures 9 and 14 it is broader and more rounded.

The loop of *Monsardithyris* is similar to that of *Pirotothyris* Sučić-Protić in having long, angular terminal points and a narrow bridge of the transverse band but Wl/Ll of *Pirotothyris* is shorter than that of *Monsardithyris*. *Pirotothyris* is rectimarginate whereas *Monsardithyris* has advanced to the uniplicate stage and occasionally to a faint sulciplication.

Rouselle's (1965:89) *Lobothyris ventricosa* differs from *Lobothyris* species in having well developed uniplication, a species which is the type of *Monsardithyris*.

Monsardithyris? buckmani (Davidson), new combination

PLATE 29: FIGURES 16–21; PLATE 71, FIGURES 3, 4

Terebratula buckmani Davidson, 1851–1852:44, pl. 7: figs. 15, 16.

DISCUSSION.—This species is geologically younger than *Lobothyris* of the Lias. It occurs in the Bajocian of England, and has generally been referred to *Lobothyris*, from which it differs in loop characters and anterior uniplication. Buckman referred this species to *Lobothyris* and Almeras (1971:181) agreed with this placement. The loop of *T. buckmani* is similar to that of *Senokosica* Sučić-Protić, but is somewhat more massive with wider lateral and transverse bands. Loop statistics place *T. buckmani* close to *Monsardithyris* and its folding is in accordance with that of *Monsardithyris*. *Terebratula buckmaniana* Walker, another British species, is also assigned to *Monsardithyris*.

Monsardithyris buckmaniana (Walker), new combination

PLATE 47: FIGURES 1–4

Terebratula buckmani var. *buckmaniana* Walker, in T. Davidson, 1876–1878: 156, pl. 19: figs. 14–17.

Morrisithyris Almeras, 1971

PLATE 38, FIGURES 1–13; PLATE 75, FIGURES 11, 12

Morrisithyris Almeras, 1971:131.

SUBFAMILY.—Morrisithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula phillipsi* Morris, in Morris and Davidson, 1847:255, pl. 18: fig. 9a–c (= holotype).

TABLE 26.—Loop statistics for the genus *Morrisithyris*

Proportions	USNM 551015a	USNM 551015b	USNM 551015d	USNM 551015e	USNM 551015f	USNM 551015g	USNM 551015h	USNM 551016c	Almeras, 1971
∠	30°	33°	30°	25°	28°	23°	32°	29°	33°
Wl/Ll	0.67	0.65	0.63	0.47	0.56	0.50	0.62	0.53	0.60
Ll/LD	0.30	0.32	0.35	0.35	0.33	0.40	0.35	0.40	0.36
Wl/WD	0.24	0.28	0.22	0.17	0.19	0.20	0.29	0.28	0.28
a/Ll	0.56	0.54	0.50	0.53	0.56	0.50	0.58	0.43	0.50
b/Ll	0.44	0.46	0.50	0.47	0.44	0.50	0.42	0.57	0.50
c/Ll	0.33	0.42	0.32	0.35	0.37	0.40	0.46	0.43	0.31
d/Ll	0.23	0.12	0.19	0.18	0.19	0.10	0.12	0.00	0.15
e/Ll	0.11	0.13	0.19	0.21	0.13	0.10	0.21	0.33	0.27
f/Ll	0.33	0.33	0.31	0.26	0.31	0.40	0.21	0.24	0.23
g/WD	0.32	0.19	0.25	0.23	0.23	0.24	0.25	0.27	0.26
g/Wl	1.33	0.87	0.90	1.00	1.00	1.20	0.87	0.94	0.96
h/f	0.33	0.15	0.26	0.27	0.32	0.12	0.47	0.21	0.30
h/Ll	0.11	0.05	0.08	0.07	0.10	0.05	0.10	0.05	0.07
WD/LD	0.83	0.76	0.78	0.73	0.81	0.80	0.76	0.75	0.80

USNM 551015a,b, d–h; 551016c: *Morrisithyris phillipsi* (Morris), Jurassic (Bajocian), quarry La Roche-Vineuse, Monsard, Saône-et-Loires, France.
Almeras (1971, pl. 21A–C): from same place.

SPECIMENS STUDIED.—Thirty, 12 silicifed specimens showing loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITIES.—Great Britain and France.

EXTERIOR.—Medium to large, posteriorly attenuated, outline elongate pentagonal. Maximum width anterior to midvalve. Lateral commissure abruptly bent ventrally in the anterior third. Anterior commissure strongly sulciplicate. Beak long, narrow, suberect to erect, slightly labiate. Foramen apical, large, permesothyridid. Symphytium visible. Surface smooth except for growth lines often concentrated anteriorly.

INTERIOR.—Ventral valve interior with narrowly elongated teeth separated from shell margin by narrow groove. Pedicle collar short. Other features not resolved.

Loop and Cardinalia: The loop is triangular, usually longer than wide and occupies slightly more than a third of the length and less than a third the width of the dorsal valve. The cardinal process is small, narrowly semielliptical with a median indentation on the free edge. The lateral margins of the myophore are raised and the myophore faces posteroventrally. The socket ridges are thin, slightly inclined laterally and bound narrow sockets. The fulcral plates are well developed and have short lateral extensions. The outer hinge plates are long, narrowly triangular and taper along the dorsal edge of the crural bases to a point at or posterior of the crural processes (Plate 38: figures 10, 11). The crural bases are strongly elevated along the inner edge of the outer hinge plates and form, with the socket ridges short narrow, V-shaped troughs. Serial sections (Almeras, 1971, pl. 21A–C) shows this trough to be rather more U-shaped than V-shaped. The crural processes are erect, slightly approximate, acutely pointed and are usually located at or anterior to midloop. The crest of the transverse band protrudes slightly beyond the ends of the crural processes. The descending lamellae are short, thin and bowed laterally. The transverse band is broad laterally, narrowed medially and is broadly arched to form a flattened median, protuberant crest. The flattening of the crest occupies from a third to a half the width of the loop. The flattened portion or bridge is much narrowed by a deep posterior reentrant which is further emphasized by the posterior extension of a small prong on each side (Plate 38: figure 5). The terminal points are acute, wide in some specimens, truncated in others (Plate 38: figure 4) but not extended into points.

Loop Statistics.—See Table 26.

Discussion.—The loop of *Morrisithyris* is unlike that of any other Jurassic terebratulacean. It is more like the loop of some Recent brachiopods than that of the commoner Jurassic genera. The loop is variable and no two of the dozen specimens studied were identical. The loop proportion Wl/Ll varies between 0.47 and 0.67. The outer hinge plates are variable, not so much in width, as in their taper along the dorsal edge of the crural bases. In Plate 38: figure 10 the taper extends to the crural processes but in figure 4 of the same plate the taper ends posterior of the crural processes. In figure 5 of the same plate the taper is different on the two sides of the loop, that on the reader's right being longer than that on the left. The length and width of the loop seem not to correlate with the width/length of the dorsal valve. The short taper of some of the hinge plates means a longer measure for the crus whereas the long tapered plate limits that figure, often to zero.

The variation in the transverse band and the terminal points is also striking. In most specimens there is a strong reentrant on the posterior side of the transverse band that may be bounded by angular projections which may be prolonged into spines as in figure 5 of Plate 38. The terminal points vary from moderately long to absent, nothing like the length of those of *Monsardithyris*. The terminal points on figure 10 of Plate 38, are moderately long and sharp, but those of figure 4 are aborted and rounded.

Another variable feature is the distance between the crural processes and the bridge of the transverse band. In some (Plate 38: figure 4) the crural processes almost overhang the transverse band but in figure 5 there is a wide gap between them.

Muirwoodella Tchorszhevsky, 1974

Subfamily.—Muirwoodellinae Tchorszhevsky, 1974.

Type-Species.—*Muirwoodella muirwoodae* Tchorszhevsky, 1974:52, figs. 7, 9.

Specimens Studied.—Literature only.

Geologic Occurrence.—Jurassic (Upper Bajocian).

Locality.—Carpathians, Transcarpathia, and Russia.

Diagnosis (Tchorszhevsky, 1974).—Shells with uniplicate or faintly biplicate anterior commissure. Beak is thick, long, slightly curved with an apical permesothyridid foramen of medium size. Cardinal process is small, oval, not divided. Outer hinge plates well developed, even, slightly inclined dorsally. Processes of outer hinge plates with indistinct curvatures, and arranged approximately parallel to each other.

Comparison (Tchorszhevsky, 1974).—This genus is most similar in external appearance to *Lissajousithyris* Almeras, 1970 [sic 1971], and differs from it in the even outer hinge plates with more strongly developed processes their form and arrangement as well as the somewhat longer loop.

Loop Statistics (from serial sections fig. 7).—$\angle = 28°$; a/Ll = 0.32; b/Ll = 0.68; c/Ll = 0.18; d/Ll = 0.14; e/Ll = 0.25; f/Ll = 0.43. Dimensions of sectioned specimen not given.

Nalivkinella Popov, 1974

Plate 63: figure 4

Loboidothyris.—Makridin, 1964:214.
Nalivkinella Popov, in Katz and Popov, 1974b:23.

Subfamily.—Lissajousithyridinae, new subfamily.

Type-Species.—*Terebratula retrocarinata* Nalivkin, 1910. Makridin, 1964:214 (not Rothpletz, 1886–1887) = *Nalivkinella nalivkini* Popov, in Katz and Popov, 1974a.

Specimens Studied.—Literature only.

Geologic Occurrence.—Jurassic (Oxfordian).

Localities.—Russian Platform, Crimea, Caucasus. Central Asia, and western Europe.

Description (Popov, in Katz and Popov, 1974a).—Smooth, pyriform or elongate-pentagonal, moderately convex with a tightly or strongly curved beak, apical foramen large; anterior commissure faintly uniplicate or weakly biplicate. Cardinal process lamellate, weakly developed.

Hinge plates delicate, oriented laterally in the posterior portion; crura hooklike, weakly carinate, crural processes high. Loop extends half the length of the dorsal valve. Loop flanges well developed.

Shell Structure: Walls of shell formed of primary, secondary, and Tertiary layers. The last is traceable for the entire extent of the valves, being absent in only a narrow zone along the hinge margin, and is developed to a degree equal to that of the secondary layer.

COMPARISONS (Popov, in Katz and Popov, 1974a).—In the structure of its shell this genus is like *Postepithyris* Makridin and differs from it in the form of the cardinal process and almost complete absence of dorsal carinae on the crura [not in agreement with above].

COMMENT.—The loop of this species was reconstructed from serial sections by Makridin (1964:216, figs. 72, 73) illustrating a long wide loop with long terminal points.

LOOP STATISTICS (from reconstruction of Makridin, 1964:216, fig. 73).—∠ = 35°; Wl/Ll = 0.65; Ll/LD = 0.51; Wl/WD = 0.35; a/Ll = 0.35; b/Ll = 0.65; c/Ll = 0.26; d/Ll = 0.09; e/Ll = 0.22; f/Ll = 0.43; g/WD = 0.33; g/Wl = 0.93; h/f = 0.14; h/Ll = 0.06; WD/LD = 0.96.

The loop differs from that of *Loboidothyris* (as described by Almeras and discussed herein) in its extremely long terminal points. The loop is suggestive of that of *Postepithyris* as mentioned by Popov. It is probable that Makridin was influenced by the loop of this species, which he called *Loboidothyris*, in establishing the Loboidothyrinae as a subfamily characterized by long-flanged loops.

Notosia, new genus

PLATE 49: FIGURES 9–17; PLATE 71: FIGURES 9, 10

SUBFAMILY.—Notosiinae, new subfamily.

TYPE-SPECIES.—*Notosia chiliensis*, new species.

DIAGNOSIS.—Medium size, oval terebratulaceans with gently curved lateral commissures and rectimarginate to gently uniplicate anterior commissures; loop widely and roundly triangular, with long terminal points (f/Ll = 0.40 or more), and crural processes posterior of midloop.

SPECIMENS STUDIED.—Twenty-five, 8 silicified specimens with loop.

GEOLOGIC OCCURRENCE.—Jurassic (Lias).

LOCALITY.—Chile.

EXTERIOR.—Medium size, roundly oval, biconvex, ventral valve slightly deeper than dorsal valve; lateral commissure gently curved toward the ventral side. Anterior commissure varying from rectimarginate to gently uniplicate. Beak short, suberect, slightly labiate, close to dorsal umbo. Beak ridges sharply angular. Foramen moderately large, permesothyridid. Symphytium mostly hidden. Surface smooth.

INTERIOR.—Ventral valve interior with small, long and narrow teeth; pedicle collar short; muscle marks elongate, not separable.

Loop and Cardinalia: The loop is roundly triangular and occupies about a half the length and a third to ⅖ of the width of the dorsal valve. The cardinal process is a small, thin, semielliptical shelf medially indented. The socket plates are thin and delicate, slightly curved and define narrow sockets. The fulcral plates are well individu-

TABLE 27.—Loop statistics for the genus *Notosia*

Proportions	USNM 551049b	USNM 551049c	USNM 551049d	USNM 551049e
∠	29°	34°	32°	34°
Wl/Ll	0.50	0.58	0.63	0.63
Ll/LD	0.57	0.55	0.51	0.51
Wl/WD	0.31	0.32	0.31	0.32
a/Ll	0.37	0.33	0.31	0.37
b/Ll	0.63	0.67	0.69	0.63
c/Ll	0.37	0.33	0.31	0.31
d/Ll	0.00	0.00	0.00	0.00
e/Ll	0.21	0.18	0.20	0.23
f/Ll	0.41	0.49	0.49	0.40
g/WD	0.37	0.32	0.33	0.30
g/Wl	1.22	1.00	1.00	0.92
h/f	0.12	0.10	0.12	0.11
h/Ll	0.05	0.05	0.06	0.05
WD/LD	0.94	1.00	1.00	1.00

USNM 551049 b–e: *Notosia chiliensis* new species, Jurassic (Lias), 4 miles (6.4 km) ENE of the Smithsonian Montezuma Observatory, Calama, Chile.

alized and have a short lateral extension. The outer hinge plates are narrowly triangular, concave and taper anteriorly along the dorsal margin of the crural bases to terminate at the crural processes. The crural bases form a high ridge along the inner margin of the outer hinge plates. The crural processes are located posterior to midloop and are drawn into needle-like points that are directed ventrally and medially. The descending branches are moderately long, slender, laterally bowed ribbons. The transverse band is a broad web where it joins the descending lamellae. It narrows as it rises steeply to a narrow flat bridge that occupies about a third of the loop width. The transverse band is tilted at about 35° from the horizontal. It is protuberant to about equal to or slightly beyond the distal ends of the crural processes. The terminal points are fairly long and form an angle of about 15° with the side of the loop.

LOOP STATISTICS.—See Table 27.

DISCUSSION.—This genus appears to be related to *Inaequalis* Sučić-Protić of the European Lias but differs in having a proportionally shorter and more roundly triangular loop, with longer terminal points and more gently arched transverse band. The exterior of the two genera is similar but the anterior commissure of *Notosia* tends to uniplication in the adult, a condition not noted for *Inaequalis*.

ETYMOLOGY.—From the Greek *notos* (south).

Notosia chiliensis, new species

PLATE 49: FIGURES 9–17

DIAGNOSIS.—Medium size, roundly oval, gently uniplicate terebratulaceans with wide loop, broadly arched transverse band, and posteriorly located crural processes.

DESCRIPTION.—Exterior and interior characters as for the genus.

Ventral valve moderately convex in lateral profile but broadly convex in anterior view. Beak and umbonal region roundly carinate, narrow swelling merging into general convexity at midvalve. Anterior slope gently convex, forming barely perceptible tongue at anterior.

Dorsal valve gently and fairly evenly convex in lateral view; broadly, gently convex in anterior profile. Median region moderately swollen, swelling continuing anteriorly to form gentle fold to receive tongue of ventral valve.

MEASUREMENTS (MM).—

	length	*dorsal valve length*	*width*	*thickness*	*apical angle*
551049a	23.3	19.5	19.5	12.5	106°
551049f	27.4	24.0	22.6	14.8	105°
551049g	23.3	21.1	20.0	12.8	107°
551049h	22.3	19.4	18.7	12.8	93°
551049i	24.8	22.3	20.2	14.0	96°

OCCURRENCE.—Same as for genus.

TYPES.—Holotype: USNM 551049a; paratypes: USNM 551049b–i.

DISCUSSION.—No other species of this genus is known to which this one may be compared. It differs from *Inaequalis rotundata*, to which it may be related, in its uniplication, wider and longer loop with much longer terminal points.

Nucleata Quenstedt, 1868–1871

PLATE 36: FIGURES 7–9

Nucleata Quenstedt, 1868–1871:25.
Glossothyris Douvillé, 1879:267 [objective synonym].

FAMILY.—Nucleatidae Schuchert, 1929.

TYPE-SPECIES.—*Nucleata collina* Quenstedt, 1868–1871:25 (= *Terebratulites nucleata* Schlotheim, 1820:267).

SPECIMENS STUDIED.—Forty-five, one with loop (BM B45093).

GEOLOGIC OCCURRENCE.—Jurassic and Cretaceous.

LOCALITIES.—Europe and Russia.

EXTERIOR.—Small to medium size, rounded to tranversely pentagonal; inequivalve, dorsal valve flatly convex, shallow; ventral valve deep, convex. Sides rounded, anterior margin often with anterior reentrant. Lateral commissure slightly oblique, sharply curved ventrally at anterior. Anterior commissure strongly sulcate. Beak erect, large, closely appressed to dorsal umbo. Foramen small to medium. Beak ridges defining modest interarea. Surface smooth.

INTERIOR.—Ventral valve interior not seen

Loop and Cardinalia: The loop is short, almost as wide as long and with a wide angle (?). The cardinal process is wide, flattened, half elliptical not thickened on its anterior surface. The socket plates are thin and inclined over the narrow sockets. The fulcral plates are well developed. The socket ridges seem to slope steeply to the broad crural base. A narrow outer hinge plate may be present but could not be resolved. There is no crus because the crural bases expand immediately opposite the end of the socket ridges to become blunt crural processes. These are approximate but short. The anterior slope of the crural processes curves directly into the wide transverse band which is slightly convex toward the anterior. It has a slight median fold. The anterolateral extremities are narrowly rounded making the loop angle difficult to measure.

LOOP STATISTICS.—BMNH B45093: ∠ 60°?; Wl/Ll = 0.86; Ll/LD = 0.26; Wl/WD = 0.19; a/Ll = 0.57; b/Ll = 0.43; c/Ll = 0.57; d/Ll = 0.00; e/Ll = 0.18; f/Ll = 0.25; g/WD = 0.24; g/Wl = 1.25; h/f = 0.84; h/Ll = 0.21; WD/LD = 1.15.

British Museum (Natural History) B45093: *Nucleata nucleata* (Schlotheim), Jurassic (White Jura - gamma), Grafenberg, Bavaria, Germany.

DISCUSSION.—Although the silicified specimen (Plate 36) that exposes the loop is well preserved there are some ambiguities connected with it. It was not possible to distinguish an outer hinge plate but there is ample space for a narrow plate. The brevity of the crural bases and their abrupt elevation as crural processes is unusual. The loop is also remarkable for its anteriorly curved transverse band reminiscent of the loop of *Dyscolia*.

Katz (1962:137) regards the structure (from serial sections) of *Nucleata* to be like that of *Nucleatina*, a genus he proposed. He speaks of a groove in the median fold of *Nucleata* as another item relating the two genera. *Nucleata*, being a sulcate form, does not have a fold on the dorsal valve. Comparison of the loops of the two genera (Plates 28, 36) clearly indicate that the two are not related. Neither the serial section by Muir-Wood (1965:H805) nor those by Katz (1962:137, fig. 5a) give any detail that will supplement that seen in the illustrated silicified specimen (B45093).

That *Nucleata*, as presently identified, includes more than one generic form seems evident. Rothpletz (1886–1887, pl. 8: fig. 29) shows a sketchy drawing of *Terebratula bifida* (Rollier) with a wide loop having angular anterolateral extremities and a posteriorly convexly arched transverse band. The loop of *Terebratula curviconcha* Oppel (fig. 30) has a narrow, short, anteriorly indented loop with rounded anterolateral extremities like those of *N. nucleata*. *Terebratula nepos* Canavari, on the same plate (fig. 36), has a loop like that of *N. nucleata*. These citations are excellent examples of homeomorphy.

Askerov (1967:48–51) made a study of *Nucleata* in material from the Upper Jurassic and Lower Cretaceous and found great variation in the structure of the cardinalium and brachial apparatus. It is evident that a detailed study of these sulcate brachiopods, commonly referred to *Nucleata*, is needed. Barczyk (1972) made a study of Polish *Nucleata*.

The subfamily Nucleatinae Schuchert, in Schuchert and LeVene, 1929b, was created for *Nucleata* and related forms, yet Dieni, Middlemiss and Owen (1973:195) place *Nucleata* in their new subfamily Pygopinae, in the family Pygopidae, which seems to have absorbed the Nucleatinae/Nucleatidae without explanation by Dieni, Middlemiss and Owen or Muir-Wood.

Odarovithyris Tchorszhevsky, 1971

Odarovithyris Tchorszhevsky, 1971c:62.

SUBFAMILY.—Lophrothyridinae, new subfamily.

TYPE-SPECIES.—*Odarovithyris odarovi* Tchorszhevsky, 1971c:64.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Upper Bajocian).

LOCALITY.—Transcarpathia.

DIAGNOSIS (Tchorszhevsky, 1971c).—Biconvex, dorsal valve flattened. Anterior margin biplicate. Beak short, stout, moderately curved. Cardinal process low, not divided. Outer hinge plates wide, thin, coalesced with socket ridges. Their inner margin curved at an angle. Crural bases low, do not project dorsally. Crura similar to the "lobothyroid" type (Dagis, 1970). Loop a little longer than half the length of the dorsal valve with a high, narrow, transverse band.

DESCRIPTION (Tchorszhevsky, 1971c).—Shells of medium size (3–4 cm long). Dorsal valve more depressed than the ventral valve, especially in the posterior half (1.5–2 times). Plication traced up to half the shell length from the posterior margin. Anterior commissure from uni- biplicate with sharply angular plicae. Beak short, thick, móderately to weakly curved. Foramen small, round, permesothyridid. Cardinal process low, narrow, indistinctly expressed myophore. Outer hinge plates wide, thin, fused to the inner socket ridges.

Crural bases low, delicate, do not project dorsally. Crural processes high. Crural bases, crura, and crests of flanges meet ventrally (loop is of the "closed" type). Transverse band rather high, narrow, slightly depressed in a curve. Loop flanges long, in transverse section their curvatures are rounded.

LOOP STATISTICS (from Tchorszhevsky, 1971c: 64, fig. 2).—a/Ll = 0.55; b/Ll = 0.45; c/Ll = 0.29; d/Ll = 0.26; e/Ll = 0.15; f/Ll = 0.30.

COMMENTS.—Tchorszhevsky distinguishes his genus from *Euidothyris*, *Epithyris*, and *Loboidothyris* in the width, thinness, ventrally curved hinge plates together with the flanged loop of the "closed" type.

***Oligorhytisia*, new genus**

PLATE 48: FIGURES 15–20; PLATE 73: FIGURES 15, 16

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Oligorhytisia magnifica*, new name for *Terebratula plicata* J. Buckman, 1845, pl. 7: fig. 6; preoccupied by *Terebratula plicata* Say, 1820:43.

DIAGNOSIS.—Large, peripherally costate in adulthood, elongate oval terebratulaceans with long, wide loop.

SPECIMENS STUDIED.—Thirteen, one with excavated loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian - Inferior Oolite).

LOCALITY.—England.

EXTERIOR.—Large, elongate oval, valves subequally convex, ventral slightly deeper and more convex than dorsal valve; sides rounded; anterior margin rounded, posterolateral margins forming an angle of 74° to 105°. Lateral commissure straight; anterior commissure rectimarginate. Beak narrow, short, suberect; beak ridges poorly developed. Foramen large, permesothyridid. Symphytium partially visible. Surface of posterior ¾ usually smooth, anterior quarter marked by irregularly developed, often obscure costae.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is widely triangular and occupies nearly a half the length and almost ⅖ the width of the dorsal valve. The cardinal process is small for such a large shell and is a flattened half ellipse, thin, and with a slightly concave myophore. The socket ridges are thin and inclined laterally to bound narrow sockets. The fulcral plates were not seen. The outer hinge plates are unusually short, concave, without long taper. The crural bases are elevated along the inside margin of the outer hinge plates that are attached to the dorsal edge of the crural bases. The crus is short, flattened laterally, and merges into the crural process a short distance anterior to the end of the outer hinge plate. The crural bases, which are located posterior of midloop, are short and have ventrally directed, sharply acute points. The descending lamellae are long and gently bowed laterally. The transverse band forms a strong arch with wide lateral supports and narrowed protuberant bridge. The junction of the descending lamellae and the transverse band forms a fairly long web. The terminal points are fairly long and angular.

LOOP STATISTICS.—USNM 88729a: ∠ = 37°; Wl/Ll = 0.76; Ll/LD = 0.48; Wl/WD = 0.39; a/Ll = 0.38; b/Ll = 0.62; c/Ll = 0.19; d/Ll = 0.19; e/Ll = 0.29; f/Ll = 0.33; g/Wd = 0.24; g/Wl = 0.62; h/f = 0.24; h/Ll = 0.08; WD/LD = 0.95.

USNM 88729a: *Oligorhytisia magnifica*, new name, Jurassic (Bajocian - Inferior Oolite - Pea Grit), Birdlip, Gloucestershire, England.

DISCUSSION.—S. S. Buckman included *Terebratula plicata* J. Buckman in *Plectoidothyris* along with the more strongly peripherally costate *Plectoidothyris polyplecta*, which is the type of the genus. The two differ strongly in exterior and interior details. *Terebratula polyplecta* is more regularly costate around the anterior border than *O. magnifica*. The loops of the two are different in many ways: that of *O. magnifica* is shorter and wider than that of *T. polyplecta*. The crural processes are somewhat more posterior and much less produced into needlelike points in *O. magnifica*.

The loop of *Oligorhytisia* is similar to that of *Monsardithyris* but differs in being of greater proportional width and with a wider loop angle. The bridge of the loop is much broader in *Oligorhytisia* when compared to that of *Monsardithyris*.

ETYMOLOGY.—From the Greek *oligos* (few) plus *rhytis* (wrinkle).

Oligorhytisia magnifica, new name

Terebratula plicata J. Buckman, 1845, pl. 7: fig. 6 [preoccupied by *Terebratula plicata* Say, 1820:43].

The diagnosis, references, and exterior and interior details in the foregoing description will serve to indicate the specific as well as generic characters.

Pachythyris Boullier, 1976

Pachythyris Boullier, 1976:154.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula arduennensis* Douvillé, 1886:65. pl. 1; fig. 2.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Middle Oxfordian).

LOCALITY.—France.

ORIGINAL DIAGNOSIS (Boullier, 1976).—Shell small to medium, very strongly biconvex, with more or less elevated incurved beak. Foramen small. Anterior commissure sulciplicate to paraplicate.

Pedicle collar present, narrow. Cardinal process short, a little protruding, may be denticulate. Hinge plates nearly horizontal posteriorly, weakly inclined anteriorly; flat and thin to gently concave, with small crural bases, pointed or rounded. Crura parallel. Transverse band narrow. Terminal points [ailes] like divergent gutters. Loop occupying nearly 40% of the dorsal valve.

LOOP STATISTICS (prepared from Boullier's serial sections, p. 167, fig. 83).—∠ = 35°; Wl/Ll = 0.66; Ll/LD = 0.42; Wl/Wd = 0.27; a/Ll = 0.45; b/Ll = 0.55; c/Ll = 0.17; d/Ll = 0.28; e/Ll = 0.20; f/Ll = 0.35; g/WD = 0.27; g/Wl = 1.00; h/f = 0.31; h/Ll = 0.11; WD/LD = 1.00.

Boullier 1976, fig. 83: *Pachythyris arduennensis* (Douvillé), Jurassic (Middle Oxfordian - ferruginous oolite - *plicatilis* Zone), La Pérouse, near Plombiéres-lés-Dijon, Cote d'Or, France.

COMMENT.—Boullier likens her genus to *Argovithyris*, *Sphaeroidothyris*, and *Ferrythyris*. She finds the loop of *Argovithyris* shorter and with shorter terminal points than that of *Pachythyris*. There are also differences in the two when the beaks and foramen are compared. Internally the hinge plates of *Pachythyris* are horizontal, flat, and carinate and the crural processes, in section, are curved in the form of a parenthesis; the transverse band is low and rounded, ending in very short points; all different from these features in *Argovithyris*.

In comparing *Sphaeroidothyris* and *Pachythyris*, Boullier notes that the cardinal process of the latter is less long and less protuberant than that of *Sphaeroidothyris*; the hinge plates of *Pachythyris* are not as strongly inclined and never form a spoon as in *Sphaeroidothyris*.

Pachythyris resembles *Ferrythyris* Almeras (1971) of the Bajocian, as well as *Conarothyris*, new genus, in external form but may become more globose than the former and its plication is never as prominent and the loop is shorter than that of either *Ferrythyris* or *Conarothyris*. Boullier did not reconstruct the loop of *Pachythyris*.

Cowen (1981:680) has pointed out that the name *Pachythyris* is preoccupied by a moth of the same name and recommended synonymizing *Pachythyris* with *Sphaeroidothyris*, which it resembles. This homonymy can only be adjusted satisfactorily when the characters of *P. arduennensis* Douvillé and *Sphaeroidothyris* are better known. *Sphaeroidothyris* at present seems to embrace a number of homeomorphs. (See discussion under *Sphaeroidothyris*.)

Pentithyris, new genus

PLATE 40: FIGURES 1–6; PLATE 74: FIGURES 5, 6

SUBFAMILY.—Lophrothyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula pelagica* Rollier, 1918:233, new name for *Terebratula bicanaliculata* Douvillé, 1886:82, 100, pl. 3: fig. 1; preoccupied by *T. bicanaliculata* Schlotheim, 1820.

DIAGNOSIS.—Small, subpentagonal terebratulacean with incipiently sulciplicate anterior commissure; loop moderately wide with crural processes slightly anterior of midloop.

SPECIMENS STUDIED.—Many, three excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Oxfordian).

LOCALITIES.—France.

EXTERIOR.—Small, subpentagonal, inequivalve, ventral valve having greater depth and convexity than dorsal valve. Lateral commissure oblique except at anterior where it deflects toward ventral valve. Anterior commissure sulciplicate, plication confined to anterior half. Beak short, acute, suberect to erect, labiate. Foramen large, permesothyridid. Symphytium partially visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is elongate, narrowly triangular, and extends for nearly half the dorsal valve length. The cardinal process is a narrow half ellipse with myophore facing posteriorly. The socket ridges are thin, curved, and bound narrow sockets proximally roofed by shell. The fulcral plate was not seen. The outer hinge plates are short, deeply concave, fairly wide, and tapering. They are attached to the dorsal edge of the crural bases but send a tapering ridge from their anterior tip, which rises slightly on the outside of the crural bases and terminates near the crural processes. The crural bases are nearly flat blades that extend posteriorly along the inner edge of the outer hinge plates and form a moderately high ridge. Together with the outer hinge plates and socket ridges, the crural bases form U-shaped troughs. The crural processes are located slightly anterior of midloop and are drawn into acute points of moderate length. The descending lamellae are narrow ribbons, moderately bowed laterally, and tied by a strongly arched, narrow transverse band, medially flattened and protuberant. The flattened median bridge approximates half the loop width. The terminal points are moderately short and angular.

LOOP STATISTICS.—USNM 123177b: $\angle = 34°$; Wl/Ll = 0.60; Ll/LD = 0.45; Wl/WD = 0.26; a/Ll = 0.53; b/Ll = 0.47; c/Ll = 0.40; d/Ll = 0.13; e/Ll = 0.13; f/Ll = 0.34; g/WD = 0.34; g/Wl = 1.33; h/f = 0.20; h/Ll = 0.07; WD/LD = 1.06.

USNM 123771b: *Pentithyris pelagica* (Rollier), Jurassic (Oxfordian), Chatillon, France.

DISCUSSION.—The loop of this genus resembles that of *Bihenithyris* (as described herein) but the exterior is not similar because the valves of the French specimens are rounder and the beak is not strongly pressed onto the dorsal umbo. The loops differ in detail, that of *Bihenithyris* has the crural processes posterior of midloop and has the transverse band farther from the crural processes.

The loop of *Pentithyris* is different from other "*subsella*" appearing shells, such as *Dolichobrochus*, which has a long loop with crural processes far anterior of midloop and a long crus; *Habrobochus* has a wider loop and more slender transverse band than *Pentithyris*. *Apatecosia* resembles *Penti-*

thyris externally but the loop of the former has a wider angle, greater Wl/Ll and a wider transverse band.

Boullier (1976:220) places *Terebratula pelagica* Rollier in *Dorsoplicathyris*. The form and loop of *Pentithyris*, as described herein, are differnt from those of *Dorsoplicathyris*, which has a loop with somewhat longer terminal points and a narrower bridge of the transverse band.

ETYMOLOGY.—From the Greek *pente* (five) plus *thyris* (opening).

Perrierithyris Almeras, 1971

Perrierithyris Almeras, 1971:423.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula dorsoplicata* var. *perrieri* Deslongchamps, 1856 (in literis); 1859:22, pl. 2: figs. 1, 2; pl. 3: figs. 1–3.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Callovian - Lower Oxfordian).

LOCALITIES.—France, Switzerland, Germany, and Portugal.

ORIGINAL DIAGNOSIS (Almeras, 1971:423).—Medium to large size. Thick shells of triangular contour. Maximum width at front margin. Valves equally swollen. Beak thin, almost straight, short, overhanging dorsal valve, truncated by very large circular foramen, not laterally carinate. Symphytium low, exposed. Dorsal umbo swollen. Lateral commissures deflected ventrally, recurving gently toward the dorsal valve near the anterior margin of the shell. Anterior commissure paraplicate. Median sulcus wide and deep. Muscle impressions long, straight, and divergent.

Pedicle collar present. Deltidial plates very thick, welded. Cardinal process short, trilobed, not grooved. Umbonal cavity much enlarged. Hinge plates in the form of a deep V, well differentiated from the socket ridges, and with the crural bases elevated. Teeth having the aspect of short and thin tongues; no plane of articulation; denticles. Crural processes low, oblique, delicate. Transverse band subhorizontal. No euseptoidum. Length of brachidium 0.51–0.56.

LOOP STATISTICS (from Almeras serial sections, 1971, pl. 85A,B).—$\angle$ = 28°; Wl/Ll = 0.49; Ll/LD = 0.56; Wl/WD = 0.35; a/Ll = 0.43; b/Ll = 0.57; c/Ll = 0.18; d/Ll = 0.25; e/Ll = 0.21; f/Ll = 0.36; g/WD = 0.23; g/Wl = 0.70; h/Ll = ?; WD/LD = 0.81.

COMMENT.—This genus has a distinctive form somewhat reminiscent of *Goniothyris*, sensu stricto, with its fairly strongly swollen dorsal valve. Boullier (1976:173) suggests a possible relationship to *Aromasithyris* (Almeras, 1971).

Petalothyris, new genus

PLATE 51: FIGURES 1–7; PLATE 75: FIGURES 15, 16

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula simplex* J. Buckman, 1845, pl. 7: fig. 5. Davidson, 1851–1852:48, pl. 8: figs. 2, 3. Rollier, 1918:255.

DIAGNOSIS.—Large plano-convex terebratulaceans having long fairly wide loop with moderate, webbed terminal points and wide-ribboned, steeply arched, flat-crested transverse band.

SPECIMENS STUDIED.—Six, one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Lower Bajocian).

LOCALITY.—Great Britain.

EXTERIOR.—Large, roundly subpentagonal, maximum width just anterior of midvalve; plano-convex in profile, dorsal valve flat to faintly convex, ventral valve strongly swollen. Lateral commissure straight; anterior commissure rectimarginate to incipiently sulcate. Beak incurved over dorsal umbo; beak ridges strong. Foramen large, permesothyridid. Symphytium hidden. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is large, long, narrowly triangular and occupies about ½ the length and more than ⅓ of the width of the dorsal valve. The cardinal process is a small half ellipse with roughened myophore surface facing posteroventrally. The socket ridges are thin and lean toward the narrow sockets. The fulcral plates were not seen. The outer hinge plates are short, narrow triangles, deeply concave and tapering anteriorly as a ridge along the dorsal margin of the crural bases. The troughs formed by the hinge plates and the strongly elevated crural bases that margin them and the socket ridges form a narrow U or wide V in cross-section. The crural bases expand rapidly into the crural processes near the junction with the outer hinge plates. The crural processes are located posterior of midloop and are wide triangles tapering to acute points distally. The descending lamellae are fairly long, laterally bowed, narrow ribbons forming the terminal points. They are joined to the transverse band by a fairly long web about ⅙ the length of the loop. The transverse band is fairly wide and forms a steep-sided protuberant arch flattened on its crest. The flattened bridge occupies about ⅓ of the width of the loop. The loop is elevated about 20° above the horizontal and projects to a point about even with that of the ventral extent of the crural processes.

Loop Statistics.—USNM 88735: ∠ = 34°; Wl/Ll = 0.67; Ll/LD = 0.51; Wl/WD = 0.35; a/Ll = 0.40; b/Ll = 0.60; c/Ll = 0.27; d/Ll = 0.13; e/Ll = 0.27; f/Ll = 0.33; g/WD = 0.33; g/Wl = 0.93; h/f = 0.30; h/Ll = 0.10; WL/LD = 1.05.

USNM 88735: *Petalothyris simplex* (J. Buckman), Jurassic (Bajocian – Inferior Oolite), Gloucestershire, England.

Discussion.—The loop figured by Sahni (1928:132, fig. 5) for this species, which he refers to *Pseudoglossothyris*, is in substantial agreement with the excavated loop described herein, but some minor differences are apparent. Sahni's drawing has a wider angle and much narrower transverse band than the excavated specimen. He fails to show the webbed terminal points that are depicted as somewhat flaring. The crural processes are figured as more approximate than in the excavated loop. The differences cited are probably not natural variations that might exist between two specimens but are more likely defects in depiction.

Two genera already described have the same or similar exterior as that of *Petalothyris*: *Gigantothyris* Seifert (1963), and *Rugithyris*. The loops of *Gigantothyris* and *Petalothyris* are different. The former has a larger loop angle, wider Wl/Ll, and occupies more of the dorsal valve interior. Other differences are the longer terminal points of *Petalothyris* and the crest of the loop farther anterior of the crural processes. Furthermore the anterior commissure of *Gigantothyris* is rectimarginate or biplicate, not tending to sulcation as in *Petalothyris*.

Rugithyris Buckman is a small brachiopod having a flat dorsal valve and strongly lamellose surface. Its interior is very poorly known because the serial sections offered in Muir-Wood (1965:H787) give no idea of the extent or character of the loop or of the hinge plates.

Buckman (1917:98) referred *T. simplex* to *Pseudoglossothyris* but indicated that there were beak and foraminal differences between them. Other differences are the strong sulcation, posteriorly shouldered outline, and size. The loops of the genera are similar but differ in detail. The crural processes are anterior of midloop in *Pseudoglossothyris* but posterior in *Petalothyris*. There is a difference in the length of the descending lamellae and the terminal points are proportionally longer in *Petalothyris* than in the other genus.

Strongylobrochus, new genus, is plano-convex, like *Petalothyris*, but its loop is very wide and exceptionally long, quite unlike that of *Petalothyris*.

Etymology.—From the Greek *petalos* (broad) plus *thyris* (opening).

Pinaxiothyris Dagis, 1968

Plate 62: figure 20

Subfamily.—Loboidothyridinae Makridin, 1964.

Type-Species.—*Pinaxiothyris campestris* Dagis, 1968:86, figs. 52, 53, pl. 10: figs. 1–3.

Specimens Studied.—Literature only.

Geologic Occurrence.—Jurassic (Kimmeridgian) to Cretaceous (Neocomian).

Locality.—Arctic Siberia.

Exterior. (Dagis, 1968).—Medium size, oval, thin, with thickened dorsal valve. Anterior commissure rectimarginate, no marginal plicae. Beak short, slightly curved. Foramen transversely oval, not large, permesothyridid. Symphytium low, partially hidden.

INTERIOR (Dagis, 1968).—Pedicle collar short. Cardinal process massive, not lobed. Hinge plate straight, perpendicular to plane of symmetry. Umbonal cavity small. Septal ridge low, wide. Crural bases distinct, perpendicular to hinge plate, projecting slightly dorsally. Loop ⅓ dorsal valve length, with transverse band. Flanges [terminal points] of loop short, rounded. Muscle impressions in dorsal valve wide, elongate triangular.

LOOP STATISTICS. (from Dagis reconstruction, fig. 53).—∠ = 48°; Wl/Ll = 0.85; Ll/LD = 0.35; Wl/WD = 0.34; a/Ll = 0.56; b/Ll = 0.44; c/Ll = 0.41; d/Ll = 0.15; e/Ll = 0.21; f/Ll = 0.23; g/WD = 0.23; g/WL = 0.73; h/f = 0.13; h/L1 = 0.03; WD/LD = 0.90.

Dagis reconstruction: *Pinaxiothyris campestris* Dagis, Jurassic (lower Volgian), northern Urals.

COMMENT.—According to Dagis a similar outline of the shell and structure of the cardinalia are seen in the genus *Rugithyris* Buckman (as described by Dagis 1968:108). *Pinaxiothyris* differs from *Rugithyris* in the character of the shell sculpture and the short loop with rounded, short flanges. (Dagis' reconstruction shows angular terminal points rather than rounded ones.)

The shell outline, the character of the beak, and the rather massive cardinalia of *Pinaxiothyris* liken it to *Lenothyris* Dagis. *Pinaxiothyris* differs from the latter in the absence of a short partition in the anterior part of the shell, and also the short loop. He further states that young individuals of *Uralella* have similarity to *Pinaxiothyris* but the loops are different and the cardinalia of *Pinaxiothyris* are less massive and the structure of the beaks, as well as the size of the adults, is different.

Pionothyris, new genus

PLATE 57: FIGURES 39–44; PLATE 70: FIGURES 3, 4

SUBFAMILY.—Loboidothyridinae Makridin, 1964.

TYPE-SPECIES.—*Terebratula eudesiana* S. S. Buckman, in Davidson, 1884:255, Supl. pl. 18: fig. 18.

DIAGNOSIS.—Small, bilobed terebratulaceans having wide loop (Wl/Ll = 0.67) and crural processes anterior of midloop (a/Ll = 0.67).

SPECIMENS STUDIED.—Seven, one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian – Inferior Oolite).

LOCALITY.—Great Britain.

EXTERIOR.—Small, narrowly oval to subpentagonal; valves subequal in depth, ventral valve strongly swollen, usually slightly less so than ventral valve. Sides rounded, anterior margin narrowly rounded, medially indented. Posterolateral extremities slightly acute to slightly obtuse. Both valves often with gentle median sulcus producing median indentation. Lateral commissure gently concave toward ventral side, becoming strongly so in anterior half. Anterior commissure biplicate. Beak short, erect; beak ridges rounded. Foramen large, slightly labiate to slightly excavated, mesothyridid. Symphytium partially visible. Surface marked only by lines and lamellae of growth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is widely triangular and occupies about ½ the length and ⅓ of the width of the dorsal valve. The cardinal process is a fairly large half ellipse thickened on its anterior surface and with the myophore facing posteriorly. The socket ridges are thin, erect, and bound narrow sockets. The outer hinge plates are long, triangular, concave, and tapered along the dorsal edge of the crural bases almost to the crural processes. They are broadly U-shaped in section. The crural bases are moderately elevated along the inner edge of the outer hinge plates. The crural processes are well anterior of midloop, are short, erect, slightly approximate, and directed ventrally. The descending lamellae are broad, short, and nearly straight. The transverse band is a broad, low arch widest at its junction with the descending lamellae but narrow medially. In side view the transverse band is almost horizontal. The bridge is flattened for almost half the loop width. The terminal points are short.

LOOP STATISTICS.—USNM 551102: ∠ = 35°; Wl/Ll = 0.70; Ll/LD = 0.45; Wl/WD = 0.33; a/Ll = 0.67; b/Ll = 0.33; c/Ll = 0.67; d/Ll = 0.00; e/Ll = 0.16; f/Ll = 0.17; g/WD = 0.39; g/

Wl = 1.25; h/f = 0.41; h/Ll = 0.07; WD/LD = 0.95.

USNM 551102: *Pionothyris eudesiana* (S. S. Buckman), Jurassic (Bajocian - Inferior Oolite), Dundry, Somerset, England.

DISCUSSION.—This genus is characterized by having an indented anterior margin. The loop differs from that of *Conarothyris* by its long outer hinge plates, the strongly anterior position of the crural processes, and the nearly horizontal transverse band.

ETYMOLOGY.—From the Greek *pion* (plump) plus *thyris* (opening).

Pirotothyris Sučić-Protić, 1971

PLATE 52: FIGURES 8–14, 17; PLATE 62: FIGURES 1, 2; PLATE 77: FIGURE 5

Pirotothyris Sučić-Protić, 1971:31.

SUBFAMILY.—Notosiinae, new subfamily.

TYPE-SPECIES.—*Pirotothyris fortis* Sučić-Protić, 1971:32, pl. 12: figs. 4–6; pl. 31: fig. 2; pl. 40: fig. 1 (reconstruction of loop).

SPECIMEN STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Lower to Middle Lias).

LOCALITIES.—Lower Lias: Romania. Middle Lias: Yugoslavia, France, and Great Britain.

DIAGNOSIS (Sučić-Protić, 1971:31).—"Oviform, thick shells. The beak is wide. The foramen is small. The cardinal process is massive. The brachidium is long. Flanks [terminal points] are long and parallel" [rectimarginate].

MORPHOLOGICAL DESCRIPTION (Sučić-Protić, 1971:31–32).—

Shells that belong to this genus are biggest amongst Liassic terebratulids, up to 45 mm long. Contours of the shell are elongated-oval, both valves are convex - the ventral one is always more convex. Growth lines are clearly expressed in all species. The beak is narrow, short, curved, in more convex species it is massive. The foramen is round. The inner pedicle collar is developed. Internal structure: small hinge teeth, shallow and short dental cavities, massive cardinal process, wide and short hinge plates which support expressed crural bases, a long brachidium which reaches the middle of the valve because of flanks [terminal points] which are sometimes longer than the descending branches. The branches themselves always support the crural processes developed to a various extent. Flanks [terminal points] are wide, almost parallel. The transverse plate is ventrally convex.

LOOP STATISTICS.—See Table 22.

COMMENT.—This genus is characterized by the great length of its loop, reminiscent of *Lissajousithyris* of the Bajocian of France. The loop is of the same pattern as that of the French silicified specimens and excavated English specimen formerly referred to *Lobothyris* and figured herein on Plate 52. *Pirotothyris subpunctata* (Davidson) is thought to belong to the genus but the test of relationship is rather on the inside than the outside. The reconstructed loop of *P. subpunctata* (Davidson) is based on sections prepared from a Yugoslavian shell. The loop of this species resembles that of the excavated specimen from England. Some French specimens described herein have similar loop characters.

Placothyris Westphal, 1970

PLATE 62: FIGURE 15; PLATE 63: FIGURE 24

Placothyris Westphal, 1970:38.—Boullier, 1976:303.

SUBFAMILY.—Psebajithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula rollieri* Haas, 1893, pl. 16: fig. 13.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Malm).

LOCALITY.—Swabian Alps, Germany and Switzerland.

DESCRIPTION (Westphal 1970).—Medium to large, longitudinally pentagonal; ventral valve more convex than dorsal valve. Anterior commissure uniplicate with a weak tendency toward sulciplication. Beak labiate. Pedicle collar present. Loop length a third length of dorsal valve.

Dorsal valve with pendent hinge plates. Westphal (pl. 1: fig. 1) shows a loop with broad transverse band, and blunt cardinal processes about 0.60 the loop length from its posterior.

DISCUSSION.—Westphal places *Placothyris* in the Gibbithyrididae because of the dorsal extensions of the crural bases which resemble those of *Gibbithyris*. *Karadagella* and *Iberithyris* are provided with these extensions but these Jurassic genera are not at home in Gibbithyrididae because the form of the loop is different from that of the Cretaceous genus, which is a much stouter structure, although the statistics are similar.

In his discussion and comparison of *Moisseevia* Makridin (1964) states that "no particular doubt arises that the *T. rollieri* Haas should be referred to the genus *Moisseevia* gen. nov." Barczyk (1969:24) placed *T. rollieri* in *Epithyris* and illustrated the species by a reconstruction showing a loop of great width (Wl/Ll = 0.95). The loop of *Placothyris* as illustrated by Westphal is very narrow (Wl/Ll = 0.50). Boullier's reconstructions of the loop of two species of *Placothyris* depict a narrow loop without terminal points.

Boullier (1976:316) finds a convergence of form between some species of *Argovithyris* and *Placothyris* but examination of serial sections shows internal differences in *Placothyris*: a bulging and denticulate cardinal process, crural bases very expanded dorsally, the crural processes like an S almost reaching the floor of the dorsal valve, a less thick jugum [transverse band] from back to front, and a short loop about 30% of the dorsal valve length. She has misgivings about placing *Placothyris* in the Gibbithyrididae, and believes the two genera, *Argovithyris* and *Placothyris*, are intimately related despite the difference in outer hinge plates.

LOOP STATISTICS (Boullier serial sections of *P. rollieri*).—∠ = 30°; Wl/Ll = 0.54; Ll/LD = 0.27; Wl/WD = 0.17; a/Ll = 0.64; b/Ll = 0.36; c/Ll = 0.25?; d/Ll = 0.39; e/Ll = 0.23; f/Ll = 0.13; g/WD = 0.27; g/Wl = 1.63; h/f = 0.54; h/Ll = 0.07; WD/LD = 0.89.

Placothyris rollieri (Haas) (Boullier, 1976, fig. 163): Jurassic (Oxfordian – *transversarium* Zone), Birmensdorf Beds, Ravin d'Eisengraben, near Mönthal, Argovie, Switzerland.

Plectoidothyris Buckman, 1917

PLATE 51: FIGURES 8–15; PLATE 72: FIGURES 5, 6

Plectoidothyris Buckman, 1917:122.—Sahni, 1928:134.—Muir-Wood, 1934:538; 1965:H813, fig. 692: 5a,b, fig. 693: 2a–c.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula polyplecta* Buckman, 1901:242.

SPECIMENS STUDIED.—Two, one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Lower Bajocian).

LOCALITY.—Great Britain.

EXTERIOR.—Large, elongate oval to elongate pentagonal, maximum width at midvalve; ventral valve slightly more convex than dorsal valve. Lateral commissure straight; anterior commissure rectimarginate. Beak short, sub-erect, truncated by large permesothyridid foramen. Symphytium partially visible. Surface of young shells smooth, adults marked for about ⅓ length at anterior and side by irregular, rounded costae.

INTERIOR.—Ventral interior not seen.

Loop and Cardinalia: The loop forms a long, narrow triangle occupying a half the length and about ⅖ the dorsal valve width. The cardinal process is a narrow half ellipse, a thin shelf at the apex (damaged in preparation). The myophore is directed posteroventrally. The socket ridges are thin, erect and bound narrow sockets. The fulcral plates were not seen. The outer hinge plates are

TABLE 28.—Loop statistics for the genus *Plectoidothyris*

Proportions	USNM 551043a	Reconstruction Muir-Wood, 1934, pl. 63: fig. 37
∠	30°	36°
Wl/Ll	0.58	0.69
Ll/LD	0.58	0.51
Wl/WD	0.37	0.38
a/Ll	0.44	0.47
b/Ll	0.56	0.53
c/Ll	0.27	0.28
d/Ll	0.17	0.19
e/Ll	0.24	0.26
f/Ll	0.32	0.27
g/WD	0.28	0.20
g/Wl	0.75	0.20
h/f	0.22	0.07
h/Ll	0.07	0.02
WD/LD	0.84	0.94

USNM 551043a: *Plectoidothyris polyplecta* (Buckman), Jurassic (Bajocian Inferior Oolite – Oolite Marl), near Notgrove, Gloucestershire, England.

very short, narrow, deeply concave and taper anteriorly along the dorsal edge of the crural bases to terminate posterior of the crural processes. The crural bases form a high ridge along the inner edge of the outer hinge plates, and with those plates and the socket ridges, form narrow U-shaped troughs. The crura are variable because recognition depends on the end of the taper of the outer hinge plates. In this genus they are short and flat. The crural processes are narrow, much elongated into long sharp points that are directed anteroventrally and medially. They almost overhang the crest of the transverse band. The descending lamellae are long and slender and join elongated webs of the transverse band. The transverse band is a narrow arch with flattened bridge and wide, steep sides. It rises steeply from the inside of the concave webs and narrows at the bridge which is moderately protuberant and occupies a third of the loop width. The webbed terminal points are long and wide.

Loop Statistics.—See Table 28.

Discussion.—Beside the prepared specimen discussed and illustrated herein, the loop of *Plectoidothyris* has been described by Sahni (1928b:134, fig. 11) and by Muir-Wood (1934:538, pl. 63: fig. 37; also figured in Muir-Wood, 1965:H814, fig. 692: 5b, and in Licharev, 1960:294, fig. 454) as serial sections and a reconstruction from them. The Sahni drawing of the loop is inaccurate in the depiction of the outer hinge plates and crural processes but the terminal points and transverse band are substantially correct. Comparison of both Sahni's drawing and the Muir-Wood reconstruction shows important differences, some of which are inherent in transforming serial sections into reconstructions. The reconstructed loop is widely triangular with concave descending lamellae, producing an anterior flare unlike the excavated specimen. The reconstruction shows the sides of the loop distinctly bowed inward, a feature rare in the short-looped terebratulids. The reconstruction shows a loop with length equal to about half the length of the dorsal valve; however, it is stated in the description (1934:538) to be "approximately two-thirds of length of brachial [dorsal] valve." The reconstruction is most inaccurate in the depiction of the anterior part of the loop. This is shown as a thin ribbon with long, flaring terminal points without webs. The transverse band is shown as a narrow, slender ribbon forming a low, broad arch, whereas actually it is a steep-sided arch. The hinge plates are inaccurate and the crural processes too short in the reconstruction. Sahni was correct in believing the loops of *Lobothyris* (as illustrated by Dubar, 1925) and *Plectoidothyris* are similar but the two are certainly not congeneric. The Dubar conception of *Lobothyris* has been altered by the work of Sučić-Protić who shows the true *Lobothyris* loop to have moderately long terminal points and other loop characters deviating strongly from those of *Plectoidothyris*.

Plectothyris Buckman, 1917

Figure 12; Plate 34: figures 14–19; Plate 44: figures 18–25; Plate 73: figures 7, 8

Plectothyris Buckman, 1917:115.

Subfamily.—Cererithyridinae, new subfamily.

Type-Species.—*Terebratula fimbria* J. Sowerby, 1821–1825:27.

Specimens Studied.—Ninety, three excavated for loop.

Geologic Occurrence.—Jurassic (Lower Bajocian).

Localities.—Great Britain and France.

Exterior.—Medium to large, subcircular, with obtusely angular posterolateral margins. Ventral valve more convex than dorsal valve. Lateral commissure straight; anterior commissure rectimarginate. Beak short, suberect to erect, closely appressed to dorsal umbo. Foramen large, permesothyridid. Surface of young specimens smooth; adults marked peripherally by costae extending for about third to half shell length.

Interior.—Ventral valve interior not seen.

Loop and Cardinalia: The cardinal process is small, bilobed anteriorly and with myophore directed posteroventrally. The socket ridges are thin and slightly inclined laterally to bound narrow sockets. The fulcral plates are small. The outer hinge plates are triangular and are tapered an-

TABLE 29.—Loop statistics for the genus *Plectothyris*

Proportions	USNM 551001b	USNM 551029a	USNM 551029c
∠	37°	41°	43°
Wl/Ll	0.75	0.75	0.83
Ll/LD	0.42	0.48	0.39
Wl/WD	0.27	0.39	0.30
a/Ll	0.56	0.50	0.50
b/Ll	0.44	0.50	0.50
c/Ll	0.37	0.25	0.22
d/Ll	0.19	0.25	0.28
e/Ll	0.19	0.21	0.22
f/Ll	0.25	0.29	0.28
g/WD	0.25	0.27	0.24
g/Wl	0.92	0.78	0.80
h/f	0.52	0.41	0.28
h/Ll	0.13	0.12	0.08
WD/LD	1.15	1.04	1.08

USNM 551001b: *P. fimbria* (J. Sowerby), Jurassic (Lower Bajocian - Oolite Marl), Cleave Hill, Cheltenham, England. (Young specimen).

USNM 551029a,c: *Plectothyris fimbria* (J. Sowerby), Jurassic (Bajocian - Inferior Oolite - Oolite - *murchisonae* Zone), Catbrain Quarry, Painswick, Gloucestershire, England.

teriorly for a short distance along the dorsal edge of the crural base. They are deeply concave and have the strongly elevated crural bases along their inner edge to form wide U-shaped troughs with the socket ridges. The crura are short, broad and flat in section, their extent depending on the taper of the outer hinge plates. The crural processes are located near midloop and face inward fairly strongly. The points are acute, narrow and directed ventrally and slightly anteriorly. The descending lamellae are narrow and fairly strongly bowed laterally. The transverse band is a fairly high arch, wide at its junction with the descending lamellae, flattened and narrowed medially, and directed posteriorly at about 30° to the horizontal. The median flattening of the loop or bridge varies about a quarter to slightly more of the loop width. The terminal points are only moderately developed. The crest of the transverse band is produced ventrally to a point about equal to the maximum distal extend of the crural processes.

LOOP STATISTICS.—See Table 29.

DISCUSSION.—The only previous figure of the loop of this genus is that by Davidson (1851–1852, pl. 12: fig. 9) which shows a loop much longer than wide with a broadly rounded transverse band having nearly obsolete outer hinge plates and much longer terminal points. The Wl/Ll of the Davidson loop is 0.64 and it occupies 40% of the dorsal valve length, about the same as the dissected specimens.

The serial sections of *Plectothyris* illustrated in Muir-Wood (1965:H815, fig. 695) under the caption of "Cancellothyrididae (Subfamily Uncertain)" show shallowly U-shaped outer hinge plates posteriorly becoming rather strongly V-shaped anteriorly and with a slight suggestion of a keel. There is no indication of the length of the terminal points suggesting that sectioning was not complete or the specimen had a damaged loop. The loop is said to have a medially horizontal band but the preparations show the loop to be off the horizontal by nearly 30°.

Postepithyris Makridin, 1964

FIGURE 11; PLATE 56: FIGURES 5–8A; PLATE 63: FIGURES 18–21; PLATE 72: FIGURES 9, 10

Postepithyris Makridin, 1960:294; 1964:226.—Boullier, 1981:29–67.

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Terebratula cincta* Cotteau, 1857:137. Douvillé, 1886:78, pl. 2: fig. 5.

SPECIMENS STUDIED.—Four; two excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Sequanian).

LOCALITIES.—France and Russia(?).

EXTERIOR.—Medium size, subcircular, sides and anterior margin rounded. Posterolateral extremities near 90°. Maximum width at or near midvalve. Lateral extremity nearly straight except anterior quarter where it is ventrally convex. Anterior commissure with poorly developed sulciplication. Beak short, protuberant, erect, with strong beak ridges. Foramen large, permesothyridid. Symphytium partially visible. Surface smooth

TABLE 30.—Loop statistics for the genus *Postepithyris*

Proportions	USNM 551075	Reconstruction (Makridin, 1964, fig. 77)
∠	35°	34°
Wl/Ll	0.62	0.67
Ll/LD	0.50	0.56
Wl/WD	0.36	0.39
a/Ll	0.48	0.34
b/Ll	0.52	0.66
c/Ll	0.29	0.22
d/Ll	0.19	0.12
e/Ll	0.13	0.14
f/Ll	0.39	0.54
g/WD	0.39	0.30
g/Wl	1.06	0.75
h/f	0.26	0.31
h/Ll	0.10	0.17
WD/LD	0.90	1.00

USNM 551075: *Postepithyris cincta* (Cotteau), Jurassic (Sequanian), Bourges, Cher, France.

INTERIOR.—Ventral valve interior with small teeth and short pedicle collar. Other details not seen.

Loop and Cardinalia: The loop is an elongate triangle with gently bulging sides, occupying more than a half the length and about ⅖ the width of the dorsal valve. The cardinal process is a fairly large semielliptical shelf flattened along its free margin and with a depressed myophore bearing a low median ridge. The socket ridges are thin, curved plates bounding narrow sockets that are roofed over proximally. The fulcral plates are thin with only a trace of lateral extension. The outer hinge plates are triangular, short, flatly concave and attached to the dorsal part of the crural base. Their inner margin is bordered by the ventral part of the crural base, thus the anterior or distal ends of the outer hinge plates appear to support the anterior part of the loop with apparent narrow crura. The crural processes originate at the anterior apex of the outer hinge plates. They are acutely angular, slightly approximate and directed anteroventrally. The descending lamellae are fairly long and thin and extend into long webbed terminal points. The transverse band is a high arch with wide nearly vertical sides and narrowed, flattened protuberant crest or bridge which is medially indented on its posterior side. The median protuberance is about equal in extent to the distal ends of the crural processes and its surface slopes anteriorly. The bridge occupies more than half the loop width. The transverse band varies off the horizontal by about 25°.

LOOP STATISTICS.—See Table 30.

DISCUSSION.—In proposing *Postepithyris* Makridin stated that it differed from *Epithyris* in a wider and less recurved beak, longer and distinctly triangular loop, a weaker dorsal "septum" and short, subparallel dorsal adductor impressions which diverge only at the extremities. Interest here centers on the loop of *Postepithyris* which has, among other characters, great length of the terminal points. The loop is suggestive of that of *Epithyris* in its strongly protuberant bridge of the transverse band but the terminal points and proportions of the loop are different from those of *Epithyris*.

A comparison of Makridin's (1964) reconstruction of the loop of *Postepithyris cincta* with the excavated loop of the French specimen indicates that the reconstruction is faulty or that the species is not *T. cincta* Cotteau (as Tchorszhevsky, 1974, maintains). The reconstruction agrees in loop angle, Wl/Ll, Ll/LD, and Wl/WD. The proportions of the loop proper do not agree with those of the preparation. The crural processes are posterior of midloop and the terminal points are excessively long (f/Ll = 0.54) in the reconstruction. Makridin shows a reconstruction of *"Postepithyris" bauchini* (sic) (fig. 79) with a loop totally unlike that of his *P. cincta* (pl. 76: fig. 4). *Postepithyris subrhomboidalis* (Gurov) Makridin (1964:241, fig. 81) is illustrated by drawing and an actual loop (pl. 15: fig. 9). This species is shown with a short loop, with thick posteriorly notched transverse band and extremely short terminal points.

Barczyk (1969:17) doubted the validity of *Postepithyris* and referred the same species placed by Makridin in *Postepithyris*: *T. haasi* Rollier, *T. cincta* Cotteau, and *T. bauchini* (sic) Etallon in his conception of *Epithyris*. None of the loops of these species reconstructed by Barczyk have any resemblance to Makridin's reconstructions or the real loop. Barczyk's idea of the loop of *T. cincta* is a loop wider than long with no extended terminal points, different from the excavated loops.

On Plate 63: figures 18–20, three different reconstructions of the loop of *Postepithyris cincta* are shown. The first is by Boullier (1976:369), in her stylized form, and strongly resembling her reconstruction of *Epithyris* (Plate 63: figure 6). The second reconstruction is by Makridin (1964, fig. 77) and is more like the excavated specimen than Boullier's. The last figure is Barczyk's (1969, fig. 20) reconstruction which is unlike the others. A fourth reconstruction of *Postepithyris subrhomboidalis* (Gurov) (Licharev, fig. 455) is completely unlike the others and unlike any loop from the Jurassic revealed in this study; it is also unlike the illustration of an actual loop of this species figured by Makridin (1964, pl. 15: fig. 9). These all suggest faulty reconstruction or different species or genera.

Tchorszhevsky (1974:50, footnote) contends that the type-species of *Postepithyris* should be *P. cincta* Makridin, 1960 (not Cotteau, 1857) described by Makridin (1960, 1964) from Upper Jurassic of the Russian Platform and the Donets folded structure.

Psebajithyris Tchorszhevsky, 1974

Psebajithryis Tchorszhevsky, 1974:48.

Subfamily.—Psebajithyridinae Tchorszhevsky, 1974.

Type-Species.—*Psebajithyris rostovtsevi* Tchorszhevsky, 1974:48, fig. 6, 9.

Specimens Studied.—Literature only.

Geologic Occurrence.—Jurassic (Oxfordian).

Locality.—Northwestern Caucasus, Russia.

Brief Description (Tchorszhevsky, 1974).—Shells moderately biconvex, rather large, [length 36.5 mm, width 28 mm, thickness 20 mm], oval or rounded pentagonal. Anterior commissure uniplicate in very old, large shells, one or two fine, often asymmetrical creases appear on the fold. The greatest width occurs at the center, and the greatest thickness somewhat toward the anterior margin. The beak is thick, of medium length, curved strongly and perforated by a rather large oval, apical foramen. Beak ridges are short, rounded.

Inner pedicle collar short and delicate, crescentic. Cardinal process very small, oval. Outer hinge plates of medium width, delicate and rather long, hook-like, dorsally curved. Processes of outer hinge plates goniothyrid, do not rest on floor of the valve, and extend to the level of the posterior margin of the transverse band of the loop.

Loop Statistics.—$\angle = 33°$; Wl/Ll = 0.64; a/Ll = 0.64; b/Ll = 0.36; c/Ll = 0.30; d/Ll = 0.34; e/Ll = 0.34; f/Ll = 0.02.

Observations (Tchorszhevsky, 1974).—As the result of homeomorphy the new genus exhibits some similarity to the internal structure of *Goniothyris* Buckman, 1918 (sic), which occurs in the Middle Jurassic, and differs from it first of all in a markedly shorter loop which lacks flanges, and also in the character of the commissure, and the thick and strongly curved beak.

Pseudoglossothyris Buckman, 1917

Plate 37: figures 15–24; Plate 62: figures 9–11; Plate 70: figures 5, 6

Pseudoglossothyris Buckman, 1901:240; 1917:98.

Subfamily.—Loboidothyridinae Makridin, 1964.

Type-Species.—*Terebratula curvifrons*, in sensu Davidson, 1876–1878:153, supplement pl. 24: 33 (not Oppel, 1858; = *Aulacothyris leckhamptonensis* Rollier, 1919:347; = *Pseudoglossothyris leckhamptonensis* (Rollier)).

Specimens Studied.—Twenty-three; one excavated for loop.

Geologic Occurrence.—Jurassic (Lower Bajocian).

Localities.—Great Britain and France.

Exterior.—Medium size, pentagonal, strongly inequivalve, ventral valve strongly convex, dorsal valve shallow and flatly convex. Lateral commissure concave toward ventral side. Anterior commissure strongly sulcate. Beak short, erect to sub-

TABLE 31.—Loop statistics for the genus *Pseudoglossothyris*

Proportions	USNM 551010c	Roche, 1939
∠	37°	37°
Wl/Ll	0.76	0.65
Ll/LD	0.40	0.42
Wl/WD	0.32	0.28
a/Ll	0.57	0.46
b/Ll	0.43	0.54
c/Ll	0.38	0.31
d/Ll	0.19	0.15
e/Ll	0.14	0.31
f/Ll	0.29	0.23
g/WD	0.30	0.30
g/Wl	0.94	1.56
h/f	0.34	0.09
h/Ll	0.10	0.02
WD/LD	0.96	0.97

USNM 551010c: *Pseudoglossothyris leckhamptonensis* (Rollier), Jurassic (Bajocian - Inferior Oolite - Oolite Marl), Leckhampton Hill, Gloucestershire, England.

Roche (1939, pl. 10: fig. 12): *Pseudoglossothyris curvifrons* (Oppel), Jurassic (Bajocian), Chaintré, Macconais, France.

erect; beak ridges strong, short. Foramen large, permesothyridid. Symphytium partially visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is widely triangular with somewhat bulging sides. It is slightly longer than wide and occupies almost ⅖ the length and a third the width of the dorsal valve. The cardinal process is a wide half ellipse with concave myophore surrounded by a slightly elevated rim. The myophore faces posteriorly. The socket ridges are short and moderately thick, inclined slightly laterally and bound a wide socket. The fulcral plates are thick and only slightly extended laterally. The outer hinge plates are narrow and taper onto the dorsal edge of the crural base. The crura are broad and short. The crural bases are extended as a high ridge along the inside margin of the outer hinge plates, and form with them and the socket ridges, short V-shaped troughs. These are shown in serial section as nearly flat and clubbed but the description (Muir-Wood 1965:H787, fig. 649:2a–i) states that they become V-shaped, a feature not shown in the sections). The crural processes are anterior to midloop, are narrow and are drawn into long, sharp points that project ventrally and slightly anteriorly. The descending lamellae are fairly long, narrow, laterally bowed bands. The transverse band is a high narrow arch with steep sides that form short webs in the short terminal points. The arch is protuberant but does not extend ventrally beyond the distal ends of the crural processes. The bridge is flattened for a third the loop width. The transverse band is elevated about 20° from the horizontal.

LOOP STATISTICS.—See Table 31.

DISCUSSION.—The loop of *Pseudoglossothyris* has a wide angle and resembles the loop of a number of Jurassic genera in having modest terminal points, such as *Plectothyris*, *Ptychtothyris*, *Avonothyris*, *Lophrothyris* and *Stiphrothyris*. The ultimate generic distinction from all these is the strongly sulcate anterior commissure.

Roché (1939, pl. 10: figs. 12, 15, 16; herein Plate 62: figures 9–11) figures the silicified loop of *Pseudoglossothyris curvifrons* (Oppel) from the Bajocian. The loops have very slender parts. The crural processes are posterior and the transverse band is a low arch at a low angle to the horizontal. The crural processes are long and needle-like and the terminal points are short.

The loops of the French specimens differ from those of the English species in having the crural processes posterior, rather than anterior, to midloop, a narrower bridge of the transverse band, a greater distance between crural processes and the bridge of the transverse band. The two differ in the delicacy of the French loops compared to the more rugged British ones. The two agree fairly well in loop dimensions and the amount of the dorsal valve occupied by the loop.

Pseudokingena Böse and Schlosser, 1900

PLATE 61: FIGURE 25

Pseudokingena Böse and Schlosser, 1900:177.

SUPERFAMILY.—Cancellothyridacea? Thomson, 1926.

TYPE-SPECIES.— *Terebratulina deslongchampsi* Davidson, 1850:450, pl. 15, fig. 6, 6a.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Lias).

LOCALITIES.—Great Britain, France, and Italy.

DISCUSSION.—This small brachiopod is unusual for its exterior which is covered by granules of two sizes. It has not yet been satisfactorily placed in the brachiopod kingdom. The interior and loop were figured by Deslongchamps (1862–1885:138, pl. 33: figs. 4, 9). The loop as depicted is similar to that of *Eucalathis* and its cardinalia are most suggestive of *Terebratulina.* Böse and Schlosser figured a loop similar to that of Deslongchamps but emphasized the presence of a median thickening which, to them, suggested a relationship to *Centronella*. Deslongchamps' restoration illustrates a slight median thickening. A median plate on the loop, characteristic of the centronellids, is not indicated by this author. It is suggested here that *Pseudokingena* may be placed in the Cancellothyridacea because of the similarity of its cardinalia to those of the superfamily.

Pseudotubithyris Almeras, 1971

PLATE 32: FIGURES 7–12; PLATE 33: FIGURES 23–28; PLATE 36: FIGURES 10–15; PLATE 40: FIGURES 7–18; 29–32; PLATE 62: FIGURE 16; PLATE 74: FIGURES 19, 20; PLATE 75: FIGURES 1, 2

Pseudotubithyris Almeras, 1971:361.

SUBFAMILY.—Lophrothyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula globata* J. de C. Sowerby, 1821–1825:51, pl. 436. Davidson, 1851–1852, pl. 13: figs. 2, 3.

SPECIMENS STUDIED.—Four of *T. globata* J. de C. Sowerby, one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bathonian).

LOCALITIES.—Great Britain and France.

EXTERIOR.—Small to medium, roundly subpentagonal, strongly biconvex, valves subequal in convexity. Sides and anterior margin rounded; posterolateral sides forming an angle of 80° (*P. globata*, England). Lateral commissure slightly oblique; anterior commissure uniplicate to moderately sulciplicate. Beak erect, beak ridges not defined. Foramen large, round, submesothyridid. Symphytium partially visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The dorsal umbonal chamber is moderately deep. The loop is moderately long and wide, occupying nearly a half the length and more than a third the width of the dorsal valve. The cardinal process is fairly large and forms a narrow thin shelf with depressed myophore facing ventroposteriorly. The socket ridges are thin, erect and bound narrow sockets. The fulcral plates were not seen in the excavated British specimen. The outer hinge plates are short, moderately wide and have a long taper along the dorsal side of the crural bases, the taper extending to a point almost under the crural processes. The crural bases form a ridge along the inside of the outer hinge plates and with them and the socket ridges form deep U-shaped troughs. The crural processes form blunt points anterior to midloop. The descending lamellae are slightly bowed and short. The transverse band forms a nearly horizontal arch, widest on the slopes and narrowing to the crest which is flattened and occupies about a third of the loop width. The median part of the loop is protuberant. The terminal points are moderately long.

LOOP STATISTICS.—See Table 32.

DISCUSSION.—Although the loop of *P. globata* figured by Deslongchamps (1862–1885:336, pl. 109: fig. 3) and listed in Almeras synonymy of this species (1971:370) is a silicified specimen there are some differences between it and the excavated English specimen (Plate 36: figures 13–15). Almeras does not include Deslongchamps' figure 6 in his synonymy yet its statistics are almost identical to those of the English specimen, and very close to those of Deslongchamps' figure 3 given here. The statistics of figure 5 of Deslongchamps deviate in loop proportions (Wl/Ll = 0.80) and loop length (Ll/LD = 0.36) but other relationships agree with those of other specimens. The excavated specimen is close to that of Deslongchamps' figure 6 in which the sides of the loop are slightly bowed laterally. The hinge plates

TABLE 32.—Loop statistics for the genus *Pseudotubithyris*

Proportions	USNM 75068a	USNM 550994b	USNM 550995c	USNM 551018	USNM 551019b	USNM 551090a	Almeras, 1971	Deslongchamps 1862–1885, pl. 109: fig. 3	fig. 6
∠	43°	38°	36°	41°	45°	40°	38°	39°	39°
Wl/Ll	0.80	0.69	0.68	0.70	0.80	0.77	0.70	0.76	0.73
Ll/LD	0.49	0.44	0.50	0.56	0.39	0.45	0.45	0.49	0.48
Wl/WD	0.37	0.30	0.39	0.39	0.29	0.35	0.37	0.37	0.33
a/Ll	0.50	0.52	0.52	0.55	0.67	0.53	0.44*	0.52	0.53
b/Ll	0.50	0.48	0.48	0.45	0.33	0.47	0.56	0.47	0.47
c/Ll	0.35	0.42	0.40	0.50	0.40?	0.53	0.28	0.38	0.33
d/Ll	0.15	0.10	0.12	0.05	0.27?	0.00	0.16	0.14	0.20
e/Ll	0.10	0.16	0.20	0.15	0.13	0.15	0.24	0.14	0.13
f/Ll	0.40	0.32	0.28	0.30	0.20	0.32	0.32	0.34	0.34
g/WD	0.32	0.35	0.35	0.39	0.29	0.27	0.23	0.30	0.24
g/Wl	0.88	1.15	0.89	1.00	1.00	0.86	0.72	0.73	0.73
h/f	0.20	0.31	0.28	0.33	0.45	0.09	0.19	0.15	0.20
h/Ll	0.08	0.10	0.08	0.10	0.09	0.03	0.06	0.05	0.07
WD/LD	1.07	1.00	0.98	0.96	1.05	1.00	0.98	1.00	1.08

* Discrepancy here is probably due to inexact location of the crural processes.

USNM 75068a: *Pseudotubithyris* aff. *globata* (J. deC. Sowerby), Jurassic (Bathonian), Marquise, Pas-de-Calais, France.

USNM 550994b: *Pseudotubithyris* sp. 1, Jurassic (Bathonian), quarry of National Cement Company, Langueville, Calvados, France.

USNM 550995c: *Pseudotubithyris capillata* (Arkell), Jurassic (Upper Bathonian), quarry at Ardley, Route A43, between Oxford and Northhampton, England.

USNM 551018: *Pseudotubithyris* species 3, Jurassic (Bradfordian), Route 814, 1 km W of Amfreville, 10.8 km NE of Caen, Calvados, France.

USNM 551019b: *Pseudotubithyris* species 2, Jurassic (Bathonian), NW of Bir, Gebel Moghara, Sinai.

USNM 551090a: *Pseudotubithyris globata* (J. de C. Sowerby), Jurassic (Bathonian – Fullers Earth), Whatley, near Frome, Somerset, England.

Almeras (1971, pl. 65): *P. globata* (J. de C. Sowerby), Jurassic (Bathonian – *retrocostatum* Zone), S of Molards, Saône-et-Loire, France.

Deslongchamps: *P. globata* (J. de C. Sowerby), Jurassic (Bathonian – Fullers Earth), near Turnus, Saône-et-Loire, France.

of figures 5 and 6 are smaller and the width of the hinge is much narrower in these than in figure 3 and the excavated specimen. The cardinal process in the three figures of Deslongchamps and that of the dissected specimen is small and not lobed as indicated by Muir-Wood (1936:87).

In addition to the British specimen, examples of *Pseudotubithyris* from France and Egypt have been dissected to exhibit their loops. These are described below and their statistics summarized.

Pseudotubithyris aff. *globata* (J. de C. Sowerby)

PLATE 40: FIGURES 14–18

LOOP OF USNM 75068a.—The loop is slightly distorted. It is a wide triangle occupying nearly half the length and ⅖ of the dorsal valve width. The cardinal process is a flattened half ellipse. The socket ridges are thin and bound narrow sockets. The outer hinge plates are short, close to the valve floor, deeply concave, moderately wide and form U-shaped troughs with the high crural bases and socket ridges. The crural processes are at midloop and are wide and acute. The descending lamellae are short. The transverse band is a broad arch medially flattened and about flush with the ends of the crural processes. The terminal points are fairly long.

Pseudotubithyris species 1

PLATE 32: FIGURES 7–12

LOOP OF USNM 550994b.—The loop preparation is deficient in the crural processes with probable loss of their full extent. The loop is moderately widely triangular and occupies ⅖ the length and a third the width of the dorsal valve.The socket ridges are thin and delicate; the sockets are narrow. The outer hinge plates are close to the valve floor, are deeply concave, rather narrow and form deep U-shaped troughs with the high bounding crural bases and socket ridges. The crural processes are acutely pointed as shown by the left side of the preparation. The descending lamellae are short and slender. The transverse band is a high arch, medially flattened and narrowed for about a third the loop width. In side view the transverse band is gently lifted above the horizontal. For loop statistics see table 32.

Pseudotubithyris species 2

PLATE 40: FIGURES 7–13

LOOP OF USNM 551019b.—The loop is fairly widely triangular and occupies not quite 40% of the length and a third the width of the dorsal valve. The cardinal process is a half ellipse. The socket ridges are thin and erect and bound narrow sockets. The outer hinge plates are narrow and short and attached along the dorsal margin of the crural bases. With the crural bases that form a high wall along the inner margin of the outer hinge plates, these form narrow V-shaped troughs. The crural processes are located anterior of midloop, and are extended into long needle-like points. The descending lamellae are thin, laterally bowed bands. The transverse band is a strongly elevated arch medially flattened for about a quarter its width. The terminal points are short. For loop statistics see table 32.

Pseudotubithyris species 3

PLATE 40: FIGURES 29–32

LOOP OF USNM 551018.—The loop is narrowly triangular with gently bulging sides. The cardinal process is a small, thin, half ellipse with sunken myophore facing posteriorly. The socket ridges are thin plates bounding narrow sockets. The outer hinge plates are triangular, short, attached to the dorsal edge of the high crural base. They terminate just posterior of the crural processes which are fairly long and drawn into sharp points. The descending lamellae are fairly long, thin bands. The transverse band is strongly arched and medially flattened for about a third of the loop width. The lateral branches of the transverse band are steeply inclined and the median bridge protrudes to a point about flush with the ends of the crural processes. The terminal points are only moderately long. For loop statistics see Table 32.

Pseudotubithyris capillata (Arkell)

PLATE 33: FIGURES 23–28

Stiphrothyris capillata Arkell, 1931:602

LOOP OF USNM 550995c.—The loop is fairly widely triangular and occupies a half the length and about ⅖ the width of the dorsal valve. The cardinal process is a thin flattened shelf. The outer hinge plates are short. The crural processes are long and are located slightly anterior to midloop. The descending lamellae are short. The transverse band is slightly posterior of horizontal, moderately broad and has a protuberant bridge. The terminal points are fairly short.

This species was first placed in *Stiphrothyris* but was later assigned to *Pseudotubithyris* by Almeras (1971:368) where it seems more at home. The loop differs from that of *Stiphrothyris* in being less wide, proportionally less long, in having more pronounced terminal points and less attenuated crural processes. For loop statistics see Table 32.

Pseudowattonithyris Almeras, 1971

PLATE 32: FIGURES 13–17; PLATE 73: FIGURES 9, 10

Pseudowattonithyris Almeras, 1971:393.

SUBFAMILY.—Lophrothyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula circumdata* Deslongchamps 1862–1885, pl. 131: figs. 4, 5, 7b, 8, 9.

SPECIMENS STUDIED.—Six; one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bathonian).

LOCALITY.—France.

EXTERIOR.—Small to medium size, elongate oval or elliptical, valves swollen, ventral valve slightly deeper. Maximum width at or near midvalve. Lateral commissure moderately oblique. Anterior commissure sulciplicate to episulcate. Beak short, suberect, beak ridges rounded. Foramen large, permesothyridid. Symphytium mostly hidden. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is elongate triangular and occupies nearly a half the length and a third the width of the dorsal valve. The cardinal process is a small half ellipse (lost in the preparation). The socket ridges are high, thin, curved, erect plates bounding narrow sockets. The outer hinge plates are narrow, triangular, short, and form narrow U-shaped troughs with the marginal crural bases. The distal edge of the outer hinge plates tapers anteriorly, is attached to the dorsal edge of the crural bases, and reaches to a point just dorsad of the crural process. The crural processes taper to acute points that are slightly approximate and extend directly ventrally. The descending lamellae are narrow, nearly straight, moderately long and taper to the junction with the transverse band. The latter forms a narrow arch with steep sides. The crest of the arch is flattened for about a third the loop width. The transverse band extends posteroventrally at an angle of 30° from the horizontal, but does not protrude beyond the distal ends of the crural processes. The terminal points are only moderately long and make an angle of about 25° with the sides of the loop.

LOOP STATISTICS.—See Table 33.

TABLE 33.—Loop statistics for the genus *Pseudowattonithyris*

Proportions	USNM 550988b	Almeras, 1971
∠	33°	37°
Wl/Ll	0.64	0.66
Ll/LD	0.48	0.46
Wl/WD	0.34	0.39
a/Ll	0.55	0.46
b/Ll	0.45	0.54
c/Ll	0.55	0.39
d/Ll	0.00	0.07
e/Ll	0.13	0.26
f/Ll	0.32	0.28
g/WD	0.32	0.37
g/Wl	0.93	0.92
h/f	0.19	?
h/Ll	0.06	?
WD/LD	0.89	0.92

USNM 550988b: *Pseudowattonithyris circumdata* (Deslongchamps), Jurassic (Bathonian), Campagnettes, at entrance to quarry N of Ranville, Route 814 to Salenelles, 9.6 m below road, 1.5 km N of Ranville, France.

Almeras (1971, pl. 75A,B): *P. circumdata* (Deslongchamps), Jurassic (Upper Bathonian – zone of *retrocostatum*), S of Molards, Davayé, Saône-et-Loire, France.

DISCUSSION.—Compared to the loop of *Pseudotubithyris* that of *Pseudowattonithyris* has a smaller loop angle, narrower dimensions (Wl/Ll) and slightly shorter Ll/LD. The crural processes of the two are about midway of the loop and the terminal points are approximately the same in length. The transverse band of *Pseudotubithyris* is broader than that of *Pseudowattonithyris*.

Almeras (1971:393) created *Pseudowattonithyris* because of the difference in interior details compared to those of *Wattonithyris*, an external homeomorph. The loop of *Wattonithyris* as revealed by *W. fullonica* Muir-Wood (Plate 43: figures 1–6) has a wider loop angle and the Wl/Ll is greater. The length of the loop of *Wattonithyris* in relation to that of the dorsal valve is less than in Almeras' genus. The statistics of the loop proper (a-f/Ll) of the two genera are close. The hinge width of *W. fullonica* is proportionally less than that of *Pseudowattonithyris*.

Ptychtothyris Buckman, 1917

PLATE 39: FIGURES 1–6; 16–21; PLATE 45: FIGURE 7; PLATE 75: FIGURES 5, 6

Ptychtothyris Buckman, 1917:101.

SUBFAMILY.—Loboidothyridinae Makridin, 1964.

TYPE-SPECIES.—*Terebratula stephani* Davidson, 1877:12, pl. 1: fig. 3; 1876–1878:147, suppl., pl. 18: figs. 1–7.

SPECIMENS STUDIED.—Eight specimens of the type species, one with loop showing all parts well except the outer hinge plates; one specimen showing part of loop with well preserved outer hinge plates.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITIES.—Great Britain and France.

EXTERIOR.—Large, subtriangular to subpentagonal, inequivalve, dorsal valve less deep than ventral valve. Lateral commissure oblique in posterior two-thirds, strongly concave toward ventral side in anterior third. Anterior commissure strongly sulciplicate to episulcate. Beak short, suberect to erect, slightly labiate. Foramen large, permesothyridid. Symphytium partially hidden. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The cardinal process is a thin, half ellipse with myophore facing posteriorly. The socket ridges are thin and lean slightly toward the socket. The fulcral plates were not seen. The outer hinge plates are short, very close to the valve floor, and are attached to the dorsal edge of the crural bases. They are concave and taper anteriorly but do not reach the crural processes. The crural bases are extended posteriorly to form a high wall along the inside edge of the outer hinge plates, making with them and the socket ridges short U-shaped troughs. The crura are flat and expand to form the crural processes which are acutely pointed and slightly approximate. The descending lamellae are short and anteriorly form terminal webs with the transverse band. The transverse band is a fairly stout, moderately wide ribbon, widest where it joins the terminal points, forming a steep slope of the sides joining the terminal points. The crest of the arch is flattened and tilted slightly anteriorly. The flattened crest occupies about a third of the loop width and bears a narrow reentrant on its posterior margin in the type species.

LOOP STATISTICS.—See Table 34.

TABLE 34.—Loop statistics for the genus *Ptychtothyris*

Proportions	USNM 19878b	USNM 551011b	Almeras, 1971
∠	37°	44°	44°
Wl/Ll	0.73	0.86	0.80
Ll/LD	0.41	0.39	0.32
Wl/WD	0.33	0.33	0.35
a/Ll	0.58	0.55	0.56
b/Ll	0.42	0.45	0.44
c/Ll	0.39	0.29	0.32
d/Ll	0.19	0.26	0.24
e/Ll	0.20	0.16	0.33
f/Ll	0.22	0.29	0.11
g/WD	0.28	0.24	0.31
g/Wl	0.90	0.73	1.17
h/f	0.45	0.45	0.36
h/Ll	0.10	0.13	0.04
WD/LD	0.94	1.02	0.95

USNM 19878b: *Ptychtothyris helena* (Bayle) [= *P. baylei*, new name], Jurassic (Inferior Oolite), Luc, Calvados, France.

USNM 551011b: *Ptychtothyris stephani* (Davidson), Jurassic (Inferior Oolite – *schloenbachi* Zone), Broad Windsor, Dorset, England.

Almeras (1971, p. 36A,B): *Ptychtothyris stephani* (Davidson), Jurassic (Bajocian – Inferior Oolite), Bradford Abbas, England.

DISCUSSION.—The French specimen identified as "*T.*" *helena* Bayle is very close to *P. stephani* in exterior details but varies slightly in interior characters. The loops of both are characterized by rather short terminal points but the loop of "*T.*" *helena* (= *P. baylei*, new name) is slightly shorter and the descending branches are moderately bulging whereas those of *P. stephani* are nearly straight.

The figures of the loop of *Ptychtothyris stephani* (Davidson) Plate 75: figures 5, 6, are composites of specimens USNM 551011b and 551057a, the former with damaged outer hinge plates, the latter with those plates well exposed, but the anterior part of the loop missing.

Prosorovskaya (1968:49, fig. 24) gives a reconstruction of two loops of *Ptychtothyris subcanaliculatea* that are in fair accordance with the excavated loop of *P. stephani* figured herein but details of the hinge plates and crural processes are lacking. The reconstruction of the loop of *P. turkemenensis* Prosorovskaya (1968:53, fig. 29) is entirely unlike that of her other two species with loop reconstructed and not in accordance with the loop of *Ptychtothyris stephani* in either its form or the details of its parts. Prosorovskaya 1968 refers *T. dorsoplicathyris* Suess to *Ptychtothyris*.

Ptychtothyris baylei, new name

Terebratula helena Bayle (1878, pl. 7: fig. 3) is preoccupied by *Terebratula helena* Whitfield (1875: 103, figs. 5–10). The substitute name *Ptychtothyris baylei* is proposed.

Pyraeneica Sučić-Protić, 1971

PLATE 33: FIGURE 29; PLATE 52: FIGURE 15; PLATE 77: FIGURE 9

Pyraeneica Sučić-Protić, 1971:23.

SUBFAMILY.—Lobothyridinae Makridin, 1964.

TYPE-SPECIES.—*Pyraeneica numerosa* Sučić-Protić, 1971, pl. 8: figs. 4–7; pl. 27: fig. 2; pl. 38: fig. 6 (reconstruction of loop).

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Lower to Middle Lias).

LOCALITIES.—Madagascar, Spain, France, Italy, Romania, and Yugoslavia.

DIAGNOSIS (Sučić-Protić, 1971:23).—Biconvex shells. The beak is short. Crural processes are well expressed. Flanks [terminal points] are short, rounded, widely disjoined.

MORPHOLOGICAL DESCRIPTION (Sučić-Protić, 1971:23).—

Round to subpentagonal biconvex shells. The beak is short and narrow and is supported by the umbo of the dorsal valve. The inner pedicle collar is developed. Hinge teeth and dental cavities are of the same shape as in other genera. Hinge plates are short and wide. The cardinal process is wide and low. Crural bases are very expressed and strongly curved ventrally. The medium-sized brachidium has very disjoined flanks [terminal points] rounded on the ends. Crural processes are well developed. The transverse plate is wide.

LOOP STATISTICS.—See Table 22.

COMMENT.—The type species has a very wide loop, nearly as wide as the widest loop encountered in this study. The transverse band of the reconstruction is uncertain.

Rhapidothyris Tuluweit, 1965

Rhapidothyris Tuluweit, 1965:72.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Rhapidothyris arciferens* Tuluweit, 1965:73.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Lias - Spinatus and Ibex Zones.

LOCALITY.—South England and northern Germany.

DIAGNOSIS (from Tuluweit, 1965).—Rounded to pentagonal to spindle-shaped, biconvex. Beak suberect to curved. Foramen usually medium size, beak angles and interarea frequently present, even lateral margins; anterior commissure distinctly sulcate, the unthickened tongue-shaped front lengthened; symphytium broad; hinge plate curved ventrally, cardinal process crown shaped, extremely thin crural bases, socket ridges steep, crural base junction with socket plates very deep lying, hinge teeth undifferentiated, euseptoid distinct, loop taking about a third of the dorsal valve length.

COMMENT.—*Nucleata* alone is comparable to *Rhapidothyris*. The serial sections do not show the complete loop.

Rocheithyris Almeras, 1971

Rocheithyris Almeras, 1971:345.

SUBFAMILY.—Cererithyridinae, new subfamily.

TYPE-SPECIES.—*Rocheithyris curvata* Almeras, 1971:346, pl. 62: figs. 7–14; pl. 63A-B.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Upper Bajocian - Lower Bathonian).

LOCALITY.—France.

ORIGINAL DIAGNOSIS (Almeras, 1971:345).—Medium size. Pentagonal. Valves moderately swollen. Beak short, straight, touching the dorsal valve, provided with beak ridges, truncated by a circular permesothyridid to mesothyridid foramen. Symphytium not exposed. Lateral commissures strongly curved on their whole course. Anterior commissure sulciplicate to episinuate. Muscle imprints long, divergent, with anterior terminations widened.

Pedicle collar present. Cardinal process planoconvex, grooved, slightly elevated anteriorly. No umbonal cavity. Hinge plates club-shaped, then a deep V at the front, well separated from the socket ridges and crural bases. Hinge teeth elongated, sockets deep, enclosed by the internal and external borders, plane of articulation very short. Loop at the level of the transverse band in the form of a raised arch. Euseptoidum low, present between the plane of articulation and the anterior extremity of the brachidium. Length of brachidium: 0.5.

LOOP STATISTICS (from Almeras sections, pl. 63A,B).— ∠ = 43°; Wl/Ll = 0.80; Ll/LD = 0.52; Wl/WD = 0.42; a/Ll = 0.45; b/Ll = 0.55; c/Ll = 0.30; d/Ll = 0.15; e/Ll = 0.27; f/Ll = 0.28; g/WD = 0.27; g/Wl = 0.67; h/Ll = ?; WD/LD = 0.93.

Almeras, 1971, pl. 63A,B: *Rocheithyris curvata* Almeras, Jurassic (Lower Bathonian - Zigzag Zone), Prémeyzel, Ain, France.

Rouillieria Makridin, 1960

PLATE 63: FIGURE 26

Rouillieria Makridin, 1960:295; 1964:245.

SUBFAMILY.—Lissajousithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula michalkowii* Fahrenkohl, 1855-1856:228, pl. 3: fig. 2.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Lower and Upper Voltzian), Lower Cretaceous (Valangian).

LOCALITY.—Russian Platform and Great Britain (?).

EXTERIOR (Makridin, 1964).—Elongate, pyriform, more rarely ovate of varying size; adult anterior commissure weakly uniplicate. Beak ridges developed. Foramen large.

INTERIOR (Makridin, 1964).—Pedicle collar present. Teeth long and delicate, lacking notches but with three small denticles. Socket ridges delicate, faintly curved; outer hinge plates wide. Crural bases touching the valve floor to form apical chambers. Loop narrow with very long flanges [terminal points], ⅔ the length of the dorsal valve. Transverse band delicate. Crural processes straight. Median septum long. Adductor impressions paddle-shaped.

LOOP STATISTICS (from Makridin reconstruction, 1964, fig 84).—∠ = 32°; Wl/Ll = 0.60; Ll/LD = 0.66; Wl/WD = 0.46; a/Ll = 0.27; b/Ll = 0.73; c/Ll = 0.27; d/Ll = 0.00; e/Ll = 0.13; f/Ll = 0.60; g/WD = 0.37; g/Wl = 0.61; h/f = 0.05; h/Ll = 0.03; WD/LD = 0.81.

COMMENT.—Makridin's reconstruction (1964, figs. 83, 84) shows a loop with terminal points rivalling in length those of *Lissajousithyris* and *Exceptothyris* of the Bajocian and Lias. Cretaceous specimens referred to this genus by Middlemiss (1976) in serial section do not show the extremely long terminal points of the type species.

Rugithyris Buckman, 1917

Rugithyris Buckman, 1917:127.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Terebratula subomalogaster* Buckman, 1901:259.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITIES.—Great Britain and Russia (?).

DISCUSSION.—Buckman proposed this genus for small shells having a squamose concentric ornament and a flatly convex dorsal valve. The genus is diagnosed in Muir-Wood (1965:H787, fig. 648:4a-c) and its interior illustrated by incomplete and inadequate serial sections. The loop of the type species is unknown.

Dagis (1968:108, pl. 10: figs. 1, 2) described *Rugithyris anabarensis* which agrees with the type in having closely crowded, raised concentric lines but deviates in having a strongly convex dorsal valve. Dagis (1968:109, fig. 65) illustrates the interior of his species by a complete series of sections that show the loop. Unfortunately the interval between sections is not indicated making it impossible to judge the length of the loop and its parts. There are narrow, slightly concave outer hinge plates and stout socket ridges. The transverse band is somewhat narrowly rounded with flattened bridge. The full length of the loop is not indicated because the last section exhibits lateral portions of the transverse band.

The strong convexity of the dorsal valve makes the identification of the species *anabarensis* with *Rugithyris* doubtful.

Saucrobrochus, new genus

PLATE 50: FIGURES, 13–18; PLATE 71: FIGURES 7, 8

SUBFAMILY.—Lissajousithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula whaddonensis* Buckman, 1910:101, pl. 12: figs. 15, 16.

DIAGNOSIS.—Medium sized terebratulaceans with subpentagonal outline having its loop reaching half dorsal valve length and crural processes posterior of midloop, paraplicate anterior commissure.

SPECIMENS STUDIED.—Three; one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian – Inferior Oolite).

LOCALITIES.—Great Britain and France.

EXTERIOR.—Medium size, roundly pentagonal, anterior margin and sides rounded, posterolateral margins forming angle of 100°–110°. Lateral commissure posteriorly slightly oblique, becoming strongly convex anteriorly. Anterior commissure strongly paraplicate. Valves unequally convex, dorsal valve with swollen umbonal region, ventral valve slightly greater in depth. Beak short, suberect, anteriorly somewhat excavated. Foramen large, mesothyridid. Symphytium partially visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is long and occupies more than a half the length and more than a third the dorsal valve width. The cardinal process is a small half ellipse slightly folded and reentrant in the middle and with the sides bounded by a low elevated ridge. The myophore is directed posteroventrally. The socket ridges are thin, short, curved, erect and bound narrow sockets. The outer hinge plates are very short and deeply concave. They are notched at about half way of their length and the inner side of the notch is extended as a taper along the dorsal edge of the crural bases to a point just under or dorsad of the crural processes. The taper eliminates any measure of the crus. The crural bases are elevated along the inner margin of the outer hinge plates. The crural processes are large, bluntly acute points directly slightly anteroventrally but not noticeably approximate. The descending lamellae are broad, short and slightly bowed. The transverse band is a low arch having widely expanded sides that form a web with the descending lamellae. The arch is thinned and flattened on its crest or bridge, the flattening occupying about a third of the loop width. The terminal points are long and narrowly rounded.

LOOP STATISTICS.—USNM 551089a: $\angle = 35°$; Wl/Ll = 0.71; Ll/LD = 0.53; Wl/WD = 0.36; a/Ll = 0.33; b/Ll = 0.67; c/Ll = 0.33; d/Ll = 0.00; e/Ll = 0.25; f/Ll = 0.42; g/WD = 0.34; g/Wl = 0.94; h/f = 0.09; h/Ll = 0.04; WD/LD = 1.04.

USNM 551089a: *Saucrobrochus whaddonensis* (Buckman), Jurassic (Bajocian – Inferior Oolite), Stoke Knapp, Whaddon Hill, near Broad Windsor, Dorset, England.

DISCUSSION.—"*Terebratula*" *whaddonensis* is externally similar to "*T.*" *pisolithica* S. S. Buckman but differs in being somewhat more elongate and with more rounded posterolateral margins. The beak characters are similar but the ridges on "*T.*" *whaddonensis* are more acute than those of "*T.*"

pisolithica. The folding of "*T.*" *whaddonensis* is somewhat deeper than that of the other species. Although the shells are extremely similar, the loops of these two species are unlike. The loop of "*T.*" *pisolithica* (= type of *Stroudithyris*) has a much wider angle, a proportionally wider loop, is wider compared to shell width and has the crural processes farther forward than in *Saucrobrochus*. The terminal points of *S. whaddonensis* are longer than those of *Stroudithyris*. The crural processes of *S. whaddonensis* are blunter than those of *Stroudithyris* and the transverse band of the latter is directed from the horizontal at a higher angle that that of *Saucrobrochus*. The outer hinge plates of *Saucrobrochus* have narrow reentrants not seen in *Stroudithyris*.

The loop and hinge plates of *Saucrobrochus* are similar to those of *Monsardithyris* but the exteriors are completely unlike.

The French species *Terebratula infraoolitica* Deslongchamps (1872), which is almost identical to *S. whaddonensis* externally, probably belongs to *Saucrobrochus*.

ETYMOLOGY.—From the Greek *saukros* (graceful) plus *brochos* (noose or loop).

Senokosica Sučić-Protić, 1971

PLATE 77: FIGURE 4

Senokosica Sučić-Protić, 1971:28.

SUBFAMILY.—Notosiinae?, new subfamily.

TYPE-SPECIES.—*Senokosica matura* Sučić-Protić, 1971:29, pl. 11: figs. 1–4; pl. 29: fig. 2; pl. 39: fig. 3 (reconstruction of loop)

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Middle Lias).

LOCALITIES.—Romania, Bulgaria, and Yugoslavia.

DIAGNOSIS (Sučić-Protić, 1971:28).—Elongated-oval shells. The beak is narrow and curved. The foramen is big. The cardinal process is expressed. Hinge plates are short. Flanks [terminal points] are narrow and disjoined."

MORPHOLOGICAL DESCRIPTION (Sučić-Protić, 1971:28).—

Elongated-oval shells with a straight anterior margin. Most species have expressed growth lines. The beak is wide, thick and strongly curved. The foramen is round. The inner pedicle collar is developed. The symphytium is low and ventrally curved. Hinge teeth are narrow, curved towards the lateral slopes, strengthened by small, sharp denticula. Dental cavities are narrow and short. The cardinal process is on the very umbo of the dorsal valve. In some species it is strongly developed and concave on the top. Hinge plates are wide and support curved crural bases. The loop of the brachidium goes to one half of the valve's length. Flanks [terminal points] are characteristically narrow, fairly disjoined, with thin and rounded ends which are slightly curved towards the slopes. The transverse plate is sufficiently wide and very convex ventrally.

LOOP STATISTICS.—See Table 22.

COMMENT.—The reconstruction of the loop of *S. edwardsi* (Davidson) (Sučić-Protić, 1971, pl. 39: fig. 6) is similar to that of the excavated English specimen (Plate 52).

Serbiothyris Sučić-Protić, 1971

PLATE 77: FIGURE 6

Serbiothyris Sučić-Protić, 1971:25.

SUBFAMILY.—Notosiinae, new subfamily.

TYPE-SPECIES.—*Serbiothyris medioliassica* Sučić-Protić, 1971:26; pl. 9; figs. 6–8; pl. 28; fig. 2; pl. 39: fig. 1 (reconstruction of loop).

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Lower-Middle Lias).

LOCALITIES.—Lower Lias: Italy; Middle Lias: France and Yugoslavia.

DIAGNOSIS (Sučić-Protić, 1971:25).—"Elongated; five-sided shells with a straight frontal margin. The beak is short and curved, with inner pedicle collar. Flanks [terminal points] are medium-sized and disjoined. The cardinal process is wide; it is low on most species."

MORPHOLOGICAL DESCRIPTION (Sučić-Protić, 1971:26).—

Biconvex shells with a straight frontal margin. Length is always bigger than width. The beak is wide at the base, narrows toward the top; it is short and curved. The foramen is small. The inner pedicle collar is developed. Internal structure: wide and high cardinal process, short hinge plates, wide descending branches, well developed crural processes, quite long flanks [terminal points], disjoining by degrees and ending in rounded peaks. The transverse plate is narrow and ventrally convex.

LOOP STATISTICS.—See Table 22.

COMMENT.—The sectioned specimen of the type species is without the transverse band which appears to have been narrow. The loop is similar to that of the dissected English specimen.

Sphaeroidothyris Buckman, 1917

PLATE 44: FIGURES 1–11; PLATE 70: FIGURES 7, 8

Sphaeroidothyris Buckman, 1917:115.

SUBFAMILY.—Loboidothyridinae Makridin, 1964.

TYPE-SPECIES.—*Sphaeroidothyris globisphaeroidalis* Buckman, 1917:115, pl. 20: fig. 1.

SPECIMENS STUDIED.—About one hundred; four with complete loop, two with damaged loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian – Bathonian).

LOCALITIES.—Great Britain and France.

PRELIMINARY REMARKS.—The species of this genus are characterized by obesity of the shells that are usually approximately equivalved. Inasmuch as many genera in late life tend to obesity, homeomorphy may be expected in *Sphaeroidothyris*. In this study several specimens identified as *Sphaeroidothyris* were excavated and by the structure of their loops gave indication that more than one genus is now present under this name. The type species *S. globispharoidalis*, proves to have a wide loop with short terminal points while two others have long loops with fairly long terminal points. These specimens are described below, the type species considered first.

EXTERIOR.—Small to large, globular, strongly but unequally convex, ventral usually slightly deeper than dorsal valve. Lateral commissure straight or convex ventrally at anterior; anterior commissure rectimarginate to faintly uniplicate to slightly sulciplicate, folding not showing on

TABLE 35.—Loop statistics for the genus *Sphaeroidothyris*

Proportions	USNM 92910	USNM 551031a	USNM 551032a	USNM 551101	Davidson, 1851–1852
∠	45°	44°	43°	25°	37°
Wl/Ll	0.95	1.00	0.83	0.53	0.82
Ll/LD	0.41	0.36	0.33	0.53	0.50
Wl/WD	0.40	0.38	0.31	0.31	0.44
a/Ll	0.40	0.51	0.56	0.49	0.50
b/Ll	0.60	0.49	0.44	0.51	0.50
c/Ll	0.40	0.16?	0.56	0.30	0.29
d/Ll	0.00	0.35	0.44	0.19	0.21
e/Ll	0.18	0.21	0.16	0.08	0.14
f/Ll	0.42	0.28	0.33	0.43	0.36
g/WD	0.32	0.38	0.31	0.29	0.44
g/Wl	0.77	0.78	1.00	1.04	0.61
h/f	0.14	0.32	0.25	0.21	0.22
h/Ll	0.06	0.09	0.07	0.09	0.08
WD/LD	1.05	0.95	1.06	0.92	0.93

USNM 92910: *Sphaeroidothyris?* species, Jurassic, Calvados, France.

USNM 551031a: *Sphaeroidothyris globisphaeroidalis* Buckman, Jurassic (Bajocian Inferior Oolite – *parkinsoni* Zone), Broad Windsor, Dorset, England.

USNM 551032a: *Sphaeroidothyris sphaeroidalis* (Sowerby), Jurassic (Bajocian – Inferior Oolite), St. Vigor, near Bayeux, Calvados, France.

USNM 551101: *Sphaeroidothyris?* species, Jurassic (Bajocian), Sully, Calvados, France.

Davidson (1851–1852, pl. 11: fig. 11): *Sphaeroidothyris sphaeroidalis* (Sowerby), Jurassic (Bajocian – Inferior Oolite), ?Sherborn, England.

shell body and confined to anterior commissure. Beak erect, short; beak ridges short, subangular. Foramen large, permesothyridid. Symphytium usually hidden. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop as revealed by the type species (USNM 551031a) and another smaller one, is widely triangular with length and width nearly equal. The loop occupies a third to two-fifths of the length and width of the dorsal valve. The cardinal process is a small half ellipse, divided into lobes by a small groove at its middle. The socket ridges are curved, erect, thick, and bound a fairly wide socket. The fulcral plates are thick and extended laterally for a short distance toward the valve margin. The outer hinge plates are short, triangular, thin, and close to the valve floor. They have a narrow taper posterior to the crural processes and unite with the dorsal side of the crural bases which are narrow. The crural bases form margins along the inner edge of the outer hinge plates, thus creating short, shallow U-shaped troughs. The crura are short. The crural processes are broad, elongated and acutely pointed. The descending lamellae are short and nearly straight. The transverse band is angularly arched, broad on the lateral slopes near the attachment with the descending lamellae but narrowed at the crest of the arch. The crest of the transverse band is slightly dorsad of the distal extremities of the crural processes.

LOOP STATISTICS.—See Table 35.

DISCUSSION.—The loop of *S. sphaeroidalis* figured by Davidson (1851–1852, pl. 11: fig. 11) is longer and narrower than that of two excavated specimens (Plate 44). The loop proportions are about the same but the crural processes in the drawing are located at midloop rather than anterior to it. The crural bases are higher in the drawing and the hinge plates do not show any taper. The transverse band is inaccurate in the drawing and is indicated as tilted somewhat anteriorly.

The exterior of *Sphaeroidothyris* is similar in some of its forms to *Stiphrothyris*, the loop of the latter, however, is not as widely triangular as that of *S. globisphaeroidalis* and its outer hinge plates are longer and deeper. Moreover, the folding of *Stiphrothyris* is stronger than that of *Sphaeroidothyris* which is confined to the anterior commissure.

The loop of *Gigantothyris* is widely triangular as shown by Seifert (1963) but the holotype of that genus has a flatly convex dorsal valve.

The loops of *Xestosina*, *Euidothyris*, *Avonothyris*, and *Epithyris* are widely triangular. They are all strongly plicated anteriorly unlike *Sphaeroidothyris*, the folding of which, when it occurs, is seen only on the anterior commissure.

Sphaeroidothyris? species 1

PLATE 49: FIGURES 18–23; PLATE 72: FIGURES 17, 18

DISCUSSION.—A third excavated specimen from Calvados, France (USNM 92910) preserved the left half of the loop in good condition so that all parts of the loop can be studied. The outer hinge plates and socket ridges are like those of *S. globisphaeroidalis* and the loop proportions and loop angle conform fairly well to those of the type of the genus. The outer hinge plates have a strong taper to the crural processes. The terminal points are longer than those of the type. The crural bases at their posterior are extended in a dorsal direction to form a plate separated from the descending branch of the loop. The anterior commissure of this specimen is faintly plicated like that of the specimen from Sully described below. This specimen may belong to the Lissajousithyridinae.

Sphaeroidothyris? species 2

PLATE 36: FIGURES 1–6; PLATE 72: FIGURES 15, 16

EXTERIOR.—The specimen has the morphology of *Sphaeroidothyris* with strongly convex valves and with faint anterior biplication of the anterior commissure.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is elongate, narrow with the length about twice the width. The cardinal process is a thin, half elliptical shelf slightly indented on its free margin and with a slightly concave myophore. The fulcral plates were not seen. The socket ridges are thin, slightly inclined, and bound narrow sockets that are distally roofed by shell. The outer hinge plates are short, attached on the dorsal side of the crural bases. The hinge plate taper is short and terminates posterior to the crural processes. The crural bases are strongly elevated along the inside margin of the outer hinge plates and form shallow U-shaped troughs. The outer hinge plates at the junction with the socket ridges are gently convex and become concave toward the crural bases. The crura are broad. The crural processes are broad and taper to a blunt point and are located at about midloop. The descending lamellae form the anterior side of the crural processes and taper quickly to the web of the transverse band, which is steeply inclined (about 48°), wide laterally and narrows to the crest or bridge. This occupies about 15% of the loop width.

DISCUSSION.—Almeras (1971, pl. 44: fig. 17) illustrated a round specimen of *S. sphaeroidalis* from Calvados, France. The serial sections are reproduced on his plate 45 and show a narrow loop compared to that of *S. globisphaeroidalis*. Ll/LD of Almeras' specimen is close to that of the specimen from Sully figured herein = 0.46. The crural processes of Almeras' specimen are more posterior in position than the Sully individual. It is difficult to imagine such variation of the loop as that shown by this specimen and that of *S. globisphaeroidalis* as being congeneric. The *Sphaeroidalis* type of brachipod needs close study because the exterior globular form may have been assumed by several different stocks. For statistics see generic description. This specimen may be referrable to the Lissajousithyridinae.

The loop of *Sphaeroidothyris* reconstructed by Prosorovskaya (1968:69, fig. 43) is unlike that of the type species, *S. globisphaeroidalis* Buckman but strongly resembles that of the loop of a sphaeroidothyrid such as that figured herein, Plate 36: figures 4, 5. The loop of the Russian species has shorter terminal points than the French specimen.

Squamiplana Sučić-Protić, 1971

PLATE 77: FIGURE 2

Squamiplana Sučić-Protić, 1971:8.

SUBFAMILY.—Lobothyridinae Makridin, 1964.

TYPE-SPECIES.—*Squamiplana piroidea* Sučić-Protić, 1971:9, pl. 2: figs. 2–4; pl. 21: fig. 2; pl. 37: fig. 4 (reconstruction of loop).

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Middle Lias).

LOCALITIES.—Italy, Romania, and Yugoslavia.

DIAGNOSIS (Sučić-Protić, 1971:8).—Round flat shells. The beak is high and narrow. The foramen is big. Flanks [terminal points], short and widely disjoined, are pointed at their ends.

MORPHOLOGICAL DESCRIPTION (Sučić-Protić, 1971:8, 9).—

Contours of the shell are almost round. The convexity of the valves is fair so that they seem to be flat. Some species have growth lines expressed in the anterior part. The beak is short, narrow and curved. The foramen is round and variable in size. The inner pedicle collar is developed. The symphytium is wide and straight. Hinge teeth are small, with an auxilliary denticulum. Dental sockets are shallow and narrow. The cardinal process is small. Hinge plates are rectangular and support curved crural bases. The brachidium is smaller than one-half of the valve's length. Crural processes are well developed on descending branches. Flanks [terminal points] are medium-sized and fairly disjoined. The transverse plate is narrow because of maximum width of flanks in this part of shell.

LOOP STATISTICS.—See Table 22.

COMMENT.—To the diagnosis may be added the fact that the loop as shown by the type species and *S. gemmellaroi* (Fucini) is wide. The width however, is not shared by the third species placed in the genus, *S. renevieri* (Haas) with an ∠ = 35° and Wl/Ll = 0.63.

Stenogmus, new genus

PLATE 50: FIGURES 1–6; PLATE 61: FIGURES 27–31; PLATE 75: FIGURES 9, 10

SUBFAMILY.—Loboidothyridinae Makridin, 1964.

TYPE-SPECIES.—*Stenogmus pentagonalis*, new species.

DIAGNOSIS.—Medium size, roundly pentagonal, strongly sulciplicate; beak short, truncated; foramen large, mesothyridid; loop almost reaching midvalve, crural processes anterior to midloop; transverse band strongly protuberant.

SPECIMENS STUDIED.—Fifteen, one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Callovian).

LOCALITY.—Switzerland.

EXTERIOR.—Medium to large, subpentagonal, slightly longer than wide; valves subequally convex. Sides rounded; maximum width slightly anterior of midvalve; apical angle slightly obtuse. Lateral commissure oblique posteriorly, strongly convex toward ventral side at anterior. Anterior commissure strongly sulciplicate. Beak short, suberect, truncated; beak ridges short, rounded. Foramen large, mesothyridid. Symphytium visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is wide and long and occupies almost a half the length and width of the dorsal valve. The umbonal chamber is shallow. The cardinal process is a thin half ellipse, small, with concave myophore, slightly indented medially at the ventral margin. The socket ridges are thin, curved, erect and bound narow sockets. The fulcral plates are narrow and thin and slightly recessive. The outer hinge plates are short and are attached to the dorsal margin of the crural bases. They have a wide taper to the posterior end of the crural processes. The crural bases are strongly elevated along the inside edge of the outer hinge plates. The crura are short and broad. The crural processes are located slightly anterior of midloop, are narrowly elongated into long acute points that are directed slightly anteriorly and medially, and strongly ventrally. The descending lamellae are moderately broad and short, terminating in broad webs to which the transverse band is attached. The struts of the transverse arch are broad at their base, thinning to the bridge which is flattened and strongly protuberant. The bridge extends slightly beyond the ends of the crural processs. The bridge occupies about 40% of the loop width. The ventral margin of the bridge is narrowly rounded. The terminal points are fairly short and broadly webbed.

LOOP STATISTICS.—USNM 551095: $\angle = 43°$; Wl/Ll = 0.84; Ll/LD = 0.46; Wl/WD = 0.45; a/Ll = 0.53; b/Ll = 0.47; c/Ll = 0.39; d/Ll = 0.14; e/Ll = 0.19; f/Ll = 0.28; g/WD = 0.27; g/Wl = 0.72; h/f = 0.25; h/Ll = 0.07; WD/LD = 1.01.

USNM 551095: *Stenogmus pentagonalis* new species, Jurassic (Callovian - Variansschichten), Bölchenstrasse, oberhalb Kamberberg/ Hägendorf, Switzerland.

DISCUSSION.—Specimens of this genus externally resemble *Arceythris diptycha* (Oppel) but are larger and rounder although the two have the same type of folding. Statistics of the loop of *Arceythyris* reconstructed by Contini and Rollet (1970:40, fig. 3) are almost identical to those of the excavated specimen described above. The only major difference is in the position of the crural processes, anterior in *Stenogmus*, posterior in *Arceythyris*. There is also a slight difference in the loop proportion (Wl/Ll), that of the reconstruction being slightly narrower. The relationship of hinge to loop width is much too small in the reconstruction.

There is usually a considerable difference in the appearance of a loop reconstructed from serial sections and an actual loop. A feature that reconstructions usually fail in depicting accurately is the crural processes. This is especially true of most reconstructions which show the crural processes as obtuse. In excavated loops the crural processes more commonly prove to have acute angles or long, needle-like points. Contini and Rollet's reconstruction shows broadly obtuse crural processes; the excavated specimen has long, acute points. Another difference between the reconstruction and the actual loop is in the transverse band. In the reconstruction the bridge is broad and the band thin, but not protuberant. The form of the webs in the actual loop is different from those of the reconstruction in which they are very wide posteriorly. See Plate 50 for excavated loop; Plate 63: figure 8 for reconstruction of *Arceythyris*. Although there is statistical similarity between the loop of *Stenogmus* and the reconstructed loop of *Arceythyris*, the appearance of the two when compared is so unlike that they cannot be admitted under the same name.

Stenogmus resembles *Kutchithyris* and *Bihenithyris* externally. It differs from the former in its lower, less incurved beak and rounder sides. It differs from *Bihenithyris* in its smaller foramen and rounder sides. The reconstructed loop of *Kutchithyris* by Ovcharenko (1969, fig. 3) has only sketchy details of the hinge plates and crural processes and the transverse band is unlike that of *Stenogmus*. (See Plate 63: figure 3.)

ETYMOLOGY.—From the Greek *stenos* (narrow) plus *ogmus* (furrow).

Stenogmus pentagonalis, new species

PLATE 50: FIGURES 1–6; PLATE 61: FIGURES 27–31

DIAGNOSIS.—Large strongly plicated *Stenogmus* with narrow plications.

DESCRIPTIONS.—Exterior and interior as for genus. Exterior details below.

Ventral valve moderately convex in both profiles. Umbo subcarinate, carination continuing to midvalve and extended anteriorly as narrow, sharp fold making notch at anterior margin. Median fold becoming elevated at midvalve where broad sulcus originates. Flanks steep.

Dorsal valve evenly convex in lateral profile with median half swollen, anterior flattened. Anterior profile broadly convex, less so than ventral anterior profile. Umbonal region strongly swollen to midvalve where two plications originate and diverge to anterior margin. Sulcus between plications narowly U-shaped. Flanks bounding plications concave; posterolateral flanks rounded and steep.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
551155a	30.3	27.0	28.7	18.0	106°
551155b	29.0	25.5	24.7	17.9	88°
551155c	32.6	28.3	28.0	19.5	83°
551155d	31.6	27.8	28.0	18.2	86°
551155e	33.4	29.7	28.2	20.3	106°

OCCURRENCE.—Jurassic (Callovian - Variansschichten), Hägendorf-Homberg, Switzerland.

TYPES.—Holotype: USNM 551155a; paratypes: USNM 551155b–e, 551094.

DISCUSSION.—*Stenogmus pentagonalis* slightly resembles *Arceythyris diptycha* (Oppel) but is much larger, has a rounder outline and less sharply folded shell. It has some resemblance to *Dorsoplicathyris prolifera* Boullier although it is smaller, rounder and with narrrower folding. *Stenogmus pentagonalis* resembles *Kutchithyris acutiplicata* (Kitchin), which is about the same size. They differ in outline, *Kutchithyris* having a lobed lateral margin while that of *Stenogmus* is rounded. The folding of *Kutchithyris* is stronger than that of *Stenogmus*.

Stiphrothyris Buckman, 1917

PLATE 43: FIGURES 22–31; PLATE 50: FIGURES 19–24; PLATE 74: FIGURES 11, 12, 17, 18, 21, 22

Stiphrothyris Buckman, 1917:109.—Muir-Wood, 1965: H788.—Almeras, 1971:294.

SUBFAMILY.—Loboidothyridinae Makridin, 1964.

TYPE-SPECIES.—*Terebratula globata* var. *tumida* Davidson, 1876–1878:149. Buckman, 1917:109. pl. 20: fig. 6.

SPECIMENS STUDIED.—Many, three excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian and Bathonian).

LOCALITY.—Great Britain.

EXTERIOR.—Globular, rounded oval to subcircular; sides strongly rounded; valves nearly equally convex, ventral usually slightly deeper than dorsal valve. Lateral commissure straight in young, convex toward ventral side in old shells. Anterior commissure sulciplicate. Beak short, erect. Foramen large, permesothyridid. Symphytium partially visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is fairly widely triangular with the length and width variable, often nearly equal. The cardinal process is narrow and protuberant, forming a half ellipse medially notched and with sides folded posteriorly to bound the myophore which faces posteroven-

TABLE 36.—Loop statistics for the genus *Stiphrothyris*

Proportions	USNM 64436a	USNM 551026b	USNM 551027b	USNM 551028a
∠	40°	40°	44°	53°
Wl/Ll	0.86	0.80	0.88	1.00?
Ll/LD	0.44	0.43	0.48	0.40
Wl/WD	0.39	0.36	0.44	0.40
a/Ll	0.62	0.60	0.50	0.60
b/Ll	0.38	0.40	0.50	0.40
c/Ll	0.46	0.40	0.42	0.30
d/Ll	0.16	0.20	0.08	0.10
e/Ll	0.25	0.20	0.21	0.20
f/Ll	0.13	0.20	0.29	0.20
g/WD	0.26	0.32	0.31	0.28
g/Wl	0.67	0.88	0.71	0.61
h/f	0.61	0.65	0.14	0.25
h/Ll	0.08	0.13	0.04	0.05
WD/LD	1.04	0.92	0.96	1.00

USNM 64436a: *Stiphrothyris?* species, Jurassic (Bajocian - Inferior Oolite), Stroud, Gloucestershire, England.

USNM 551026b: *Stiphrothyris tumida* (Davidson), Jurassic (Bajocian Inferior Oolite - *Clypeus* Grit), Top of Birdlip Hill, Gloucestershire, England.

USNM 551027b: *S. tumida* (Davidson), Jurassic (Bajocian - Inferior Oolite - *Clypeus* Grit), Snows Hill Mill, Gloucestershire, England.

USNM 551028a: *S. tumida* (Davidson), Jurassic (Bajocian - Inferior Oolite - *Clypeus* Grit), Little Rissington, Cheltenham, Gloucestershire, England. (not figured).

trally. The socket ridges are short, thin, curved and slightly inclined to bound narrow sockets. The fulcral plates are small. The outer hinge plates are short, narrowly triangular and attach along the dorsal side of the crural bases, terminating dorsad of the crural processes. The crural bases form a high ridge along the inner margin of the outer hinge plates, which with the crural bases, form narrowly U-shaped troughs. The crural processes are narrowly triangular in lateral view and are tapered into long needle-like points. The descending branches are narrow ribbons usually widely bowed that unite with the transverse band to form blunt points. The transverse band forms a high arch, narrowly flattened medially for about a quarter of the width of the loop. The transverse band is moderately broad. The terminal points are short.

LOOP STATISTICS.—See Table 36.

DISCUSSION.—The question, what is the correct type species of *Stiphrothyris*?, has been raised by Almeras (1971:294). Buckman (1917:109) cited the type as "Type, *S. tumida* Davidson" and figured an example on pl. 20: fig. 6 that comes from the Vesulian [Bajocian] *schloenbachi*, *Clypeus* Grit, from Cottswolds, England. He calls the figured specimen "genotype" in the plate legend. In a list of species assigned to *Stiphrothyris* (p. 110) Buckman records *T. globata* var. *tumida* Davidson. In citing the type species he elevated Davidson's variety to full specific status.

Ambiguity and timidity appear in Davidson's (1876–1878:149) proposal of *T. globata* var. *tumida*, as follows:

> *Terebratula globata* Sow. Supl., pl. 17, fig. 3 (see page 135): Specimens of this typical form of *T. globata* have been found at Whatley Church, near Frome, and at Burton Station in the Fuller's Earth rock, by Mr. J.F. Walker, along with *Wald* [*heimia*] *bullata*. It is probable that Sowerby's type from Nunney, near Frome, came from this rock. Another variety of *Ter. globata* occurs in the Inferior Oolite of Leckhampton Hill, Gloucestershire. It differs from the type specimens in being more tumid, the valves being convex, and the plications not extending as far up the valves; the outline of the shell is rounder. The beak is short, incurved, the foramen large and the hingeline straighter. It might be called *T. globata* var. *tumida*.

Ambiguity arises from this statement because the discussion concerns the species *T. globata* and the plate reference is to a shell entirely different from *T. globata tumida*. Although the statement "It might be called *T. globata* var. *tumida*" is rather tentative, this taxon has long been recognized as valid in the works of Buckman and Muir-Wood.

Concerning the problem of choice of type-species, Almeras (1971:294) raises this issue:

> The type species (Buckman, 1917:109) is *St. tumida* (Davidson), that is to say the form from the Fuller's Earth Rock (dug along the route from Whatley near Frome and Nunney), described by Davidson (1876–1878, pl. 17: fig. 3, 3a) under the name of *Terebratula globata* (not Sowerby) var. *tumida*, and which Buckman named a little later *T. nunneyensis* nom. nov. (1907:226). Now according to the original diagnosis of *Stiphrothyris* S. Buckman figures (1917, pl. 20: fig. 6a) a specimen from the *Clypeus* Grit of the Cotteswolds (Vesulian, *schloenbachi* zone), which, independent of chronologic lag, differs from the type species by dimensional characters and lesser plication of the sulciplicate anterior com-

missure and less elevated. Thus the genus *Stiphrothyris* is based altogether on this example (which is the generotype [Buckman used genotype] of Buckman) and on those of the type species. Generotype and type species are not here synonyms, by virtue of the lack of respect by S. Buckman for the rules of zoological nomenclature. Likewise in the Treatise by R. C. Moore, H. M. Muir-Wood (1965, fig. 657: 2) illustrates the genus by the generotype specimen of Buckman (1917, pl. 20: fig. 6a), and by a Bajocian form (fig. 652- 3a-c) mistakenly called *St. tumida,* and much closer to *St. cheltensis* (Buckman) of *St. birdlipensis* (Walker-Davidson) than to *nunneyensis*, which poses the problem of the designation of the type species.

Furthermore Muir-Wood (1936:96) studying the morphology and internal characters of *nunneyensis*, referred this species to her new genus *Wattonithyris*. The characters of the hinge, the internal criteria such as the form of the cardinal process and the hinge plates, umbonal cavity, less developed dorsoventrally, presence of a euseptoidum, thickness of internal structures, justify this point of view. So, one arrives at the following paradox: The type species of *Stiphrothyris* is referred to *Wattonithyris*. More exactly following the rules of nomenclature *Watttonithyris* ought to be placed in the synonymy of *Stiphrothyris*, defined by *T. nunneyensis*, and it is necessary to create a new genus for the generotype of S. Buckman, fig. 6a and for the neighboring species of the Upper Bajocian and Lower Bathonian studied hereafter. In fact, I am following a little different approach with the sole reason to upset the existing systematics as little as possible. The internal characters of *Stiphrothyris* (except those of *T. nunneyensis*) and of *Wattonithyris*, being different, I designated *S. cheltensis* (Buckman) as new type of *Stiphrothyris*, which preserves the original morphological understanding given by Buckman, and I propose the complete diagnosis of it which follows.

My interpretation of this problem is that Davidson made it clear that he was naming a "variety" and that the variety came from the *Clypeus* Grit. It seems unnecessary to submerge *Wattonithyris*. The erection of a substitute type species in order to save the name *Stiphrothyris* is illegal and not needed. The type, as noted by Muir-Wood, is *Terebratula globata* var. *tumida* Davidson, elevated by Buckman to *T. tumida* Davidson (= *Stiphrothyris tumida* (Davidson)).

Stiphrothyris? species

PLATE 50: FIGURES 19–24

SPECIMENS STUDIED.—Two specimens, one excavated for loop, are tentatively placed in *Stiphrothyris*. The specimens are of medium size with narrowly sulciplicate anterior commissure, have a short beak with large mesothyridid foramen.

LOOP AND CARDINALIA.—The loop is triangular and occupies nearly ⅖ the length and width of the dorsal valve. The cardinal process is a small half ellipse. The socket ridges are thin, erect, slightly inclined and bound narrow sockets. The fulcral plates are thin and not laterally extended. The outer hinge plates are short, concave and have a long taper along the dorsal edge of the crural bases to a point below or dorsad of the crural processes. The crural processes, located well anterior to midloop, are produced into long needle-like points. The descending lamellae are narrow, moderately bowed laterally and short. The transverse band is a fairly broad arch, with flattened median crest and short, expanding lateral supports. The flattening of the arch occupies about half the loop width. The terminal points are short and rounded.

LOOP STATISTICS.—See Table 36.

DISCUSSION.—The exterior of this species suggests *Saucrobrochus whaddonensis* in its convex dorsal valve, fairly strongly rounded form and its folding. The loop, however, is entirely different. The crural processes in *S. whaddonensis* are posterior of midloop while those of *Stiphrothyris* species are well forward and have longer crural processes. The terminal points of *Stiphrothyris* species are much shorter than those of *S. whaddonensis.*

Stroudithyris pisolithica is suggestive of *Stiphrothyris* species externally; its loop has longer terminal points and the crural processes are posterior of midloop unlike those features of the loop of *Stiphrothyris* species.

Striithyris Muir-Wood, 1935

PLATE 37: FIGURES 9–14; PLATE 53: FIGURES 22–25; PLATE 70: FIGURES 13, 14

Striithyris Muir-Wood, 1935:129.

SUBFAMILY.—Loboidothyridinae Makridin, 1964.

TYPE-SPECIES.—*Striithyris somaliensis* Muir-Wood, 1935:129, figs. 26, 27, pl. 13: fig. 1a–c.

SPECIMENS STUDIED.—Sixteen; one from Israel and one from Saudi Arabia excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Callovian).

LOCALITIES.—Somali Republic, Saudi Arabia, and Israel.

EXTERIOR.—Small to medium size, elongate oval, sides and anterior margins rounded. Posterolateral extremities forming an acute angle. Inequivalve, ventral valve deeper, more convex than dorsal one. Lateral commissure straight in young shells, sharply curved to ventral side in anterior half of mature individuals. Anterior commissure rectimarginate, uniplicate to sulciplicate in adults. Beak short, suberect. Foramen large, marginate. permesothyridid. Symphytium partially visible. Surface prominently marked by closely crowded costellae.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is triangular and occupies nearly half the length and a third the width of the dorsal valve. The cardinal process is a narrow half ellipse, not strongly protuberant and with the myophore facing posteroventrally. The socket ridges are curved, erect and bound a long, narrrow socket. The fulcral plates are not extended laterally. The outer hinge plates are short, narrow and attached to the dorsal side of the crural bases. They taper anteriorly nearly to the crural processes. The crura are short and flat. The crural base forms a wall along the inside edge of the outer hinge plates and with the socket ridges form moderately broad U-shaped troughs. These are shown in the serial sections of Muir-Wood (1935:130), second tier from bottom. The crural processes are narrowly triangular and are drawn into fairly long, sharp points. The descending lamellae are narrow ribbons of moderate length and slightly bowed laterally. The transverse band is a low arch, nearly horizontal and has a low angular bridge. The terminal points are short, small and not extended anteriorly. They form an angle of 57° with the sides of the loop.

LOOP STATISTICS.—See Table 37.

DISCUSSION.—The loops of the Israeli and Saudi Arabia specimens differ very slightly. The one from Israel is somewhat narrower than that from Saudi Arabia and seems to occupy less of the dorsal valve. The loop proportions are similar and the outer hinge plates are in accordance as is the position of the crural processes anterior to midloop. Both specimens are young individuals. African specimens of more than 30 mm in length are known. Muir-Wood's incomplete serial sections (1935:130) give no measurements, making it impossible to obtain loop statistics for a large adult. The sections show flattish outer hinge plates posteriorly, becoming broadly U-shaped anteriorly. As usual with the serial sections in Muir-Wood (1965) these sections were not carried to completion (or the loop was broken), making it impossible to ascertain the length of the terminal points or the nature of the transverse band. It is also not possible to determine the position of the crural processes.

Ovcharenko (1967) regards *Striithyris* as a junior synonym of *Kutchithyris* (= *Holcothyris*?) because of its costellate exterior. Ovcharenko's (1969) re-

TABLE 37.—Loop statistics for the genus *Striithyris*

Proportions	USNM 551008a	USNM 551054b*
∠	32°	27°
Wl/Ll	0.60	0.53
Ll/LD	0.48	0.39
Wl/WD	0.32	0.23
a/Ll	0.60	0.62
b/Ll	0.40	0.38
c/Ll	0.40	0.47
d/Ll	0.20	0.15
e/Ll	0.25	0.18
f/Ll	0.15	0.20
g/WD	0.35	0.36
g/Wl	1.08	1.55
h/f	0.40	0.30
h/Ll	0.06	0.06
WD/LD	0.88	0.91

* Slight discrepancies appear in some of the measurements probably due to the difficulty of obtaining accurate measurements of the exterior dimensions of USNM 551054b, the left lateral and anterior margins of which had been eroded. The statistics for a–f/Ll are, nevertheless, very close.

USNM 551008a: *Striithyris somaliensis* Muir-Wood, Jurassic (Tuwaiq Mountain Formation - *Erymnoceras* Zone), 24°51′30″N, 46°07′12″E, Saudi Arabia.

USNM 551054b: *S. somaliensis* Muir-Wood, Jurassic (Callovian - *Grossuvira* Beds), Maktesh, Hathira, Kurnub, Israel.

construction of the loop of *Kutchithyris* (Plate 63: figure 3) is different from that of *Striithyris* with its nearly horizontal transverse band.

Strongylobrochus, new genus

PLATE 50: FIGURES 25–33; PLATE 75: FIGURES 17, 18

SUBFAMILY.—Lissajousithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula omalogastyr* Zieten, 1830:54, pl. 40: fig. 4a–c.

DIAGNOSIS.—Terebratulaceans with flattish dorsal valve and very long, widely bowed loop.

SPECIMENS STUDIED.—Three, one dissected to show loop.

GEOLOGIC OCCURRENCE.—Jurassic (Dogger - *humphriesianum* Zone).

LOCALITY.—Germany.

EXTERIOR.—Medium to large, rounded subpentagonal to widely ovate, inequivalve, ventral valve moderately convex, dorsal valve nearly flat. Maximum width at midvalve. Sides and anterior margin rounded, posterolateral margins nearly 90°. Lateral commissure straight; anterior commissure rectimarginate in young, gently uniplicate in adult. Beak large, moderately protuberant; beak ridges rounded. Foramen large, permesothyridid. Symphytium visible. Surface smooth.

EXTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is very long and its descending branches are widely bowed. The great bowing of the branches makes definition of the loop angle diffficult. The cardinal process is a thin, narrow shelf with excavated myophore and with low lateral rims. The socket ridges are stout, slightly inclined plates bounding a moderately wide socket. The fulcral plates are moderately thick and are extended laterally to form a small shelf. The outer hinge plates are narrow, and have a long, narrow, gradual taper terminating just posterior to the beginning of the crural processes. The outer hinge plates are located close to the valve floor indicating a low notothyrial chamber. The outer hinge plates are attached to the dorsal edge of the crural bases. The crural bases are broad and flat in section and form a steep wall along the inside edge of the outer hinge plates. The crural processes (their distal points lost in the preparation) are wide and tapering, probably having bluntly acute points according to their taper. They are located posterior to mid-loop. The descending lamellae are unusually long, thin and widely bowed. The transverse band is a broad, gentle, medially flattened arch, the flattening amounting to about half the loop width. The sides of the arch unite with long webbed terminal points that are bowed inward.

LOOP STATISTICS.—USNM 75808: ∠ = 28°; Wl/Ll = 0.66; Ll/LD = 0.66; Wl/WD = 0.27; a/Ll = 0.41; b/Ll = 0.59; c/Ll = 0.31; d/Ll = 0.10; e/Ll = 0.11; f/Ll = 0.48; g/WD = 0.36; g/Wl = 0.95; h/f = 0.27; h/Ll = 0.13; WD/LD = 1.13.

USNM 75808: *Strongylobrochus omalogastyr* (Zieten), Jurassic (Dogger - *humphriesanum* Zone), Auerbach, Oberfalz, Bavaria, Germany.

DISCUSSION.—This is one of the most unusual loops excavated during this study. It is unlike the loops of *Petalothyris* and *Gigantothyris*, which have flattish dorsal valves like that of *Strongylobrochus*.

Singeisen-Schneider (1976:104–106) restored the loop of *T. omalogastyr* in young, medium and adult stages inside view only. The young loop (fig. 7h,j) shows very little development of the terminal points. The adult (fig. 7k) shows a fair development of the terminal points. Statistics from this figure are: Ll/LD = 0.58; a/Ll = 0.37; b/Ll = 0.63; c/Ll = 0.33; d/Ll = 0.04; e/Ll = 0.14; f/Ll = 0.49. These figures compare favorably with those of the loop of the excavated specimen.

ETYMOLOGY.—From the Greek *strongylos* (rounded) plus *thyris* (opening).

Stroudithyris Buckman, 1917

PLATE 43: FIGURES 13–21; PLATE 71: FIGURES 13, 14

Stroudithyris Buckman, 1917:111.

SUBFAMILY.—Lissajousithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula pisolithica* Buckman, 1890:41, pl. 3; 1917:111, pl. 20: fig. 23a.

SPECIMENS STUDIED.—Three; one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITIES.—Great Britain and France.

EXTERIOR.—Medium size, inequivalve, ventral valve having greater depth and convexity; dorsal valve flatly convex in profile. Pentagonal, maximum width anterior to midvalve. Posterolateral margins approximating 90°. Lateral commissure slightly oblique posteriorly, becoming strongly convex toward ventral side at anterior. Anterior commissure sulciplicate. Beak, short, suberect, slightly labiate. Foramen large, mesothyridid. Symphytium mostly concealed. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is widely triangular and occupies nearly a half the length and more than ⅖ the width of the dorsal valve. The cardinal process is a small half ellipse. The socket ridges are thin, erect and bound narrow sockets. The fulcral plates are thin. The outer hinge plates are narrow, deeply concave and have a short taper that terminates posterior of the crural processes. They attach on the dorsal edge of the crural bases. The crural bases are broad and flat and form a wall along the inside edge of the outer hinge plates. The crural processes are located posterior of midloop and are drawn into needle-like points which are directed slightly anteriorly and medially and strongly ventrally. The descending lamellae are slender, moderately long, and slightly bowed laterally. The transverse band is a high, posteriorly directed arch, flattened medially for less than a fifth of the loop width. The bridge is flat, very narrow and notched on its posterodorsal side. The terminal points are fairly long, narrowly rounded and moderately broadly webbed.

Loop Statistics.—See Table 38.

DISCUSSION.—The loop of *Stroudithyris* resembles that of *Saucrobrochus*. The loop of the latter is narrower and has slightly longer terminal points and less acutely drawn out crural processes.

Stroudithyris and *Avonothyris* are similar in appearance and have loops of similar construction. The crural processes of *Avonothyris* are far anterior to midloop compared to those of *Stroudithyris*.

TABLE 38.—Loop statistics for the genus *Stroudithyris*

Proportions	USNM 75569a	USNM 75569b
∠	48°	46°
Wl/Ll	0.83	0.83
Ll/LD	0.51	0.49
Wl/WD	0.41	0.42
a/Ll	0.40	0.39
b/Ll	0.60	0.61
c/Ll	0.23	0.28
d/Ll	0.17	0.11
e/Ll	0.21	0.18
f/Ll	0.39	0.43
g/WD	0.24	0.24
g/Wl	0.60	0.57
h/f	?	0.12
h/Ll	?	0.05
WD/LD	1.02	1.06

USNM 75569a,b: *Stroudithyris pisolithica* (Buckman), Jurassic (Bajocian - Inferior Oolite - Pea Grit), Randwick Ash, Stroud, Gloucestershire, England.

***Systenothyris*, new genus**

PLATE 33: FIGURES 15–22; PLATE 72: FIGURES 11, 12

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Systenothyris triangulata*, new species.

DIAGNOSIS.—Elongate, subtriangular, sulciplicate terebratulaceans having a long loop with moderately long terminal points.

SPECIMENS STUDIED.—Three; two with loop excavated.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITY.—France.

EXTERIOR.—Medium size, elongate subtriangular, maximum width anterior of midvalve, posterolateral margins forming acute angle. Lateral commissure oblique posteriorly, concave toward dorsal side at anterior. Anterior commissure sulciplicate, plication confined to anterior third. Beak short, narrow, suberect, labiate. Foramen large, permesothyridid. Symphytium partially visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is a long triangle occupying half the length and a third the width of the dorsal valve. The cardinal process is a small, narrow half ellipse with its myophore facing posteriorly. The socket ridges are long, thin, slightly curved erect plates that bound narrow sockets. The fulcral plates are small and without lateral extensions. The outer hinge plates are narrow triangles that form, with the crural bases and socket ridges, narrow U-shaped troughs the bottoms of which are situated close to the valve floor. The distal end of the outer hinge plates tapers anteriorly to attach to the dorsal edge of the crural bases and terminate just posterior of the crural processes. The crural bases are strongly elevated along the inner edge of the outer hinge plates. The crura are broad, flat blades expanding to the crural processes which are acutely pointed. The descending lamellae are short, almost nonexistent as plates separate from the crural processes. The transverse band forms a narrow web along the terminal points where it joins the descending lamellae. The transverse band forms an arch having broad struts that thin toward the flattened crest or bridge. The sides of the arch are fairly steep and the width of the bridge is about a quarter of the loop width. The bridge is slightly protuberant, not reaching the distal ends of the crural processes. The transverse band is inclined toward the posterior at an angle of about 20°.

TABLE 39.—Loop statistics for the genus *Systenothyris*

Proportions	USNM 550996a	USNM 550996b
∠	30°	36°
Wl/Ll	0.62	0.65
Ll/LD	0.49	?
Wl/WD	0.33	?
a/Ll	0.50	0.50
b/Ll	0.50	0.50
c/Ll	0.29	0.31
d/Ll	0.21	0.19
e/Ll	0.15	0.13
f/Ll	0.35	0.37
g/WD	0.31	?
g/Wl	0.94	?
h/f	0.28	0.27
h/Ll	0.10	0.20
WD/LD	0.92	?

USNM 550996a,b: *Systenothyris triangulata*, new species. Jurassic (Upper Bajocian – Oolite Blanche), abandoned quarry, 20 m W of route D6, 2.7 km NW of Bayeux city limits, Calvados, France.

LOOP STATISTICS.—See Table 39.

DISCUSSION.—The exterior of *Systenothyris* strongly resembles that of *Ptychtothyris helena* (Bayle) (= *P. baylei*, new name). It is however, less strongly folded. The loop of *Systenothyris* is much narrower and longer than that of *Ptychtothyris* and has longer terminal points. The loop resembles that of *Dorsoplicathyris* in its narrow form and moderately long terminal points but the exterior shell details are different.

ETYMOLOGY.—From the Greek *systenos* (tapering to a point) plus *thyris* (opening).

Systenothyris triangulata, new species

PLATE 33: FIGURES 15–22; PLATE 72: FIGURES 11, 12

DIAGNOSIS.—Elongate, subtriangular shells resembling *Ptychtothyris* externally but having a long narrow loop.

DESCRIPTION.—Gross exterior and interior as for the genus. Shell detail below.

Ventral valve moderately and evenly convex in lateral view, flatly convex in anterior profile. Umbonal region slightly carinate, the narrow swelling continuing and broadening to midvalve where it increases in height and occupies about ⅓ width of sulcus which forms about half maximum shell width at front. Flanks narrowly rounded.

Dorsal valve nearly flat, posterior half slightly convex, anterior half slightly concave in lateral view. Anterior profile broadly, gently convex. Umbonal and median regions convex. Fold originating at midvalve, narrow, moderately elevated, formed by two plications separated by a narrow moderately deep sulcus. Shell bounding plications steep.

MEASUREMENTS (in mm).—USNM 550996. Length 30.7; dorsal valve length 27.6; width 24.3; thickness 14.7; apical angle 64°

OCCURRENCE.—Jurassic (Upper Bajocian – Oolite Blanche), Sully, abandoned quarry, 20 m west of route D6, 2.7 km northwest of Bayeux City limits, Calvados, France.

TYPES.—Holotype: USNM 550996; paratypes: USNM 550996a,b.

COMPARISON.—This species is similar to *Ptychtothyris stephani* (Davidson) but is smaller, narrower, with the maximum width farther anterior and the folding less prominent. It differs from *P. baylei* in its smaller size, less deep dorsal sulcus, less prominent folding and less convex valves.

Taurothyris Kiansep, 1961

Taurothyris Kiansep, 1961:27.—Muir-Wood, 1965:H790, 791.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Taurothyris avundaensis* Kiansep, 1961:27, fig. 7, pl. 1: fig. 1a,b.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Oxfordian).

LOCALITY.—Crimea, Russia.

DIAGNOSIS. (from Kiansep, 1961).—Biconvex shells with an elongate-oval external outline. Beak small, straight, with a high, clearly visible deltidium. Flanks of beak rounded. Anterior margin slightly flexed. Socket ridges high, well developed. Cardinal process heavy, bilobed. Hinge plates absent. Crura small. Loop small with triangular outline. Teeth large. Denticle developed. Shell smooth, punctate.

ECOLOGIC FEATURES (from Kiansep, 1961).—The massive shells and comparatively small beak in mature forms indicates the supporting attachment which is characteristic of the animal during most of its existence.

GENERAL OBSERVATIONS (from Kiansep, 1961).—The genus is characterized by specific features of internal and external structure which make it possible to separate it from known genera of the family Terebratulidae.

Tchegemithyris Tchorszhevsky, 1972

PLATE 63: FIGURE 21

Tchegemithyris Tchorszhevsky, 1972:36.

SUBFAMILY.—Tchegemithyridinae Tchorszhevsky, 1972.

TYPE-SPECIES.—*Terebratula tchegemensis* Moisseiev, 1934:97, pl. 9; figs. 36–39.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Callovian and Oxfordian).

LOCALITY.—Central Asia Turkmen, north Caucasus, Lebanon, and Syria.

DESCRIPTION (Tchorszhevsky, 1972).—Strongly biconvex, almost spherical with a uniplicate anterior commissure, rounded subpentagonal in outline. Beak thick, long and strongly curved, touches the surface of the dorsal valve. Foramen medium-sized, round, located at summit or a trifle beyond the summit. Internal pedicle collar weakly developed. Cardinal process short and not divided into lobes. Symphytium concealed by the apex, narrow short. Deltidial plates conjunct. Outer hinge plates narrow, thick, and rather long, situated horizontally or sloping slightly downward low above the floor of the dorsal valve. Crural processes originate on a level with the anterior margin of the hinge plates, they are extremely high, and long, parallel with each other. Their ventral extremities extend toward the hinge margin. Transverse band is high and divided into two parts: one situated above the other, the "descending." The "ascending" bands also clearly divided into upper and lower parts. The loop extends ⅔ the length of the dorsal valve. The loop flanges are long with low crests.

COMPARISONS (Tchorszhevsky, 1972).—From *Bejrutella* it is distinguished by the uniplicate anterior commissure, rather wide and horizontally situated or slightly sloping outer hinge plates, equal crural processes, complex form of the transverse band, and somewhat long loop. The enumerated features also distinguish the new genus from the genus *Turkmenithyris* Prosorovskaya (1968).

LOOP STATISTICS (from serial sections of Tchorzshevsky, 1972:37, fig. 1).—a/Ll = 0.51; b/Ll = 0.49; c/Ll = 0.39; d/Ll = 0.13; f/Ll = 0.47; h/Ll = 0.04.

Prosorovskaya (1968:77, fig. 5) placed *T. tchegemensis* in *Loboidothyris* and reconstructed its loop. This structure is shown as fairly long, with long terminal points. Statistics of the loop are: $\angle$ = 38°; a/Ll = 0.56; b/Ll = 0.44; c/Ll = 0.43;

d/Ll = 0.13; e/Ll = 0.01; f/Ll = 0.43. The reconstruction shows the crural processes as broadly blunt and near the transverse band.

Tegulithyris Buckman, 1917

PLATE 30: FIGURES 1–9; PLATE 69: FIGURES 10, 11

Tegulithyris Buckman, 1917:123.

FAMILY.—Tegulithyrididae Muir-Wood, 1965.

TYPE-SPECIES.—*Terebratula bentleyi* Morris, in Davidson, 1851–1852:58, pl. 13: figs. 9–11.

SPECIMENS STUDIED.—Eight; one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bathonian).

LOCALITY.—Great Britain, France, Germany, and Russia.

EXTERIOR.—Medium size, pentagonal to rhomboidal; greatest width at or posterior to midvalve. Sides narrowly rounded, anterior margin narrow, posterolateral margins forming an obtuse angle. Lateral commissure forming an S. Anterior commisure antiplicate. Beak fairly long, erect. Foramen large, permesothyridid. Symphytium visible. Surface marked by concentric lines and lamellae of growth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is wide and occupies about a half the length and a third the width of the dorsal valve. The cardinal process is a small, longitudinal half ellipse, bilobed, and with myophore sunken and divided medially by a low ridge. The socket plates are thin, slightly inclined and bound wide sockets that are proximally roofed. The fulcral plates were not seen. The outer hinge plates are short, narrow, concave, much thickened in the specimen excavated. They attach to the dorsal edge of the crural bases. No anterior taper was observed. The crural bases extend posteriorly along the inner margin of the outer hinge plates. They are not strongly elevated. The crural processes originate just anterior to the junction of the crural bases and the outer hinge plates so that the crus is the expanding crural process, the crural processes themselves are drawn into long sharp points that are directed ventrally and slightly anteriorly. The descending lamellae are narrow bands, widely bowed laterally to form moderately long terminal points. The transverse band is a steep, medially flattened arch that unites laterally with the webs of the descending lamellae. The transverse band flattened portion or bridge is protuberant beyond the distal ends of the crural processes. The flattened portion of the transverse band occupies a half the loop width. This portion of the band also bears a wide reentrant on the posterodorsal side.

LOOP STATISTICS.—USNM 550977b: ∠ = 40°; Wl/Ll = 0.80; Ll/LD = 0.51; Wl/WD = 0.33; a/Ll = 0.48; b/Ll = 0.52; c/Ll = 0.28; d/Ll = 0.20; e/Ll = 0.20; f/Ll = 0.32; g/WD = 0.28; g/Wl = 0.85; h/f = 0.37; h/Ll = 0.12; WD/LD = 1.22.

USNM 550977b: *Tegulithyris bentleyi* (Morris), Jurassic (Cornbrash), Peterborough, Northants, England.

DISCUSSION.—The loops of *Dictyothyris* and *Tegulithyris* are similar in appearance, both have short, non-tapering outer hinge plates, wide angled loop, arched and protuberant transverse band and the crural processes located not far anterior of the ends of the outer hinge plates. The loops differ importantly in the attachment of the outer hinge plates to the crural bases, those of *Tegulithyris* attaching on the dorsal edge, those of *Dictyothyris* attaching on the ventral edge.

The serial sections in Muir-Wood (1965:H802) are without numbers showing the distance between sections but the narrow hinge plates are shown, the crural processes (section 1h) are evident and the protuberant nature of the transverse band is clear.

Makridin (1964:265, fig. 92) shows a reconstruction of the loop of *Tegulithyris* which is shorter than that of the British specimen. Most other details, however are in fair accordance.

Delance and Tintant (1965:135), in a fine study of the various species of *Dictyothyris*, suggest that, despite the difference in exterior surface, *Tegulithyris* and *Dictyothyris* are structurally very close, and cite a study of *Tegulithyris laevis* by Seifert

(1963) that showed no essential differences between the two genera. Delance and Tintant think it probable that a comparative study of the two genera would lead to abandonment of *Tegulithyris*. The difference in the attachment of the outer hinge plates to the crural bases, to the dorsal edge in *Tegulithyris* leads to a concave outer hinge plate and an elevated crural base bounding the inner edge of the outer hinge plates, quite unlike the condition in *Dictyothyris*. The latter has the outer hinge plates attached to the ventral edge of the crural bases, the outer hinge plate is convex and there is no elevated margin along the inner margin of the outer hinge plates.

Seifert (1963:187, fig. 39) gives a short description of *T. laevis* (Quenstedt) in which she mentions that "die Schlossplatten sind ventral konkav gebogen" as is shown by the excavated specimen illustrated herein.

"*Terebratula*" *movelierensis* Mühlberg, 1900

PLATE 57: FIGURES 30–38; PLATE 63: FIGURE 22; PLATE 70: FIGURES 21, 22

Terebratula movelierensis Mühlberg, 1900:312.

FAMILY.—Placement uncertain.

SPECIMENS STUDIED.—Ten; one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Upper Bathonian).

LOCALITY.—France.

EXTERIOR.—Small, roundly oval, sides and anterior margin rounded; posterolateral margins forming an angle near 90° Lateral commissure straight; anterior commissure rectimarginate to faintly sulciplicate. Beak short, suberect, beak ridges rounded. Foramen large, mesothyridid. Symphytium partially visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is triangular and occupies about ⅖ of the length and slightly less than a third of the width of the dorsal valve. The cardinal process is only slightly developed. The socket ridges are thin, erect, and bound narrow sockets. The outer hinge plates are fairly wide, deeply concave and taper almost to the dorsal side of the crural processes. They are attached to the dorsal edge of the crural bases which form a strong wall along the inner edge of the outer hinge plates. In section this ensemble would form a broad open U. The crural processes are located just anterior to midloop, and are drawn into long sharp points that are directed ventrally and slightly medially. The descending lamellae are short and bowed laterally. The transverse band forms a subangular arch with wide struts narrowing medially where the band is narrowest. The flattened bridge occupies about a third of the loop width. The terminal points are moderately long.

LOOP STATISTICS.—See Table 40.

TABLE 40.—Loop statistics for "*Terebratula*" *movelierensis*

Proportions	USNM 123747a	Contini and Rollet
∠	37°	36°
Wl/Ll	0.69	0.69
Ll/LD	0.39	0.48
Wl/WD	0.26	?
a/Ll	0.50	0.45
b/Ll	0.50	0.55
c/Ll	0.46	0.42
d/Ll	0.04	0.13
e/Ll	0.19	0.34
f/Ll	0.31	0.21
g/WD	0.27	?
g/Wl	1.00	0.58
h/f	0.13	0.24
h/Ll	0.04	0.05
WD/LD	1.00	?

USNM 123747a: "*Terebratula*" *movelierensis* Mühlberg, Jurassic (Upper Bathonian), Chenove, Cote d'Or, France.

Contini and Rollet (1970:33, fig. 2 - reconstruction): "*Terebratula*" *movelierensis* Mühlberg, Jurassic (Upper Bajocian), Movelier, Switzerland.

DISCUSSION.—Comparison of the reconstruction of this species by Contini and Rollet (1970, fig. 2) with the excavated specimen shows significant differences. Although the loop angles are the same the relation of loop length to that of dorsal valve length is greater in the reconstruction and the crural processes lie farther posteriorly in the reconstruction. The biggest differences are in the proportions of e and f to the loop length. The distance between the crural processes and the transverse band of the reconstruction is almost twice that of the excavated loop. The crural processes of the excavated specimen are long points, a feature not shown in the reconstruction. Most reconstructions of loops are faulty in restoration of the crural processes, seldom showing a loop with long points.

Rouselle (1965b:129) places specimens identified as this species in *Wattonithyris* Muir-Wood. The specimens figured herein are unlike those of Rouselle and have a loop different from that of *Wattonithyris fullonica*. It is possible that the excavated specimen is not correctly identified even though it was received from a French institution.

"Terebratula" suprajurensis Thurmann, 1862

PLATE 41: FIGURES 8–10; PLATE 57: FIGURES 13–18

Terebratula suprajurensis Thurmann, in Etallon, 1859–1862: 283, pl. 41: fig. 1.

FAMILY.—Placement uncertain.

SPECIMENS STUDIED.—Nine; two excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Sequanian).

LOCALITY.—France.

EXTERIOR.—Small roundly pentagonal, inequivalve, dorsal valve nearly flat, ventral valve strongly convex; maximum width at about midvalve; sides rounded, anterior margin slightly nasute; posterolateral margins near 90°. Lateral commissure slightly oblique, curving ventrally at anterior. Anterior commissure incipiently sulciplicate. Beak fairly long, erect. Beak ridges rounded. Foramen large, mesothyridid. Symphytium partially visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is widely triangular and occupies nearly a half the length and a third the width of the dorsal valve. The cardinal process is a small, thin, half ellipse with gently concave myophore facing posteriorly. The socket ridges are thin, slightly curved and inclined laterally over narrow sockets. The fulcral plates are thin and not extended laterally. The outer hinge plates are short, deeply concave and taper along the dorsal edge of the crural bases to the crural processes. The crural bases are broad and flat and form a high bounding wall along the inner edge of the outer hinge plates. The crural processes are broad and acutely pointed but not needle-like. They are fairly strongly approximate. The descending lamellae are moderately broad, slightly bowed laterally and short. The transverse band is narrow and forms a broad arch directed strongly posteriorly when seen in profile. The sides of the arch are only slightly wider than the crest which is rounded. The terminal points are moderately long.

LOOP STATISTICS.—USNM 123754: ∠ 43°, Wl/Ll = 0.83; Ll/LD = 0.43; Wl/WD = 0.33; a/Ll = 0.51; b/Ll = 0.49; c/Ll = 0.51; d/Ll = 0.00; e/Ll = 0.13; f/Ll = 0.36; g/WD = 0.33; g/Wl = 1.00; h/f = 0.17; h/Ll = 0.06; WD/LD = 1.07.

USNM 123754: *"Terebratula" suprajurensis* Thurmann, Jurassic (Sequanian), Romagne, sur Mont Fauco, Meuse, France.

DISCUSSION.—These specimens identified as *T. suprajurensis* resemble those of *"T." movelierensis* described above but the loops are different, that of *"T." suprajurensis* is wider, and has longer terminal points. The loop of the latter also resembles that of *Animonithyris* and has crural processes close to the open end of the sockets. The terminal points of the Mexican genus are not as long as those of *"T." suprajurensis*.

Trigonithyris Muir-Wood, 1935

Trigonithyris Muir-Wood, 1935, 131–133.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Trigonithyris eruduwensis* Muir-Wood, 1935:131, figs. 28, 29, pl. 12: fig. 1a–c.

GEOLOGIC OCCURRENCE.—Jurassic (Oxfordian).

LOCALITY.—Somali Republic.

DISCUSSION.—*Trigonithyris* has its outer hinge plates convex toward the ventral valve like those of *Placothyris* and *Heterobrochus*. These genera are too unlike in exterior features to permit a family based chiefly on the convexity of the outer hinge plates. The full loop of *Trigonithyris* is unknown, consequently the genus cannot be placed satisfactorily in a described family. It does not belong with the Dyscoliidae where it is now placed (Muir-Wood, 1965:H807) because of its well developed outer hinge plates. The loop is quite definitely longer than 4 mm as stated by Muir-Wood. An attempt to excavate a specimen was unsuccessful. Nevertheless some information on the loop was obtained. The crura are fairly long and narrow, the crural processes are well anterior of the outer hinge plates. The transverse sections (Muir-Wood, 1935:132) do not show a complete loop and the crural processes and transverse band are not shown. The genus must remain difficult of classification until such time as its loop is fully revealed either by serial section or excavation.

Tubithyris Buckman, 1917

PLATE 43: FIGURES 7–12; PLATES 74: FIGURES 7, 8

Tubithyris Buckman, 1917:115.

SUBFAMILY.—Lophrothyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula wrighti* Davidson, 1851–1852 (Appendix):21. Buckman, 1917:115, pl. 21: fig. 1.

SPECIMENS STUDIED.—Seven; one excavated for loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITY.—Great Britain.

EXTERIOR.—Small, globular, valves strongly subequally convex, subcircular to widely elliptical; maximum width at about midvalve. Lateral commissure nearly straight or slightly oblique posteriorly, curved at anterior. Anterior commissure strongly uniplicate to rarely sulciplicate. Beak short, erect, not in contact with dorsal umbo; beak ridges subangular. Foramen small, mesothyridid. Symphytium partially visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is wide and occupies almost half the length and nearly ⅖ the width of the dorsal valve. The cardinal process is a narrow half ellipse. The socket ridges are narrow, short and erect and define a slitlike socket. Fulcral plates not seen. The outer hinge plates are narrowly triangular, deeply concave and taper along the dorsal edge of the crural bases to a point just dorsad of the crural process points. The crural bases are elevated along the inner margin of the outer hinge plates to form narrow U-shaped troughs with the socket ridges. The crural processes are stout and are drawn into sharp points that are directed ventrally, slightly anteriorly and medially. The descending lamellae are short, wide ribbons bowed laterally. The transverse band is fairly broad and forms a moderately high arch directed posteroventrally at a fairly large angle (30°). The terminal points are moderately long and have short webs.

LOOP STATISTICS.—USNM 551025a: ∠ = 42°; Wl/Ll = 0.80; Ll/LD = 0.48; Wl/WD = 0.37; a/Ll = 0.55; b/Ll = 0.45; c/Ll = 0.45; d/Ll = 0.00; e/Ll = 0.10; f/Ll = 0.35; g/WD = 0.25; g/Wl = 0.68; h/f = 0.27; h/Ll = 0.10; WD/LD = 1.02.

USNM 551025a: *Tubithyris wrighti* (Davidson), Jurassic (Bajocian – Inferior Oolite – *Witchelia* Bed), Cold Comfort, near Cheltenham, Gloucestershire, England.

DISCUSSION.—The serial sections of *T. wrighti* figured by Muir-Wood (1936:84, fig. 23) do not show the entire loop and the transverse band is missing. The loop is said to be 7.25 mm long in a specimen 17 mm in length. This indicates a loop with Ll/LD = 0.43 which is not in complete accordance with Ll/LD of the excavated specimen.

The loops of *Lophrothyris* and *Tubithyris* are in close accord but the exteriors are sufficiently different that I prefer to retain *Tubithyris* as a separate genus rather than regard them as synonyms as Almeras suggests.

Terebratula saemani Oppel resembles *Tubithyris* externally but its loop is closer to that of *Lophrothyris subequestris* (Rollier) described by Almeras (1971) and is here named *Caryona*, new genus.

Turkmenithyris Prosorovskaya, 1962

Turkmenithyris Prosorovskaya, 1962:109.—Muir-Wood, 1965: H791, figs. 654: 4a–d, 656a–g′

SUBFAMILY.—Turkmenithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.—*Turkmenithyris krimholzi* Prosorovskaya, 1962:109, figs. 1–3; 1968:97, figs. 68, 69, pl. 14: figs. 2, 3.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Late Kelloway).

LOCALITY.—Turkmen and Russia.

EXTERIOR (Prosorovskaya, 1962).—Medium, oval, longer than wide, subequivalve, anterior commissure strongly uniplicate. Beak erect; foramen large, mesothyridid. Symphytium hidden. Surface smooth.

INTERIOR (Prosorovskaya, 1962).—Pedicle collar present; dorsal umbonal chamber shallow; cardinal process large, bilobed. Crural processes high, their ventral extremities "recurved outward." Loop ⅓ length of dorsal valve; outer hinge plates short, socket ridges thin, inclined, high. Outer hinge plates concave, posteriorly U-shaped, becoming V-shaped anteriorly. Descending lamellae flaring; transverse band thin, forming broad arch with webbed, long terminal points.

LOOP STATISTICS (from Prosorovskaya, 1962:109, fig. 1).—$\angle$ = 47°; Wl/Ll = 0.95; Ll/LD = 0.39; Wl/WD = 0.44; a/Ll = 0.38; b/Ll = 0.62; c/Ll = 0.38; d/Ll = 0.0.00; e/Ll = 0.12; f/Ll = 0.50; g/WD = 0.33; g/Wl = 0.75; h/f = 0.01; h/Ll = 0.02; WD/LD = 0.85.

COMMENT.—In exterior form and uniplication this genus suggests *Glyphisaria* but differs markedly in details of the loop, especially the position of the crural processes which are said to flare "outward" (laterally). The reconstruction of the loop is figured in Muir-Wood, 1965:H790, fig. 645:4d.

Uralella Makridin, 1960

PLATE 63: FIGURE 7

Uralella Makridin, 1960:295.

SUBFAMILY.—Lissajousithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula strogonowii* d'Orbigny, 1845:483, pl. 42: figs. 31, 32. Makridin, 1960, pl. 73: fig. 3.

SPECIMENS STUDIED.—One, without loop.

GEOLOGIC OCCURRENCE.—Upper Jurassic.

LOCALITY.—Arctic Urals, Russia.

DIAGNOSIS (Makridin, 1960).—Large, elongate oval, oviform or thickwalled, almost unwrinkled, with heavy cardinal and brachial apparatus. Cardinal process large, almost quadrate in cross-section. Dorsal septum wide and rather high. Dorsal adductor impressions elongate-triangular, narrow, deep, strongly divergent.

COMMENT.—The loop of *Uralella strogonowii* has not been figured either by serial section or excavation. Makridin (1964) gives a reconstruction of the loop of *Urallela gigantea* which shows a wide structure with long terminal points. Statistics based on this reconstruction (Makridin 1964:257, fig. 86) are: $\angle$ = 46°; Wl/Ll = 0.86; Ll/LD = 0.53; Wl/WD = 0.45; a/Ll = 0.35; b/Ll = 0.65; c/Ll = 0.35; d/Ll = 0.00; e/Ll = 0.15; f/Ll = 0.50; g/WD = 0.25; g/Wl = 0.54; h/f = 0.14; h/Ll = 0.07; WD/LD = 1.03. The crural processes are located at the distal end of the outer hinge plates, an unusual position.

Viallithyris Vörös, 1978

FIGURE 16

Viallithyris Vörös, 1978:62

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Terebratula gozzanensis* Parona, 1880:196, pl. 1: fig. 8.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Lias – Pliensbachian).

LOCALITY.—Alps, Italy, and Hungary.

DESCRIPTION.—Abstracted from Vörös, 1978.

EXTERIOR.—Medium to large, subpentagonal to subcircular, rarely oval. Subequally convex. Anterior commissure sulcate. Exterior finely capillate when well preserved.

INTERIOR.—Pedicle valve with long collar; symphytium thin; teeth moderately long, laterally expanded.

Dorsal valve with crenulated cardinal process extending anteroventrally into delthyrial cavity. Socket ridges well demarcated from outer hinge plates which are thin and horizontal [in serial section]. Crural bases given off on dorsal side.

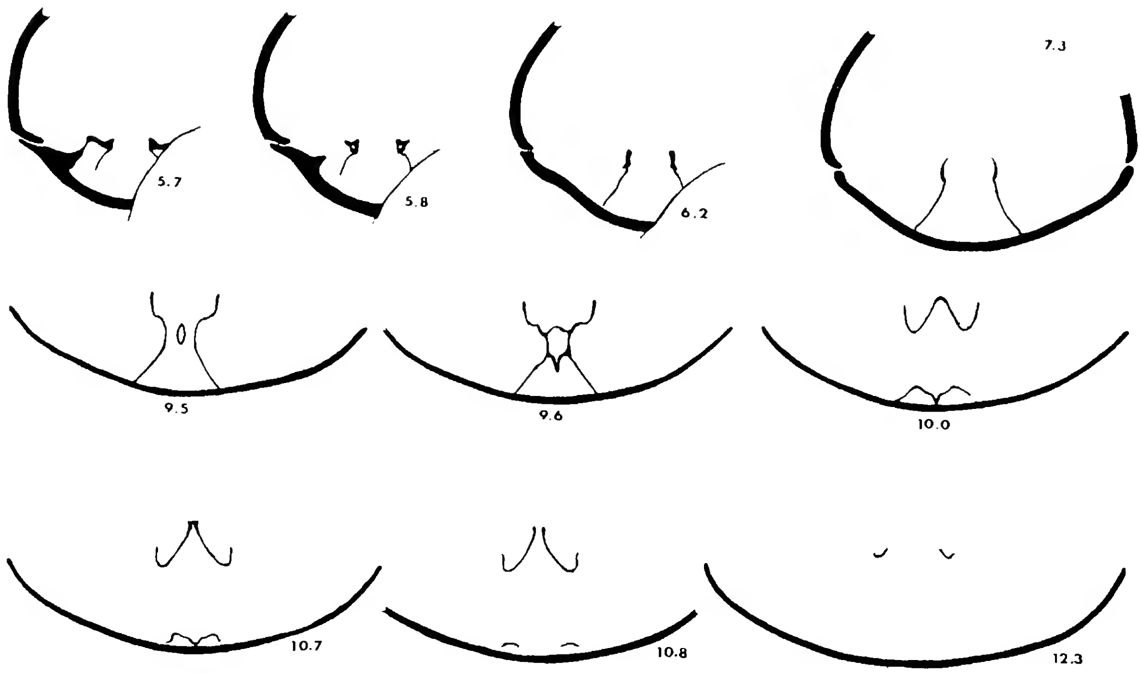


FIGURE 16.—Serial sections showing the complicated loop of *Viallithyris gozzanensis* (Parona) from Scacchi and Cantaluppi, 1967:73, fig. 2.

Crura arched in cross-section, convex at first, but anteriorly become concave toward each other. Crural processes not well defined. Loop short, about ¼ dorsal valve length, ends in two distinct points.

COMMENT.—Vörös presents serial sections of two individuals that show considerable variation. The loop shown in both is very narrow and evidently has fairly long terminal points (1.4 mm in fig. 4; f/Ll = 0.37). The most important feature of this genus is the struts supporting the loop, thus resembling *Erymnia* and *Iberithyris*. In Vörös, fig. 3, they form on the dependent crural bases and extend to the valve floor and along the crural base and crura to the transverse band which appears to be broad.

It was not possible to make satisfactory statistics on the genus because of the uncertainty as to the position of the crural processes. These must be unusually small and obscure.

Viallithyris differs from *Iberithyris* which is oval and rectimarginate with widely spreading struts (brachidium supports of Vörös). These struts unite to form a chamber on the valve floor after receding from support of the loop, a condition unlike that of *Viallithyris*.

Vörös places his genus in the Gibbithyrididae, the hinge plates of which belong to the pendent type of Muir-Wood (Plate 76: figure 15). *Gibbithyris* is not provided with brachidial supports and is commonly sulciplicate.

The serial sections figured by Vialli and Cantaluppi (1967) are more aberrant than those of Vörös. The specimens of the Italian geologists show the loop attached as in Vörös' sections. In addition they show a short tube dorsad of the transverse band. The tube is short and the dorsal part descends toward the valve floor on the freeing of the transverse band to form a blister. This structure is similar to that illustrated by Kvakhadze (1972) for *Iberithyris rionensis* Kvakhadze. This is a remarkable case of parallelism because Vörös' genus is Liassic in age whereas *Iberithyris* occurs in rocks of Early Cretaceous age.

Viligothyris Dagis, 1968

PLATE 63: FIGURE 15

Viligothyris Dagis, 1968:89.

SUBFAMILY.—Tchegemithyridinae Tchorszhevsky, 1972.

TYPE-SPECIES.—*Viligothyris orientalis* Dagis, 1968:89, figs. 54, 55, pl. 12: fig. 3; pl. 13: figs. 3, 4.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Lias - Upper Pliensbachian - Domerian).

LOCALITY.—Northeast Russia.

EXTERIOR (Dagis, 1968).—Medium size, elongate oval or pyriform, biconvex, Anterior commissure uniplicate or biplicate with weakly developed plicae. Beak short, moderately or slightly curved with rounded shoulders. Foramen rounded or oval, permesothyridid. Symphytium low.

INTERIOR (DAGIS, 1968).—Pedicle collar long and tubular. Outer hinge plates narrow, lying in the plane of the commissure; umbonal cavity small. Inner socket ridges almost perpendicular to the hinge plates. From the inner edges of the outer hinge plates, narrow plates come off which are seen in varying degrees of clarity, and these are similar to the inner hinge plates found in the genus *Neoliothyrina* Sahni. Cardinal process low, not divided. Crural bases small, seen as a small thickening of the edges of the [outer] hinge plates. Crural processes rather high, loop diverging, long descending branches. The transverse band is strongly curved and thickened on the bend. Flanges [terminal points] are long. The total length of the arm supports reaches ⅔ the length of the dorsal valve. Impressions of the adductors in the dorsal valve are elongated, petaloid, diverging through an angle of about 30°.

COMPARISON (Dagis, 1968).—Many genera of terebratulid brachiopods have a similar external appearance to *Viligothyris* (form, beak character, plication of the anterior margin and others). These include *Loboidothyris* Buckman, *Stroudithyris* Buckman, *Cererithyris* Buckman and others. From all these genera *Viligothyris* differs in the presence in the inner regions of the outer hinge plates, of subsidiary plates, present in varying degrees, These may be called inner hinge plates.

LOOP STATISTICS (reconstruction of *Viligothyris* Dagis 1968:91, fig. 55).—$\angle = 31°$; Wl/Ll = 0.55; Ll/LD = 0.54; Wl/WD = 0.37; a/Ll = 0.53; b/Ll = 0.47; c/Ll = 0.39; d/Ll = 0.14; e/Ll = 0.05; f/Ll = 0.42; g/WD = 0.30; g/Wl = 0.85; h/f = 0.09; h/Ll = 0.04; WD/LD = 0.84.

COMMENT.—Other species of *Viligothyris* illustrated by serial sections do not reveal inner hinge plates.

Wattonithyris Muir-Wood, 1936

PLATE 43: FIGURES 1–6; PLATE 70: FIGURES 1, 2; PLATE 76: FIGURE 3

Wattonithyris Muir-Wood, 1936:91.

SUBFAMILY.—Loboidothyridinae Makridin, 1964.

TYPE-SPECIES.—*Wattonithyris wattonensis* Muir-Wood, 1936:91, figs. 5G, 6A, 28; pl. 3: fig. 4a–c, 5a,b.

SPECIMENS STUDIED.—Thirty-five; one specimen of *W. fullonica* Muir-Wood excavated to show loop.

GEOLOGIC OCCURRENCE.—Jurassic (Bathonian).

LOCALITIES.—Great Britain, France, Poland, and Russia.

EXTERIOR.—Medium size, pentagonal or oval, maximum width near midvalve; valves subequal in depth and convexity, ventral valve usually slightly more convex. Lateral commissure convex toward ventral side at anterior third. Anterior commissure sulciplicate to episulcate. Beak suberect to erect; beak ridges short and rounded. Foramen large, submesothyridid. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: As shown by *W. fullonica* Muir-Wood, the loop is widely triangular with nearly straight sides and occupies about ⅖ the length and width of the dorsal valve. The cardinal process is a small half ellipse. The socket ridges are thin, slightly curved and lean slightly toward the narrow sockets. The fulcral plates are narrow. The outer hinge plates are narrow, triangular and taper anteriorly to attach to the dorsal edge of the crural bases. The taper extends to a point just dorsad of the crural processes. The crural bases posteriorly are marginal and elevated along the inner edges of the outer hinge plates and with them, and the socket ridges, make narrow U-shaped troughs. The crural processes are broad at their base and taper to needle-sharp points that are directed ventrally and slightly medially. The descending lamellae are nearly straight, thin ribbons. The transverse band is narrow but fairly even in width and rises with a steep slope to a flattened crest or bridge which occupies nearly a third of the width of the loop. The flattened crest is protuberant and its outer edge in lateral view is about even with the distal points of the cardinal processes. There are no extended terminal points, the descending lamellae rounding narrowly into the transverse band at an angle of about 40° The transverse band in lateral view deviates from the horizontal at about 20°

LOOP STATISTICS.—USNM 75618b: ∠ = 43°; Wl/Ll = 0.85; Ll/LD = 0.40; Wl/WD = 0.36; a/Ll = 0.61; b/Ll = 0.39; c/Ll = 0.61; d/Ll = 0.00; e/Ll = 0.15; f/Ll = 0.24; g/WD = 0.31; g/Wl = 0.86; h/f = 0.50; h/Ll = 0.12; WD/LD = 0.95.

USNM 75618b: *Wattonithyris fullonica* Muir-Wood, Jurassic (Bathonian - Fullers Earth), Hawkesbury, Upton, England.

DISCUSSION.—The serial sections of this genus (Muir-Wood, 1936, figs. 25–28) do not give a complete picture of the loop because the transverse band is missing and the crural processes are not certainly identifiable. Nevertheless the loop is said to be "equal to or greater than, half the length of the brachial [dorsal] valve"; *W. fullonica* does not fulfill these dimensions.

Lack of distinct terminal points, loop width and length nearly equal and the crural processes located anterior to midloop are marks of the loop of *Wattonithyris*. The loop of *Wattonithyris* reconstructed by Tchoumatchenko (1976–1977:209, fig. 9A; herein Plate 76: figure 3) shows a long loop with long terminal points, unlike the loop of the excavated specimen shown here. The loop of the excavated specimen is reminiscent of that of *Sphaeroidothyris* (sensu stricto) which has an entirely different exterior.

Weldonithyris Muir-Wood, 1952

Weldonithyris Muir-Wood, 1952:130; 1965:H792, figs. 654: 1; 655: 1.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Weldonithyris weldonensis* Muir-Wood, 1952:131, fig. 45, Pl. 6: figs. 4a,b, 5a,b, 6a–c, 7a–c, 8, 9, 10a–c.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian–Inferior Oolite–Upper Lincolnshire Limestone).

LOCALITY.—England.

DIAGNOSIS (Muir-Wood, 1952:130).—

Epithyrid, beak ridges indistinct, umbo often curved in adult, foramen circular, marginate or labiate, sometimes in contact with brachial [dorsal] valve, concealing symphytium. Valve biconvex, brachial valve without posterior sulcus, but less convex then pedicle [ventral] valve, elongate-oval in outline with short uniplicate stage immediately followed by sulciplication. Growth-halts often conspicuous, growth-lines forming well-marked concentric ornament especially anteriorly. Loop extending for about one-third of length of brachial valve. Muscle-scars ill-defined and obscure. Median septum thread-like. Adductors diverging from umbo at angle of about 20°, increasing slightly in width anteriorly and extending less than half of shell. Cardinal process small, narrow postero-anteriorly, and posteriorly concave.

REMARKS.—The serial sections are without definite distance between sections and the dimensions of the dorsal valve are not given. The 13 sections (fig. 4) seem not to have reached the crural processes and the transverse band of the loop is shown in a single section, the last of 17 (fig. 5). It is not possible to prepare statistics for this genus and to place it in the scheme of classification.

Xestosina, new genus

PLATE 31; FIGURES 7–16; PLATE 73: FIGURES 17, 18

SUBFAMILY.—Postepithyridinae Tchorszhevsky, 1974.

TYPE-SPECIES.— *Xestosina arguta*, new species

(*Terebratula subsella* auct. pars).

DIAGNOSIS.—Medium to large, strongly sulciplicate terebratulaceans having a wide moderately long loop with short outer hinge plates and slightly posteriorly placed crural processes.

SPECIMENS STUDIED.—Seven; two excavated to show loop.

GEOLOGIC OCCURRENCE.—Jurassic (Kimmeridgian).

LOCALITY.—France.

EXTERIOR.—Medium size to fairly large, subpentagonal, suggesting *Sellithyris*, sides rounded, maximum width anterior to midvalve, apical angle near 90°. Lateral commissure oblique posteriorly, convex ventrally at the anterior. Anterior commissure strongly sulciplicate, plication confined to anterior third to half. Beak short, with short rounded ridges, erect and overhanging dorsal umbo. Foramen large, permesothyridid. Symphytium partially visible or hidden. Surface smooth, often polished.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is widely triangular and occupies nearly half the length and almost ⅖ the width of the dorsal valve. The cardinal process is a narrow, half elliptical shelf with flat myophore facing posteriorly. The socket ridges are thin, curved and bound narrow sockets. The fulcral plates are thin and extend a short distance laterally. The outer hinge plates are short, narrow, concave and very close to valve floor. They attach to the dorsal edge of the crural bases which are strongly elevated along their inner margin. The outer hinge plates taper about to the crural processes. The ensemble of socket ridges, outer hinge plates and crural bases forms U-shaped troughs. The crural processes are located less than half the loop length and are extended into sharp points directly ventrally. The descending lamellae are fairly long, thin bands, slightly bowed laterally. The broad transverse band forms a fairly high arch with moderately steep sides, flattened medially, the flattening forming about a fifth of the loop width. The transverse band is directed posteroventrally at an angle of about 35° from the horizontal. The terminal points are angular and only moderately extended.

TABLE 41.—Loop statistics for the genus *Xestosina*

Proportions	USNM 550983	USNM 92030
∠	47°	44°
Wl/Ll	0.90	0.80
Ll/LD	0.47	0.41
Wl/WD	0.39	0.35
a/Ll	0.43	0.46
b/Ll	0.57	0.54
c/Ll	0.38	0.31
d/Ll	0.05	0.15
e/Ll	0.19	0.19
f/Ll	0.38	0.35
g/WD	0.33	0.35
g/Wl	0.84	0.90
h/f	0.15	0.14
h/Ll	0.04	0.05
WD/LD	1.08	0.94

USNM 92030: *Terebratula subsella* (= *Xestosina arguta*, new species). Jurassic (Kimmeridgian), Mont-le-Vernois, Haute Saône, France.

USNM 550983: *Xestosina arguta*, new species. Jurassic (Kimmeridgian), Le Havre, Cap de la Hève, Seine Inferieur, France.

LOOP STATISTICS.—See Table 41.

DISCUSSION.—Barczyk (1969) referred a number of Late Jurassic species to the Cretaceous genus *Sellithyris* Middlemiss. His reconstructed loops, however, are different from that of *Sellithyris*. The loop of his *Sellithyris subsella* has long terminal points unlike *Sellithyris* which does not have terminal points. His *S. pseudosella* is unlike any other loop in having the terminal points obliquely truncated and is unlike that of *Sellithyris* in having longer crura. These species of Barczyk resemble in their selliform the French specimens here referred to *Xestosina*, which, in the character of the loop are unlike *Sellithyris*, although similar to it externally.

ETYMOLOGY.—From the Greek *xestos* (polished).

Xestosina arguta, new species

PLATE 31: FIGURES 7–16

DIAGNOSIS.—Large sulciplicate, oval to subpentagonal terebratulaceans with wide loop, having crural processes slightly posterior to midloop.

DESCRIPTION.—Exterior and interior as for genus. Shell details below. Ventral valve unevenly convex in lateral profile with most convexity in umbonal and median regions; anterior half somewhat flattened. Anterior profile broadly and flatly convex. Anterior third forming broad, shallow sulcus marked medially by low, narrow fold, not extending to midvalve. Costae bounding sulcus short, variable, best defined by sharp wave of anterolateral margin. Flanks moderately steep; posterolateral slopes rounded and steep.

Dorsal valve flatly, unevenly convex, often with slight concavity at point of initiation of fold. Anterior profile gently domed. Umbonal and median regions moderately swollen: fold originating anterior to midvalve, short, narrow, marked medially by short, fairly deep sulcus. Lateral plications bounding sulcus narrowly convex, not extending beyond midvalve. Flanks bounding anterior costae steep and flattened; lateral and posterolateral flanks rounded.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
92030	37.6	32.4	30.0	?	75°
104717a	34.3	31.2	28.3	17.7	85°
104717b	33.8	30.0	27.5	17.0	88°
104717c	27.6	23.5	23.8	15.7	75°
550981	27.5	23.6	22.7	14.6	73°

OCCURRENCE.—USNM 92030: *Xestosina arguta*, new species, Mont-le-Vernois, Haute Saône; USNM 104717: Cap de la Hève, Seine Inferieure; USNM 550981: Le Havre, Cap de la Hève, Seine Inferieure; France.

TYPES.—Holotype: USNM 92030; paratypes: USNM 104717a–d, 550981.

DISCUSSION.—This species was hitherto identified as *Terebratula subsella* Leymerie. Compared to specimens from Germany and elsewhere in France and Leymerie's figures, it is a much larger brachiopod with more strongly defined folding. It also differs from these in the form of its loop. It also differs from the larger and strongly folded forms referred to *T. subsella* (placed in *Sellithyris*) by Barczyk (1969:51) which are much thicker and more elongate than the specimens from France. Furthermore the loop of *T. subsella* reconstructed by Barczyk (1969, fig. 3) shows a structure with long terminal points unlike any of the French or German forms figured on Plate 31 of this monograph.

The similarity of *Xestosina* to *Sellithyris sella* is striking but the beak and loop characters are different. The beak of *Sellithyris* exposes the complete symphytium whereas that structure is wholly or partially concealed in *Xestosina*. The loop of *Xestosina* has moderately strong terminal points unlike the loop of *Sellithyris* which has short, rounded anterolateral extremities. Middlemiss (1980:539, fig. 20) places specimens from Le Havre in *Kutchithyris*.

Etymology.—From the Latin *arguta* (sharply defined or distinct).

Jurassic Genus and Species Undetermined

PLATE 57: FIGURES 8–12; PLATE 73: FIGURE 3, 4.

TYPE-SPECIES.—*Terebratula circumdata* Deslongchamps, 1862–1885, pl. 129: figs. 3, 4.

SPECIMENS STUDIED.—One with loop excavated.

GEOLOGIC OCCURRENCE.—Jurassic (Bathonian).

LOCALITY.—France.

EXTERIOR.—Medium size, longer than wide, elongate oval, sides rounded, anterior margin narrowly rounded; apical angle 95°. Lateral commissure nearly straight; anterior commissure narrowly uniplicate. Beak truncated, suberect. Foramen large, submesothyridid. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is widely triangular with the length and width nearly equal. The socket ridges are thin and bound narrow sockets. The fulcral plates were not seen. The cardinal process is a small half ellipse. The outer hinge plates are narrowly triangular and deeply concave. They are extended from their attachment along the dorsal edge of the crural bases anteriorly as a ridge to a point just posterior of the crural processes. The outer hinge plates are bounded along their inner edges by a high extension of the crural base. This, with the outer hinge plates and socket ridges, forms fairly deep U-shaped troughs. The basal part of the crural processes are located anterior to midloop and are produced into acute points that are approximate and directed ventrally. They are flush with the somewhat protuberant transverse band. The descending branches are narrow, thin lamellae with a slight bow laterally. The transverse band is moderately broad and forms a high arch with medially flattened, protuberant bridge. The flattening amounts to nearly 40% of the loop width. The transverse band in side view is almost parallel to the horizontal. The terminal points are not extended and form an angle of 30° with the sides of the loop.

LOOP STATISTICS.—USNM 551024: ∠ = 49°; Wl/Ll = 0.93; Ll/LD = 0.40; Wl/WD = 0.38; a/Ll = 0.60; b/Ll = 0.40; c/Ll = 0.48; d/Ll = 0.12; e/Ll = 0.17; f/Ll = 0.23; g/WD = 0.31; g/Wl = 0.81; h/f = 0.48; h/Ll = 0.11; WD/LD = 0.96.

USNM 551024: Genus?, species?, Jurassic (Bathonian), Amfreville, Calvados, France.

DISCUSSION.—It was at first thought that this species was related to *Pseudowattonithyris circumdata* because of its resemblance to specimens identified as this species by Deslongchamps (1862–1885, pl. 129: fig. 6, 6a). Comparison of the loop of the specimen described above with that of *Pseudowattonithyris* shows the described loop to be shorter and wider than that of *Pseudowattonithyris*.

Although the shape of this specimen is like that of *Lophrothyris*, both with a uniplicate anterior commissure, the loops are quite different. The loop of the specimen under discussion has an angle of 49°, the cardinal processes are more anterior and the terminal points shorter than those of *Lophrothyris*.

The loop of this specimen is statistically close to that of *Stiphrothyris*, the loop proportions vary but the crural processes of both are located anterior of midloop and the terminal points are short. The exterior of the two however, is quite different, the specimen under consideration being strongly uniplicate while *Stiphrothyris* is sulciplicate.

Although this specimen suggests relationship to *Pseudotubithyris? lambertensis* Almeras, the loop statistics of the two are widely different. The loop of the latter is narrower and the crural processes are more posterior than those of the specimen being considered. The terminal points are longer in Almeras' species.

In their discussions of *Pseudowattonithyris circumdata*, Rollier and Almeras fail to take note of the specimens figured on pl. 129 of Deslongchamps (1862–1885). Although Rollier (1918:223) notes that species different from *T. circumdata* appear on pls. 129 and 130, he does not assign these figured specimens to known species or to new ones as he did in numerous other examples. Almeras (1971:395), in his discussion of *Pseudowattonithyris*, does not discuss these neglected specimens. Rollier (1919:337–380) omits pls. 129–131 in his recording of Deslongchamps' species.

The specimen described herein seems to be a new taxon, but there is not enough material in the collections of the National Museum of Natural History, Smithsonian Institution, to establish it. According to Almeras (1971:396) Deslongchamps' types were destroyed in World War II. Consequently more complete knowledge of this taxon must await further collecting or its recognition in existing collections.

Jurassic Genus Incorrectly Assigned to the Terebratulacea

Parathyridina Schuchert and LeVene, 1929a

Parathyris Douvillě, 1916:35 [preoccupied by Hübner, 1816, Insecta].

Parathyridina Schuchert and LeVene, 1929a:121 [new name for *Parathyris* Douvillé, 1916].

TYPE-SPECIES.—*Parathyris plicatoides* Douvillé, 1916:36, pl. 1: fig. 15a,b.

SPECIMENS STUDIED.—Six; none with loop exposed.

GEOLOGIC OCCURRENCE.—Jurassic (Bajocian).

LOCALITY.—Sinai Peninsula.

DISCUSSION.—Specimens from Maghara Massif received from Israel and Egypt conform strictly to the figures given by Douvillé for his species *Parathyris plicatoides*, type of the genus. All of the specimens studied by me are provided with a prominent median septum clearly visible on the partially worn specimens and can be seen readily by moistening the umbonal region of the dorsal valve of those specimens that still retain some of the original shell. The presence of a strong median septum is conclusive evidence that *Parathyridina* belongs to the Zeilleriacea and is not a Terebratulacean.

Douvillé (1916:36, pl. 1: figs. 16–20) describes another species, *P. plicatissima*, which is differently costated and is strongly suggestive of a terebratulid with some similarity to *Plectothyris*. This is also suggestive of *Magharithyris* Farag and Gatinaud (1960:77, pl. 1: fig. 1a–c). That species, however, is said to come from Bathonian beds rather than from the Bajocian, which is the source of Douvillé's specimens. Farag and Gatinaud cite differences in foramen, shape and plication of their genus from *Parathyridina*.

Douvillé (1916:35) cites the difference in plication and folding of *Parathyridina* from *Plectothyris fimbria* in making his genus, comparing the folding to that of living *Magellania*. Douvillé evidently thought that the specimens he was dealing with had no median septum. *Parathyridina,* with type *P. plicatoides*, now appears to be a zeillerid and should be transferred to that group. *Parathyridina plicatoides* resembles the Liassic zeillerid *Fimbriothyris guerangeri* (Deslongchamps).

Cretaceous TEREBRATULACEA

Aniabrochus, new name

PLATE 19: FIGURES 25–29; PLATE 61: FIGURES 14, 15; PLATE 66: FIGURE 1

Platythyris Middlemiss, 1959:109 [preoccupied by *Platythyris* Grote and Robinson, 1867:362 (Lepidoptera)].

SUBFAMILY.—Platythyridinae Dieni, Middlemiss, and Owen, 1973.

TYPE-SPECIES.—*Platythyris comptonensis* Middlemiss, 1959:109, figs. 2, 3, 8, pl. 15: figs. 9–11.

SPECIMENS STUDIED.—Sixty; one excavated to show loop, one with cardinalia only.

GEOLOGIC OCCURRENCE.—Cretaceous (Aptian).

LOCALITY.—England.

EXTERIOR.—Medium size, almond-shaped, lenticular profile, valves subequal in depth. Lateral commissure gently curved toward the ventral valve; anterior commissure narrowly uniplicate. Beak thick, short, suberect, truncated; foramen large, mesothyridid to permesothyridid. Symphytium short, usually visible. Surface finely capillate especially on flanks.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is long, narrowly triangular and occupies nearly a half the length and a third the width of the dorsal valve. The cardinal process is large for such a small shell and forms a wide half ellipse with myophore facing posteroventrally. The myophore is gently concave and margined anteriorly by a slight upturned rim. The fulcral plates are thick and laterally extended as a buttress. The socket ridge is thick, strongly elevated toward the posterior margin and very slightly inclined laterally. The sockets are long and deep. The outer hinge plates are narrow, gently concave and slope steeply toward midvalve. The anterior tapering edge of the outer hinge plates is extended to attach along the ventral edge of the crural processes which makes for a somewhat rectangular cross-section of that part of the loop just posterior of the crural processes. The crural bases are not clearly defined and do not form a ridge along the inside margin of the outer hinge plates, although there is a suggestion of a rim at the posterior near the cardinal processes, seen in two specimens. The outer hinge plates form shallow troughs that in section would be gently concave but not clubbed. The crural processes are located anterior of midloop and are obtusely pointed. The descending lamellae are short and straight. The transverse band is broad and gently arched. The median fold is low and narrow.

Loop Statistics.—USNM 550944b: ∠ = 20°; Wl/Ll = 0.50; Ll/LD = 0.45; Wl/WD = 0.32; a/Ll = 0.67; b/Ll = 0.33; c/Ll = 0.67; d/Ll = 0.00; e/Ll = 0.17; f/Ll = 0.16; g/WD = 0.43; g/Wl = 1.33; h/f = 1.19; h/Ll = 0.19; WD/LD = 0.70.

USNM 550944b: *Aniabrochus comptonensis* (Middlemiss), Cretaceous (Aptian - Lower Greensand), Brickhill, Buckinghamshire, England.

Discussion.—The outer hinge plates in serial section are described as "horizontal tapering." In the type species the serial sections indicate rather flat plates posteriorly but they are distinctly concave anteriorly. The excavated loop is unlike that of *Praelongithyris* which has wide and deeply concave outer hinge plates margined by strongly elevated crural bases.

The crural processes of the specimen illustrated herein have been damaged and the margin of the outer hinge plates also, but the transverse band and loop proportions are correct and match those of Middlemiss's sections (1959:110, fig. 18).

Cox and Middlemiss (1978:432) place *Capillithyris* and *Capillarina* in *Platythyris*. Middlemiss (1978:41) likewise places *Terebratula disparilis* d'Orbigny, herein named *Liramia*, because of its "horizontal" hinge plates and capillae in *Platythyris*. The *Platythyris* loop is unlike the loops of these three genera. Middlemiss (1978) relates *Platythyris* to *Pygope*, *Pygites*, and *Nucleata* because of details of the loops seen in serial section, especially those of the hinge plates. The loops of *Pygites* and *Nucleata* are different from the loop of *Platythyris* illustrated herein.

Cowan (1981:680) has shown that *Platythyris* Middlemiss is preoccupied by *Platythyris*, a moth described in 1867. The moth name, however, proved to be a synonym of another moth (*Dyssodia*). Nevertheless, the brachiopod name is invalid and should be replaced. Cowan, following Middlemiss, accepts *Capillithyris* Katz, 1974 as synonymous with *Platythyris*. As shown herein, *Platythyris* has a completely different loop from that of *Capillithyris* and is not a synonym. Hence the name *Aniabrochus* is proposed as a substitute for *Platythyris*.

Etymology.—From the Greek *ania* (trouble) plus *brochos* (noose or loop).

Aphragmus, new genus

Plate 17: figures 28–35; Plate 56: figures 15–19; Plate 68: figures 1, 2

Subfamily.—Eurysoriinae?, new subfamily.

Type-Species.—*Aphragmus sohli*, new species.

Diagnosis.—Small terebratulaceans externally resembling *Sellithyris*, having a somewhat quadrangular loop without definable crural base elevated along the inner edge of the outer hinge plates and the loop anteriorly narrowed.

Specimens Studied.—Four excavated, 2 with complete loop, two with cardinalia only.

Geologic Occurrence.—Cretaceous (Cenomanian).

Locality.—France.

Exterior.—Small, suggestive of *Sellithyris*, subpentagonal, sides rounded, maximum width slightly anterior to midvalve. Subequally convex. Lateral commissure strongly concave toward ventral side in anterior half. Anterior commissure

Table 42.—Loop statistics for the genus *Aphragmus*

Proportions	USNM 550931c	USNM 550931d
∠	26°	34°
Wl/Ll	0.72	0.62
Ll/LD	0.38	0.35
Wl/WD	0.24	0.22
a/Ll	0.66	0.63
b/Ll	0.34	0.37
c/Ll	0.34	0.37
d/Ll	0.00	0.00
e/Ll	0.12	0.16
f/Ll	0.22	0.21
g/WD	0.38	0.38
g/Wl	1.47	1.68
h/f	0.54	0.57
h/Ll	0.12	0.12
WD/LD	1.00	0.93

USNM 550931c,d: *Aphragmus sohli*, new species, Cretaceous (Upper Cenomanian - lower part of sands with *Catopygus obtusus*), colline de la Goupillerie, Le Mans Area, France.

sulciplicate. Beak short, suberect, truncated; beak ridges strong. Foramen large, mesothyridid to permesothyridid. Symphytium visible. Surface with faint capillae on flanks, otherwise smooth.

INTERIOR.—Ventral interior with large, elongate teeth; pedicle collar poorly developed. Dorsal valve interior with long tear shaped adductor scars.

Loop and Cardinalia: The loop is short, narrowed anteriorly and occupies about a third the length and width of the dorsal valve. The cardinal process is a small, wide, shelflike semiellipse. The socket ridges are short, thin, erect and bound narrow sockets. The fulcral plates are extended laterally to form a short buttressing ridge. The outer hinge plates are long, narrow and taper anteriorly, attaching to the anterior scoop-like part of the loop bearing the crural processes and the transverse band. The tapered hinge plate is attached at the posterior slope of the cardinal processes. A crural base is not visible as a ridge along the inside edge of the outer hinge plates. The crural processes are narrow and drawn distally into sharp points that are strongly directed medially. The descending lamellae are non-existent, the anterior of the crural processes meeting the transverse band. This is narrow, angularly arched in the middle and somewhat protuberant. The crest of the arch is flattened. The transverse band is nearly parallel to the horizontal in side view. The anterolateral extremities of the loop are not extended into long points.

LOOP STATISTICS.—See Table 42.

DISCUSSION.—The loop of this genus is unusal in having no crural base visible as a wall along the inner edges of the outer hinge plates. Most terebratulid genera have the crural base forming a wall along the inner edge of the crural bases or flush with the edge and still visible. In *Aphragmus* the outer hinge plates are steeply concave but flatten along their inner edge. They taper anteriorly, the taper forming the attachment for the crural processes and transverse band. The ensemble is somewhat suggestive of the loop of *Nucleatina* but in that genus the socket ridges are extended farther forward than in *Aphragmus*. The loop of *Aphragmus* is different from that of *Sellithyris* in the features discussed. The loop of *Sellithyris* differs also in its triangular shape and the presence of well-marked crural bases on the inside edge of the outer hinge plates.

ETYMOLOGY.—From the Greek *a* (without) plus *phragmos* (partition).

Aphragmus sohli, new species

PLATE 17, FIGURES 28–35

DIAGNOSIS.—Small terebratulaceans resembling *Sellithyris*, elongate oval with subequally convex valves.

DESCRIPTION.—Gross exterior and interior as for the genus. Exterior details of the valves below.

Ventral valve moderately convex in lateral profile, broadly convex in anterior view. Umbonal and median regions swollen, anterior half depressed to form shallow sulcus marked medially by narrow fold. Flanks steep.

Dorsal valve moderately convex in lateral view, strongly convex in anterior view with steep lateral slopes. Median and umbonal regions swollen. Fold originating slightly anterior to midvalve, narrow; median sulcus shallow, occupying slightly less than half valve width.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
550931a	16.0	13.9	13.9	9.4	103°
550931e	16.4	14.3	13.2	9.6	102°

OCCURRENCE.—Cretaceous (Upper Cenomanian – lower part of sand with *Catopygus obtusus*; *Metacoceras gourdoni* Zone), colline de la Goupillerie, Le Mans area, France.

TYPES.—Holotype: USNM 550931a; paratypes: USNM 550931b–f.

COMPARISON.—This species differs from the larger species of *Sellithyris* in its narrow anterior and less strong plication. It differs from *Sellithyris phaseolina* (Lamarck) in its smaller size, narrower form and more swollen valves.

ETYMOLOGY.—Named in honor of Dr. Norman F. Sohl, United States Geological Survey.

Atactosia, new genus

PLATE 24: FIGURES 1-7, 15-17; PLATE 29: FIGURES 4-7; PLATE 58: FIGURES 9-22; PLATE 68: FIGURES 15-18

SUBFAMILY.—Gibbithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Terebratula obtusa* J. deC. Sowerby, 1821-1825:53, pl. 437: fig. 4.

DIAGNOSIS.—Medium-sized terebratulids with rectimarginate to incipiently paraplicate anterior commissure; loop short, narrow with broad transverse band.

SPECIMENS STUDIED.—Twenty, four with excavated loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Cenomanian).

LOCALITY.—Great Britain.

EXTERIOR.—About medium size, dorsal valve flatly convex, ventral valve strongly convex. Lateral commissure posteriorly oblique, strongly convex toward ventral side at anterior. Anterior commissure rectimarginate to incipiently paraplicate. Beak marginate, erect, somewhat labiate. Foramen large, permesothyridid. Symphytium hidden. Surface irregularly lamellose, lamellae tending to concentrate anteriorly.

INTERIOR.—Ventral valve with short, excavate pedicle collar.

Loop and Cardinalia: The loop is short and narrow. The cardinal process is a thin, half ellipse with myophore facing posteriorly. The socket ridges are low, stout, and have moderately thick fulcral plates. The outer hinge plates are moderately wide, triangular, sloping medially, and are gently concave. They are attached to the broad crural base near its ventral edge and taper onto the posterior part of the crural processes just dorsad of their posteroventral edge. The crural processes are not readily separable from the crural bases and are bluntly pointed and approximate. The anterior edge of the crural processes serves as descending lamellae. The transverse band is very broad and only gently elevated as a low arch. The posterolateral extremities are not extended.

LOOP STATISTICS.—See Table 43.

DISCUSSION.—The loops of the two specimens from Hunstanton are alike and differ slightly from those of the specimens from Cambridge. The exterior of the Hunstanton species is not as strongly lamellose as some of the specimens from Cambridge. They are different specifically in their shape.

The loops of the Cambridge specimens are similar to the loop of *Ornatothyris sulcifera* (Morris), differing slightly in the attachment of the outer hinge plates to the crural bases. The outer hinge plates of *O. sulcifera* are narrower and not so concave and are thicker than those of the Cambridge specimens. *O. sulcifera* has less taper to the outer hinge plates than the Cambridge specimens. Furthermore the lamellation of the exterior of *O. sulcifera* is more regular than that of *A. obtusa*.

Atactosia differs from *Biplicatoria* in the lesser folding of the anterior commissure and the narrower loop. The specimens here referred to *Atactosia obtusa* (Sowerby) bear close resemblance to *Ornatothyris curvirostris* Sahni which belongs to his

TABLE 43.—Loop statistics for the genus *Atactosia*

Proportions	USNM 551112	USNM 551134c	USNM 551134d	USNM 551135
∠	22°	20°	20°	23°
Wl/Ll	0.47	0.47	0.50	0.58
Ll/LD	0.34?	0.31	0.32	0.26
Wl/WD	0.18	0.17	0.16	0.15
a/Ll	0.63	0.53	0.58	0.67
b/Ll	0.37	0.47	0.42	0.33
c/Ll	0.58	0.47	0.50	0.58
d/Ll	0.05	0.06	0.08	0.09
e/Ll	0.08	0.06	0.17	0.04
f/Ll	0.29	0.41	0.25	0.29
g/WD	0.27	0.33	0.33	0.31
g/Wl	1.55	1.75	2.00	2.00
h/f	0.72	0.63	0.68	0.72
h/Ll	0.21	0.26	0.17	0.21
WD/LD	0.91?	0.87	0.97	1.00

USNM 551112: *Atactosia species*, Cretaceous (White Chalk), cliffs at Hunstanton, Norfolk, England.

USNM 551134c,d: *Atactosia obtusa* (J. de C. Sowerby), Cretaceous (Cenomanian - Upper Greensand), Cambridge, England.

USNM 551135: *Atactosia* species, Cretaceous (White Chalk), cliffs at Hunstanton, Norfolk, England.

Partirugose group of Ornatothyrids. Sahni does not illustrate a loop of any species in this group.

ETYMOLOGY.—From the Greek *ataktos* (disordered).

Atelithyris Smirnova, 1975

PLATE 62: FIGURE 14

Atelithyris Smirnova, 1975a:77.

SUBFAMILY.—Spasskothyridinae Smirnova, 1977.

TYPE-SPECIES.—*Atelithyris crestensis* Smirnova, 1975a:79, figs. 6, 7, pl. 10: figs. 1, 2.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Lower Hauterivian – *Homolsomites bojarkensis* Zone).

LOCALITY.—Upper Volga, Russian Platform.

EXTERIOR (Smirnova, 1975a).—Ovally extended shell with an elongate beak, constricted laterally with weakly expressed uniplication at the anterior margin, more rarely smooth. Foramen large, permesothyridid.

INTERIOR (Smirnova, 1975a).—There is a pedicle collar. Cardinal process is low. Hinge plates are inclined insignificantly toward the plane of symmetry, depressed. Inner socket ridge faintly expressed. Crural bases almost perpendicular to the hinge plates. Crural processes high. Loop takes up half the length of the dorsal valve. Transverse band of the loop is narrow, curved in the form of a high arc. Flanges [terminal points] of the loop are long. Muscle impressions of the anterior adductors on the dorsal valve are long, narrow, slightly divergent.

LOOP STATISTICS (from reconstruction by Smirnova, 1975a, fig. 7).—$\angle = 35°$; Wl/Ll = 0.58; Ll/LD = 0.39; Wl/WD = 0.27; a/Ll = 0.31; b/Ll = 0.69; c/Ll = 0.27; d/Ll = 0.04; e/Ll = 0.21; f/Ll = 0.48; g/WD = 0.26; g/Wl = 0.94; h/f = 0.08; h/Ll = 0.04; WD/LD = 0.83.

COMPARISON (Smirnova, 1975a).—From *Okathyris* [Smirnova] it is distinguished by the extended shell, high beak, wide hinge plates, less steeply inclined crural bases and the narrow transverse band of the loop. In internal structure the present genus [*Atelithyris*] is close to *Avonothyris* Buckman, 1918 (sic), from the Bathonian of England (presence of a pedicle collar, low cardinal process depressed, hinge plates with crural bases steeply oriented toward them), but differs from it in an elongate shell and faintly noticeable plication at the anterior margin.

COMMENT.—Smirnova relates her genus to *Uralella* but the loop of the type species has not been figured. The loops of *Avonothyris* and *Atelithyris* are unlike as comparison with Smirnova's reconstruction and the excavated loop of *Avonothyris* (Plate 48: figures 7–10) will show. Statistics prepared from Smirnova's serial sections are not in accordance with those made from the reconstruction: Wl/Ll = 0.98; Ll/LD = 0.48; Wl/WD = 0.57; a/Ll = 0.34; and f/Ll = 0.38.

Biplicatoria, new genus

PLATE 20: FIGURES 21–27; PLATE 21: FIGURES 1–6; PLATE 67: FIGURES 12, 13, 23, 24

SUBFAMILY.—Gibbithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Biplicatoria ferruginea*, new species (= *Terebratula biplicata dutempleana* sensu Davidson, 1852–1855, pl. 6: fig. 1; not *Terebratula dutempleana* d'Orbigny, 1847).

DIAGNOSIS.—Medium to large biplicate terebratulaceans having a narrow loop with broad transverse band and narrow crural bases and crus.

SPECIMENS STUDIED.—Eleven, two with excavated loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Albian).

LOCALITY.—Great Britain.

EXTERIOR.—Medium to large, biconvex, ventral valve deeper, more convex than dorsal valve, oval to pentagonal, greatest width in anterior half. Anterior margin often with reentrant. Lateral commissure anteriorly convex toward ventral valve; anterior commissure broadly paraplicate. Dorsal sulcus deep, bounding plications strong. Beak short, suberect, labiate, truncated by a large permesothyridid foramen. Symphytium partially visible or concealed. Surface marked by incremental lines of growth only.

TABLE 44.—Loop statistics for the genus *Biplicatoria*

Proportions	USNM 64628b	USNM 550947	Davidson 1852–1855
∠	26°	36°	35°
Wl/Ll	0.52	0.61	0.60
Ll/LD	0.35	0.30	0.38
Wl/WD	0.19	0.21	0.31
a/Ll	0.58	0.50	0.50
b/Ll	0.42	0.50	0.50
c/Ll	0.58	0.50	0.36
d/Ll	0.00	0.00	0.14
e/Ll	0.13	0.17	0.07
f/Ll	0.29	0.33	0.43
g/WD	0.39	0.29	0.28
g/Wl	2.00	1.36	0.89
h/f	0.66	0.39	0.49
h/Ll	0.19	0.13	0.21
WD/LD	0.93	0.88	0.78

USNM 64628b: *Biplicatoria hunstantonensis*, new species, Cretaceous (Red Chalk), cliffs at Hunstanton, Norfolk, England.

USNM 550947: *Biplicatoria ferruginea*, new species. Cretaceous (Red Chalk), cliffs at Hunstanton, Norfolk, England.

Davidson 1852–1855, pl. 6: fig. 7: *Terebratula biplicata dutempleana* sensu Davidson (not d'Orbigny), Upper Greensand, Cambridge, England.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The cardinal process is a small, flattened half ellipse, thickened in large or old specimens. The loop is short and only slightly expanded anteriorly. It occupies a third the length and ⅕ the width of the dorsal valve. The socket ridges are inclined laterally. The fulcral plates were not seen. The outer hinge plates are fairly wide, thin, concave and are attached to the ventral part of the crural bases, making the anterior part of the loop seem scooplike. The outer hinge plates do not reach to the crural processes but die out on their posterior edge. The crural processes are broad, acutely pointed and slightly approximate. The transverse ribbon is unusually broad, strongly arched, and is attached to the anterior termination of the crural processes without any development of descending lamellae. The arch of the transverse band is narrowly rounded and has even lateral slopes. It is inclined at an angle of 30° from the horizontal. The anterolateral extremities are only slightly extended into angular points.

LOOP STATISTICS.—See Table 44.

DISCUSSION.—The drawing of the interior of *Terebratula biplicata dutempleana* Davidson (1852–1855, pl. 6: fig. 7) of a specimen from the Upper Greensand of Cambridge, England is correct in its proportions with the crural processes drawn at midloop. The drawing seems to exaggerate the breadth and folding of the transverse band and the length of the anterolateral extremities. The cardinal process is thicker than that of the large Hunstanton specimen but this may be an age character. The long taper of the outer hinge plates is not shown.

Biplicatoria resembles *Dilophosina* externally but the loops are different, that of *Dilophosina* having its hinge plates attached on the dorsal side of the crural bases rather than on the ventral side as in *Biplicatoria.*

The loop of *Biplicatoria* is suggestive of that of *Concinnithyris* in having the outer hinge plates attached to the ventral edge of the crural bases. *Biplicatoria*, as the name implies, is always strongly plicated, whereas *Concinnithyris* is usually more or less strongly uniplicate except for the type species which is slightly sulciplicate.

ETYMOLOGY.—From the Latin *bis* (two) plus *plico* (fold).

Biplicatoria ferruginea, new species

PLATE 21: FIGURES 1–6

Terebratula biplicata dutempleana, sensu Davidson, 1852–1855, pl. 6: fig. 1 [not d'Orbigny 1847].

DIAGNOSIS.—Large, elongate oval terebratulid with short, deep dorsal sulcus bounded by subangular plicae, maximum width anterior to midvalve, and no fold on ventral valve.

DESCRIPTION.—Large, elongate oval in outline, maximum width anterior to midvalve where maximum rounding of sides occurs; posterolateral margins nearly straight, forming an angle of 70° Lateral commissure strongly curved in anterior half. Anterior commissure strongly paraplicate. Beak short, suberect, labiate, truncated by a large permesothyridid foramen. Surface marked by growth lines and concentric growth lamellae.

Ventral valve moderately convex in lateral profile, somewhat flattened anteriorly. Anterior profile gently convex. Umbonal region narrowly swollen; midregion gently swollen from midvalve to anterior margin, the gentle swelling serving as a fold. Tongue moderately long, indented medially.

Dorsal valve gently convex in both profiles. Umbonal region swollen. Anterior sulcate, the sulcus originating at midvalve, deepening and broadening anteriorly, deep at front. Bounding plicae strongly elevated and subangular. Anterolateral flanks concave, posterolateral ones gently convex.

Interior as for genus.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
550946	41.0	36.0	30.8	21.6	70°

OCCURRENCE.—Cretaceous (Red Chalk), cliffs at Hunstanton, Norfolk, England.

TYPES.—Holotype: USNM 550946; paratype: USNM 550947.

DISCUSSION.—The species differs from *Terebratula dutempleana* d'Orbigny (1847, pl. 511: figs. 1–3) in its narrower form, more tapering posterior, position of maximum width anterior to midvalve, the greater depth of the anterior sulcus, and greater width of the anterior folding. D'Orbigny figures a more slender form of his *T. dutempleana* on the same plate but this is smaller and more slender than *B. ferruginea*, and has its maximum width at midvalve.

Biplicatoria hunstantonensis, new species

PLATE 20: FIGURES 21–27

DIAGNOSIS.—Small *Biplicatoria* with short plications and W/L = 0.81.

DESCRIPTION.—Small, subtriangular to subpentagonal; sides rounded, greatest width anterior to midvalve. Anterior margin truncated to slightly bilobed. Anterior commissure strongly paraplicate but plicae short, located in anterior quarter of dorsal valve; median sulcus wide; ventral fold not well defined, showing as slight wave of growth lines. Beak erect to incurved; foramen moderately large, permesothyridid; symphytium partially visible. Surface marked by growth lines only.

Ventral valve interior not seen. Loop narrow, having an angle of 26°, in all other respects like that of *Biplicatoria* described above.

MEASUREMENTS (mm).—

USNM	*Length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
64628a	26.0	22.4	21.0	16.9	72°
64628c	26.5	23.4	24.6	17.3	89°

OCCURRENCE.—Cretaceous (Red Chalk), cliffs at Hunstanton, Norfolk, England.

TYPES.—Holotype: USNM 64628a; paratypes: USNM 64628b,c.

DISCUSSION.—This species differs from *B. ferruginea* in its smaller size, shorter plications, smaller foramen and different proportions: W/L = 0.81 for *B. hunstantonensis*, W/L = 0.73 for *B. ferruginea*.

Boubeithyris Cox and Middlemiss, 1978

PLATE 20: FIGURES 13–20; PLATE 22: FIGURES 14–19; PLATE 28: FIGURES 24–27; PLATE 67: FIGURES 19, 20

Boubeithyris Cox and Middlemiss, 1978:419.

SUBFAMILY.—Nerthebrochinae, new subfamily.

TYPE-SPECIES.—*Terebratula boubei* d'Archiac, 1847:320, pl. 19: fig. 11.

SPECIMENS STUDIED.—Six, two with excavated loop, one with cardinalia only.

GEOLOGIC OCCURRENCE.—Cretaceous (Tourtia).

LOCALITIES.—Belgium and Great Britain.

EXTERIOR.—Oval to pentagonal, medium size, valves unequally convex, ventral valve deeper and more convex; anterior commissure sulciplicate. Beak long, suberect. Foramen large, submesothyridid. Symphytium completely visible, convex, reminiscent of that of *Rectithyris*. Surface marked only by lines of growth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is widely triangular and occupies more than a third the length but less than a third of the width of the dorsal valve. The socket ridges are thin, slightly inclined toward the narrow sockets. The cardinal process is small and forms a concave half ellipse. The fulcral plates are thin and laterally extended. The outer hinge plates are triangular, fairly broad and shallowly concave. They have a long taper along the dorsal edge of the narrow crural base. The taper extends to the cardinal processes. The crural bases are not elevated along the inside edge of the outer hinge plates and thus are concealed. Inner hinge plates are moderately developed. The crural processes are narrow in lateral view and are drawn into needle-like points. The descending lamellae are short and slightly bowed laterally. The transverse band is narrow and gently arched with a narrowly rounded crest.

LOOP STATISTICS.—USNM 551097c: ∠ = 32°; WL/Ll = 0.67; Ll/LD = 0.35; Wl/WD = 0.28; a/Ll = 0.60; b/Ll = 0.40; c/Ll = 0.60; d/Ll = 0.00; e/Ll = 0.20; f/Ll = 0.20; g/WD = 0.31; g/Wl = 1.10; h/f = 0.35; h/Ll = 0.07; WD/LD = 84.

USNM 551097c: *Boubeithyris boubei* (d'Archiac), Cretaceous (Tourtia), Tournay, Hainaut, Belgium.

DISCUSSION.—The loop of *Harmatosia*, new genus, has the crural bases farther anterior than that of *Boubeithyris*. The two loops are differently proportioned with the Belgian one having a greater angle.

British specimens identified as *Terebratula boubei* differ from the Belgian ones in having wider and more elongated outer hinge plates and in having crural bases forming a wall along the inner margin of the outer hinge plates. The inner hinge plates are somewhat more strongly developed in the British specimens than in the Belgian ones. *Terebratula boubei* differs externally from *Harmatosia* in not having as strong a median sulcus in the dorsal valve as that of *H. crassa*.

A German specimen (Plate 28: figures 24–27) identified as *Terebratula tornacensis* d'Archiac is narrow and externally similar to *Boubeithyris boubei*. It is elongate but is more strongly folded than *B. boubei*. Its loop statistics are almost identical to those of *B. boubei* and has modest inner hinge plates.

LOOP STATISTICS.—USNM 551133: ∠ = 34°; Wl/Ll = 0.67; Ll/LD = 0.36; Wl/WD = 0.28; a/Ll = 0.60; b/Ll = 0.40; c/Ll = 0.60; d/Ll = 0.00; e/Ll = 0.20; f/Ll = 0.20; g/WD = 0.37; g/Wl = 1.30; h/f = 0.25; h/Ll = 0.05; WD/LD = 0.86.

USNM 551133: *Boubeithyris* species. Cretaceous (Cenomanian), Kessenberg, Germany.

Capillarina, new genus

PLATE 23: FIGURES 1–11, 19–22; PLATE 66: FIGURES 18, 19

SUBFAMILY.—Capillarininae, new subfamily.

TYPE-SPECIES.—*Platythyris diversa* Cox and Middlemiss, 1978, fig. 13a,b, pl. 42: figs. 3a–c, 4a–c, new name for *Terebratula capillata* Lamplugh and Walker, 1903:249, pl. 16: figs. 1a–c, 2–6; preoccupied by *T. capillata* d'Archiac, 1847.

DIAGNOSIS.—Capillate terebratulaceans having a narrow loop with broad, moderately folded non-protuberant transverse band and outer hinge plates attached on the ventral edge of the crural bases.

SPECIMENS STUDIED.—Eleven, 3 with excavated loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Albian).

LOCALITY.—Great Britain.

EXTERIOR.—Small to large, biconvex, roundly ovoid to subpentagonal; greatest width at midvalve. Lateral commissure straight; anterior commissure rectimarginate to gently uniplicate. Beak short, suberect to erect, truncated by a large mesothyridid foramen. Symphytium short, visible. Surface marked by radial capillae and concentric lines of growth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is variable, and although it is short in relation to the length of the dorsal valve, it is half as wide as long or nearly so. The socket ridges combined with the cardinal process make a straight line across the posterior

TABLE 45.—Loop statistics for the genus *Capillarina*

Proportions	USNM 550952b	USNM 550953	USNM 550955*
∠	31°	23°	32°
Wl/Ll	0.71	0.51	0.64
Ll/LD	0.30	0.30	?
Wl/WD	0.17	0.14	?
a/Ll	0.56	0.57	0.57
b/Ll	0.44	0.43	0.43
c/Ll	0.56	0.57	0.57
d/Ll	0.00	0.00	0.00
e/Ll	0.19	0.21	0.19
f/Ll	0.25	0.22	0.24
g/WD	0.28	0.25	?
g/Wl	1.70	1.78	1.23
h/f	0.80	0.82	0.71
h/Ll	0.20	0.18	0.17
WD/LD	1.11	1.04	?

* The exact length and width of the specimen 550955 from Hunstanton are not known because the specimen is imperfect, but the loop details are accurate.

USNM 550952b, 550953: *Capillarina diversa* (Cox and Middlemiss), Cretaceous (Lower Albian Shenley Limestone - *regularis* Zone), Shenley Hill Pit, Leighton Buzzard, Bedfordshire, England.

USNM 550955: *Capillarina diversa rubicunda* (Cox and Middlemiss), Cretaceous (Red Chalk), sea cliffs at Hunstanton, Norfolk, England.

margin of the shell to the socket where they descend to the fulcral plates. The fulcral plate is laterally extended to form a concave shelf. The straight posterior edge of the socket ridges roofs over the proximal parts of the socket. The cardinal process is small, a flat half ellipse only moderately protuberant. The outer hinge plates are broadly triangular, gently concave except along the anterior free edge where they are slightly convex. The sutural contact with the socket ridges is clear and is depressed below the socket ridge. The anterior end of the outer hinge plates tapers onto the narrow crus. The crural bases are not visible along the inner margin of the outer hinge plates. The crura, together with the tapered anterior angle of the outer hinge plates, form narrow, rounded solid shafts supporting the scoop-like ensemble of the crural processes and the transverse band. The crural processes are acutely pointed and moderately strongly inclined toward the valve median. The descending element carrying the transverse band is the anterior side of the crural processes, thus there are no descending lamellae. The transverse band is a broad arch more or less strongly angulated medially. The arch is fairly low and the angle is different in Shenley specimens from that of the specimen from the Red Chalk of Hunstanton (USNM 550955) which is broader and more strongly angulated. The posterior side of the transverse band of the Shenley species has a broad median concavity. The anterolateral extremities of the loop are subangular.

LOOP STATISTICS.—See Table 45.

DISCUSSION.—This genus is externally most like *Capillithyris* Katz with type-species *Terebratula capillata* d'Archiac from the Tourtia of Belgium, but differs in the development of the anterior commissure which is rectimarginate to uniplicate whereas that of *Capillithyris* is rectimarginate with a tendency to sulciplication. As detailed below the loops of the two genera are different. *Paracapillithyris* Katz and Popov (1974a) is another capillate terebratulacean from the Cenomanian of the Russian Platform. It differs from *Capillithyris*, according to Katz and Popov in the presence of a third shell layer, the apical position of the foramen, narrow palintrope and absence of shoulders. Aside from a reference to the crura the interior details are not known. At any rate the mentioned characters would separate it from *Capillarina*.

The cardinal process of *Capillithyris* is larger and the loop angle greater than those of *Capillarina*. The socket ridges of *Capillithyris* do not form a straight ridge across the posterior but are curved and define a more open socket than that of *Capillarina*. Another major difference between the loops of the two genera is the thick and broad crural base of *Capillithyris* that is reminiscent of the stout descending elements of *Gibbithyris* and *Concinnithyris* of the Senonian. In contrast the crural bases of *Capillarina* are narrow and rounded and suggest the handle of a scoop holding the scoop-like anterior parts of the loop. In addition to all of these differences the transverse band of *Capillithyris* is narrow and protuberant whereas that of *Capillarina* is broad with a subangular or angular nonprotuberant median fold.

Cox and Middlemiss (1978:434) refer *Terebratula capillata* Lamplugh and Walker (not d'Archiac) to *Platythyris* (= *Aniabrochus*) a long narrow shell with a long loop and with a capillate exterior. The loops of *Capillarina* and *Capillithyris* are completely different from that of *Platythyris*. *Platythyris* has wider and longer, more tapering hinge plates, the crural processes are farther anterior, and the length and width of the loop in relation to those dimensions of the dorsal valve are greater in *Platythyris* which also has a proportionally longer and wider loop than *Capillarina*.

The capillate terebratulid found in the Red Chalk of Hunstanton, formerly *T. capillata*, was renamed *Platythyris diversa rubicunda* by Cox and Middlemiss (1978:437). This is an oval, thicker form than the Shenley species and probably should be ranked as a separate species because its loop, as well as its exterior differs from that of *C. diversa* from Shenley.

The Cox and Middlemiss serial sections show the narrowness of the loop of *Capillarina diversa* and *C. d. rubicunda* (1978:436, 437, figs. 11, 12). Compare these with their serial sections of *Capillithyris capillata* (fig. 10) with its very wide loop. The sections do not show the extent of the loop in a longitudinal direction.

ETYMOLOGY.—From the Latin *capillus* (hair).

Capillithyris Katz, 1974

PLATE 23: FIGURES 12–18; PLATE 66: FIGURES 16, 17

Capillithyris Katz, 1974:258.

SUBFAMILY.—Capillithyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula capillata* d'Archiac, 1847:323, pl. 20: figs. 1–3 (1 and 2 only fixed by Katz, 1974a).

SPECIMENS STUDIED.—Three, one with loop excavated.

GEOLOGIC OCCURRENCE.—Cretaceous (Tourtia).

LOCALITY.—Belgium and Russia.

EXTERIOR.—Large, oval, with rounded sides, strongly rounded anterior, posterolateral margins forming an obtuse angle. Inequivalve, ventral valve more convex than dorsal one. Lateral commissure nearly straight; anterior commissure rectimarginate to incipiently sulciplicate. Beak erect, short, with prominent beak ridges and narrow lateral interareas. Foramen large mesothyridid. Symphytium partially visible. Surface marked by closely crowded radial capillae and prominent growth varices.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop forms an isoceles triangle that occupies about a quarter of the width and length of the dorsal valve. The cardinal process is a large half ellipse with myophore directed posteriorly and bearing two lateral depressions separated by a low median ridge. The anterior margin is notched at the median ridge and bears a low ridge around its edge. The outside wall of the socket bears a low submarginal ridge that extends to just beyond the socket opening and serves as a denticle (Plate 23: figure 18). The proximal part of the socket is roofed. The socket ridge is thick and strongly inclined laterally to lean over the socket. The fulcral plate is thick. The outer hinge plate is short and thick and not readily separable from the socket ridge. It is attached near the ventral edge of the crural base. Its anterior end is extended onto the cardinal process. There is no space on the crural base between the outer hinge plate and the crural process that can be identified as a crus. The crural bases form a low ridge along the inner edge of the outer hinge plates. The crural bases are short and broad as in many other Cretaceous genera. The crural processes appear at the anterior edge of the outer hinge plates at about midloop, are pointed and approximate. The descending branches are short, broad, and gently bowed laterally. They support a narrow transverse band that is medially angulated. The transverse band is horizontally extended toward the ventral valve.

The median crest is narrowly folded. There are no terminal points because the anterolateral extremities are narrowly rounded.

LOOP STATISTICS.—USNM 550949c: ∠ = 48°; Wl/Ll = 1.00; Ll/LD = 0.24; Wl/WD = 0.20; a/Ll = 0.55; b/Ll = 0.45; c/Ll = 0.55; d/Ll = 0.00; e/Ll = 0.24; f/Ll = 0.21; g/WD = 0.25; g/Wl = 1.18; h/f = 0.48; h/Ll = 0.10; WD/LD = 1.13.

USNM 550949c: *Capillithyris capillata* (d'Archiac), Cretaceous (Tourtia), Chercq, quarry du Cornet, near Tournay, Belgium.

DISCUSSION.—This species was formerly identified in Great Britain at Shenley and Hunstanton but the loop of the British forms is quite different from that of the Belgian species. In the Shenley species the socket ridges are welded with the cardinal process to form a posterior ridge. The loop of *Capillarina*, the British form, is narrow and the transverse band is broader than that of *Capillithyris*. The transverse band of the latter is strongly protuberant whereas that of the British form is only gently folded.

Cox and Middlemiss (1978:432) place the Belgian species in *Platythyris*, a much smaller elongate oval brachiopod with indifferent radial capillae. The loop of *Capillithyris* is completely different from that of *Platythyris* in having the crural processes farther posterior and in having a smaller loop angle. Cox and Middlemiss' serial sections show the greater width of the *Capillithyris* loop compared to that of *Platythyris* (1978:433, fig. 10).

Bilinkevich and Popiel-Barczyk (1979) redescribed *Capillithyris* using specimens from Shenley limestone of Leighton Buzzard, Bedfordshire, England to illustrate the interior. The serial sections show the extended socket ridges characteristic of the Shenley form. Their reconstruction, however, does not give any detail of the socket ridges but the loop is similar to that of the preparation shown herein (Plate 23: figures 6, 10). This loop as shown above is unlike that of *Terebratula capillata* d'Archiac from Belgium, which is the type and the loop of which is unlike that of the Shenley species. Bilinkevich and Popiel-Barczyk do not reconstruct the loop of *Capillithyris podolica* (Zareczny) from the Upper Cenomanian of Podolia. Their sections are not in complete accordance with those of the Shenley specimen but are rather suggestive of *Capillithyis* from Belgium (Bilinkevich and Popiel-Barczyk, 1979:13, fig. 6). The sections do not show the same thickening and extension of the socket ridges as in the Shenley species and the loop is wider with a broader transverse band.

Cox and Middlemiss (1978:432) place *Capillithyris* in synonymy with *Platythyris* (=*Aniabrochus*) which is a prior genus. The loops of the two genera are entirely different. The serial sections of Cox and Middlemiss (1978:433) are very sketchy but show the wide transverse band of *Capillithyris*. The loop of *Capillithyris* is entirely unlike that of *Platythyris* (=*Aniabrochus*) and *Capillithyris* is regarded as a good genus.

Carneithyris Sahni, 1925

PLATE 25: FIGURES 20–36; PLATE 26: FIGURES 3, 7, 8, 16–18; PLATE 27: FIGURES 1–7, 19; PLATE 29: FIGURES 22–24 PLATE 53: FIGURES 32–34; PLATE 69: FIGURES 22, 23

Carneithyris Sahni, 1925:364; 1929:30.

POSSIBLE SYNONYMS.—*Chatwinothyris* Sahni, 1925:371; 1929:38. *Ellipsothyris* Sahni, 1925:368; 1929:40. *Magnithyris* Sahni, 1925:367; 1929:38. *Ornithothyris* Sahni, 1925:374; 1929:43. *Piarothyris* Sahni, 1925:370; *Pulchrithyris* Sahni, 1925:361; not recognized by Sahni in 1929.

SUBFAMILY.—Carneithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Carneithyris subpentagonalis* Sahni 1925:365, pl. 23: fig. 15, 15a; pl. 24: figs. 2, 13, 13a; pl. 25: fig. 3, 3a; pl. 26: fig. 3.

SPECIMENS STUDIED.—Many, 11 excavated for the loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Senonian) to Danian.

LOCALITIES.—Great Britain, France, Germany, Russia, Poland, Denmark, and Sweden.

EXTERIOR.—Medium to large, elongate oval to semicircular, valves subequal in depth and convexity. Lateral commissure straight; anterior commissure rectimarginate. Beak low, suberect to erect. Foramen small, often minute. Symphytium hidden. Surface smooth.

TABLE 46.—Loop statistics for the genus *Carneithyris*

Proportions	USNM 12584	USNM 32125a	USNM 75698	USNM 112298	USNM 550961a	USNM 550962	USNM 550963a	USNM 550964a	USNM 550966	USNM 550970b	USNM 551093
∠	37°	33°	32°	27°	32°	30°	31°	32°	28°	37°	32°
Wl/Ll	0.71	0.76	0.65	0.75	0.70	0.67	0.69	0.66	0.80	0.67	0.63
Ll/LD	0.39	0.27	0.35	0.33	0.39	0.32?	0.36	0.35	0.35	0.31	0.43
Wl/WD	0.27	0.21	0.24	0.28	0.22	0.21	0.21	0.24	0.34	0.21	0.28
a/Ll	0.65	0.64	0.76	0.63	0.65	0.61	0.62	0.71	0.60	0.73	0.65
b/Ll	0.35	0.36	0.24	0.37	0.35	0.39	0.38	0.29	0.40	0.27	0.35
c/Ll	0.41	0.36	0.53	0.50	0.59	0.44	0.48	0.41	0.50	0.47	0.39
d/Ll	0.24	0.28	0.23	0.13	0.06	0.17	0.14	0.29	0.10	0.26	0.26
e/Ll	0.12	0.21	0.06	0.12	0.21	0.17	0.21	0.12	0.25	0.14	0.22
f/Ll	0.23	0.15	0.18	0.25	0.14	0.22	0.17	0.17	0.15	0.13	0.13
g/WD	0.27	0.24	0.24	0.29	0.31	0.21	0.21	0.20	0.23	0.25	0.31
g/Wl	1.00	1.12	1.00	1.00	1.00	0.92	1.10	1.00	0.81	1.20	1.10
h/f	0.30	0.13	0.50	0.56	0.36	0.55	0.53	0.53	0.33	0.85	0.54
h/Ll	0.07	0.02	0.09	0.14	0.05	0.12	0.09	0.09	0.05	0.11	0.07
WD/LD	1.00	1.00?	0.94	0.87	1.00?	1.00?	1.12	1.00	1.00	1.00	0.98

USNM 12854: *Carneithyris carnea* (Sowerby), Cretaceous (Senonian), Shilofka, Simbirsk, Russia.

USNM 32125a: *C. carnea* (Sowerby), Cretaceous (Senonian Craie Blanche), Meudon, France.

USNM 75698: *C. rotunda* Sahni, Cretaceous (Senonian), ?Norwich, Norfolk, England.

USNM 112298: *C. subrotundata ? nilssoni* Hadding, Cretaceous (Upper Campanian – Lower Maastrichtian – Köpinge Sandstone), Köpinge, Scania, Sweden.

USNM 550961a: *C. carnea* (Sowerby), Cretaceous (Senonian – *B. mucronata* Zone), Hartford Bridge, Norfolk, England.

USNM 550962: *C. carnea* (Sowerby), Cretaceous (Senonian – *B. mucronata* Zone), ? Norwich, Norfolk, England.

USNM 550963a: *C. circularis* Sahni, Cretaceous (Upper Maastrictian), Nasitow, near Putaway, Poland.

USNM 550964a: *C. circularis* Sahni, Cretaceous (Senonian), Sussex, England.

USNM 550966: *C. carnea* (Sowerby), Cretaceous (Senonian), Meudon, France.

USNM 550970b: *C. elongata* (Sowerby), Cretaceous (base of Maastrictian), Slenaken, Netherlands.

USNM 551093: *C. carnea* (Sowerby), Cretaceous (Senonian), beach at Sargard, near Sassnitz, Rügen, Germany.

INTERIOR.—Delthyrial cavity almost tubular; teeth large; muscle field small, elongate oval in outline. Vascula media well impressed.

Loop and Cardinalia: The loop is subtriangular to subrectangular. The cardinal process is usually large and often massive having a swollen anterior and deeply impressed myophore which forms a lobate pit divided medially by a low median ridge. The socket ridges are thick and erect or slightly inclined and bound wide sockets. The fulcral plates are usually often so obscured by excess shell that they cannot be distinguished. They taper onto the crural bases posterior to the cardinal process.The crural bases are thick, laterally compressed, short and broad. They expand into the crural processes which are more or less strongly bent medially and usually have sharp, thin points. The crural bases may be seen in the excess tissue of the outer hinge plates as ridges running toward the cardinal processes. The descending lamellae are short and slightly bowed. They support a fairly strongly arched transverse band, variable in width. The median crest is variable, often roundly angulated or narrowly rounded.

LOOP STATISTICS.—See Table 46.

DISCUSSION.—Asgaard (1975) made an exhaustive study of Sahni's types of the above genera in the British Museum (Natural History) as well as quantities of supplementary material. The study included examination and analysis of both exterior and interior details and a statistical study of specimens purported to be species of *Carneithyris* and *Chatwinothyris* from seven localities of the upper Chalk. The specimens studied came from well documented localities and were collected from parts of the sequence having established stratigraphic level. The statistics failed to show any basic differences between the two genera or between the various species of the two genera, or with five other genera described by Sahni. Moreover, the stratigraphic sequence for the development of the cardinal process proposed by Sahni proved not to be in proper stratigraphic order. Asgaard therefore came to the conclusion that she could recognize only two valid species and a single genus. Thus the genera *Chatwinothyris*, *Ellipsothyris*, *Magnithyris*, and *Ornithothyris* are placed by Asgaard in the synonymy of *Carneithyris*. In the present study similarity of the loop of *Carneithyris* to those of the genera named is apparent and it is difficult to separate *Carneithyris* from *Chatwinothyris* except for bizarre internal developments. Consistent and persistent exterior characters are also lacking. There is variation in the size of the foramen and the character of the beak ridges of these genera. When folded the anterior commissure is usually uniplicate except the Danish species called *Carneithyris incissa* (von Buch) which is fairly strongly sulcate in adult stages.

Muir-Wood (1965:H799) proposed the subfamily Carneithyridinae with two genera: *Carneithyris* and *Chatwinothyris*. She placed *Ellipsothyris*, *Magnithyris*, *Ornithothyris*, *Piarothyris*, and *Pulchrithyris* in the synonymy of *Carneithyris*. *Chatwinothyris* was recognized as a valid genus.

In this study specimens originally identified as *Ellipsothyris*, *Ornithothyris*, and *Magnithyris* have been excavated and their loops illustrated herein for comparison with those of *Carneithyris*. I have given herewith descriptions and statistics of the loops of specimens identified as *Carneithyris*, *Chatwinothyris*, *Ellipsothyris*, *Magnithyris*, and *Ornithothyris*.

Chatwinothyris Sahni, 1925

PLATE 20: FIGURES 1–6; PLATE 24: FIGURES 8–14; PLATE 26: FIGURES 1, 2; PLATE 69: FIGURES 18, 19

Chatwinothyris Sahni, 1925:368; 1929:40.—Popiel-Barczyk, 1968:44.—Asgaard 1975:335.

SUBFAMILY.—Carneithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Chatwinothyris subcardinalis* Sahni, 1925:369, pl. 23: fig. 9; pl. 24: fig. 4, 4a; pl. 26: fig. 4, 4a. Asgaard, 1975:335, pl. 8; figs. 1–4.

SPECIMENS STUDIED.—Seventy-five specimens, 5 excavated for loop.

GEOLOGIC OCCURRENCE.—Upper Cretaceous to Danian.

LOCALITIES.—Great Britain, Denmark, Sweden, Germany, Poland, Belgium, and Russia.

EXTERIOR.—Resembling *Carneithyris* in its circular to longitudinally elliptical outline, subequally convex valves. Lateral commissure straight; anterior commissure rectimarginate. Beak suberect to erect. Foramen small to minute. Surface smooth.

INTERIOR.—For ventral valve interior see Steinich, 1965 and Popiel-Barczyk, 1968.

Loop and Cardinalia: *Chatwinothyris* usually has an enormous development of the cardinal process. This is usually bulbous but with the myophore etched into the surface of the bulb. The myophore is a bilobed pit with elevated sides and median ridge which, in some specimens, amounts to a septum. Popiel-Barczyk illustrates the numerous variations of the cardinal process. The median ridge on the cardinal process is best seen in a specimen from Sweden (Plate 53: figures 32–34). The fulcral plate is thick and massive, as is the socket ridge which is difficult to identify. When distinguishable it is thick, curved and bounds a wide socket. The outer hinge plates are buried under thick shelly deposits. Drawings of the young of *C. subcardinalis* Sahni show no outer

TABLE 47.—Loop statistics for the genus *Chatwinothyris*

Proportions	USNM 75694b	USNM 104846a	USNM 550975a
∠	41°	30°	35°
Wl/Ll	0.82	0.57	0.75
Ll/LD	0.26	0.31	0.36
Wl/WD	0.20	0.21	0.37
a/Ll	0.55	0.57	0.70
b/Ll	0.45	0.43	0.30
c/Ll	0.46	0.46	0.55
d/Ll	0.09	0.11	0.15
e/Ll	0.27	0.14	0.15
f/Ll	0.18	0.29	0.15
g/WD	0.24	0.25	0.36
g/Wl	1.22	1.20	1.00
h/f	0.50	0.40	0.20
h/Ll	0.09	0.11	0.03
WD/LD	1.09	0.83	0.94

USNM 75694b: *Chatwinothyris curiosa* Sahni. Cretaceous (Senonian - *Ostrea lunata* Zone), Trimingham, Norfolk, England.

USNM 104846a: *C. ciplyensis* Sahni, Cretaceous (Senonian - Craie phosphaté de Ciply), Ciply, Belgium.

USNM 550975a: *Chatwinothyris* species, Paleocene (Danian), Limhamn Quarry, Limhamn, Sweden.

hinge plates, the crural bases being welded to the socket ridges to form V-shaped troughs (Steinich, 1965:43, figs. 29–31). The crural bases are also well buried but may be seen in some specimens where they emerge from the mass of shell material covering their proximal parts. The crural bases are always short, thick and broad. The crural processes are bluntly acute and when complete are provided with needle-sharp points. The position of the crural processes is usually at or near midloop. There are scarcely any descending lamellae because the anterior slope of the crural processes unites with the transverse band. The transverse band is variable according to species. In *C. ciplyensis* Sahni it is a moderately wide ribbon, moderately arched and with a rounded crest. In *C. curiosa* Sahni it is narrower than the preceding and is less sharply folded. Steinich's (1965:43, fig. 32) figure of the loop of *C. subcardinalis* Sahni shows complete covering of the outer hinge plates. The anterolateral extremities of the loop of *Chatwinothyris* are not drawn into long points.

LOOP STATISTICS.—See Table 47.

DISCUSSION.—In accordance with the painstaking work of Asgaard (1975) it is difficult to find any valid difference between the loops of *Carneithyris* and *Chatwinothyris*.

Concinnithyris Sahni, 1929

PLATE 20: FIGURE 35; PLATE 24: FIGURES 18–22; PLATE 26: FIGURES 9–15, 27–31; PLATE 28: FIGURE 32; PLATE 29: FIGURES 1–3; PLATE 56: FIGURES 20–26; PLATE 68: FIGURES 11, 12, 19, 20

Concinnithyris Sahni, 1929:11.

SUBFAMILY.—Gibbithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Terebratula obesa* J. deC. Sowerby, 1821–1825:54, pl. 438: fig. 1.

SPECIMENS STUDIED.—Twenty-four, 5 with loop excavated.

GEOLOGIC OCCURRENCE.—Cretaceous (Neocomian and Turonian).

LOCALITIES.—Great Britain and France.

EXTERIOR.—Medium to large, roundly to elongate oval, biconvex, ventral valve deeper than dorsal valve. Lateral commissure nearly straight in posterior two-thirds, convex toward dorsal valve in anterior third. Anterior commissure usually uniplicate, becoming gently sulciplicate in the type species. Beak short, erect, often labiate and closely pressed onto or close to the dorsal umbone. Foramen small to medium size, round, submesothyridid. Surface smooth.

INTERIOR.—Ventral valve interior with stout teeth and variable pedicle collar.

Loop and Cardinalia: The cardinal process is small, usually a half ellipse with myophore facing posteriorly. The myophore surface consists of two shallow depressions separated by a low median ridge. The lateral margins of the cardinal process are deflected to form low rims. The fulcral plates are laterally extended. The socket ridges are variable in thickness depending on specimen age and are inclined laterally to define narrow sockets. The outer hinge plates are variable. They are concave and attached to the crural bases just dorsad of their ventral edge. The crural bases are broad, flat plates. There are no inner hinge plates.

TABLE 48.—Loop statistics for the genus *Concinnithyris*

Proportions	USNM 75687b	USNM 77379a	USNM 77447a	USNM 551072a	USNM 551098
∠	25°	40°	33°	32°	33°
Wl/Ll	0.50	0.78	0.66	0.61	0.73
Ll/LD	0.27	0.33	0.35	0.35	0.33
Wl/WD	0.15	0.29	0.23	0.22	0.22
a/Ll	0.72	0.61	0.66	0.61	0.65
b/Ll	0.28	0.39	0.34	0.39	0.35
c/Ll	0.72	0.35	0.53	0.41	0.50
d/Ll	0.00	0.26	0.13	0.20	0.15
e/Ll	0.11	0.11	0.16	0.09	0.23
f/Ll	0.17	0.28	0.18	0.30	0.12
g/WD	0.26	0.29	0.26	0.30	0.25
g/Wl	1.66	1.00	1.12	1.35	1.12
h/f	0.65	0.39	0.72	0.57	0.50
h/Ll	0.11	0.11	0.13	0.17	0.06
WD/LD	0.88	0.88	1.00	0.97	0.06

USNM 75687b: *Concinnithyris albensis* (Leymerie), Cretaceous (Turonian *T. gracilis* Zone), Whyteleaf Quarry, Warlingham, Surrey, England.

USNM 77379a: *Concinnithyris obesa* (Sowerby), Cretaceous (Chalk), exact locality unknown (see text below).

USNM 77447a: *Concinnithyris rouenensis*, new species, Cretaceous (Cenomanian), Ste. Catherine, Rouen, France.

USNM 551072a: *Concinnithyris rouenensis*, new species, Cretaceous (Cenomanian), Ste. Catherine, Rouen, France.

USNM 551098: *Concinnithyris burhamensis* Sahni, Cretaceous (Cenomanian - Lower Chalk), Bluebell Hill, Burham, Kent, England.

The ventral edge of the crural bases form a low ridge along the inner margin of the outer hinge plates. These with the socket ridges and hinge plates form shallow U-shaped troughs. The crural processes are acutely pointed. The anterior slope of the crural processes is short and steep. The transverse band is moderately broad and widely arched, usually with a rounded or narrowly angular crest.

LOOP STATISTICS.—See Table 48.

DISCUSSION.—The loop of *Concinnithyris* is similar to that of *Carneithyris* in having broad crural bases with the outer hinge plates attached just dorsad of the ventral edge of the crural base. *Concinnithyris* is never so extravagantly thickened as *Carneithyris* and the cardinal process is not grossly overgrown. The foramen, except for the name typed of *Concinnithyris*, is usually larger than that of *Carneithyris*. The anterior commissure of *Carneithyris* is commonly rectimarginate whereas that of *Concinnithyris* is usually uniplicate with a tendency to sulciplication in some species.

The specimens figured on Plate 26: figures 27–31 were originally labelled Norwich, England, but no members of *Concinnithyris* are known from Norwich (oral communication from Dr. Ellis F. Owen, British Museum (Natural History)). These specimens were compared closely with Sahni's (1929, pl. 1) illustrations of *Concinnithyris obesa* (Sowerby) and close agreement was seen between these uncertain specimens and Sahni's illustration of the type specimen of *C. obesa* (1929, pl. 1: figs. 7–9). These specimens also agree with Sowerby's (1821–1825, pl. 438: fig. 1; this paper, Plate 20: figure 35) figure of the type specimen. I feel confident that these specimens are examples of *C. obesa*.

The illustrations of the loop of *C. obesa* illustrated by Sahni (1929, pl. 8: figs. 1, 2) are not in agreement with the loop of USNM 77379a, although the loop of the uncertainly located specimens agrees in all details with the definition of *Concinnithyris*. French specimens from Rouen, France commonly identified as *C. obesa* (Sowerby), are not specifically the same as the British type. They are rounder and the anterior commissure is uniplicate not incipiently sulcate like Sowerby's type. *Concinnithyris obesa* is said by Sahni (1929) to be the only species of *Concinnithryis* having a sulciplicate anterior commissure, all the others being uniplicate. This species was an unfortunate choice for the type of the genus because so much weight is given to folding of the anterior commissure in generic evaluation. The loop of *Concinnithyris* resembles that of *Biplicatoria* but that genus is always strongly biplicate.

Concinnithyris rouenensis, new species

PLATE 26: FIGURES 9–15; PLATE 56: FIGURES 20–26; PLATE 68: FIGURES 11, 12, 19, 20

DIAGNOSIS.—Strongly biconvex, roundly oval *Concinnithyris* of large size, and small foramen.

DESCRIPTION.—Large, roundly oval; valves unequally but strongly convex; ventral valve with greater convexity and depth. Sides and anterior margin rounded. Posterolateral margins greater than a right angle in adult. Lateral commissure forming an elongate S. Anterior commissure broadly uniplicate with tendency to weak sulciplication. Beak low, incurved onto dorsal umbo. Beak ridges rounded. Foramen small. Surface smooth.

Ventral valve strongly convex in lateral profile, highly domed and with steep lateral slopes in anterior view. Umbonal region swollen, flattening anteriorly to form an ill-defined sulcus.

Dorsal valve strongly convex in both profiles but not as strongly convex as ventral valve. Lateral slopes steep. Median region swollen, anterior slightly flattened to form a low fold.

Ventral valve interior not seen. Dorsal valve interior with triangular loop occupying a third the length and width of the dorsal valve. Crural processes anterior to midloop. Transverse band wide.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
551072	36.0	32.0	31.2	26.5	101°
77447a	30.0	26.4	27.8	20.0?	99°
77447b	36.0	31.6	29.6	26.5	82°

OCCURRENCE.—Cretaceous (Cenomanian), Ste. Catherine, Rouen, France.

TYPES.—Holotype: USNM 551072; paratypes: USNM 77447a,b; USNM 551072a.

COMPARISON.—This species differs from *C. obesa* (Sowerby) in its shorter, rounder outline and profile, deeper shell and narrower loop.

Cyranoia, new genus

PLATE 21: FIGURES 21–26; PLATE 54: FIGURES 25, 26; PLATE 55: FIGURE 13; PLATE 66: FIGURE 2

SUBFAMILY.—Rectithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Terebratula depressa vissae* Hadding, 1919:20, pl. 9: fig. 1a–c.

DIAGNOSIS.—Terebratulacea with exterior like that of *Rectithyris* with long beak, round, uncovered symphytium, short outer hinge plates, wide loop and strong development of inner hinge plates; socket ridges not extended laterally.

SPECIMENS STUDIED.—Forty-one, seven unsuccessfully excavated, all with incomplete loop but good cardinalia.

GEOLOGIC OCCURRENCE.—Cretaceous (Senonian)

LOCALITY.—Sweden.

EXTERIOR.—Like that of *Rectithyris* with long beak, large apical permesothyridid foramen. Completely visible convex symphytium. Rectimarginate to sulciplicate anterior commissure.

INTERIOR.—Ventral interior with large teeth and short, excavate pedicle collar.

Loop and Cardinalia: The cardinal process is large, strongly protuberant and somewhat quadrate in outline. It is marked medially by a low ridge. The myophore faces posteriorly. The socket ridges are stout, erect and slightly inclined laterally to bound narrow sockets. The sockets are roofed near the cardinal process. The fulcral plates are well defined. The outer hinge plates are narrow, a mere connective dorsally welding the high crural bases and socket ridges, the combination producing narrow V-shaped troughs. The outer hinge plate tapers to disappearance a short distance anterior to the fulcral plate. At this point the crural process is formed and is long and needle-like. The points are strongly directed medially and anteriorly. Inner hinge plates are strongly but variably developed, completely covering the notothyrial cavity in some mature specimens. They are marginal or absent in the young. Transverse band not seen.

LOOP STATISTICS.—USNM 112312b: $\angle = 47°$: Wl/Ll = 0.87; Ll/LD = 0.35; Wl/WD = 0.29; a/Ll = 0.56; b/Ll = 0.44; c/Ll = 0.50; d/Ll = 0.06; e + f/Ll = 0.44; g/WD = 0.24; g/Wl = 0.71; h/Ll = ?; WD/LD = 0.92.

USNM 112312b: *Cyranoia longirostris* (Wahlenberg), Cretaceous (Senonian – *Actinocamax mammillatus* Zone), Ifö, Blaksudden, Scania, Sweden.

DISCUSSION.—Although the generic definition of *Rectithyris* calls for the presence of inner hinge plates, the two specimens of its type species from the type locality, excavated for the loop and illustrated herein (Plate 21) show no trace of these structures. Middlemiss (1959:124) saw no such structures in his study of the type species. Inner hinge plates are a mark of *Cyranoia*, well developed in adult specimens and thus a means of distinction from *Rectithyris*. The loop and cardinalia of the Swedish shells also differ from the Belgian ones in having the crural processes located almost opposite the fulcral plates. The crural processes of *Cyranoia* are longer than those of *Rectithyris* and are more incurved. The socket ridges of *Cyranoia* are not extended posteriorly to form a ridge flush with the posterior margin which is the most characteristic feature of *Rectithyris*. Unfortunately it is not possible to compare the transverse bands of the two genera. *Terebratula praelustris* (von Hagenow) is closely related to *C. longirostris* and is well provided with inner hinge plates.

ETYMOLOGY.—From the Latin *Cyrano* (lover with a long nose).

Cyrtothyris Middlemiss, 1959

PLATE 19: FIGURES 23, 24; PLATE 76: FIGURES 6, 7

Cyrtothyris Middlemiss, 1959:123.

SUBFAMILY.—Rhombothyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula depressa* var. *cyrta* Walker, 1868:404, pl. 18: fig. 1, 1b. Middlemiss, 1959:125, figs 2, 14, pl. 16: fig. 13, pl. 17: fig. 1.

SPECIMENS STUDIED.—Twelve, one excavated for loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Aptian – Hauterivian).

LOCALITIES.—Great Britain and Germany.

EXTERIOR.—Large, oval, lenticular in profile; valves subequal in depth. Lateral commissure nearly straight; anterior commissure widely uniplicate. Beak short, massive, suberect, truncated. Foramen large, permesothyridid. Symphytium wholly visible. Surface smooth.

INTERIOR.—Ventral interior not seen.

Loop and Cardinalia: The loop is moderately long and wide, with length and width nearly equal; it occupies nearly 40% of the length and width of the dorsal valve. The cardinal process is a flattened ellipse, seemingly small for so large a shell. The fulcral plates are well developed and extend as a strong ridge laterally. The socket ridges are moderately thick and slightly inclined to overhang the socket. The outer hinge plates are short, narrow and steeply inclined. They are attached along the dorsal side of the crural bases. The narrow outer hinge plate tapers anteriorly forming a flange, and is extended to a point just dorsad of the crural process thus eliminating a measurable crus. The crural bases form high walls along the inner edge of the outer hinge plates, and with them and the socket ridges, form short troughs. The crural processes are long, sharp points strongly directed anteroventrally and toward midvalve. The anterior edge of the crural processes form slightly bowed, short descending lamellae. The transverse band is fairly wide, moderately arched and flattened medially, the flattening forming a narrow slightly protuberant platform about a third of the loop width. The posterior side of this small platform is concave toward the posterior. The anterolateral extremities of the loop form subangular points.

LOOP STATISTICS.—USNM 550943b: $\angle = 43°$; Wl/Ll = 0.94; Ll/LD = 0.39; Wl/WD = 0.36; a/Ll = 0.63; b/Ll = 0.37; c/Ll = 0.63; d/Ll = 0.00; e/Ll = 0.12; f/Ll = 0.25; g/WD = 0.29; g/Wl = 0.80; h/f = 0.24; h/Ll = 0.06; WD/LD = 1.00.

USNM 550943b: *Cyrtothyris cyrta* (Walker), Cretaceous (Aptian – Lower Greensand), Brickhill, Buckinghamshire, England.

DISCUSSION.—Some members of this genus were formerly placed in *Rectithyris* because of the straight beak with its convex symphytium. The two differ internally. The socket ridges of *Cyrtothyris* are not elevated to form a ridge protruding posteriorly as they do in *Rectithyris*. Middlemiss mentions differences seen in serial sections such as the virgate hinge plates that are more open in *Rectithyris* than in *Cyrtothyris*. The hinge plates of

Rectithyris are keeled for their whole length but "in *Cyrtothyris* the keel is typically a crural one, although not always present, and is associated with a flange more or less at right angles to the crus to give the 'golf-club' shape of the crura typical of this genus in cross-section." The transverse band of *Rectithyris* is more narrowly folded than that of *Cyrtothyris*.

Dilophosina, new genus

PLATE 18: FIGURES 1–12; PLATE 67: FIGURES 21, 22

SUBFAMILY.—Nerthebrochinae, new subfamily.

TYPE-SPECIES.—*Dilophosina paraplicata*, new species.

DIAGNOSIS.—Externally like *Harmatosia*, new genus, with a roughly squarish loop lacking inner hinge plates.

SPECIMENS STUDIED.—Thirty-two, four excavated for loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Cenomanian).

LOCALITY.—France.

EXTERIOR.—Medium size, narrowly oval, biconvex, ventral valve slightly deeper, more convex than dorsal valve. Posterolateral extremities large acute angle. Lateral commissure convex toward ventral side anteriorly; anterior commissure paraplicate. Dorsal sulcus short, less than half dorsal valve length. Beak suberect, beak ridges short, rounded. Foramen large, mesothyridid to permesothyridid. Symphytium visible. Surface with concentric lines and undulations of growth only.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is short, squarish, gently expanding anteriorly and occupies a third the length and slightly less than a third the width of the dorsal valve. The socket plates are erect and bound narrow sockets that are roofed proximally. The fulcral plates are thick and slightly extended laterally. The outer hinge plates are narrow, steeply inclined and are attached to the dorsal edge of the crural bases. The tapered edge of the outer hinge plates extend to the crural processes where they disappear. The crural bases form a strong, high ridge along the inside edge of the outer hinge plates. Inner hinge plates are not developed. The socket ridges, outer hinge plates and elevated crural bases combine to make narrow U-shaped troughs. The crural processes are located at more than half the loop length, are acutely angular and gently approximate. They have a short, abrupt anterior slope that supports the transverse band, thus there are measurable descending lamellae. The transverse band is narrow, nearly horizontal in profile, gently arched and with a low, narrow subangular median fold.

LOOP STATISTICS.—See Table 49.

TABLE 49.—Loop statistics for the genus *Dilophosina*

Proportions	USNM 550932b	USNM 550932d	USNM 550933b
∠	29°	33°	27°
Wl/Ll	0.68	0.71	0.67
Ll/LD	0.33	0.31	0.30
Wl/WD	0.27	0.21	0.24
a/Ll	0.64	0.57	0.67
b/Ll	0.36	0.43	0.33
c/Ll	0.64	0.57	0.67
d/Ll	0.00	0.00	0.00
e/Ll	0.15	0.18	0.13
f/Ll	0.21	0.25	0.20
g/WD	0.24	0.24	0.31
g/Wl	1.10	1.10	1.40
h/f	0.43	0.40	0.45
h/Ll	0.09	0.10	0.09
WD/LD	0.83	0.85	0.84

USNM 550932b,d: *Dilophosina paraplicata*, new species, Cretaceous (Cenomanian), quarry 200 m SW of Billot, on E side road from Billot to Notre Dame de Fresney, 23 km SW of Lisieux, Calvados, France.

USNM 550933b: *Dilophosina paraplicata*, new species, Cretaceous (Cenomanian), Villers-sur-Mer, Calvados, France.

DISCUSSION.—This genus in its external form is an almost exact homeomorph of *Harmatosia* and *Boubeithyris* from the Cenomanian of Germany and the Tourtia of Belgium. *Harmatosia* has inner hinge plates but *Dilophosina* does not. *Boubeithyris* is sulciplicate while *Dilophosina* is paraplicate. *Dilophosina* suggests a small example of *Biplicatoria*, The loops of the two genera are quite different, that of the former has a narrowly triangular form and a broad transverse band. Furthermore, the outer hinge plates of *Biplicatoria* are attached on the ventral part of the crural bases, not on the dorsal side as in *Dilophosina*.

ETYMOLOGY.—From the Greek *di* (two) plus *lophos* (ridge).

Dilophosina paraplicata, new species

PLATE 18: FIGURES 1–12

DIAGNOSIS.—Small to medium biplicate terebratulaceans having a squarish loop with crural processes anterior of midloop and narrow nearly horizontal non-protuberant transverse band.

DESCRIPTION.—Exterior and interior as for genus. Valve details below.

Ventral valve moderately convex in lateral view, broadly convex in median region with abruptly steep flanks in anterior profile. Median region with poorly defined fold extending to anterior margin and set off by short lateral sulci. Anterolateral flanks narrowly folded in anterior third.

Dorsal valve gently convex in lateral profile, moderately convex medially in anterior view with sides descending steeply. Umbonal and median regions gently swollen. Sulcus originating near midvalve, narrow, widening and deepening anteriorly where it is defined by bounding, narrowly rounded plicae. Anterolateral flanks concave.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
550932a	27.5	24.6	21.3	15.6	86°
550932c	25.7	22.5	19.0	14.8	81°

OCCURRENCE.—Cretaceous (Cenomanian), quarry 200 m southwest of Billot on east side of road from Billot to Notre Dame de Fresnay, 23 km (airline) southwest of Lisieux, Calvados, France.

TYPES.—Holotype: USNM 550932a; paratypes: USNM 550932b–f.

DISCUSSION.—This species suggests relationship to *Biplicatoria hunstantonensis* but differs in details of the exterior and interior. The beak of *Biplicatoria* is more incurved and the symphytium wholly or partially hidden whereas the symphytium of *Dilophosina* is wholly visible. The loops of the two are quite different as mentioned under the genus.

Dyscritothyris Cooper, 1979

PLATE 61: FIGURES 10–13

Dyscritothyris Cooper, 1979:15

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Dyscritothyris cubensis* Cooper, 1979:16, fig. 1, pl. 7: figs. 3–8.

SPECIMENS STUDIED.—Fifteen, four excavated unsuccessfully, two sectioned serially.

GEOLOGIC OCCURRENCE.—Upper Cretaceous.

LOCALITY.—Cuba.

DISCUSSION.—This is a small subcircular brachiopod with uniplicate anterior commissure. The dorsal valve interior has nearly flat outer hinge plates and loop length about a third the dorsal valve length. The genus is based on a few specimens showing most characters. Four specimens were excavated in an effort to show the loop but the loop was imperfect in all of them. Two specimens were sectioned serially and both failed to show a complete loop which must have been a delicate structure. The cardinalia pattern produced by the serial sections corresponds to the type designated by Muir-Wood (1965:H818; herein, Plate 76: figure 15) as "horizontal tapering." This type of hinge plate is described by Middlemiss (1959) for *Platythyris*. The Cuban genus however, is quite different in shape and has a smooth exterior surface. *Platythyris* has its hinge plates attached to the socket ridges more posteriorly than in *Dyscritothyris*. The sections of *Dyscritothyris* offer no possibility of preparing the usual statistics from them.

Ellipsothyris Sahni, 1925

PLATE 25: FIGURES 7–13

Ellipsothyris Sahni, 1925:371; 1929:38.

SUBFAMILY.—Carneithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Ellipsothyris similis* Sahni, 1925: 371, pl. 23: fig. 13, 13a; pl. 24: fig. 8, 8a; pl. 25: fig. 9, 9a. Asgaard, 1975:344, fig. 2E, pl. 4: fig. 10; pl. 5: fig. 5.

SPECIMENS STUDIED.—Three specimens, one with imperfect loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Senonian).

LOCALITY.—Great Britain.

EXTERIOR.—Oval, lateral commissure straight; anterior commissure rectimarginate. Beak short, suberect, labiate. Foramen small, permesothyridid. Symphytium visible. Smooth.

INTERIOR.—Ventral valve with stout, hook-like teeth; pedicle collar moderately long, excavate. Muscle field just posterior of midvalve, elongate elliptical.

Loop and Cardinalia: The loop is short and occupies a third of the length and a fifth of the width of the dorsal valve. The cardinal process is small with a half elliptical myophore with slightly depressed lateral hollows separated by a low median ridge. The anterior or under surface of the cardinal process is thickened to form a short, stout shaft. The socket ridges are thick and erect, bounding wide sockets that are proximally roofed. The fulcral plates are thin and well-defined. The outer hinge plates are difficult to separate from the socket ridges, are narrow and taper onto the ventral edge of the crural bases. The crural bases are broad and extend to the apex below the outer hinge plates. The crural processes are wide, bluntly pointed and are located anterior of midloop. No measurable descending lamellae appear. The transverse band is moderately broad, gently arched and moderately protuberant.

LOOP STATISTICS.—USNM 550957b: $\angle = 27°$; Wl/Ll = 0.57; Ll/LD = 0.33; Wl/WD = 0.19; a/Ll = 0.60; b/Ll = 0.40; c/Ll = 0.60; d/Ll = 0.00; e/Ll = 0.27; f/Ll = 0.13; g/WD = 0.22; g/Wl = 1.18; h/f = 1.00; h/Ll = 0.13; WD/Ll = 1.00.

USNM 550957b: *Ellipsothyris similis* Sahni, Cretaceous (Senonian - *B. mucronata* Zone), St. James Pit, Denmark Farm, Norwich, Norfolk, England.

DISCUSSION.—The specimens figured herein have cardinalia similar to those of the holotype figured by Asgaard (1975, pl. 4: fig. 10). The loop and cardinalia do not conform to those of Sahni's paratype figured by Asgaard (1975, pl. 7: fig. 5) which shows a loop with unusual proportions: Wl/Ll = 0.57; a/Ll = 0.82; b/Ll = 0.18; c/Ll = 0.47; d/Ll = 0.35; e/Ll = 0.08; f/Ll = 0.10. These figures show exceptionally anterior crural processes, unusually long crura and moderately wide transverse band.

Eurysoria, new genus

PLATE 17: FIGURES 1–15; PLATE 54: FIGURES 1–8; PLATE 68: FIGURES 3, 4

SUBFAMILY.—Eurysoriinae, new subfamily.

TYPE-SPECIES.—*Eurysoria texana*, new species.

DIAGNOSIS.—Small to medium sized terebratulaceans with exterior resembling *Waconella*, with short, wide loop, with obscure crural bases.

SPECIMENS STUDIED.—One hundred, including three specimens with excavated loop and one sectioned serially.

GEOLOGIC OCCURRENCE.—Lower Cretaceous.

LOCALITY.—Texas.

EXTERIOR.—Small to medium size, subcircular to subpentagonal, sides and anterior rounded. Lateral commissure gently curved toward the ventral side; anterior commissure somewhat narrowly uniplicate. Valves unequal in depth, ventral valve with greater depth and convexity. Beak short, moderately protuberant, erect. Beak ridges strong, interarea wide laterally. Foramen moderately large, round to roundly elliptical, mesothyridid. Deltidium usually visible occasionally partially or wholly resorbed. Surface usually smooth occasionally with faint radial capillae.

INTERIOR.—Ventral valve with small narrow teeth; other details not clear.

Loop and Cardinalia: The cardinal process is small. The loop is short and wide and occupies a third or slightly less of the length and a third to quarter of the width of the dorsal valve. The socket ridges are thick, erect, and bound narrow sockets. The fulcral plates are thick and narrow. The outer hinge plates are variable, narrow to

TABLE 50.—Loop statistics for the genus *Eurysoria*

Proportions	USNM 550566	USNM 550567d	USNM 550573	USNM 551051b
∠	46°	46°	48°	45°
Wl/Ll	0.93	1.00	0.93	0.90
Ll/LD	0.33	0.30	0.26	0.33
Wl/WD	0.32	0.28	0.19	0.25
a/Ll	0.53	0.53	0.64	0.60
b/Ll	0.47	0.47	0.36	0.40
c/Ll	0.53	0.53	0.35	0.60
d/Ll	0.00	0.00	0.29?	0.00
e/Ll	0.20	0.29	0.22	0.20
f/Ll	0.27	0.18	0.14	0.20
g/WD	0.30	0.25	0.25	0.30
g/Wl	0.93	0.88	0.90	1.22
h/f	0.48	0.50	0.50	0.60
h/Ll	0.13	0.09	0.07	0.12
WD/LD	0.96	1.05	0.86	1.21

USNM 550566: *Eurysoria compressa*, new species, Cretaceous (Edwards Formation - *Radiolites* Bed), Bluff Creek, 4 miles (6.4 kms) NW of Crawford, McLennon County, Texas.

USNM 550567d: *Eurysoria compressa*, new species, Cretaceous (Edwards Formation), 3 miles (4.8 kms) NE and 1.5 miles (2.4 kms) N of Oglesby, Texas.

USNM 550573: *Eurysoria robusta*, new species, Cretaceous (Comanche), W side of Rio Grande, 4 miles (6.4 kms) NW of El Paso, Texas (statistics prepared from serial sections).

USNM 551051b: *Eurysoria texana*, new species, Cretaceous (Main Street Formation), 0.5 mile (0.8 km) N of Meadow Brook Country Club on Wallace Road, E side of Fort Worth, Texas.

moderately wide and attach to the narrow crural bases and terminate at the crural processes. The crural bases do not form an elevated margin on the inside margin of the outer hinge plates. In lateral view the crural bases are narrow and hold the scoop-like anterior elements of the loop. The crural processes are fairly long and acutely pointed. They are anterior to midlength of the loop. The crural process points are approximate. The descending part of the crural processes are so short that there is no definable descending lamellae. The transverse band is moderately broad and forms a moderately strong median fold that is somewhat protuberant and is directed a short distance posteriorly at a low angle. There are no terminal points. The crest of the fold is flattened for about a third of the loop width.

LOOP STATISTICS.—See Table 50.

DISCUSSION.—The statistics obtained from the serial sections of USNM 550573 are not entirely accurate because of difficulty in identifying key parts of the loop. The identification of c and d are especially doubtful as is the exact position of the ends of the crural processes. It is probable that there is no measurable crus in specimen USNM 550573 as it is lacking from the other three specimens.

Eurysoria compressa is unusual among Cretaceous terebratulaceans for its resorption of the deltidium. The other species assigned to this genus also show this feature. Specimens of the type species from the Main Street Formation are variable, one showing a long deltidium, but a second with the deltidium almost half resorbed. The largest species, *E. robusta*, shows some resorption of the deltidium, but does not reach the extreme shown by *E. compressa*.

The loop of *Eurysoria* is unusual among Cretaceous brachiopods because of its great width (Wl/Ll = 0.80–1.00). It is also unusual for its narrow crural bases and scoop-like anterior part of the loop. In the latter character *Eurysoria* resembles *Aphragmus* but the species of that genus are biplicate and its loop is narrower than that of *Eurysoria*.

Eurysoria occurs with *Waconella*, a genus with long loop related to *Kingena*. The two are close homeomorphs but can be readily distinguished by the small foramen and presence of a long, strong septum in *Waconella*. The septum of *Waconella* can usually be seen through the thin shell as a dark line.

ETYMOLOGY.—From the Greek *eurys* (wide).

Eurysoria compressa, new species

PLATE 17: FIGURES 4–15

DIAGNOSIS.—*Eurysoria* with narrowly lenticular profile and small size.

DESCRIPTION.—Small, rounded to subpentagonal, sides gently rounded, anterior margin narrowly rounded. Ventral valve deeper than dorsal valve. Maximum width slightly posterior to midvalve. Anterior commissure uniplicate. Foramen large, deltidium largely resorbed, remnantal. Surface marked only by lines of growth. Puntae distant.

Pedicle valve moderately convex in lateral profile with maximum convexity at midvalve; anterior profile with median region swollen, with long lateral slopes. Sulcus obsolete, its presence shown by moderately long tongue.

Dorsal valve gently convex in lateral profile, maximum convexity in posterior half; anterior profile broadly, evenly convex, lateral slopes long and gentle. Umbonal region swollen, swelling extending from beak to anterior margin. Fold gently but narrowly rounded, defined only in anterior half.

Loop as in generic description.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
550567e	18.8	16.4	16.7	7.6	116°
550567b	15.6	13.7	13.7	7.0	100°
550567a	18.6	16.3	17.1	8.2	103°

TYPES.—Holotype: USNM 550567a; paratypes: USNM 550567b–e, 550566.

OCCURRENCE.—Cretaceous (Edwards Formation), three miles (4.8 km) northeast and 1.5 miles (2.4 km) north of Oglesby, Coryell County, Texas.

COMPARISON.—Of the three species of *Eurysoria* described herein this is the smallest, with narrowly lenticular profile, drastic resorption of the deltidium and consequently large pedicle opening.

Eurysoria robusta, new species

FIGURE 17; PLATE 17: FIGURES 1–3

DIAGNOSIS.—Large *Eurysoria* resembling *Waconella* with which it occurs, valves strongly convex, strongly uniplicate, deltidium short.

DESCRIPTION.—Medium size, large for genus, longer than wide, maximum width posterior of midvalve; sides rounded, anterior margin somewhat nasute; Apical angle usually obtuse. Beak and umbo narrow; foramen rounded, small, mesothyridid. Surface smooth; radial capillae visible on decorticated surfaces.

Ventral valve strongly convex in lateral profile, most convex slightly posterior to midvalve; anterior view, narrowly domed with long moderately sloping sides. Umbonal region narrowly swollen, swelling continuing to beyond midvalve where shell is flattened to form narrowly rounded, short tongue.

Dorsal valve of about same moderate convexity in lateral profile, anterior profile narrowly domed; median region forming a narrow hump extending from beak to anterior margin to form low fold occupying more than half valve width.

Interior known from serial section only. Outer hinge plates flattened; crural bases narrow; crural processes fairly long, located near midloop. Loop slightly longer than ⅓ dorsal valve length; transverse band fairly broad and arched medially. Low euseptoidum present.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
550571	24.0	21.0	22.6	15.1	93°
551052a	28.0	22.8	25.4	16.0	91°
551052b	28.7	25.6	24.0	17.0	81°

OCCURRENCE.—Lower Cretaceous (Comanche), Kent, east of Van Horn, Texas. Cretacous (Duck Creek), east side of east end of Sierra Prieta, Sierra Diablo, Texas.

TYPES.—Holotype: USNM 550571; paratypes: USNM 551052a,b, 550573.

COMPARISON.—This species bears a close resemblance to *Waconella* (formerly *Kingena*) *wacoensis* (Roemer) because it has a narrowed umbonal region, incurved beak and plump valves. It is readily distinguished from *Waconella* by the presence of a well marked dorsal median septum in *Waconella*.

Eurysoria robusta differs from *E. compressa* in its larger size, deeper and more convex valves, short deltidium, more strongly incurved beak and more strongly folded anterior commissure. *E. robusta* differs from *E. texana* in its larger size, smaller foramen, more convex valves and longer deltidium.

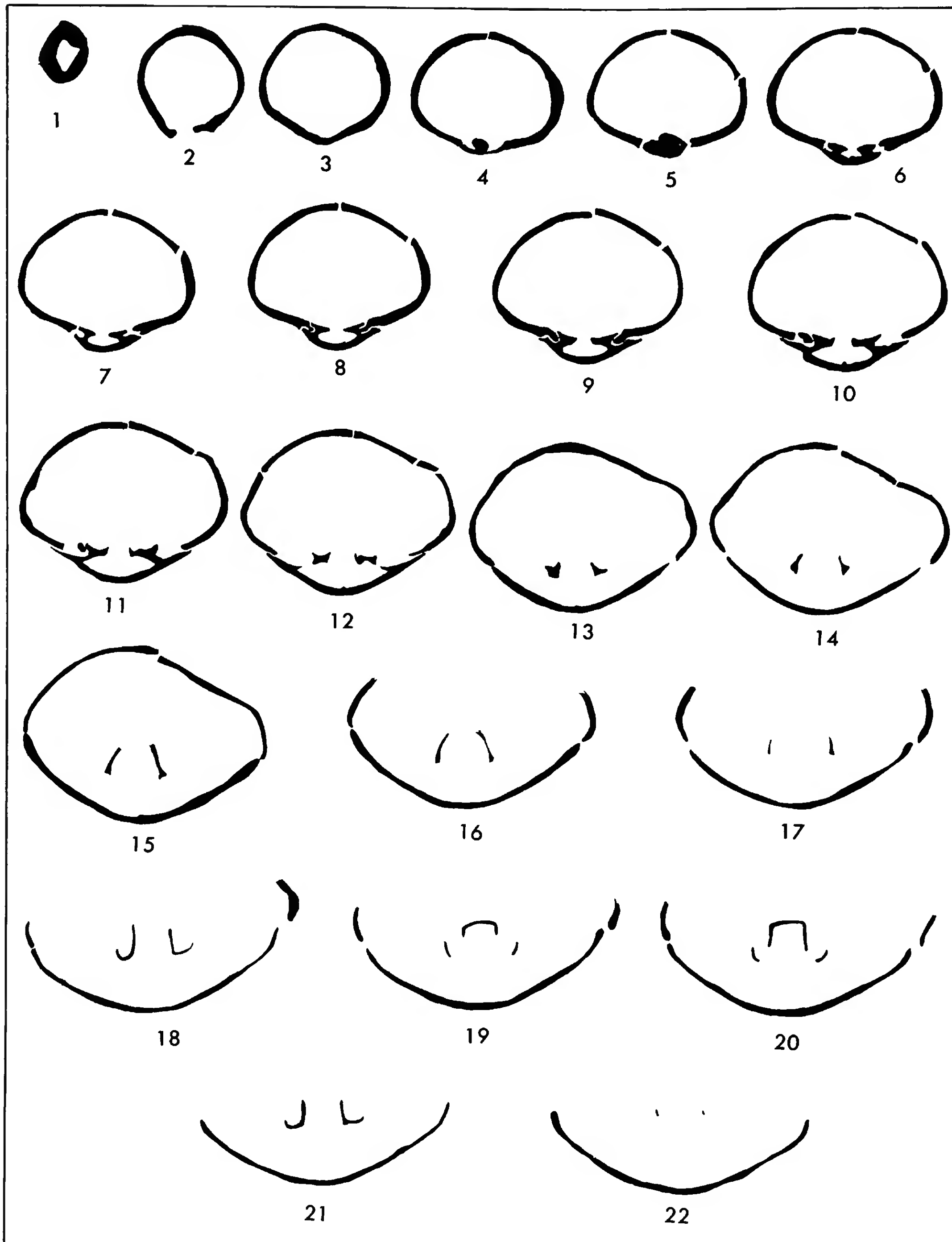


FIGURE 17.—Serial sections of *Eurysoria robusta*, new species, USNM 550573, distance between sections from beak to end of loop (in mm): 1 = 0.5, 2 = 2.0, 3 = 1.1, 4 = 0.6, 5 = 0.4, 6 = 0.5, 7 = 0.3, 8 = 0.3, 9 = 0.3, 10 = 0.3, 11 = 0.4, 12 = 0.5, 13 = 0.7, 14 = 0.4, 15 = 0.5, 16 = 0.1, 17 = 0.6, 18 = 0.8, 19 = 0.2, 20 = 0.3, 21 = 0.2, 22 = 0.5. Total length of loop = 7.2; length of dorsal valve = 28.3.

Eurysoria texana, new species

PLATE 54: FIGURES 1-8; PLATE 68: FIGURES 3, 4

DIAGNOSIS.—Medium size, moderately lenticular *Eurysoria* with well developed long deltidium (symphytium).

DESCRIPTION.—Medium size, anterior margin slightly to moderately nasute, sides shouldered; roundly pentagonal. Lateral margin curved toward ventral side at anterior; anterior commissure narrowly uniplicate. Beak moderately protuberant, suberect, set off by strong beak ridges defining lateral interareas. Foramen moderately large, round, mesothyridid. Surface smooth, finely capillate on decorticated surfaces.

Ventral valve moderately convex in lateral profile, more strongly convex than dorsal valve; anterior profile a broad dome. Umbonal and median regions somewhat narrowly swollen, swelling continuing to anterior third where valve flattens. Tongue moderately long, slightly convex.

Dorsal valve gently and evenly convex in lateral profile; broadly subcarinate in anterior profile. Umbonal region somewhat narrowly convex, convexity increasing anteriorly to form low, narrow fold.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
550572a	21.3	18.0	21.0	11.0	102°
550572b	21.2	17.0	18.7	10.0	86°

OCCURRENCE.—Cretaceous (Main Street), road cut north of Glen Garden Country Club swimming pool, Forth Worth, Texas; 0.5 mile (0.8 km) north of Meadow Brook Country Club, on Wallace Road, east side of Forth Worth, Texas.

TYPES.—Holotype: USNM 550572a; paratypes: USNM 550572b; 551051a,b.

COMPARISON.—This species is intermediate in convexity between *E. compressa* and *E. robusta*. It has a well developed deltidium or symphytium and is thus easily distinguished from *E. compressa* in which this structure is poorly developed or absent. It has a larger foramen and less incurved beak then *E. robusta* as well as much less convexity.

Gibbithyris Sahni, 1925

PLATE 24: FIGURES 29, 30; PLATE 26: FIGURES 4-6; PLATE 27: FIGURES 20-39; PLATE 28: FIGURES 28-30; PLATE 29: FIGURE 15; PLATE 30: FIGURES 10-13, 23-28; PLATE 68: FIGURES 7, 8

Gibbithyris Sahni, 1925:372; 1929:19.—Vantchurov and Kalugin, 1966:118-121.
Kestonithyris Sahni, 1925:372; 1929:44.
Piarothyris Sahni, 1925:370; 1929:37.—Asgaard, 1975:334 (part).

SUBFAMILY.—Gibbithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Gibbithyris gibba* Sahni, 1925: 372, pl. 23: fig. 4, 4a; pl. 24: fig. 3, 3a; pl. 25: fig. 2, 2a.

SPECIMENS STUDIED.—Many, eight excavated for loop.

GEOLOGIC OCCURRENCE.—Upper Cretaceous (Turonian and Senonian).

LOCALITIES.—Great Britain, France, and Russia.

EXTERIOR.—Medium to large, circular to broadly and roundly oval, thickly lenticular, ventral valve deeper than dorsal valve. Lateral commissure variable straight to ventrally curved depending on anterior folding. Anterior commissure rectimarginate to slightly to strongly sulciplicate. Beak short, suberect to erect, incurved, almost meeting or resting on dorsal umbo thus obscuring symphytium. Foramen small, often minute, permesothyridid. Surface smooth.

INTERIOR.—Ventral valve interior with stout teeth, short pedicle collar often obsolete by deposit of adventitious shell. Muscle field near midvalve; vascula media strong.

Loop and Cardinalia: The loop is stout, one-third the length and about a fifth the width of the dorsal valve. The cardinal process is a small, flattened half ellipse with myophore directed posteriorly or posteroventrally. The socket ridges are erect and stout, often obscured by the outer hinge plates. The fulcral plates are thin, well defined or thickened by adventitious shell. The fulcral plate is often extended laterally as a stout ridge. In USNM 75691b it is extended laterally for some distance to form a bed for the large, swollen teeth.

TABLE 51.—Loop statistics for the genus *Gibbithyris*

Proportions	USNM 75691b	USNM 75693a	USNM 123748	USNM 550968b	USNM 550969b	USNM 550971a	USNM 550978	USNM 550980b
∠	30°	29°	38°	34°	25°	28°	26°	25°
Wl/Ll	0.55	0.53	0.67	0.53	0.54	0.60	0.45	0.50
Ll/LD	0.33	0.37	0.31	0.36	0.28	?	0.37	0.35
Wl/WD	0.18	0.20	0.23	0.19	0.14	0.19	0.19	0.20
a/Ll	0.67	0.60	0.67	0.67	0.58	0.60	0.63	0.69
b/Ll	0.33	0.40	0.33	0.33	0.42	0.40	0.37	0.31
c/Ll	0.56	0.47	0.47	0.47	0.42	0.40	0.53	0.44
d/Ll	0.11	0.13	0.20	0.20	0.16	0.20	0.10	0.25
e/Ll	0.11	0.20	0.07	0.13	0.09	0.14	0.13	0.06
f/Ll	0.22	0.20	0.26	0.20	0.33	0.26	0.24	0.25
g/WD	0.30	0.27	0.25	0.29	0.20	0.25	0.31	0.28
g/Wl	1.60	1.37	1.20	1.50	1.38	1.33	1.65	1.37
h/f	0.59?	0.90	0.54	0.60	0.82	054?	0.46	0.64
h/Ll	0.13?	0.18	0.14	0.12	0.27	0.14?	0.11	0.16
WD/LD	1.00	1.00	1.00?	0.98	1.07	1.00	0.87	0.87

USNM 75691b: *Gibbithyris semiglobosa* (Sowerby), Cretaceous (Turonian – *H. planus* Zone), Dover, Kent, England.

USNM 75693a: *Gibbithyris semiglobosa* (Sowerby), Cretaceous (Turonian), same as above.

USNM 123748: *Gibbithyris semiglobosa* (Sowerby), Cretaceous (Craie de Chateaudun), Eure-et-Loire, France.

USNM 550968b: *Gibbithyris semiglobosa* (Sowerby), Cretaceous (Turonian), Croydon, Surrey, England.

USNM 550969b: *Gibbithyris* species, Cretaceous (Turonian), Guilford, Surrey, England.

USNM 550971a: *Gibbithyris inflata* (Sahni), Cretaceous, Greenwich, England.

USNM 550978: *Gibbithyris semiglobosa* (Sowerby), Cretaceous (Turonian), England (exact locality unknown).

USNM 550980b: *Gibbithyris semiglobosa* (Sowerby), Cretaceous (Turonian), landslip on Beachy Head, Sussex, England.

The outer hinge plates lap onto the socket ridges and their inner edge is attached to the ventral edge of the broad crural bases. The outer hinge plates are variable from gently concave to convex. The attachment to the crural bases may extend to the end of the crural processes. The crural bases are broad, nearly flat, nearly vertical and almost reach the valve floor at the posterior. The crural processes are not well defined because they are at the distal ends of the outer hinge plates and are marked by an abrupt descent anteriorly, giving the lateral branch of the loop a triangular aspect. The crural processes may be obtusely pointed or project anteriorly as small, sharp points. The transverse band is broad and forms a low arch that is gently angulated in the middle. The band is attached to the anterior slope of the crural processes without descending lamellae.

LOOP STATISTICS.—See Table 51.

DISCUSSION.—*Gibbithyris* is especially characterized by its broad crural bases and the usually convex outer hinge plates. All specimens do not show the ventrad convexity to the same degree and in young specimens the hinge plates are often gently concave (Plate 27: figures 30, 31). The cardinalia and hinge plates are suggestive of *Erymnia* but in *Gibbithyris* there are no struts to the floor supporting the crural bases. Muir-Wood (1965:H797) placed *Kestonithyris* Sahni in the synonymy of *Gibbithyris*. Asgaard (1975:334) stated that Sahni's *Piarothyris rotunda* "possesses all the characteristics of *Gibbithyris*."

Ventrally convex hinge plates have been noted in a number of unrelated genera: *Goniothyris*, *Placothyris*, *Heterobrochus*, *Karadagella*, and *Psebajithyris*.

Hadrosia, new genus

PLATE 17: FIGURES 36–41; PLATE 67: FIGURES 8, 9

SUBFAMILY.—Nerthebrochinae, new subfamily.

TYPE-SPECIES.—*Hadrosia convexa*, new species.

DIAGNOSIS.—Medium size, sulciplicate terebratulacean having shallow umbonal chamber, anteriorly rounded loop; loop with stout, broad transverse band.

SPECIMENS STUDIED.—Many, one loop excavated.

GEOLOGIC OCCURRENCE.—Cretaceous (Valanginian).

LOCALITY.—France.

EXTERIOR.—Medium size, longitudinally and widely elliptical, maximum width at midvalve, tapered toward both extremities. Valves nearly equal in depth, both swollen in umbonal region; profile roundly lenticular. Lateral commissure oblique posteriorly, convex toward ventral side anteriorly. Anterior commissure narrowly sulciplicate, median sulcus short, deep, fold in sulcus strong. Beak erect, labiate; beak ridges strong, subangular. Foramen large, permesothyridid. Symphytium mostly obscured. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: Umbonal chamber shallow. The loop is triangular, bowed laterally and occupies a third of the length and width of the dorsal valve. The cardinal process is a small half ellipse. The socket ridges are thin and erect and bound narrow sockets that are proximally roofed. Fulcral plates not seen. The outer hinge plates are fairly wide, triangular and short. They taper gradually along the dorsal edge of the crural bases and extend as a ridge to the base of the crural processes. The crural bases are broad and form a high ridge along the inside margin of the outer hinge plates, and with them and the socket ridges, form fairly wide U-shaped troughs. The crural processes are located anterior to midloop, are stoutly angular and are directed antermedially. The descending lamellae are short, laterally bowed and wide. The transverse band is broad, strongly arched and has steep lateral slopes. The terminal points are extended but are short and rounded. The transverse band is directed about 25° from the horizontal.

LOOP STATISTICS.—USNM 550930e: ∠ = 33°; Wl/Ll = 0.76; Ll/LD = 0.36; Wl/WD = 0.28; a/Ll = 0.59; b/Ll = 0.41; c/Ll = 0.59; d/Ll = 0.00; e/Ll = 0.09; f/Ll = 0.32; g/WD = 0.33; g/Wl = 1.15; h/f = 0.50; h/Ll = 0.16; WL/LD = 0.98.

USNM 550930e: *Hadrosia convexa*, new species, Cretaceous (Valanginian), Peyroules, Basse Alpes, France.

DISCUSSION.—*Hadrosia* externally resembles *Sellithyris* in its folding but the valves are more evenly and more strongly convex, the beak more incurved, hiding all or part of the symphytium. The loops of the two genera differ, that of *Hadrosia* having a narrower angle, the crural processes somewhat farther anterior, a more strongly arched transverse band, more pronounced terminal points and the transverse band much closer under the crural processes.

ETYMOLOGY.—From the Greek *hadros* (thick, bulky).

Hadrosia convexa, new species

PLATE 17: FIGURES 36–41; PLATE 67: FIGURES 8, 9

DIAGNOSIS.—Strongly lenticular *Hadrosia* resembling *Sellithyris* but having a narrower loop with broad transverse band.

DESCRIPTION.—Larger exterior characters and interior details as for the genus. Detailed exterior characters below.

Ventral valve moderately convex in lateral profile, moderately domed in anterior view. Umbonal regional narrowly swollen, swelling continued to midvalve and anteriorly to form broad to narrow fold bounded by short, variable, deep sulci. Lateral slopes steep and rounded.

Dorsal valve evenly and broadly convex in lateral view, almost semicircular in anterior profile. Umbonal region moderately swollen; median region inflated and extending anteriorly to form a strong fold just anterior to midvalve. Fold marked medially by a variably deep sulcus bounded by narrowly rounded plications to form an M-shaped anterior commissure. Flanks bounding plications shallowly concave; posterolateral flanks rounded and steep.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
550930a	28.3	24.6	23.6	17.4	100°
550930b	27.8	24.0	21.9	16.4	97°
550930c	25.8	22.9	20.7	16.5	92°
550930d	26.7	22.5	22.3	16.9	95°
550930f	25.5	21.2	22.8	17.7	95°

OCCURRENCE.—Cretaceous (Valanginian), Peyroules, Basses Alpes, France.

TYPES.—Holotype: USNM 550930a; paratypes: USNM 550930b–f.

DISCUSSION.—This species is suggestive of *Terebratula carteroniana* d'Orbigny but differs in its more rounded form, more nearly equivalve convexity and much lesser depth of the dorsal valve which is strongly swollen in "*T.*" *carteroniana*. This species also resembles *Sellithyris upwarensis* (Walker) but differs in its more convex dorsal valve, and in the more incurved beak which hides the symphytium in *Hadrosia*. *Hadrosia convexa* is larger, more rounded and has more inflated valves than *Loriolithyris valdensis* (Loriol).

Harmatosia, new genus

PLATE 19: FIGURES 13–22; PLATE 29: FIGURES 8–11; PLATE 67: FIGURES 5, 10, 11

SUBFAMILY.—Nerthebrochinae, new subfamily.

TYPE-SPECIES.—*Terebratula crassa* d'Archiac, 1847:318, pl. 18: fig. 8a–d.

DIAGNOSIS.—Exterior like *Dilophosina*, cardinalia with strong development of inner hinge plates.

SPECIMENS STUDIED.—Six, three with excavated loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Cenomanian).

LOCALITIES.—Belgium and Germany.

EXTERIOR.—Oval to pentagonal, unequally biconvex, ventral valve having greater convexity; maximum width near midvalve. Lateral commissure curved toward ventral valve at anterior; anterior commissure paraplicate. Dorsal sulcus short. Beak long, suberect. Foramen large, submesothyridid. Symphytium large, convex, completely visible, reminiscent of that of *Rectithyris*. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop has nearly parallel sides and occupies a little more than a third the length and not quite a third the width of the dorsal valve. The cardinal process is small, semielliptical with concave myophore facing dorsally. The socket ridges are strong, gently curved and incline slightly over the deep sockets. The outer hinge plates are narrow, inclined, and taper anteriorly along the dorsal edge of the crural bases, ending at about the middle of the crural processes, thus at about midlength of the loop. Inner hinge plates are strongly developed, semielliptical in outline, coalescing by overlap posteriorly. The crural bases form a high wall along the inner edge of the outer hinge plates. Hinge troughs narrowly U-shaped. The crural bases are narrow and flattened. The crural processes are located anterior of midloop, are not strongly expanded and are acutely angular. The descending lamellae are short and gently bowed. The transverse band is narrow and forms an arch inclined 25° from the horizontal. The median crest is angular. The terminal points are not extended.

LOOP STATISTICS.—USNM 550941b: $\angle = 30°$; Wl/Ll = 0.56; Ll/LD = 0.37; Wl/WD = 0.26; a/Ll = 0.70; b/Ll = 30; c/Ll = 0.70; d/Ll = 0.00; e/Ll = 0.11; f/Ll = 0.19; g/WD = 0.33; g/Wl = 1.27; h/f = 0.58; h/Ll = 0.11; WD/LD = 0.79.

USNM 550941b: *Harmatosia* aff. *H. crassa* (d'Archiac), Cretaceous (Cenomanian), Mühlheim, Germany.

DISCUSSION.—This German shell strongly resembles *H. crassa* from Tournay Belgium. The Belgian example has somewhat wider outer hinge plates but is well provided with inner hinge plates, although not so strongly developed as those of the German specimen. *Dilophosina*, externally like *Harmatosia*, is not provided with inner hinge plates. Possession of inner plates, as noted elsewhere, is an unusual development among the brachiopods, not yet seen in any Recent terebratulid, but well developed in the Paleozoic and less so in the Mesozoic. Only one Jurassic genus, *Viligothyris* Dagis, has been reported to have these structures. No Jurassic terebratulacean excavated during this study displayed inner hinge plates.

ETYMOLOGY.—From the Greek *harmatos* (fitted together).

Hesperosia, new genus

PLATE 17: FIGURES 16–27; PLATE 67: FIGURES 1, 2

SUBFAMILY.—Gibbithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Rectithyris vespertina* Cooper, 1955:4, pl. 1: figs. 18–37.

DIAGNOSIS.—Small, rectimarginate terebratulaceans having an erect beak and loop resembling that of *Concinnithyris.*

SPECIMENS STUDIED.—Thirty-five, 15 silicified specimens with loop exposed.

GEOLOGIC OCCURRENCE.—Cretaceous (Comanchian).

LOCALITY.—Arizona and adjacent Mexico.

EXTERIOR.—Small, oval, sides rounded, anterior margin narrowly rounded. Posterolateral margins approximately 90°. Inequivalve, ventral valve deeper and more convex than dorsal one. Lateral commissure straight; anterior commissure rectimarginate. Beak large, swollen, strongly protuberant, erect. Foramen fairly large, round, permesothyridid to mesothyridid. Surface smooth.

INTERIOR.—Details of ventral valve interior obscured by silicification.

Loop and Cardinalia: The cardinal process is a small half ellipse. The socket ridges are moderately thick and inclined over wide sockets. The fulcral plates are well developed and extended laterally as a ridge. The outer hinge plates are narrow, concave and anteriorly extended along the ventral edges of the crural bases on the slope leading to the crural processes. In side view the attachment is narrow and slender in young specimens but in older ones it is thickened on its dorsal edge and becomes flatter. The outer hinge plates are made shallower by thickening of the ventrad surface. The crural bases are narrow in young specimens, thick in older ones and form low ridges along the inner margin of the outer hinge plates. This low ridge may be eliminated by shell deposition on the surface of the outer hinge plates. The crural processes are located at or near midloop and have short acute points. The descending lamellae are moderately wide and gently bowed. The transverse band forms a

TABLE 52.—Loop statistics for the genus *Hesperosia*

Proportions	USNM 124187	USNM 124195	USNM 124196c	USNM 124218
∠	37°	39°	40°	40°
Wl/Ll	0.60	0.75	0.65	0.60
Ll/LD	0.42	0.37	0.34	0.47
Wl/WD	0.25	0.29	0.20	0.32
a/Ll	0.50	0.60	0.50	0.60
b/Ll	0.50	0.40	0.50	0.40
c/Ll	0.50	0.60	0.50	0.60
d/Ll	0.00	0.00	0.00	0.00
e/Ll	0.20	0.20	0.30	0.20
f/Ll	0.30	0.20	0.20	0.20
g/WD	0.29	0.27	0.20	0.32
g/Wl	1.17	0.93	1.07	1.20
h/f	0.23	0.45	0.25	0.35
h/Ll	0.07	0.09	0.05	0.07
WD/LD	1.00	0.96	1.13	1.00

USNM 124187: *Hesperosia vespertina* (Cooper), Cretaceous (Mural Formation), NW1/4 SW1/4 NE1/4, section 36, T. 23 S., R. 25, E., 300 yards (277 m) E of U.S. highway 80, Bisbee (15′) quadrangle, Arizona.

USNM 124195: *Hesperosia vespertina* (Cooper), Cretaceous (Mural Formation), 0.2 mile (0.3 km) E of US Highway 80, NW1/4 SW1/4 NE 1/4 section 36, T. 23 S, R. 25 E., opposite mouth of Glance Canyon, 3 miles (4.8 km) E of Glance, 12.7 miles (20.3 km) WNW of Douglas, Cochise County, Arizona.

USNM 124196c: *Hesperosia vespertina* (Cooper), same as above.

USNM 124218: *Hesperosia vespertina* (Cooper), Cretaceous (Mural Formation), hill by benchmark 4284, 3 miles (4.8 km) E of Glance, Bisbee (15′) quadrangle, Arizona.

strong, broad arch with rounded crest. The anterolateral extremities of the loop are angular but are not drawn into long points.

LOOP STATISTICS.—See Table 52.

DISCUSSION.—This genus differs from *Concinnithyris* in its smaller size, rectimarginate anterior commissure and relatively larger foramen. The loop differs from that of *Concinnithyris* in having narrow crural bases and a somewhat wider angle. One specimen (Plate 17: figure 24) is unusual in having the crural processes joined to form a ring as in *Terebratulina*. Whether this is a freak of mineralization or of biology it is difficult to say.

ETYMOLOGY.—From the Greek *hesperos* (west).

Iberithyris Kvakhadze, 1972

Iberithyris Kvakhadze, 1972:75.

SUBFAMILY.—Nerthebrochinae, new subfamily.

TYPE-SPECIES.—*Iberithyris rionensis* Kvakhadze, 1972:76, fig. 1, pl. 9: fig. 1.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Lower Hauterivian - Lower Barremian).

LOCALITY.—Western Georgia, Russia.

DIAGNOSIS (Kvakhadze, 1972).—Shells of different outlines, inverted [sulcate] or uniplicate. Outer hinge plates horizontal throughout their length, frequently ventrally convex.

EXTERIOR (Kvakhadze, 1972).—Small, elongate to rounded pentagonal, sulcate or uniplicate. Ventral valve more convex than dorsal. Lateral commissures straight or weakly ventrally curved; beak narrow, recurved, elongate in some species. Beak ridges rounded; foramen small, mesothyridid or permesothyridid. Symphytium low.

INTERIOR (Kvakhadze, 1972).—Ventral valve with weakly developed pedicle collar, slender teeth with weakly developed denticle, sometimes notched. Inner socket ridges low, laterally recurved. Hinge plates slender, broad, laterally oriented. In some species inner ends of hinge plates slightly drawn out dorsally in connection with which outer hinge plate has a ventral bend in central part. Cardinal process small, plate-like, less frequently cup-shaped. Crural processes slender, acute angled. Loop narrow, anteriorly rounded, with weakly convex broad transverse ribbon supported by a dorsal mantle plate. Adductor scars on dorsal valve petaloid, their anterior ends converging.

LOOP STATISTICS (reconstruction by Kvakhadze, 1972, figs. 1, 2).—$\angle = 20°$; $Wl/Ll = 0.39$; $Ll/LD = 0.30$; $Wl/WD = 0.13$; $a/Ll = 0.61$; $b/Ll = 0.39$; $c/Ll = 0.50$; $d/Ll = 0.11$; $e/Ll = 0.17$; $f/Ll = 0.22$; $g/WD = 0.18$; $g/Wl = 1.42$; $h/f = 1.00$; $h/Ll = 0.22$; $WL/LD = 0.95$.

COMPARISON (Kvakhadze, 1972).—Distinguished from *Weberithyris* Smirnova by the form of the shell, the presence of an inner pedicle collar, the structure of the low cardinal process, and most important, of the hinge plates which are broad and thin in *Iberithyris* and have their inner ends dorsally directed; distinguished from *Platythyris* Middlemiss by the contours of the shell, by the nature of the commissures, by the recurvature of the low beak with its small foramen, by the presence of lower socket ridges and horizontally situated or ventrally convex outer hinge plates, and also by the petaloid adductor scars with converging anterior ends on the brachial [dorsal] valve; distinguished from *Dallithyris* Muir-Wood by the form of the shell and the commissures, by the low beak with its small foramen, by long hinge plates and by the presence of a well expressed mantle plate [prop].

COMMENT.—Of the six species of *Iberithyris* described by Kvakhadze only two of them have the dorsal "mantle plates," the holotype and *L. linguiformis.* Middlemiss (1976:67), in discussing his Cretaceous *Rouilliaria*, mentions the occasional occurrence of props (mantle plates) secondarily formed that attach the crural bases to the valve floor. The crural props or mantle plates described by Kvakhadze do no seem to be secondary features even though all the species he attributes to *Iberithyris* do not have them. The structure of *I. rionensis* suggests that of *Erymnia* of the modern fauna. An undescribed brachiopod from Hawaii has props under the crural bases similar to those of *Erymnia.* The feature is a parallel development that appears in other genera such as the Jurassic *Karadagithyris*.

Liramia, new genus

PLATE 23: FIGURES 23–28; PLATE 67: FIGURES 6, 7

SUBFAMILY.—Nerthebrochinae, new subfamily.

TYPE-SPECIES.—*Terebratula disparilis* d'Orbigny, 1847:100, pl. 512: figs. 16–18.

DIAGNOSIS.—Small capillate terbratulaceans having a stout, narrow loop.

SPECIMENS STUDIED.—Five, one excavated to show the loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Turonian).

LOCALITIES.—Great Britain, France.

EXTERIOR.—Small, elongate oval with rounded sides, narrowly rounded anterior margin. Valves unequally convex, ventral valve more convex than dorsal one. Lateral commissure straight: anterior commissure gently sulcate. Beak short, suberect, closely appressed to the dorsal valve umbo. Foramen large, mesothyridid. Surface marked by fine radial capillae interrupted by strong concentric ridges.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is short and compact with thick lateral bands and occupies a third the length and a fifth the width of the dorsal valve. The cardinal process is large for a small shell, is half elliptical in outline and has the free margin indented by a shallow notch. The myophore faces posteriorly. The socket ridges are high and erect and bound wide sockets. The fulcral plates are recessed and obscure. The outer hinge plates are narrow, triangular and concave toward the ventral valve. They are continued anteriorly as a ridge along the dorsal edge of the crural bases almost to the expanding crural processes. The crural bases are broad and form a low wall along the inner edge of the outer hinge plates. The ensemble of socket ridge, outer hinge plate and crural base forms a deep U-shaped trough. The crural processes are terminal, bluntly angular, fairly strongly approximate and their anterior slope marks the anterior end of the loop. The transverse band is fairly broad and forms a low arch with a subangular median crest. The broad band bears a shallow posterior notch. The anterolateral extremities of the loop are narrowly rounded. There are no terminal points and no measurable descending lamellae.

LOOP STATISTICS.—USNM 550950b: $\angle = 25°$; Wl/Ll = 0.62; Ll/LD = 0.32; Wl/WD = 0.21; a/Ll = 0.67; b/Ll = 0.33; c/Ll = 0.67; d/Ll = 0.00; e/Ll = 0.17; f/Ll = 0.16; g/WD = 0.28; g/Wl = 1.33; h/f = 0.75; h/Ll = 0.12; WD/LD = 0.97.

USNM 550950b: *Liramia disparilis* (d'Orbigny), Cretaceous (Craie Chloritic), La Montagne Ste. Catherine, Rouen, France.

DISCUSSION.—This genus suggests *Paracapillithyris* Katz and Popov from the Cenomanian of the Russian Platform, Caucasus and Donbass. *Liramia* differs from the Russian genus in having a sulcate anterior commissure and larger foramen. Details of the loop of *Paracapillithyris* are vague and no serial sections are given. *Liramia* differs from *Capillithyris* and *Capillarina* in size, anterior folding and the differently proportioned loop as well as not having the socket ridges elevated and extended beyond the posterior margin.

Specimens referred by Popiel-Barczyk (1972:141) to *Platythyris capillata* and *P. rugulosa* strongly suggest species of *Liramia.* The exterior ornament and size are similar. The anterior commissure of the former is rectimarginate but that of *P. rugulosa* is sulcate. Statistics prepared from her serial sections accord fairly well with those of the French specimen described above. Popiel-Barczyk's reconstruction of the loop of *P. rugulosa* (1972:143) does not conform in detail, although its general appearance is similar to that of the French species. Her reconstructed loop is entirely different from that of *Capillithyris* and is unlike that of *Platythyris* to which these species do not belong.

Although the exterior of the type species of *Platythyris* is poorly capillate some members of the species seem not to be provided with capillae. Aside from the capillae, the type species of *Platythyris* differs from *Liramia* in its external form, which is elongate, somewhat almond-shaped, narrowed at both extremities, and with a rectimarginate or uniplicate anterior commissure. The loop of *Platythyris* is longer, and occupies more of the interior of its dorsal valve than that of *Liramia*.

Middlemiss (1978:41, pl. 16: fig. 10a–d) places the type species of *Liramia* in his genus *Platythyris* (= *Aniabrochus*).

ETYMOLOGY.—From the Latin *lira* (a ridge).

Longithyris Katz and Popov, 1974

Longithyris Katz and Popov, 1974a:30.

SUBFAMILY.—Nerthebrochinae?, new subfamily.

TYPE-SPECIES.—*Najdinothyris? longa* Katz, 1974: 260, pl. 85: fig. 9.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Cenomanian).

LOCALITIES.—Donbass and Voronezh Massif, Russia.

DIAGNOSIS (Katz and Popov, 1974a).—Elongate-oval inverted shells with an almost straight lateral commissure with a club-like [?] curvature in the antero-ventral direction, anterior arcuate V-shaped or W-shaped. Dorsal valve curved cylindrically, and strongly convex in the posterior part; ventral valve curved like a roof at the beak, lateral surfaces depressed and almost perpendicular to the plane of articulation. Beak narrow, short, straight, with a large apical foramen; apical carinae weakly differentiated, directed dorso-ventrally with a weakly developed dorsal carina. Crural processes low, slightly recurved toward the plane of symmetry of the shell. Loop narrow (extends 1/4 the length of the dorsal valve) with a wide transverse band.

SHELL STRUCTURE (Katz and Popov, 1974a).—The thin-walled shell of the type species *Longithyris longa* (Katz) consists of primary, secondary and tertiary layers. The primary layer is of insignificant thickness and is developed over the entire surface of the valves. The second and third layers, of greater thickness, are developed to a varying degree, except for the valve margins where the third layer becomes thinner. The latter is also not differentiated in the posterior part of the shell. Internal skeletal elements are formed primarily of the second layer.

COMPARISON (Katz and Popov, 1974a).—From other genera of the subfamily Dallithyridinae, the genus *Longithyris* is differentiated by a narrow, spindle-shaped shell and dorsally convex cardinal plates.

COMMENTS.—No illustrations or serial sections of this genus were given. Reference to the loop only refers to its length and width. Family placement uncertain.

Loriolithyris Middlemiss, 1968

PLATE 18: FIGURES 16–21; PLATE 64: FIGURES 23, 24

Loriolithyris Middlemiss, 1968:176.

SUBFAMILY.—Sellithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Terebratula russillensis* de Loriol, 1866:88, pl. E: figs. 12–15.

SPECIMENS STUDIED.—Twenty of *L. valdensis* (Loriol), one with loop excavated.

GEOLOGIC OCCURRENCE.—Cretaceous (Valanginian).

LOCALITIES.—Switzerland, France, Spain, and ?Morocco.

EXTERIOR.—Superficially resembling *Sellithyris*. Medium size, narrowly pentagonal, sides rounded; maximum width at about midvalve. Lateral commissure strongly curved toward ventral side; anterior commissure strongly sulciplicate. Beak moderately long, suberect, truncated, slightly labiate. Foramen large, mesothyridid. Symphytium partially visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop of *L. valdensis* is fairly widely triangular and occupies about two-fifths the length and width of the dorsal valve. The cardinal process is small, narrow, bilobed and thin. The fulcral plates were not seen. The socket ridges are slender, erect and curved. The outer hinge plates are narrow, steeply inclined and are extended along the dorsal edge of the crural bases to a point slightly posterior of the crural processes. The crural bases are strongly elevated along the inner margin of the outer hinge plates. With the latter and socket ridges, this ensemble makes narrow U-shaped troughs. The crural processes are sharply pointed and fairly long. The descending lamellae are short and bowed slightly laterally. The transverse band is narrow and forms a broad, low arch deviating from the horizontal by about 12°. The crest is low and broadly rounded. The anterolateral extremities are not extended.

LOOP STATISTICS.—USNM 550938c: ∠ = 39°; Wl/Ll = 0.76; Ll/LD = 0.44; Wl/WD = 0.37; a /Ll = 0.69; b/Ll = 0.31; c/Ll = 0.58; d/Ll = 0.11; e/Ll = 0.14; f/Ll = 0.17; g/WD = 0.37; g/Wl = 1.00; h/f = 0.41; h/Ll = 0.07; WD/LD = 0.91.

USNM 550938c: *Loriolithyris valdensis* (Loriol), Cretaceous (Middle Valanginian), quarry on north side of road, between Cerque and Arzier, Switzerland.

DISCUSSION.—*Loriolithyris* is not as strongly folded as *Sellithyris*. The loops of the two are different, that of *Loriolithyris* has a smaller loop angle than that of *Sellithyris* and the crural processes are located much farther anteriorly. The outer hinge plates of *Loriolithyris* have a lesser length of taper than those of *Sellithyris*.

Lunpolaia Ching and Ye, 1979

PLATE 76: FIGURE 5

Lunpolaia Ching and Ye, 1979:67.

SUBFAMILY.—Nerthebrochinae?, new subfamily.

TYPE-SPECIES.—*Lunpolaia cymbaliformis* Ching and Ye, 1979:67, fig. 3, pl. 1: figs. 21–41, 44, 45.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Aptian - Cenomanian).

LOCALITY.—China.

DISCUSSION.—As depicted on plate 1, *L. cymbaliformis* is subcircular with unequally convex valves, the ventral valve strongly convex, the opposite one gently convex. The anterior commissure appears to be broadly and gently uniplicate. The beak is erect and has a large foramen. Several illustrations of the loop show a short, wide structure with moderately convex transverse band and crural bases bounding narrowly concave outer hinge plates.

LOOP STATISTICS (from Ching and Ye, pl. 1: fig. 40).—∠ = 0.28°, Wl/Ll = 0.87; Ll.LD = 0.28; Wl/WD = 0.24; a/Ll = 0.67; b/Ll = 0.33; c/Ll = 0.60; d/Ll = 0.07; e/Ll = 0.20; f/Ll = 0.13; g/WD = 0.26; g/Wl = 1.07; h/f = 0.62; h/Ll = 0.08; WD/LD = 1.00.

COMMENT.—This genus resembles *Hesperosia*, new genus, from the Lower Cretaceous of Arizona. The American form is narrower than the Chinese type-species but is similar to *L. extenuata* Ching and Ye, which is subtriangular. The loops of the two genera differ in details, that of the American example is longer in relation to the length of the dorsal valve, the transverse band is more strongly elevated and the terminal points are longer than those of the Chinese genus.

Magnithyris Sahni, 1925

PLATE 24: FIGURES 23–28; PLATE 68: FIGURES 13, 14

Magnithyris Sahni, 1925:367; 1928:38.

SUBFAMILY.—Gibbithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Magnithyris magna* Sahni, 1925: 367, pl. 23: fig. 1, 1a; pl. 5: fig. 1, 1a; 1929, pl. 5: figs. 1–3; pl. 10: figs. 7, 8. Asgaard, 1975, pl. 4: fig. 2 (loop).

SPECIMENS STUDIED.—Two, one excavated for loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Senonian).

LOCALITY.—Great Britain.

EXTERIOR.—Medium to large, subpentagonal, sides rounded, anterior margin narrowly rounded; apical angle widely acute; maximum width near midvalve. Lateral commissure straight; anterior commissure rectimarginate. Beak moderately protuberant with rounded beak ridges. Foramen moderately large, submesothyridid. Symphytium partially visible. Surface smooth.

INTERIOR.—Ventral interior with short pedicle collar; teeth strongly buttressed by callus. Muscle scars and pallial marks not seen.

Loop and Cardinalia: The loop is triangular and occupies a third the length and about a fifth the width of the dorsal valve. The cardinal process is short-shafted in the specimen excavated and has a flattened semielliptical myophore facing posteriorly. The socket ridges are stout, erect, slightly curved and bound wide sockets. The fulcral plate is visible and is extended laterally for a short distance. The outer hinge plates are moderately wide, slope steeply and are attached just dorsad of the ventral edge of the crural bases, so that the crural bases form a low wall along the inside edge of the outer hinge plates, and a wider wall below. The taper of the outer hinge plates rises onto the crural processes just dorsad of their edges and terminate slightly posterior to the position of the crural process points. There are no descending lamellae because the transverse band is attached at the anterior slope of the crural processes. The transverse band is moderately wide, is gently arched and nearly horizontal in lateral view. The median part of the crest is flattened and protuberant. The posterior part of the band is notched. The flattening of the crest occupies about a fifth of the loop width. The terminal points are not extended and appear to be notched.

LOOP STATISTICS.—USNM 551124: $\angle = 37°$; Wl/Ll = 0.69; Ll/LD = 0.30; Wl/WD = 0.22; a/Ll = 0.62; b/Ll = 0.38; c/Ll = 0.62; d/Ll = 0.00; e/Ll = 0.19; f/Ll = 0.19; g/WD = 0.23; g/Wl = 1.09; h/f = 0.47; h/Ll = 0.09; WD/LD = 0.94.

USNM 551124: *Magnithyris magna* Sahni, Cretaceous (Senonian - *B. mucronata* Zone), Thorpe, near Norwich, Norfolk, England.

DISCUSSION.—The specimen described and illustrated herein agrees in its exterior details with Sahni's type specimen (1929, pl. 5: figs. 1–3), and occurs at the same stratigraphic level and geographic locality. In spite of these favorable conditions the loops of the two do not agree. It is possible that specimen USNM 551124 is a young example of *Magnithyris*. If so, it is difficult to compare its loop with those illustrated by Sahni and Asgaard. The figure by Asgaard (1975, pl. 4: fig. 2) of the *M. magna* loop shows very broad crural bases terminating in blunt crural processes and thick socket ridges. No taper of the outer hinge plates appears in her illustration. The cardinal process of the type specimen and that of the one figured herein are similar. The crural processes of the National Museum specimen do not extend anteriorly as do those of the holotype but are more erect and point more directly ventrally. The transverse bands are similar but that illustrated here is farther anterior in position and is notched on each side anteriorly and medially on the posterior side.

Mametothyris Smirnova, 1969

Mametothyris Smirnova, 1969b:34

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Mametothyris mametica* Smirnova, 1969b:35, pl. 6: fig. 1.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Albian)

LOCALITY.—Northwestern Kamchatka, Russia.

EXTERIOR (Smirnova, 1969b).—Shells large, rounded-triangular, more rarely rounded, nonplicate. Commissures straight, in one plane. Beak low, slightly curved. Beak ridges poorly defined. Foramen small.

INTERIOR (Smirnova, 1969b).—Pedicle collar absent. Cardinal process low, concave. Hinge plates slightly concave ventrally, separated from the internal socket ridges. Crural bases wide, fused with the hinge plates. Loop narrow, long, taking about one half the length of the dorsal valve. Descending branches of loop oriented parallel to the plane of symmetry. Transverse band of loop is high, rounded. Loop flanges long. Dorsal euseptoid, thin, long. Muscle impressions in the dorsal valve narrow, long.

COMPARISON (Smirnova, 1969b).—It differs from the genus *Lenothyris* Dagis (1968) in its large shell, with depressed margins, less swollen valves, crural bases not pronounced dorsally, the parallel position of the descending branches of the loop and the rounded transverse band of the loop; from *Postepithyris* Makridin (1960) it is distinguished by the absence of a pedicle collar, the concave cardinal process, absence of spurlike structures on the crural bases and the narrow muscle impressions; from *Carneithyris* Sahni it is distinguished by a heavy shell, absence of a pedicle collar, a low cardinal process, separate hinge plates and a long loop.

LOOP STATISTICS (from serial sections of Smirnova, 1969b:35, fig. 1).—a/Ll = 0.40; b/Ll = 0.60; c/Ll = 0.22; d/Ll = 0.18; e/Ll = 0.19; f/Ll = 0.41.

COMMENT.—This loop has unusually long terminal points and its crural processes are more posterior than usual in Cretaceous terebratulaceans.

Moutonithyris Middlemiss, 1976

Moutonithyris Middlemiss, 1976:63.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Terebratula moutoniana* d'Orbigny, 1847:89, pl. 510: figs. 1–5.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Berriasian to Upper Albian).

LOCALITIES.—France, Germany, Switzerland, Portugal, Spain, and Sardinia.

DIAGNOSIS (Middlemiss, 1976:63).—

Subcircular to oval in ventral profile. Umbo [beak] erect. Foramen marginate to labiate. Angle of truncation about 115°–120°. Deltidium very short, usually invisible. Anterior commissure rectimarginate to episulcate. Socket ridges not sharply differentiated from hinge plates but set at a slight angle to them. Hinge plates horizontal or slightly convex, cuneate, keeled. Crural flanges and keels may be present. Crural processes incurved. Loop narrow; transverse band low-arched. Posterior and anterior dorsal adductor muscle impressions separate and about equal in size. Dorsal pallial sinus impressions straight, diverging.

COMMENT.—The key characters of this genus are those of the hinge plates and the transverse band. It differs from *Cyrtothyris* in that the outer hinge plates are less distinct from the socket ridges and are usually keeled, the crural bases are not clubbed, the loop is narrower and the transverse band low-arched. It differs from *Rouillieria* [Middlemiss, not Makridin] in that the socket ridges are at an angle to the hinge plates, the hinge plates are usually keeled, the loop is narrower and the transverse band low-arched. From *Platythyris* it differs in having crural bases and in having cuneate keeled hinge plates which are less distinct from the socket ridges, and a longer loop.

Musculina Schuchert and LeVene, 1929

Musculus Quenstedt, 1868–1871:4, 27, 384.—Buckman, 1907:530.—Middlemiss, 1976:52. [Not *Musculus* Bolten, 1798, or Moerch, 1853, Mollusca; Rafinesque, 1818, Mammal].

Musculina Schuchert and LeVene, 1929a:120.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Terebratula biplicata acuta* von Buch, 1834 (= *Terebratula sanctaecrucis* Catzigras, 1948; non *Terebratula acuta* Sowerby, 1816).

SPECIMENS STUDIED.—Twenty, loop not successfully excavated.

GEOLOGIC OCCURRENCE.—Lower Cretaceous.

LOCALITIES.—Germany and Switzerland.

EMENDED DIAGNOSIS (Middlemiss, 1976:52).—

Small (not more than 35 mm long); elongated (much longer than wide), drawn out posteriorly. P/A [posterior/anterior ratio] ratio high (nearly 2). Brachial [dorsal] valve strongly convex posteriorly, flattening anteriorly. Umbo [beak] straight to suberect. Symphytium well exposed and clearly bordered by ridges. Foramen rather small, mesothyrid to permesothyrid, weakly marginate. Beak ridges rounded. Anterior commissure sulciplicate. Shell folded in accordance with the plication. Plication and folding developed at early stage. Hinge plates strongly concave. Crural bases high but not sharply differentiated from the hinge plates, clubbed: crural processes thickened at their bases and incurved at their tips; crura not flanged. Loop lamellae narrow and thin. Transverse band thin, high-arched.

COMMENT.—A specimen in the National Collection (USNM 31394) was excavated but the anterior of the loop was missing. Nevertheless a small, wide bilobed cardinal process and deeply concave outer hinge plates were revealed. Unfortunately this specimen fails to show the full length of the loop, nor do the serial sections of Middlemiss which give no indication of the nature of the terminal points.

Najdinothyris Makridin and Katz, 1964

PLATE 15: FIGURES 10–17; PLATE 67: FIGURES 3, 4

Najdinothyris Makridin and Katz, in Makridin, 1964:35 [not defined] fig. 11.—Katz and Popov, 1974a:30.

SUBFAMILY.—Nerthebrochinae, new subfamily.

TYPE-SPECIES.—*Terebratula becksii* Roemer, 1841:44, pl. 7: fig. 18.

SPECIMENS STUDIED.—Eight of two species, one of each species excavated for loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Turonian).

LOCALITIES.—Germany, Russia, and Poland.

EXTERIOR.—Elongate, narrowly triangular with nearly straight sides, anterior margin rounded; posterolateral margins forming a small angle. Valves of unequal convexity, ventral valve deeper than dorsal one; dorsal valve convex, lid-like. Lateral commissure concave toward dorsal side. Anterior commissure rectimarginate. Beak suberect. Foramen large, permesothyridid. Surface smooth.

TABLE 53.—Loop statistics for the genus *Najdinothyris*

Proportions	USNM 550927a	USNM 550928a
∠	15°	16°
Wl/Ll	0.30	0.30
Ll/LD	0.21	0.33
Wl/WD	0.13	0.15
a/Ll	0.64	0.75
b/Ll	0.36	0.25
c/Ll	0.40	0.35
d/Ll	0.24	0.40
e/Ll	0.08	0.07
f/Ll	0.28	0.18
g/WD	0.25	0.33
g/Wl	2.00	2.16
h/f	0.89	1.22
h/Ll	0.25	0.22
WD/LD	0.67	0.65

USNM 550927a: *Najdinothyris becksi* (Roemer), Cretaceous (Turonian - Galeriten Beds), Gaes, near Ahaus, Germany.

USNM 550928a: *Najdinothyris* species, Cretaceous (Turonian), quarry in E outskirts of Wüllen, Germany, S of Enschede, Netherlands.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop, like the shell, is very narrow with an angle under 20° and Wl/Ll = 0.30. The cardinal process is a flattened half ellipse, protuberant from the beak and with myophore directed posteroventrally. The socket ridges are thin, erect and bound narrow sockets. The fulcral plate is thin and flattish. The outer hinge plates are short, triangular, deeply concave and taper anteriorly along the dorsal edge of the crural bases, terminating at a point posterior to the crural processes. The crus is broad and flat laterally and forms a high ridge along the inside edge of the outer hinge plates. The crural bases, outer hinge plates and socket ridges make short broadly U-shaped troughs. The crural processes are erect, not significantly inclined medially, are obtusely angular and form an angle of 148 degrees. The anterior taper of the crural processes is long and results in short descending lamellae. The transverse band is broad and forms a subangular arch of moderate height. There are no elongated terminal points.

LOOP STATISTICS.—See Table 53.

DISCUSSION.—*Najdinothyris* in external form is close to the Recent genus *Stenosarina.* There is also resemblance to *Stenobrochus.* There is a significant difference in the loops, the outer hinge plates of the latter two are much more tapered than those of *Najdinothyris.* There is also a difference in the position of the crural processes, those of *Stenosarina* and *Stenobrochus* being farther posterior on the loop than those of *Najdinothyris.*

Sardope Dieni, Middlemiss, and Owen (1973: 196) has an exterior like that of *Najdinothyris* with a lid-like dorsal valve and truncated beak. Its interior is known only from incomplete serial sections and cannot be satisfactorily compared with the internal structures of *Najdinothyris.* The exteriors however, are very suggestive of relationship.

Neoliothyrina Sahni, 1925

PLATE 19: FIGURES 1-6, 7; PLATE 67: FIGURES 16-18

Neoliothyrina Sahni, 1925:375; 1929:8.—Steinich, 1965:27.—Popiel-Barczyk, 1968:52.

SUBFAMILY.—Nerthebrochinae, new subfamily.

TYPE-SPECIES.—*Neoliothyrina obesa* Sahni, 1925:375, pl. 23: fig. 18; pl. 26: fig. 10.

SPECIMENS STUDIED.—Twenty, two with loop excavated, two with cardinalia only.

GEOLOGIC OCCURRENCE.—Cretaceous (Senonian).

LOCALITIES.—Great Britain, Denmark, Netherlands, Poland, Belgium, and East Germany.

EXTERIOR.—Large, elongate oval, resembling *Oleneothyris*. Both valves strongly and nearly equally convex. Lateral commissure broadly curved ventrally. Anterior commissure moderately sulciplicate. Beak large, suberect, labiate. Foramen large, permesothyridid. Surface smooth.

INTERIOR.—Ventral valve interior with small hook-like teeth and large excavate pedicle collar.

Loop and Cardinalia: The cardinal process is a small half ellipse, with myophore facing posteroventrally. The socket ridges are erect, slightly curved and bound narrow sockets floored by thick fulcral plates, laterally extended as ridges. The outer hinge plates are narrow, concave and have a long taper, extending along the lower or dorsal edge of the crural bases to a point under the crural processes, forming a distinct shelf. The crural bases are broad, flat blades, anteriorly expanded into the crural processes. Posteriorly they form a wall along the inner edge of the outer hinge plates. The ensemble of socket ridges, outer hinge plates and crural bases, form narrowly U-shaped troughs. Inner hinge plates are variably well developed, being disjunct in some specimens but coalesced in others (Plate 19: figure 7). The crural processes are bluntly pointed. The anterior ends of the crural processes bear the transverse band, thus there are no perceptible descending lamellae. The crural process points are more or less approximate, those illustrated by Sahni and Muir-Wood (1965:H794, fig. 660:3d) strongly so,

TABLE 54.—Loop statistics for the genus *Neoliothyrina*

Proportions	USNM 75697a	USNM 75697b
∠	31°	32°
Wl/Ll	0.60	0.64
Ll/LD	0.31	0.31
Wl/WD	0.24	0.21
a/Ll	0.64	0.64
b/Ll	0.36	0.36
c/Ll	0.64	0.64
d/Ll	0.00	0.00
e/Ll	0.14	0.10
f/Ll	0.22	0.26
g/WD	0.33	0.24
g/Wl	1.40	1.00
h/f	0.77	0.65
h/Ll	0.17	0.17
WD/LD	0.80	0.82

USNM 75697a,b: *Neoliothyrina obesa* Sahni, Cretaceous (Senonian – *B. mucronata* Zone), Norwich, Norfolk, England.

those shown here, less so. The transverse band is broad and makes a moderately high arch forming a narrowly rounded crest. The anterolateral extremities of the loop are extended into small points not shown by the Sahni and Muir-Wood illustrations, but well developed in USNM specimen 75697b (Plate 19: figures 4, 5). The anterolateral extremities form an angle of 80°–90° with the sides of the loop.

LOOP STATISTICS.—See Table 54.

Discussion.—The serial sections in Muir-Wood (1965:H796, figs. 1, 2) were evidently prepared on different specimens. Sections 1a–k take the sequence possibly as far as the crural processes but these plates are not clearly defined. Sections 1e–g display the outer hinge plates. Section 1g shows a keeled, virgate plate on the left side and a broadly U-shaped plate on the opposite side. Section 2 shows an inner hinge plate on the left side but an indeterminate structure on the right side. The sections do not accurately depict the loop which is well shown in figure 660:3d on page H794 of Muir-Wood, 1965. In this picture inner hinge plates may be seen.

That the inner hinge plates are variable is shown in Sahni's (1929, pl. 8: figs. 27, 28; pl. 9: fig. 19) illustrations that show no inner hinge plates but show small disjunct inner hinge plates (pl. 8: fig. 26; pl. 9: fig. 20). These are well shown by Popiel-Barczyk (1968, pls. 14, 15). Steinich (1965:31, 32) illustrates the complete loop and inner hinge plates. The loop of a specimen 20 mm long shows only incipient inner hinge plates. One 40 mm long shows coalesced inner hinge plates and a strongly curved loop in lateral view. The Polish example excavated in this study has an incomplete transverse band and its inner hinge plates are coalesced like those of the East German specimen. The transverse band of the latter is more strongly angulated and narrower than that of the British specimens. Some features of the Polish specimens suggest possible specific difference from the British species.

Nerthebrochus, new genus

PLATE 17: FIGURE 42; PLATE 21: FIGURES 7–11; PLATE 55: FIGURES 8–12; PLATE 56: FIGURES 1–4; PLATE 67, FIGURES 14, 15, 25, 26

SUBFAMILY.—Nerthebrochinae, new subfamily.

TYPE-SPECIES.—*Terebratula robertoni* d'Archiac, 1847:315, pl. 18: fig. 2, 2a,b.

DIAGNOSIS.—Unequally convex, rectimarginate to uniplicate terebratulaceans having loop with outer hinge plates attached along dorsal edge of crural bases.

SPECIMENS STUDIED.—Three, two with loop excavated.

GEOLOGIC OCCURRENCE.—Cretaceous (Tourtia).

LOCALITY.—Belgium.

EXTERIOR.—Elongate oval, medium size, unequally convex, dorsal valve nearly flat in profile, ventral valve moderately convex. Lateral commissure nearly straight; anterior commissure gently uniplicate with slight median depression in dorsal valve suggesting trend toward sulciplication. Beak fairly long, erect, not labiate. Foramen large, submesothyridid. Symphytium visible. Surface marked by concentric growth lines and lamellae.

TABLE 55.—Loop statistics for the genus *Nerthebrochus*

Proportions	USNM 550945b	USNM 551079
∠	36°	33°
Wl/Ll	0.67	0.67
Ll/LD	0.28	0.30
Wl/WD	0.20	0.25
a/Ll	0.61	0.58
b/Ll	0.39	0.42
c/Ll	0.42	0.42
d/Ll	0.19	0.16
e/Ll	0.19	0.17
f/Ll	0.19	0.25
g/WD	0.24	0.28
g/Wl	1.16	1.08
h/f	0.58	0.44
h/Ll	0.11	0.11
WD/LD	0.92	0.78

USNM 550945b, 551079: *Nerthebrochus robertoni* (d'Archiac), Cretaceous (Tourtia), Tournay, Belgium.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is short, triangular, and measures about a third the length and a quarter or less of the width of the dorsal valve. The cardinal process is a wide half ellipse forming a thin shelf at the apex. The socket ridges are thin and inclined. The fulcral plates were not seen. The outer hinge plates are fairly wide, triangular, and concave. They are attached to the dorsal side of the crural bases and taper to a point posterior of the crural processes or nearly to them. The crural bases are broad and extend as a fairly high wall along the inside of the outer hinge plates. The crural processes are located more than halfway of loop length, are erect and acutely pointed but not extended. The anterior descending branches of the crural processes serve as the descending lamellae to which the fairly broad transverse band is attached. The transverse band is widest at its junction with the descending elements of the loop and narrows as it rises to a subangular, low and narrow fold that occupies about a fifth of the loop width.

LOOP STATISTICS.—See Table 55.

DISCUSSION.—The loop of this genus is similar to that of *Biplicatoria* but differs in having its outer hinge plates attached on the lower or dorsal side of the crural bases rather than on the ventral side as in *Biplicatoria.* The two also differ strongly in exterior characters: *Biplicatoria* is strongly paraplicate with strong plications whereas *Nerthebrochus* is gently rectimarginate to incipiently sulciplicate. *Nerthebrochus* differs from *Concinnithyris* in exterior details in not having a swollen dorsal valve and in having the outer hinge plates attached on the dorsal side of the crural bases. Strong exterior growth lamellae suggest relationship to *Ornatothyris* but the loops of the two genera are different.

ETYMOLOGY.—From the Greek *nerthe* (below) plus *brochos* (noose or loop).

Ogmusia, new genus

PLATE 27: FIGURES 8–18; PLATE 30: FIGURES 14–17; PLATE 55, FIGURE 25

SUBFAMILY.—Carneithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Terebratula incissa* von Buch, 1834:95. Asgaard, 1970:361–362.

SPECIMENS STUDIED.—Nine, two with loop, cardinalia.

GEOLOGIC OCCURRENCE.—Danian.

LOCALITY.—Denmark.

DIAGNOSIS.—Similar to *Carneithyris* and *Chatwinothyris*, differing in its sulcate anterior commissure.

COMMENT.—Specimens of this genus have the swollen cardinalia and cardinal process of *Carneithyris* and *Chatwinothyris* and are usually provided with a prominent, often thick, median septum on the swollen cardinal process.

LOOP STATISTICS.—USNM 551053a: ∠ = 33°; Wl/Ll = 0.60; Ll/LD = 0.30; Wl/WD = 0.20; a/Ll = 0.67; b/Ll = 0.33; c/Ll = 0.34; d/Ll = 0.33; e/Ll = 0.13; f/Ll = 0.20; g/WD = ?; g/Wl = ?; h/f = 0.30; h/Ll = 0.06; WD/LD = 0.88.

USNM 551053a: *Ogmusia incissa* (von Buch), Danian, old portion of quarry directly below town, Fakse, Denmark.

ETYMOLOGY.—From the Greek *ogmos* (furrow).

Okathyris Smirnova, 1975

PLATE 62: FIGURE 13

Okathyris Smirnova, 1975a:71.

SUBFAMILY.—Spasskothyridinae Smirnova, 1977.

TYPE-SPECIES.—*Okathyris chevkinensis* Smirnova, 1975a:71a, figs. 1, 2, pl. 9: figs. 1, 2.

SPECIMENS STUDIED.—Literature only.

GEOLOGICAL OCCURRENCE.—Cretaceous (Berriasian)

LOCALITY.—Russian Platform.

DIAGNOSIS (Smirnova, 1975a).—Medium size, smooth, evenly rounded outline, beak not high. Near anterior margin uni- to biplication faint. Foramen medium size, apical. Beak ridges not sharp. Pedicle collar present. Cardinal process low, slightly concave. Hinge plates narrow, oriented steeply to plane of symmetry. Inner socket ridges high. Crural bases inclined at angle of 60°–75° to the hinge plates. Crural processes low. Loop one half length of dorsal valve. Loop flanges of medium length.

LOOP STATISTICS (based on reconstruction by Smirnova, 1975a:74, fig. 2).—∠ = 34°; Wl/Ll = 0.66; Ll/LD = 0.49; Wl/WD = 0.35; a/Ll = 0.41; b/Ll = 0.59; c/Ll = 0.37; d/Ll = 0.04; e/Ll = 0.19; f/Ll = 0.40; g/WD = 0.35; g/Wl = 1.30; h/f = 0.45; h/Ll = 0.18; WD/LD = 0.90.

Smirnova reconstruction: *Okathyris chevkinensis* Smirnova, lower Cretaceous, Russian Platform.

DISCUSSION (Smirnova, 1975a:71).—Smirnova likens *Okathyris* to *Cererithyris* of the Jurassic in external form and interior structure but remarks that the loop flanges (terminal points) are too little known for this genus to make a sure comparison. "From *Loboidothyris* Buckman, 1918 (sic) which has narrow hinge plates, steeply inclined crural bases, long flanges, it [*Okathyris*] differs in the smaller size of the rounded shell and absence of a keel on the dorsal side of the crural base."

COMMENT.—*Loboidothyris* seems not to have long flanges or terminal points (see discussion under Jurassic Terebratulacea) and Almeras' (1971) sections of *Loboidothyris ingens* do not show keels on the dorsal side of the crural bases.

Statistics prepared from Smirnova's serial sections (1975a, fig. 1) do not agree with those of the reconstruction: Wl/Ll = 0.78; Ll/LD = 0.52; Wl/WD = 0.54; a/Ll = 0.37; b/Ll = 0.63.

Orientothyris **Katz and Popov, 1974**

Orientothyris Katz and Popov, 1974a:28.

SUBFAMILY.—Gibbithyridinae?, Muir-Wood, 1965.

TYPE-SPECIES.—*Gryphus orientalis* Vantschurov and Kalugin, 1966:119, fig. 4.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Maastrichtian.

LOCALITIES.—Crimea, Transcaspian, North Caucasus, and Russia.

DIAGNOSIS (Katz and Popov, 1974a).—Medium size, elongate, uniplicate with narrow massive curved beak, rounded shoulders, with a large medium size foramen. Concentric growth lines are clearly expressed, sometimes capillation is traced on the lateral commissure. Crural bases attached to wide hinge plates, hang low into the dorsal apical cavity, almost uniting with the floor of the valve, and have a high ventral carina.

SHELL STRUCTURE (Katz and Popov, 1974a).—The thick valves of shells of *Orientothyris orientalis* (Vantchurov) are almost wholly composed in the posterior portion of a slightly differentiated third layer. Internal skeletal elements are composed chiefly of the secondary layer.

COMPARISON (Katz and Popov, 1974a).—Externally, shells of this genus are like those of *Gryphus* and *Concinnithyris* but differ from them in the character of the crura and the wide hinge plates.

COMMENT.—The interior of this genus was not illustrated by serial sections or other means.

Ornatothyris **Sahni, 1929**

PLATE 25: FIGURES 14–19; PLATE 68: FIGURES 9, 10

Ornatothyris Sahni, 1929:45.

SUBFAMILY.—Gibbithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Terebratula sulcifera* Morris, in Morris and Davidson, 1847:254.

SPECIMENS STUDIED.—Six, one excavated for loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Cenomanian).

LOCALITIES.—Great Britain and France.

EXTERIOR.—Medium to large, elongate oval, thickly lenticular in profile; valves unequal in depth, ventral valve having greater convexity. Lateral commissure straight to ventrally curved at anterior; anterior commissure recimarginate to gently uniplicate with suggestion of sulciplication. Beak, large, long, erect, labiate. Foramen large, permesothyridid. Symphytium partially visible. Surface marked by fairly regular, strong concentric lamellae.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is narrow, elongate, stoutly constructed and occupies a third the length and a fifth the width of the dorsal valve. The cardinal process is a narrow half ellipse forming a small apical shelf. The socket ridges are stout, erect and bound wide sockets. The fulcral plates are stout, narrow. The outer hinge plates are short, narrow and are attached to the upper or ventral side of the crural bases. The anterior edge of the outer hinge plates forms a narrow reentrant between the crural bases and the socket ridges. The outer hinge plates taper along the ventral edge of the crural bases nearly to the crural processes, eliminating a crus. The crural bases are broad and are extended to the posterior under the outer hinge plates with its ventrad margin slightly above the inner edge of the outer hinge plates. This combination produces a keeled hinge plate in section (see Muir-Wood, 1965:H797, fig. 667: 2d–f). The crural processes are acutely pointed, not greatly extended and slightly approximate. The anterior slope of the crural processes is so short that a measurable descending lamella cannot be defined. The transverse band is broad, nearly parallel to the horizontal, and forms a low arch with a gently elevated subangular median crest. The anterolateral extremities are not drawn into long points but form an angle of 70°–80° with the side of the loop.

LOOP STATISTICS.—USNM 550959b: $\angle = 26°$;

WL/Ll = 0.53; Ll/LD = 0.30; Wl/WD = 0.18; a/Ll = 0.60; b/Ll = 0.40; c/Ll = 0.60; d/Ll = 0.00; e/Ll = 0.17; f/Ll = 0.23; g/WD = 0.18; g/Wl = 1.25; h/f = 0.87; h/Ll = 0.20; WD/LD = 0.90.

USNM 550959b: *Ornatothyris sulcifera* (Morris), Cretaceous (Cenomanian), Fullbourne, near Cambridge, England.

DISCUSSION.—That the loop of this species is variable is shown by the three specimens prepared by Sahni (1929, pl. 10: figs. 25–27). The loops of all three flare anteriorly, those in figs. 25 and 26 noticeably. The transverse band of each is more strongly arched than that of the specimen illustrated herein. The hinge plates shown in Sahni's fig. 26 are much wider (or partially covered) than those of his other two specimens and that figured herein.

Katz and Popov (1974b) report a third shell layer in this genus.

Ornithothyris Sahni, 1925

PLATE 22: FIGURES 1–4; PLATE 25: FIGURES 1–6; PLATE 69: FIGURES 20, 21

Ornithothyris Sahni, 1925:374; 1929:43.

SUBFAMILY.—Carneithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Ornithothyris carinata* Sahni, 1925:374, pl. 23: fig. 2, 2a; pl. 24: fig. 6, 6a; pl. 25: fig. 5, 5a; 1929, pl. 6: figs. 27, 28, pl. 10: fig. 19. Asgaard, 1975:335, pl. 5: fig. 2.

SPECIMENS STUDIED.—Five, two with loop excavated.

GEOLOGIC OCCURRENCE.—Cretaceous (Senonian – Campanian).

LOCALITY.—Great Britain.

EXTERIOR.—Somewhat elongate oval, valves subequally convex. Lateral commissure straight; anterior commissure rectimarginate. Beak short, erect, partially hiding symphytium. Foramen small, permesothyridid. Surface smooth.

INTERIOR.—Ventral valve interior with ponderous teeth, short pedicle collar, elongate muscle field and subparallel, well impressed vascula media.

Loop and Cardinalia: The loop is short, occupying a third the length and a fifth of the width of the dorsal valve. It expands gradually. The cardinal process is a half ellipse with sunken myophore divided medially by a low ridge. The anterior of the cardinal process is thickened by a bulbous shaft. The socket plates are erect, thick and bound wide sockets that are proximally roofed over. The fulcral plates are moderately thick and expanded laterally into a massive thickening on the end of the socket. The outer hinge plates are obscured by excess shell. They taper anteriorly onto the ventral edge of the crural bases, and extend along their margin to the crural processes. The crural bases are broad plates extending into the thickened mass of the outer hinge plates and socket ridges. The crural processes are broad and drawn into blunt points that are directed anteroventrally. There are no descending lamellae and the transverse band is attached to the descending anterior part of the crural processes. The transverse band is narrow, pinched at its middle with the lateral descending parts broader than the middle part. The median part of the transverse band forms a narrow fold that protrudes in a ventral direction. The dorsal valve is marked by a fairly prominent euseptoidum.

LOOP STATISTICS.—USNM 550958b: ∠ = 30°; Wl/Ll = 0.63; Ll/LD = 0.30; Wl/WD = 0.22; a /Ll = 0.67; b/Ll = 0.33; c/Ll = 0.67; d/Ll = 0.00; e/Ll = 0.20; f/Ll = 0.13; g/WD = 0.21; g/Wl = 0.95; h/f = 0.77; h/Ll = 0.10; WD/LD = 0.86.

USNM 550958b: *Ornithothyris carinata* Sahni, Cretaceous (Senonian – *B. mucronata* Zone), New Catton, near Norwich, Norfolk, England.

DISCUSSION.—The loop of the specimen of *Ornithothyris* figured by Sahni (1929: 19) does not resemble the one figured herein. Sahni's specimen shows a loop with sides somewhat pinched in with strongly approximate crural processes and a low arched transverse band not as strongly protuberant as that of USNM 550958b. The cardinal process and hinge plates conform in both Sahni's and the National Museum specimens, and show close relationship to *Carneithyris* and *Chatwinothyris.* Sahni's figure of *O. carinata* is a drawing, evidently rather inaccurate. Asgaard's (1975, pl. 5: fig. 2) figure of the same specimen shows the loop partly obscured by matrix, but with the hinge plates conforming to those of the specimen figured herein. This genus was regarded as a synonym of *Carneithyris* by Muir-Wood (1965:H799) and Asgaard (1975).

Paraboubeithyris Middlemiss, 1980

Paraboubeithyris Middlemiss, 1980:533.

SUBFAMILY.—Nerthebrochinae, new subfamily.

TYPE-SPECIES.—*Paraboubeithyris plicae* Middlemiss, 1980:534, fig. 16, pl. 38: fig. 8; pl. 57: figs. 1–3.

SPECIMENS STUDIED.—Literature only.

DIAGNOSIS (Middlemiss, 1980:533).—Ventral profile rounded pentagonal, as wide as, or wider than, long. Depressed. P/A ratio slightly more than 1. Umbo suberect to erect. Anterior commissure deeply uniplicate, or sulciplicate with very small median sinus. Brachial valve has a strong median fold extending from the umbonal region to the anterior; corresponding to a deep, wide sulcus in the anterior half of the pedicle valve. Hinge plates concave, thin, sharply differentiated from the inner socket ridges; piped to strongly corniced. Transverse band high-arched. Euseptoidum weak, flanked by two lateral ridges.

COMMENT.—The author gives no comparison of his genus with *Boubeithyris* Cox and Middlemiss, 1978. The folding of *Paraboubeithyris* with its broad ventral sulcus creates a broad uniplicate anterior commissure. A comparison of the serial sections of *Boubeithyris* Cox and Middlemiss (1978:420, fig. 4) and those of *Paraboubeithyris* shows the outer hinge plates of the former to be flatly concave and only slightly piped. The transverse band of *Boubeithyris* is more narrowly rounded than that of *Paraboubeithyris* according to the serial sections of the two genera.

Paracapillithyris Katz and Popov, 1974

Paracapillithyris Katz and Popov, 1974a:26

FAMILY.—Placement uncertain.

TYPE SPECIES.—*Paracapillithyris alexeevi* Katz and Popov, 1974a:27.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Upper Cenomanian).

LOCALITIES.—Russian Platform, Donbass and Caucasus, Russia.

DIAGNOSIS (Katz and Popov, 1974a).—Elongate, evenly biconvex, with narrow curved beak pierced by a somewhat apical foramen of medium size, with an almost straight anterior commissure. Surface of valve covered by fine radial striae. Hinge plates wide, set low. Crura rather wide with dorsal and ventral carinae. The third layer rarely prominent over the first and second, differentiated into sublayers in the posterior part of the shell.

SHELL STRUCTURE (Katz and Popov, 1974a).—The shell wall consists of primary, secondary and tertiary layers, the first two together being of less thickness than the third. The third layer is subdivided in the posterior part into two sublayers of which the inner is less thick.

COMPARISON (Katz and Popov, 1974a).—In features of external shell structure this genus is homeomorphic with *Capillithyris* Katz, 1973 [1974] (family Terebratulidae) and differs from it, apart from the presence of the third layer, in the apical position of the foramen, narrow palintrope and obliterated beak ridges. From other genera of the subfamily Gibbithyridinae the present genus is distinguished by distinctly expressed capillation of the shell.

COMMENT.—The exterior of the genus is illustrated (figure 1) by line drawings showing a small foramen, and beak revealing the symphytium. The interior is not figured by serial sections. See *Liramia* for comparison of *Paracapillithyris* with that genus.

Peculneithyris Smirnova, 1972

Peculneithyris Smirnova, 1972a:76.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Peculneithyris longiusculus* Smirnova, 1972a:76, fig. 3, pl. 12: fig. 3.

Specimens Studied.—Literature only.

Geologic Occurrence.—Cretaceous (Barremian – Aptian).

Locality.—Kabarovsk Region, Russia.

Diagnosis (Smirnova, 1972a).—Elongate-oval, with depressed margins and moderately convex valves. Anterior commissure uniplicate. Valves evenly convex for entire length. Beak low, with small mesothyridid foramen. Pedicle collar massive, tubelike. Cardinal process small, not divided into lobes, with distinct longitudinal striation. Secondary calcareous deposits in cardinal area absent. Hinge plates narrow, inclined toward the plane of symmetry of the valve. Crural bases distinct, wide, projecting dorsally, oriented at a sharp angle to the hinge plates and parallel to the plane of symmetry of the valves. Internal socket ridges high, detached from hinge plates. Crural processes wide, curved trapezoidally. Loop flanges [terminal points] long.

Comparison (Smirnova, 1972a).—From the externally similar genus *Uralella* Makridin (1960), from the Volshin Stage of the northern Urals and northern Siberia, it is distinguished by the sharp beak ridges, uniplicate anterior commissure, low cardinal process, high crural bases, shorter loop flanges; from *Mametothyris* Smirnova (1969b) it differs in an elongate shell, narrow imclined hinge plates, wide, dorsally projecting crural bases, and trapezoidally curved transverse loop band.

Loop Statistics (prepared from serial sections of Smirnova, 1972a:77, fig. 3).— a/Ll = 0.32; b/Ll = 0.68; c/Ll = 0.13; d/Ll = 0.19; e/Ll = 0.13; f/Ll = 0.55; h/Ll = 0.08.

Comment.—This genus has unusually long terminal points for a Cretaceous genus.

Penzhinothyris Smirnova, 1969

Penzhinothyris Smirnova, 1969b:36.

Family.—Placement uncertain.

Type-Species.—*Penzhinothyris plana* Smirnova, 1969b:37.

Specimens Studied.—Literature only.

Geological Occurrence.—Cretaceous (Upper Albian).

Locality.—Northern Kamchatka, Russia.

Exterior (Smirnova, 1969b).—Large, non-plicate, round, thick-valved, with strongly depressed margins. Valves equally convex or with the dorsal valve slightly more convex than the ventral. Commissures straight. Beak slightly curved, beak ridges distinct, sharp, long. False area high, in the form of an equilateral surface situated in the plane of valve articulation. Foramen small, its outline not observed.

Interior (Smirnova, 1969b).—Pedicle collar absent. Elements of the cardinalia heavy. Cardinal process trilobed. Hinge plates oblique to the plane of symmetry, separated by a curvature from the inner socket ridges. Crural bases are fused with the hinge plates. Loop long, taking up more than half the length of the dorsal valve. Transverse band wide and high, trapezoidal in cross-section. Flanges [terminal points] of the loop long. Septal platform massive, consists of three ridges. Impressions of adductor muscles in the dorsal valve, short, petal-shaped, slightly divergent.

Loop Statistics (from serial sections in Smirnova, 1969b:37, fig. 2).—a/Ll = 0.54; b/Ll = 0.46; c/Ll = 0.38; d/Ll = 0.16; e/Ll = 0.14; f/Ll = 0.32; h/Ll = 0.11.

Comparisons (Smirnova, 1969b).—It is distinguished from the genus *Pinaxiothyris* Dagis (1968) by its thick-valved shell, acute beak ridges, sharp area, absence of a pedicle collar, lobation of the cardinal process, obliquity of the hinge plate to the plane of symmetry, indistinct crural bases which do not project dorsally, high and wide transverse band of the loop, and short muscle impressions in the dorsal valve; from *Orthotoma* Quenstedt it differs in the depressed shell margin, longer loop, strongly curved transverse band of the loop and larger cardinal process; from *Mametothyris* gen. nov. [Smirnova, 1969b] in its higher beak, sharp beak ridges, high trilobed cardinal process, wider loop and the trapezoidal cross-section of the transverse band of the loop.

Piarothyris Sahni, 1925

Piarothyris Sahni, 1925:370; 1929:37.—Asgaard, 1975:334.

Family.—Placement uncertain.

Type-Species.—*Piarothyris rotunda* Sahni, 1925:

370, pl. 25: fig. 6, 6a, pl. 26: fig. 12; 1929:37, pl. 5: figs. 23–25, pl. 10: fig. 20. Asgaard, 1975:334, pl. 3: fig. 4

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Senonian).

LOCALITY.—Great Britain.

DISCUSSION.—Muir-Wood (1965:H799) regarded this genus as a synonym of *Carneithyris* even though its external form is more like that of *Gibbithyris*. Asgaard (1975:334) noted the resemblance of the type specimen of *Piarothyris* to *Gibbithyris*.

Praelongithyris Middlemiss, 1959

PLATE 22: FIGURES 24–27; PLATE 54: FIGURES 28, 29; PLATE 76: FIGURES 11, 12

Praelongithyris Middlemiss, 1959:134.

SUBFAMILY.—Rhombothyridinae, new subfamily.

TYPE-SPECIES.—*Praelongithyris praelongiformis* Middlemiss, 1959:134, figs. 12, 19, pl. 17: fig. 6; pl. 18: fig. 1.

SPECIMENS STUDIED.—Twenty-two, one with complete loop, one with damaged loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Aptian).

LOCALITY.—Great Britain.

EXTERIOR.—Medium size to large, narrowly and longitudinally elliptical with sides gently rounded, anterior margin narrowly rounded. Lateral commissure gently curved; anterior commissure variable from rectimarginate to sulciplicate. Beak long, suberect, truncated, strongly protuberant beyond the dorsal umbo. Foramen large, mesothyridid to submesothyridid. Symphytium wholly visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The cardinal process is moderately large, a half elliptical, thin plate with depressed myophore facing posteroventrally. The socket plates are high, thin, and slightly inclined. The fulcral plates were not seen. The sockets are narrow. The outer hinge plates are narrow, concave and taper along the dorsal edge of the crural bases to a point just under or dorsad of the crural processes. The crural bases form a wall along the inner edge of the outer hinge plates and with the socket ridges, form narow U- or wide V-shaped troughs. Incipient inner hinge plates or a thickening appear on the inside of the crural bases of USNM 551076. The crural processes are located anterior to midloop and form thin acute points directed anteromedially. The descending lamellae are short and slightly convex laterally. The transverse band is narrow and fairly strongly arched in the middle. The anterolateral extremities are narrowly rounded and somewhat extended.

LOOP STATISTICS.—USNM 551076: ∠ = 25°; Wl/Ll = 0.50; Ll/LD = 0.43; Wl/WD = 0.32; a/Ll = 0.59; b/Ll = 0.41; c/Ll = 0.41; d/Ll = 0.00; e/Ll = 0.16; f/Ll = 0.25; g/WD = 0.40; g/Wl = 1.25; h/f = 0.12; h/Ll = 0.03; WD/LD = 0.68.

USNM 551076: *Praelongithyris praelongiformis* Middlemiss, Cretaceous (Aptian - Lower Greensand). Upware, Cambridgeshire, England.

DISCUSSION.—Middlemiss' sections show "virgate strongly clubbed hinge plates" and flanged crura. Statistically this loop and that of *Platythyris* are similar but the outer hinge plates of *Praelongithyris* are deeply concave whereas those of *Platythyris* are gently concave. The terminal points of *Platythyris* are shorter than those of *Praelongithyris*.

Pulchrithyris Sahni, 1925

Pulchrithyris Sahni, 1925a:361.—Asgaard 1975:332.

SUBFAMILY.—Carneithyridinae Muir-Wood, 1965.

TYPE SPECIES.—*Pulchrithyris gracilis* Sahni, 1925:362, loop figured pl. 13: fig. 6, 6a. Asgaard, 1975, loop figured pl. 5: figs. 4–7.

DISCUSSION.—The loop of this genus was defined and figured as having the transverse band directed anteriorly ["loop exceptionally flat, bow-shaped with anteriorly directed apex (a very distinctive feature)"]. The transverse band of the loop had evidently been broken and restored incorrectly. This defect was corrected later (Sahni, 1929, pl. 9: fig. 11) and is figured by

Asgaard (1975, pl. 5: fig. 7). In his 1929 work Sahni abandoned his genus and placed it in the synonymy of *Carneithyris*.

Rectithyris Sahni, 1929

PLATE 20: FIGURES 28–34; PLATE 21: FIGURES 12–20; PLATE 55: FIGURE 7; PLATE 66, FIGURES 3, 4

Rectithyris Sahni, 1929:9, fig. 14; pl. 10: figs. 14, 15.—Cox and Middlemiss, 1978:426.

SUBFAMILY.—Rectithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Terebratula depressa* Valenciennes, in Lamarck, 1819:249.

SPECIMENS STUDIED.—Nineteen specimens from Tournay, Belgium, two excavated to show loop; four from Shenley Limestone, one excavated for loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Cenomanian – Tourtia)

LOCALITIES.—Great Britain, Belgium, Germany, and Russia.

EXTERIOR.—Elongate oval, narrowly lenticular, sides rounded, anterior margin subnasute, posterolateral margins forming acute angle. Ventral valve deeper than dorsal valve. Lateral commissure curved gently toward ventral side. Anterior commissure rectimarginate to narrowly uniplicate. Beak long, narrow, nearly straight to suberect. Foramen large, permesothyridid. Symphytium large, convex, wholly visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is triangular, widens anteriorly to occupy a third to two-fifths the length and about the same of the width of the dorsal valve. The cardinal process is a transverse half ellipse with shallow depressed surface surrounded by a low ridge and bisected by a low elevation. The fulcral plates are thick and laterally extended for a short distance. The socket ridges are moderately thick, slightly inclined toward the narrow, deep sockets. On the free edge of the socket ridge and at its proximal part, a rounded plate appears, starting at each end of the cardinal process and extended over the socket for part of its length, imparting a smooth margin at the middle of the valve posterior. The structure suggests that seen in *Capillarina*. This feature is not uniformly developed.

The outer hinge plates are narrowly triangular, moderately concave and are attached on the dorsal edge of the crural bases and taper anteriorly onto the crural processes. The anterior tapered edge of the outer hinge plates are variably situated on the crural bases and crural processes. In one specimen (USNM 104623a) the taper ends near the posterior edge of the crural processes but in the other (USNM 104623b) it rises to near the middle of the crural processes. The outer hinge plates are margined by the crural bases which form a ridge along their inner edge. The combination of socket ridges, crural bases and outer hinge plates make U-shaped troughs that in serial section probably would be comparable to the virgate keeled pattern of Middlemiss (1959, fig. 1j). The serial section figured in Muir-Wood (1965:H759, fig. 661) indicates a changing pattern from tapering to keeled, but the two sides of

TABLE 56.—Loop statistics for the genus *Rectithyris*

Proportions	USNM 104623a	USNM 104623b	USNM 551087
∠	41°	33°	41°
Wl/Ll	0.72	0.62	0.80
Ll/LD	0.35	0.40	0.32
Wl/WD	0.37	0.30	0.28
a/Ll	0.58	0.55	0.66
b/Ll	0.42	0.45	0.34
c/Ll	0.58	0.55	0.49
d/Ll	0.00	0.00	0.17
e/Ll	0.19	0.21	0.15
f/Ll	0.23	0.24	0.19
g/WD	0.23	0.25	0.28
g/Wl	0.65	0.83	1.00
h/f	0.48	0.58	0.47
h/Ll	0.11	0.14	0.09
WD/LD	0.80	0.83	0.91

USNM 104623a,b: *Rectithyris depressa* (Valenciennes), Cretaceous (Tourtia), Tournay, Belgium.

USNM 551087: *Rectithyris shenleyensis* (Walker), Cretaceous (Albian – Shenley Limestone), Shenley Hill, Leighton Buzzard, Bedfordshire, England.

the section do not match. There are no inner hinge plates in the excavated specimens from Belgium or Shenley, and none are shown in the serial sections mentioned above.

The crural bases expand into somewhat elongate crural processes with sharply acute points. The descending anterior of the crural processes is short, wide and thin, and supports a broad transverse band which is fairly strongly but evenly arched. The proximal or lateral parts are deeply concave but the median is elevated with abrupt sides and flat crest which occupies one-fourth the width of the loop. In side view the transverse band is directed posteriorly at an angle of about 12° from the horizontal. The anterolateral extremities of the loop are sharply angular but are not drawn out anteriorly into long points.

Loop Statistics.—See Table 56.

Discussion.—The serial sections (in Muir-Wood, 1965:H795, fig. 661) show virgate keeled outer hinge plates, long crural processes and a protuberant transverse band but no inner hinge plates although Sahni's generic definition calls for them.

One of the features of the *Rectithyris* loop stressed by Sahni is the presence of inner hinge plates, usually rare structures in the Terebratulacea of the Mesozoic. His illustration (Sahni, 1929, pl. 10: fig. 15) of a German specimen, not a topotype, shows questionable inner hinge plates. This specimen, B46317, is better illustrated in Muir-Wood, 1965:H794, fig. 660: 2d. Rather than illustrating inner hinge plates this shows thickening of the crural bases, misinterpreted as inner hinge plates. Sahni's (1929:10, fig. 14) figure is of *R. depressa*, B46349, from Tournay Belgium. This figure shows accurately the structure of the socket ridges and the form of the transverse band but no inner hinge plates are shown. This specimen is also poorly illustrated on Sahni's pl. 10: fig. 14 and no inner plates are to be seen. The only true inner hinge plates seen in Sahni's work are those of *Neoliothyrina*. Furthermore, the inner hinge plates shown in *Terebratula* (Sahni, 1929:6, fig. 3a) is of a specimen from the British Crag, here shown not to be a true *Terebratula* which comes from the Mediterranean region and has no inner hinge plates.

Absence of inner hinge plates from *Rectithyris* was noted by Middlemiss (1959:124). Inner hinge plates are not recorded in the emended diagnosis of *Rectithyris* by Cox and Middlemiss (1978:426). Smirnova (1972b:69) shows no inner hinge plates in her serial sections of *Rectithyris depressa sharica* Smirnova.

Sahni (1929:9) states: "The socket ridges are very characteristic in this genus and are of a type quite distinct from those met with in all other plicate genera of Upper Cretaceous Terebratulids I have investigated." The peculiarity of these plates is well illustrated by d'Archiac (1847, pl. 17: fig. 10) as well as by Sahni. This structure of the socket ridges is like that seen in *Capillarina* (Plate 23: figures 6, 7). This is also well illustrated by Muir-Wood (1965:H794, fig. 660: 2d) which indicates the proximal part of the socket decked over by shell material. Such important details are not seen in the serial sections of *Rectithyris*.

The exterior of *Rectithyris* with its straight and elongated beak and prominently displayed symphytium is very distinctive and easy to recognize. However, caution must be counseled in recognizing *Rectithyris* because this external form is duplicated by *Terebratula moravica* Glocker from the Jurassic of France and Switzerland, by *Terebratula vissae* Hadding and by *T. longirostris* Wahlenberg, from the Senonian of Sweden which does have inner hinge plates but is lacking in other details requisite for *Rectithyris*. These last two species have been placed in *Cyranoia* described above.

Rectithyris visqueneli (d'Archiac) figured by Popiel-Barczyk (1972, pl. 3: figs. 6–9) has the characteristic straight beak with completely exposed symphytium like *Rectithyris* but the cardinalia deviate from those of the type species. The Popiel-Barczyk figures show conjunct inner hinge plates (not seen in type *Rectithyris*). Moreover the socket ridges are curved and not extended posteriorly beyond the posterior margin, one of the requisites for Sahni's genus. Popiel-Barczyk's *R. visqueneli* is rectimarginate, otherwise there is similarity to *Harmatosia*.

Rectithyris shenleyensis (Walker) is an older species than *R. depressa* and varies from the type species in details of its exterior and loop. The beak is erect rather than straight but the symphytium is wholly visible. The loop is proportionally slightly wider, and slightly shorter than that of *R. depressa* when compared to the length and width of the dorsal valve. The crural processes are located farther anterior of midloop and the transverse band is narrower than those structures of the type species. The anterolateral extremities are shorter in *R. shenleyensis* than those of *R. depressa.*

These are all minor details and when considered with the peculiar development of the socket ridges, which are exactly like those of *R. depressa*, there is no question that this species belongs in *Rectithyris* where Cox and Middlemiss (1978) placed it.

Rhombaria, new genus

PLATE 53; FIGURES 8–21; PLATE 68: FIGURES 5, 6

SUBFAMILY.—Rhombariinae, new subfamily.

TYPE-SPECIES.—*Terebratula rhomboidalis* Nilsson, 1827:34, pl. 4: figs 5m, A–D.

COMPOSITION.—*Terebratula rhomboidalis* Nilsson (1827), *T. minor* Nilsson (1827).

DIAGNOSIS.—Almond-shaped to rhomboidal terebratulaceans having a wide loop with narrow, protuberant, transverse band.

SPECIMENS STUDIED.—Eleven in two species, one complete loop excavated, one cardinalia only.

GEOLOGIC OCCURRENCE.—Cretaceous (Senonian).

LOCALITY.—Sweden.

EXTERIOR.—Small to medium size, almond-shaped with well rounded sides, narrowly rounded anterior margin, acutely angular posterior. Unequally convex, ventral valve having greater convexity. Lateral commissure concave toward ventral side. Anterior commissure uniplicate. Beak fairly long, erect, with rounded beak ridges. Foramen of moderate size, permesothyridid. Symphytium visible. Surface smooth.

INTERIOR.—Ventral valve interior with long narrow teeth.

Loop and Cardinalia: The loop is flaring, as long as wide and occupies almost 40% of the length and width of the dorsal valve. The cardinal process is large, shelf-like, rather squarish and with slightly elevated rim. The socket ridges are stout, slightly inclined laterally and bound fairly wide sockets. The fulcral plates are well developed, thick and extended laterally as thick ridges. The outer hinge plates are very narrow, attached ventrally, and taper anteriorly to the crural processes where they support the scooplike anterior part of the loop. The tapered outer hinge plates join the very narrow crural bases which are extended posteriorly to form low ridges along the inner margin of the outer hinge plates. The crural bases, outer hinge plates and socket ridges form V-shaped troughs. The crural processes are drawn into sharp points and are located anterior to midloop. The descending lamellae are short, narrow and widely flared. The transverse band is a thin ribbon, gently arched and strongly protuberant at its middle. The anterolateral extremities are rounded.

LOOP STATISTICS.—USNM 551060: $\angle = 51°$; Wl/Ll = 1.00; Ll/LD = 0.38; Wl/WD = 0.38; a/Ll = 0.58; b/Ll = 0.42; c/Ll = 0.58; d/Ll = 0.00; e/Ll = 0.29; f/Ll = 0.13; g/WD = 0.36; g/Wl = 0.94; h/f = 0.23; h/Ll = 0.03; WD/LD = 1.00.

USNM 551060: *Rhombaria rhomboidalis* (Nilsson), Cretaceous (Senonian – *Actinocamax mammillatus* Zone), Klagstorp, Skåne, Sweden.

DISCUSSION.—The exterior of this genus is unlike any other Cretaceous genus seen in this study. The external almond-shape with its narrow beak and modest foramen suggest one or more genera of the Zeilleriacea. The great width of the loop is like that of *Sellithyris* but the crural processes are farther forward and the transverse band more broadly folded and protuberant than in *Sellithyris.*

ETYMOLOGY.—From the Greek *rhombos* (spinning top), in allusion to its shape.

Rhombothyris Middlemiss, 1959

PLATE 19: FIGURES 8–12; PLATE 22: FIGURES 20–23; PLATE 76: FIGURES 8–10

Rhombothyris Middlemiss, 1959:99.

SUBFAMILY.—Rhombothyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula extensa* Meyer, 1864:252, pl. 12: figs. 1–4.

SPECIMENS STUDIED.—Thirty-five of three species, two excavated loops nearly complete, two with cardinalia only.

GEOLOGIC OCCURRENCE.—Cretaceous (Aptian).

LOCALITY.—Great Britain.

EXTERIOR.—Narrowly elongate with length about 1.5 times width. Subequally convex, ventral valve usually deeper. Lateral commissure straight except at anterior. Anterior commissure variable from rectimarginate to sulciplicate and sulcate. Beak short, strongly truncated, suberect. Foramen large, mesothyridid. Symphytium short, wholly visible. Surface smooth.

INTERIOR.—Ventral valve with stout elongate teeth.

Loop and Cardinalia: The loop is comparatively short and narrow, occupying about a third the length and width of the dorsal valve. The cardinal process is a large, flattened half ellipse, medially depressed on its myophore face which is directed posteriorly. The socket ridges are rather thin, slightly inclined and bound narrow sockets. The outer hinge plates are fairly wide and deep and taper onto the outer sloping face of the crural processes. The outer hinge plates are attached along the dorsal edge of the crural bases which extend as a steep wall along their inner margins. The crural processes are long, acutely pointed, inclined fairly strongly medially and nearly overhang the transverse band. They are located slightly more than half the loop length. The descending lamellae are very short and bowed laterally. The transverse band is narrow, narrowest at the crest of the steep arch which it forms. The terminal points are moderately long and angular.

TABLE 57.—Loop statistics for the genus *Rhombothyris*

Proportions	USNM 550940a	USNM 551077
∠	26°	31°
Wl/Ll	0.56	0.67
Ll/LD	0.40	0.36
Wl/WD	0.39	0.32
a/Ll	0.70	0.62
b/Ll	0.30	0.38
c/Ll	0.60	0.54
d/Ll	0.10	0.08
e/Ll	0.16	0.13
f/Ll	0.14	0.25
g/WD	0.28?	0.44
g/Wl	0.70?	1.37
h/f	0.43	0.24
h/Ll	0.06	0.06
WD/LD	0.58	0.75

USNM 550940a: *Rhombothyris microtrema* (Walker), Cretaceous (Aptian – Lower Greensand), Upware, Cambridgeshire, England.

USNM 551077: *Rhombothyris meyeri* (Walker), same as above.

LOOP STATISTICS.—See Table 57.

DISCUSSION.—*Rhombothyris* and *Praelongithyris* with their greatly elongated valves resemble one another but the two are distinguishable by the greater length of the beak and symphytium of *Praelongithyris*. The loops are quite different because that of *Praelongithyris* is proportionately longer and narrower than that of *Rhombothyris* and the terminal points are shorter in *Praelongithyris*. The crural processes of *Rhombothyris* are closer to the crest of the transverse band than those of *Praelongithyris*.

Sardope Dieni, Middlemiss, and Owen, 1973

Sardope Dieni, Middlemiss, and Owen, 1973:196.

SUBFAMILY.—Nerthebrochinae?, new subfamily.

TYPE-SPECIES.—*Sardope sardoa* Dieni, Middlemiss, and Owen, 1973:198, fig. 15, pl. 35: fig. 9; pl. 36: figs. 1–3 (cited by Middlemiss, 1978, as Dieni and Middlemiss, 1975).

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Aptian).

LOCALITY.—Sardinia, France, and Ireland.

DIAGNOSIS (Dieni, Middlemiss, and Owen, 1973:196).—

Moderately elongated oval shell, flattened anteriorly. Both valves with maximum convexity close to umbo; extreme posterior part of brachial valve inflated. Ventral umbo [beak] very short, straight; dorsal umbo curved. Foramen small, circular, mesothyrid (sic). Beak ridges very rounded; cardinal area poorly defined. Deltidium very short. Lateral commissure straight or gently curved. Anterior commissure rectimarginate to very gently sulciplicate or parasulcate. Cardinal process initially very small, secondarily extended along hinge plates to leave posterior umbonal cavity. Hinge teeth massive. Hinge plates horizontal, with rounded inner edge, well differentiated from inner socket ridges.

REMARKS (Dieni, Middlemiss, and Owen, 1973).—The main distinctions from *Platythyris* (= *Aniabrochus*) are the very straight beak, the bulbous convexity of the extreme posterior part of the brachial [dorsal] valve and absence of capillation.

COMMENT.—The serial sections do not reveal the full extent of the loop which may have been broken in the specimen sectioned. The exterior details of this genus are very close to those of *Najdinothyris*.

Sellithyris Middlemiss, 1959

PLATE 16: FIGURES 20–22; PLATE 18: FIGURES 22–31; PLATE 20: FIGURES 7–12; PLATE 22: FIGURES 5–13; PLATE 23: FIGURES 29–34; PLATE 64: FIGURES 21, 22

Sellithyris Middlemiss, 1959:113.

SUBFAMILY.—Sellithyridinae Muir-Wood, 1965.

TYPE-SPECIES.—*Terebratula sella* J. de C. Sowerby, 1821–1825, pl. 437: fig. 1.

SPECIMENS STUDIED.—Many, six excavated for loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Aptian – Turonian).

LOCALITIES.—Great Britain, Europe.

EXTERIOR.—Small to medium size, pentagonal, length and with nearly equal or length slightly greater than width; biconvex, ventral valve usually deeper than dorsal one. Lateral commissure anteriorly strongly curved toward ventral side. Anterior commissure strongly sulciplicate. Beak short, suberect. Foramen large, mesothyridid to permesothyridid. Symphytium wholly visible. Surface smooth.

INTERIOR.—Ventral valve interior not seen.

TABLE 58.—Loop statistics for the genus *Sellithyris*

Proportions	USNM 550935	USNM 550936	USNM 550954b	USNM 551104b	USNM 551116a
∠	45°	45°	42°	41°	40°
Wl/Ll	0.88	0.88	0.78	0.83	0.74
Ll/LD	0.34	0.34	0.28	0.33	0.32
Wl/WD	0.28	0.31	0.21	0.29	0.25
a/Ll	0.53	0.53	0.63	0.61	0.63
b/Ll	0.47	0.47	0.37	0.39	0.37
c/Ll	0.53	0.53	0.63	0.61	0.63
d/Ll	0.00	0.00	0.00	0.00	0.00
e/Ll	0.29	0.38	0.22	0.22	0.21
f/Ll	0.18	0.09	0.15	0.17	0.16
g/WD	0.28	0.35	0.23	0.29	0.28
g/Wl	1.00	1.00	1.12	1.13	1.14
h/f	0.50	0.89	0.60	0.53	0.50
h/Ll	0.09	0.08	0.09	0.09	0.08
WD/LD	1.06	0.96	1.05	0.94	0.95

USNM 550935: *Sellithyris sella* (Sowerby), Cretaceous (Aptian – Fitton's Group IV), 200 yards (180 m) W of Whale Chine, Isle of Wight, England.

USNM 550936: *Sellithyris sella* (Sowerby), Cretaceous (Aptian), Atherfield, Isle of Wight, England.

550954b: *Sellithyris phaseolina* (Lamarck), Cretaceous (Cenomanian), La Donniere, Maine-et-Loire, France.

551104b: *Sellithyris phaseolina* (Lamarck), Cretaceous (Cenomanian), cliffs on S side of Route 52, 2.8 km SW of Briolay, La Donniere, Maine-et-Loire, France.

USNM 551116a: *Sellithyris* cf. *S. phaseolina* (Lamarck), Cretaceous (Turonian), NW edge of Bousse, 8 km N of La Fleche, Sarthe, France.

Loop and Cardinalia: The loop of the type species is almost as wide as long, has an angle of 45° and occupies slightly more than a third the length and a third of the width of the dorsal valve. The cardinal process is a half ellipse, wide, thin, and indented medially. The socket ridges are thin and erect, gently curved and bound a wide socket. The narrow proximal part of the socket is roofed. The fulcral plates are small and without lateral extensions. The outer hinge plates are fairly wide, concave and form deep U-shaped troughs between the socket ridges and the crural bases. The outer hinge plates are attached along the dorsal edge of the crural bases and taper anteriorly to a point just below (dorsad of) the crural processes, thus eliminating a crus. The crural bases are elevated along the inside margin of the outer hinge plates. The crural processes appear anterior to midloop, are acutely pointed, moderately long and slightly approximate. The descending lamellae are narrow, outwardly bowed and short. The transverse band is narrow, strongly arched and protuberant. It projects almost horizontally when viewed from the side, to a level slightly ventrad of the tips of the crural processes. The median crest of the transverse band is narrowly rounded rather than angular, the rounding occupying about a third the width of the loop. The anterolateral extremities are narrowly rounded.

LOOP STATISTICS.—See Table 58.

DISCUSSION.—The exterior of *Sellithyris* is quite distinctive but other genera have been confused with it, especially some of the Late Jurassic brachiopods identified as *Terebratula subsella* Leymerie. Barczyk (1969:47–55) assigns a number of Late Jurassic species from Poland to *Sellithyris*. Except for "*S.*" *pseudomaxillata* (Muir-Wood) the species so assigned are different externally from the strongly sulciplicate, pentagonal *Sellithyris*. The loops for these Jurassic species reconstructed by Barczyk are mostly wider than that of *Sellithyris*.

The loop of *Sellithyris* resembles that of *Hesperosia* but is wider and shorter in relation to the dorsal valve length and width. *Sellithyris* is suggestive of *Harmatosia* and *Boubeithyris* but differs internally from both in the shape of the loop and lack of inner hinge plates. *Xestosina*, new genus, is externally almost identical to *Sellithyris* but differs in having a more strongly arched and broader transverse band.

Tchoumatchenko (1978b:42, fig. 29) illustrates a loop purported to be that of *Sellithyris engeli engeli* (Rollier) an Upper Jurassic species also assigned to *Sellithyris* by Barczyk (1969:47). Tchoumatchenko's reconstruction shows a wide loop with narrow transverse band and long sharp terminal points. This differs strongly from Barczyk's reconstruction which shows a wide loop with very wide transverse band but short terminal points. Either the specimens sectioned by these authors represent different species or the reconstructions are faulty. Neither reconstruction has any resemblance to the actual loop of *Sellithyris sella* (J. deC. Sowerby) which is a Cretaceous genus having a wide loop with rounded anterolateral extremities. Makridin (1964:223) assigned *Terebratula engeli* Rollier to *Loboidothyris*.

Spasskothyris Smirnova, 1975

PLATE 62: FIGURE 12

Spasskothyris Smirnova, 1975a:74.

SUBFAMILY.—Spasskothyridinae Smirnova, 1977.

TYPE-SPECIES.—*Spasskothyris rjasanensis* Smirnova, 1975a:75, figs. 4, 5, pl. 9: fig. 4.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Berriasian).

LOCALITY.—Russian Platform.

DESCRIPTION (Smirnova, 1975a).—Large, elongate-oval, extended beak, faintly biplicate. Foramen large, apical. Unequally biconvex to slightly biconvex. Cardinal process low, not wide. Outer and inner hinge plates. Crural bases with long ventral and dorsal extremities, dividing outer and inner hinge plates, and in contact with valve floor, much reduced anteriorly. Ventral extremities of crural bases in form of ridgelike projections traced for entire length of hinge plates. Outer socket plates wide, curved ventrally. Crural bases and crural processes concave, parallel to plane of symmetry. Loop compact, narrow, located in mid third and takes up 3/5 the length of the dorsal valve. Flanges [terminal points] long, slightly less than half loop length. Transverse band narrow, widely arched.

LOOP STATISTICS (from reconstruction by Smirnova, 1975a, fig. 5).—∠ = 31°; Wl/Ll = 0.56; Ll/LD = 0.60; Wl/WD = 0.44; a/Ll = 0.34; b/Ll = 0.66; c/Ll = 0.34; d/Ll = 0.00; e/Ll = 0.18; f/Ll = 0.48; g/WD = 0.25; g/Wl = 0.57; h/f = 0.41; ⱶ/Ll = 0.04; h/Ll = 0.02; WD/LD = 0.71.

Smirnova reconstruction: *Spasskothyris rjasanensis* Smirnova, lower Cretaceous, Russian Platform.

DISCUSSION (Smirnova, 1975a).—This genus differs from all Jurassic and Cretaceous genera of long-flanged terebratulids except *Viligothyris* in the development of inner hinge plates; in addition, it is distinguished from the Early Cretaceous genera by a narrow, long-flanged loop and character of the crural bases. The elongate-extended shell, mono- or bi-plicate anterior margin, presence of a pedicle collar, development of inner hinge plates, long loop flanges, connect the new genus with the Early Jurassic *Viligothyris* Dagis (1968) from Siberia. Strong development of the dorsal and ventral extremities of the crural bases, wide inner hinge plates, extended beak, distinguish the present genus from the latter.

COMMENT.—Statistics from the serial sections (Smirnova, 1975a, fig. 4) do not agree with those taken from the reconstruction: Wl/Ll = 0.80; Ll/LD = 0.38; Wl/WD = 0.43; a/Ll = 0.38; f/Ll = 0.37.

Tropeothyris Smirnova, 1972

Tropeothyris Smirnova, 1972b:69.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Tropeothyris kugusemi* Smirnova, 1972b:70, pl. 6: fig. 2.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Hauterivian, Barremian, and Berriasian).

LOCALITIES.—Crimea and Switzerland.

DIAGNOSIS (Smirnova, 1972b).—Large, oval, or rounded-pentagonal shells with rounded costae expressed to some degree. Beak, high, heavy, strongly curved. Shoulders of beak insignificant. Symphytium large, well expressed. Pedicle collar usually present. Cardinal process small, transversely extended, with corrugated surface. Hinge plate concave, arcuate in cross-section, with strongly developed keels and tapering internal extremities. Crural processes slightly curved, without projections. Loop wide, short, with an abruptly curved transverse plate. Impressions of anterior dorsal adductors petal-shaped with interior margins parallel to euseptoidum; their external margins slightly concave.

COMPARISONS (Smirnova, 1972b).—The large size of the shell, rounded costae, large apical foramen, wide, triangular loop relate this genus to *Praelongithyris* Middlemiss. The more sharply expressed costation of the shell, the high strongly curved beak, tapering margins of the hinge plates, presence of keels in the latter, and absence of projections on the crural processes, allow us to distinguish this genus from *Praelongithyris*.

COMMENT.—The specimen sectioned is evidently a young one (16066/16) which has less than half the length of the holotype. The last section of the series is not measured, making it impossible to judge whether or not the loop had terminal points.

Smirnova (1975b:121) placed *Terebratula immanis* Zeuschner, in *Tropeothyris*, a genus without costae. Barczyk (1969:32) assigned Zeuschner's species to *Juralina*, where it seems better placed.

Walkerithyris Cox and Middlemiss, 1978

Walkerithyris Cox and Middlemiss, 1978:424.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Walkerithyris mendax* Cox and Middlemiss, 1978:425, fig. 6, pl. 40: figs. 7, 8.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Albian).

LOCALITY.—Great Britain.

DIAGNOSIS (Cox and Middlemiss, 1978: 425).—Ventral profile pentagonal. Brachial [dorsal] valve more obese than pedicle [ventral] valve. Beak short, wide, suberect to nearly straight. Beak ridges fairly well defined, especially near the foramen. Symphytium short, wide. Foramen circular, mesothyrid (sic); telate, attrite or slightly marginate, anterior commissure uniplicate. Hinge plates wide, thin, deeply concave, piped.

DESCRIPTION (Cox and Middlemiss, 1978: 425).—

> The lateral commissure is strongly convex towards the pedicle valve in the anterior part of the shell. The brachial valve is gently folded with a wide, median longitudinal fold that reflects the uniplicate anterior and affects at least half the length of the valve. The pedicle valve is flattened and spatulate at the anterior end. The inner socket ridges are wide, with the upper surfaces convex towards the pedicle valve. None of the serial sections prepared so far has shown the loop, which is fragile and breaks easily.

COMMENTS.—The serial sections presented do not indicate the crural processes which are an important part of the loop. The figured specimens resemble *Terebratula robertoni* d'Archiac, herein assigned to *Nerthebrochus*, new genus, which differs in having an erect (incurved) beak and a fairly convex dorsal valve and fairly strongly convex ventral valve.

Weberithyris Smirnova, 1969

PLATE 63: FIGURE 11

Weberithyris Smirnova, 1969a:144.

SUBFAMILY.—Rectithyridinae? Muir-Wood, 1965.

TYPE-SPECIES.—*Weberithyris moisseevi* Weber, 1949:116, pl. 19: figs. 3–5.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Cretaceous (Valanginian).

LOCALITIES.—Crimea and northern Caucasus, Russia.

EXTERIOR (Smirnova, 1969a).—Shell extended in length, with a wide, slightly curved beak, laterally depressed. Anterior margin wide, straight or slightly uniplicate. Symphytium high, striation distinct on casts. Pedicle collar absent.

INTERIOR (Smirnova, 1969a).—Hinge plates horizontal or somewhat concave, with blunted margins. Internal socket ridges not separated from the hinge plate. Crural bases wide. Crura narrow, massive. Loop has narrow branches. Transverse plate of the loop is thin, curved medially at a right angle. Muscle impressions of the dorsal valve are narrow, petal-like, their inner margins parallel.

LOOP STATISTICS (based on reconstruction by Smirnova, 1969a, fig. 2).—$\angle$ = 44°; Wl/Ll = 0.81; Ll/LD = 0.35; Wl/WD = 0.33; a/Ll = 0.47; b/Ll = 0.53; c/Ll = 0.37; d/Ll = 0.10; e/Ll = 0.31; f/Ll = 0.22; g/WD = 0.40; g/Wl = 1.23; h/f = 0.27; h/Ll = 0.06; WD/LD = 0.88.

DISCUSSION.—Because of the horizontal outer hinge plates (in section) Smirnova (1969a:145) compares this genus to *Platythyris* Middlemiss but she separates the two "by a strongly extended beak portion, depressed shell margins, presence of striations on the casts, absence of a pedicle collar, internal socket ridges not separated from the hinge plate and strongly curved transverse band of the loop [not clear in the reconstruction but strongly curved in the serial sections]".

The reconstructed loop is remarkable for its angular, quadrate form, long descending lamellae and delicate transverse band. Smirnova (1975b:120) assigns *Terebratula moravica* Glocker, a species of the Jurassic to this genus. *Weberithyris moisseevi* differs from this species in having "a wider shell, a lower rectified (straight) beak, larger apical angle and depressed dorsal valve". *Terebratula moravica* is mentioned in connection with *Juralina* of the Jurassic.

Boullier (1976:367) points out numerous differences of *Weberithyris* from *Juralina*. She finds differences in the cardinal processes, the hinge plates, crura and jugum (transverse band). Comparison of the reconstructions of the two loops may be made on Plate 63 (figure 11 = *Weberithyris*; figure 23 = *Juralina*).

Cretaceous Genus and Species Undetermined

PLATE 29: FIGURES 12–14; PLATE 76: FIGURES 13, 14

DISCUSSION.—A specimen (USNM 19459a) from Meudon, France has some characters like those of *Carneithyris* and others suggestive of *Concinnithyris* but the sum of its features separates it from both genera. The exterior is narrowly elliptical in profile and rectimarginate like *Carneithyris*, but unlike the genus it has a thin, shelf-like cardinal process, which is like that of *Concinnithyris* and the loop proportions are similar. It differs from *Concinnithyris* in having the outer hinge plates attached on the dorsal side of the crural bases, not ventrad as in *Concinnithyris* and *Carneithyris*, and the crura are narrow, giving the loop in side view a scooplike form. Resolution of this peculiar combination of characters must await further research on French material.

LOOP STATISTICS.—$\angle$ = 33°, Wl/Ll = 0.62; Ll/LD = 0.30; Wl/WD = 0.17; a/Ll = 0.72; b/Ll = 0.28; c/Ll = 0.48; d/Ll = 0.24; e/Ll = 0.14; f/Ll = 0.14; g/WD = 0.17; g/Wl = 1.04; h/f = 0.64; h/Ll = 0.09; WD/LD = 1.13.

Some Related Genera from Cancellothyridacea

Superfamily CANCELLOTHYRIDACEA Thomson, 1926

Family CNISMATOCENTRIDAE Cooper, 1973

Small to medium size, smooth or capillate or with teardrop ornament. Cardinalia with strong elevated socket ridges, no definable outer hinge plates. Crural processes anterior, loop bowed with approximate lateral branches and slightly arched, narrow transverse band. Musculature like that of *Terebratulina* with the dorsal adjustors on the dorsal valve floor.

Katz (1974) created the family Arcuatothyridae (herein reduced to subfamily rank) for a small Cretaceous terebratulid having a loop characterized by high and long socket plates, without visible outer hinge plates, an ensemble like that of the modern genus *Cnismatocentrum* Dall that he added to his family. The lack of outer hinge plates indicates that the musculature must have been like that of *Terebratulina*. To Katz' family also belongs *Nucleatina* Katz (1962). Katz placed his family in the Terebratelloidea (Terebratellida) but it does not belong there. The loop of *Arcuatothyris* is terebratulinid, not terebratellid, which is long and entirely different from the loop of these unusual Cretaceous shells.

The Family Cnismatocentridae is divided into two subfamilies: Cnismatocentridinae Cooper, 1973b; Arcuatothyridinae Katz, 1974.

The Inopinatarculidae (ex Inopinatarculinae Muir-Wood, 1965) is related.

Subfamily CNISMATOCENTRIDINAE Cooper, 1973

Cnismatocentrum Dall, 1920

PLATE 28: FIGURES 1, 2

Figures of the loop of this unusual genus are introduced for comparison with the loops of *Arcuatothyris*, *Nucleatina*, and *Inopinatarcula*.

Subfamily ARCUATOTHYRIDINAE Katz, 1974

Arcuatothyris Popiel-Barczyk, 1972

PLATE 28: FIGURES 3–10; PLATE 61: FIGURE 24; PLATE 63: FIGURES 9, 10

Arcuatothyris Popiel-Barczyk, 1972:136.

SUBFAMILY.—Arcuatothyridinae Katz, 1974.

TYPE-SPECIES.—*Terebratula arcuata* Roemer, 1841:44, pl. 8: fig. 18a–c.

SPECIMENS STUDIED.—Eight, three excavated, cardinalia only.

GEOLOGIC OCCURRENCE.—Cretaceous (Cenomanian).

LOCALITIES.—France, Great Britain, Germany, Poland, and Russia.

EXTERIOR.—Small, elongate oval, sides gently convex; maximum width at midvalve. Ventral valve more convex than dorsal valve. Lateral commissure nearly straight. Anterior commissure rectimarginate or with a slight wave toward the ventral valve. Beak fairly large, suberect to erect. Foramen large, permesothyridid. Symphytium visible. Surface marked by radial, interrupted tear-shaped dashes overlying fairly strong shell lamellae.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop has similarities to that of *Terebratulina*. It is somewhat oval in outline with the crural processes located far anterior, nearly opposite the transverse band. The cardinal process is small, shelf-like, half elliptical and has its myophore facing posteriorly. The socket ridges are stout, long, erect and high, actually protruding slightly posterior to the posterior margin. They bound deep and wide sockets. The fulcral plates are fairly anterior in position and inset posterior to the distal edge of the socket ridge. A deep cavity extends posteriorly under the fulcral plates and between the socket ridges (Popiel-Barczyk 1972:139, fig. 9, serial sections). The fulcral plate is extended laterally as a short narrow ridge. The crural bases are narrow and their posterior part originates along the high socket ridge. Its ventral face is concave. It narrows anteriorly, and is very long, bowed outwardly and sharply ventrally at about midlength, then approximating each other anteriorly. The plate initially faces ventrolaterally, then as it bows, it turns so that its edges are ventral and dorsal and its side lateral, anteriorly expanding into the terminal crural processes. The bowed and narrowed portion may be considered as a crus. In side view the crus is bent toward the ventral valve at about its middle. The crural processes are small, triangular expansions, bluntly angular on their distal ends. The transverse band (Katz, 1974, fig. 54: 7–9, herein Plate 63: figures 9, 10), is a narrow nearly horizontal ribbon that is attached just anterior to the anterior ends of the crural processes.

Loop Statistics.—USNM 550973b: ∠ = 30°; Wl/Ll = 0.61; Ll/LD = 0.40; Wl/WD = 0.26; a/Ll = 0.78; b/Ll = 0.22; c/Ll = 0.67; d/Ll = 0.11; e + f/Ll = 0.22; g/WD = 0.31; g/Wl = 1.18; h/Ll = ?; WD/LD = 093.

USNM 550973b: *Arcuatothyris arcuata* (Roemer), Cretaceous (Cenomanian - Chloritic Chalk), La Montagne Ste. Catherine, Rouen, France.

Discussion.—Parts of this loop are subject to different interpretations. The loop figured by Katz (herein Plate 63: figures 9, 10) shows ventral, side and cross-section views. The ventral view and the cross-section show the socket ridges and well demarcated hinge plates supported by vertical plates with a wide space between these plates and the shell wall. The serial sections of Popiel-Barczyk show an angular bend which divides the structures into two parts. The socket ridge (Popiel-Barczyk 1972:140, fig. 10) is an oblique T and the dorsal plates join the dorsal part of the T with a suture between. No such arrangement was seen in the French specimens and no suture between the plates was detected. Serial sections of *Terebratula lachrymosa* Morris, sent me by Dr. F.A. Middlemiss (in litt., 11 May 1977) agree with Popiel-Barczyk's sections in all respects except for differentiating the two separate plates. His sections differ from the preparations of the French specimens in showing a distinct convexity to the structure immediately anterior to the socket ridge. Middlemiss' sections show the abruptness and terminal nature of the crural process and the appearance of the transverse band only 0.4 mm anterior to them.

Examination of the prepared French specimens fails to show any clear-cut demarcation between the plates. The socket ridges appear as a continuous plate from the ventrad edge to valve floor. When moistened or in a strong light the fulcral plates can be seen as a dark line running from the distal end of the socket to the apex. This is the only demarcation to be seen to separate ridge from its supporting plate. The question arises as to what relation this lower or dorsal thin plate bears to the normal loop.

The plate in question originates as a thin wedge between the fulcral plate and the valve floor, it is vertical and widens or heightens as the fulcral plate ascends above the floor. At the distal end of the socket this plate widens and is concave gradually rotating to a ventrodorsal position and widens into the vertical crural process. In lateral view this plate is strongly bent at a considerable angle so that it protrudes strongly into the shell. This elongated plate appears to me to be the crural process. There is no trace of muscle marks on any part of the posterior wall-like socket ridge or the extended ventral plate. It is suggested that the dorsal pedicle muscles were attached to the valve floor between the embracing plates as they are in *Terebratulina*. The resemblance of the loop of *Arcuatothyris* to that of *Terebratulina* is fairly strong but there are differences. There is no anterior ring made by union of the crural processes as in *Terebratulina*. In the latter genus the crus extends from the distal end of the socket ridge obliquely inward. It is a narrow plate, flattened on its ventral surface and with a slight extension posteriorly suggesting an abortion of the type of plate (crus) seen in *Arcuatothyris*.

Popiel-Barczyk (1972:138) suggests that *Arcuatothyris* belongs to the Boreiothyridae of Dagis (1968:26) which is characterized by septal plates that are conjunct with a median septum of modest height. There is no such arrangement in *Arcuatothyris*. The question of whether the shell between the fulcral plates and the valve floor are hinge plates or the developing crural bases is still to be answered. If the latter *Arcuatothyris* cannot belong to the Boreiothyridae.

Davidson (1874–1882, suppl. pl. 2: fig. 16) presents a drawing of the interior of *T. arcuata* Roemer (= *T. rugulosa* Morris) showing the loop. This loop is completely unlike that of *Arcuatothyris* as it is a more or less conventional type of terebratulid loop. The loop of *Arcuatothyris* is shown above and in illustrations herein to be close to that of *Cnismatocentrum*, an aberrant and specialized loop.

Nucleatina Katz, 1962

PLATE 28: FIGURES 11–22; PLATE 63: FIGURE 12; PLATE 75: FIGURES 19, 20

Nucleatina Katz, 1962:135.

SUBFAMILY.—Arcuatothyridinae Katz, 1974.

TYPE-SPECIES.—*Terebratula nanclasi* Coquand, 1862:237, pl. 23: figs. 6–8.

SPECIMENS STUDIED.—Eight of two species, two excavated to show complete loop, two showing cardinalia only.

GEOLOGIC OCCURRENCE.—Cretaceous (Senonian).

LOCALITIES.—France and Russia.

EXTERIOR.—Medium to large, subcircular to elongate pentagonal, biconvex, ventral valve with greater convexity. Lateral commissure nearly straight; anterior commissure uniplicate in the adult. Beak short, suberect, labiate. Foramen fairly large, permesothyridid. Symphytium hidden or partially visible. Surface smooth; faint radial lines visible on decorticated patches.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is shaped like a horse-collar, wide posteriorly, narrowing and truncated anteriorly. It occupies slightly more than a third the length and a quarter or less of the width of the dorsal valve. The cardinal process is small, narrow, semielliptical and has the myophore facing posteriorly. The socket ridges are low, stout, erect, and protrude slightly beyond the posterior margin. The sockets are fairly wide and are proximally covered. The fulcral plates are narrow, slightly extended laterally and have a chamber under them. The crural bases originate at the base and edge of the socket ridges, are narrow, concave proximally, and are bent at an angle of 100° inward and toward the ventral valve. Anteriorly, they narrow to half their width. They narrow, rotate nearly to verticality, and then thin anteriorly to the low crural processes which form the apex of another change in direction to the anterior. The crural processes are a small triangular expansion of the crus and bear short but acute points. The crural process is directed dorsally for a short distance to attach the transverse band. This is fairly broad, bows slightly anteriorly and bears a median notch on its posterior side. It is nearly parallel to the horizontal and is protuberant. The anterolateral extremities form a right angle but are short and posterior of the margin of the transverse band.

LOOP STATISTICS.—See Table 59.

TABLE 59.—Loop statistics for the genus *Nucleatina*

Proportions	USNM 19866	USNM 19874
∠	27°	37°
Wl/Ll	0.53	0.67
Ll/LD	0.37	0.34
Wl/WD	0.19	0.25
a/Ll	0.87	0.81
b/Ll	0.13	0.19
c/Ll	0.67	0.71
d/Ll	0.20	0.10
e/Ll	0.06	0.05
f/Ll	0.07	0.14
g/WD	0.40	0.34
g/Wl	2.12	1.35
h/f	?	0.36
h/Ll	0.13?	0.05
WD/LD	1.02	0.90

USNM 19866: *Nucleatina toucasiana* (d'Orbigny), Cretaceous (Senonian), Rouen, France.

USNM 19874: *Nucleatina nanclasi* (Coquand), same as above.

DISCUSSION.—The two excavated specimens of

N. nanclasi supplement each other nicely. One is a young individual (USNM 551073) about half the size of the adult. It shows well-marked fulcral plates with lateral extensions and chamber under them extending posteriorly. The crural base starts as a narrow wedge that expands anteriorly, becomes concave at the distal end of the fulcral plate, and gradually rotates nearly to verticality before expanding into the crural process. This is like the loop of *Cnismatocentrum.* In the other adult shell the cavity under the fulcral plate is largely plugged by adventitious shell.

The loop of *Arcuatothyris* has a more strongly elevated socket ridge than that of *Nucleatina* but in other respects the two are the same.

The relationship of *Nucleatina* to *Nucleata* postulated by Katz is puzzling. He says that the two differ in external appearance, which is evident, the former being short and wide and strongly sulcate. Katz notes: "However, the internal structure (1962:137, fig. 5, 5A) and the presence of a groove on the median fold of the dorsal valve relate these two genera, thus forming a basis for including them in one subfamily." *Nucleata,* being strongly sulcate, has no fold in the dorsal valve and is not comparable in its folding to *Nucleatina.* Moreover, the interiors of the two genera are entirely different, that of *Nucleata* having different cardinalia and loop more like that of the Terebratulidae. The unfortunately named *Nucleatina* is best placed in the Arcuatothyridinae along with *Arcuatothyris.*

Family INOPINATARCULIDAE Muir-Wood, 1965

Inopinatarcula Elliott, 1952

PLATE 26: FIGURES 19–26; PLATE 75: FIGURES 21, 22

Inopinatarcula Elliott, 1952:2.

FAMILY.—Inopinatarculidae Muir-Wood, 1965.

TYPE-SPECIES.—*Trigonosemus acanthodes* Etheridge, 1913:15, pl. 2: figs. 1–4.

SPECIMENS STUDIED.—Fifteen, one excavated to show loop.

GEOLOGIC OCCURRENCE.—Cretaceous (Senonian).

LOCALITY.—Australia.

EXTERIOR.—Resembling *Terebratulina* but without cardinal extremities. Small, circular to rounded pentagonal, sides and anterior margin rounded. Lateral commissure moderately curved toward ventral side; anterior commissure moderately to strongly uniplicate. Interarea prominent, wide. Beak small, incurved, moderately protuberant. Foramen small, epithyridid. Symphytium short, convex, visible. Surface finely costellate, costellae with short spines.

INTERIOR.—Teeth ponderous and with wide, deep fossettes. Pedicle opening small, tubular. No dental plates. Muscle area elongate, heart-shaped. Diductors narrow, surrounding small adductor scar.

Loop and Cardinalia: The loop is short and wide and occupies more than a third the length and less than a third the width of the dorsal valve. The cardinal process is small and trilobed. The socket ridges are erect and massive. The fulcral plates are thick and massive, especially laterally. Outer hinge plates are lacking. The crural bases are concealed beneath excess tissue of the socket ridges. The crura are short. The crural processes are short, strongly approximate, and bluntly pointed, but do not meet. The descending lamellae are the anterior edges of the crural processes. The transverse band is moderately broad, medially arched with narrow concave portions adjacent to the descending lamellae. The terminal points are short and rounded.

LOOP STATISTICS.—USNM 551119a: $\angle = 33°$; Wl/Ll = 0. 72; Ll/LD = 0.40; Wl/WD = 0.26; a/Ll = 0.61; b/Ll = 0.39; c/Ll = 0.44; d/Ll = 0.17; e/Ll = 0.14; f/Ll = 0.25; g/WD = 0.24; g/Wl = 0.92; h/f = 0.32; h/Ll = 0.08; WD/LD = 1.11.

USNM 551119a: *Inopinatarcula acanthodes* (Etheridge), Cretaceous (Senonian, Gingin Chalk), Molecap Hill, Gingin, West Australia, Australia.

DISCUSSION.—This genus suggests *Terebratulina* because of its shape and exterior. Fundamental differences exist between the two. *Inopinatarcula* has a convex, massive symphytium unlike *Terebratulina*, which at best, has only vestigial deltidial plates. The foramen of *Inopinatarcula* is small while that of *Terebratulina* is large and ill-defined. Inside the ventral valve the teeth of *Inopinatarcula* are massive with deep fossettes; those of *Terebratulina* are narrow and elongate.

Inside the dorsal valve the socket ridges of *Inopinatarcula* extend from floor to posterior margin, are curved and stout like those of *Terebratulina*. There are no outer hinge plates. The crural bases are attached to the inner edges of the socket ridges and are short. The crural processes are blunt and approximate but do not meet as they do in most species of *Terebratulina*. The median callus of Elliott's figure (1952:21, pl 2; fig. 26) of the interior of the dorsal valve suggests the scars of the dorsal adjustor (pedicle) muscles. These were probably attached to the floor of the dorsal valve as in *Terebratulina* and *Cnismatocentrum*.

Although the loop is terebratuloid in its construction the cardinalia and probably the musculature suggest that *Inopinatarcula* belongs in the Cancellothyridacea rather than the Terebratulacea. It should be ranked as a family with the Cnismatocentridae in the Cancellothyridacea.

TABLE 60.—Loop statistics for the genus *Aenigmathyris*

Proportions	USNM 549414d	USNM 549414e	USNM 550891a
∠	20°	19°	16°
Wl/Ll	0.69	0.55	0.61
Ll/LD	0.20	0.29	0.33
Wl/WD	0.16	0.20	0.24
a/Ll	0.57	0.57	0.50
b/Ll	0.43	0.43	0.50
c/Ll	0.40	0.38	0.39
d/Ll	0.17	0.19	0.11
e/Ll	0.25	0.26	0.28
f/Ll	0.18	0.17	0.22
g/WD	0.21	0.27	0.36
g/Wl	1.33	1.33	1.45
h/f	0.94	1.12	0.50
h/Ll	0.17	0.19	0.11
WD/LD	0.83	0.87	0.83

USNM 549414d, e; 550891a: *Aenigmathyris stearnsi* Cooper, Eocene, at 400 feet (122 m) elevation, N of Vaingana, Island of Eua, Tonga Island Group, South Pacific.

Tertiary TEREBRATULACEA

Aenigmathyris Cooper, 1971

PLATE 1: FIGURES 1–9; PLATE 69: FIGURES 1, 2

Aenigmathyris Cooper, 1971:F2.

SUBFAMILY.—Aenigmathyridinae, new subfamily.

TYPE-SPECIES.—*Aenigmathyris stearnsi* Cooper, 1971:F3, pl 1: figs. 25–48.

SPECIMENS STUDIED.—Twenty-five, four excavated to show loop.

GEOLOGIC OCCURRENCE.—Eocene.

LOCALITY.—Island of Eua, Tonga Island Group, South Pacific.

EXTERIOR.—Medium size, biconvex, ventral valve deeper than dorsal one, widely ovate, maximum width slightly anterior to midline; lateral commissure straight; anterior commissure rectimarginate with a tendency to broad sulcation in the adult. Beak short, erect, labiate, truncated by a round to narrowly oval, permesothyridid foramen. Symphytium solid, concave, partially visible. Surface marked by fine concentric lines of growth and faint radial capillae best seen on flanks.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The cardinal process of *Aenigmathyris* is thin, excavate anteriorly, spreading laterally and forms a narrow half ellipse with its myophore directed posteriorly. The socket ridges are thick, straight or slightly curved and bound fairly wide sockets floored by thick fulcral plates. The proximal part of the sockets is filled with shell tissue.

A distinctive feature of the cardinalia of *Aenigmathyris* is the form of the hinge plate. This is triangular, thick and its free inner edge is not margined by an elevated crural base. The combination of hinge plates and socket ridges is gently concave and gives the appearance of a single structure.

The crural bases are thick, laterally compressed (broad), obliquely flattened where they join the hinge plate and are not extended posteriorly along the inner margin of the outer hinge plates as an elevated ridge defining a narrow trough as in many terebratulaceans. They are short and expand almost immediately anterior to their junction with the hinge plates into the crural processes. These are not strongly elevated and are bent slightly toward the middle. Their posteroventral edges are slightly flattened and appear as tapering extensions of the hinge plate. The sides of the crural processes are somewhat flattened and are moderately bowed. The anteroventral edge is sharp and thin. The anterior descending portion of the crural processes is variable. In one individual (USNM 549414d; Plate 1: figure 5) it is very short and the transverse band is given off directly from it. Two other specimens have somewhat longer extensions that might be called descending lamellae (Plate 1: figures 6, 8). The anterior descending lamellae are directed medially to produce an anteriorly narrowed loop.

The transverse band, as seen by the four excavated specimens, is also variable. It is broad and extends directly from the crural processes by a narrow curve. The curve is interrupted medially by a narrow, subangular fold, the narrowness and angularity of which are variable.

Loop Statistics.—See Table 60.

Discussion.—Although much stouter, the loop of *Aenigmathyris* is most like that of *Dyscolia*. The outer hinge plates are not bounded by the posterior extension of the crural bases, which are blunt and appear at or anterior to midloop. The median narrowing of the anterior of the loop of *Aenigmathyris* and the rounded lateral extremities of the loop are dyscoliid characters. The loop of *Aenigmathyris*, however, is narrower and more strongly folded medially than that of *Dyscolia*. Like *Dyscolia* the cardinal process of *Aenigmathyris* is inconspicuous. *Aenigmathyris* is the earliest of the dyscoliids to appear in the Pacific.

Measurement of the loop angle of this genus is uncertain because of the lack of well-defined angular anterolateral extremities. The measurement was taken by lines from the cardinal process to the middle of the troughs on each side of the median fold of the transverse band.

Apletosia, new genus

Plate 5: figures 10, 11; Plate 64: figures 19, 20

Subfamily.—Apletosiinae, new subfamily.

Type-Species.—*Terebratula maxima* Charlesworth, 1837:92, figs. 13a, 14.

Diagnosis.—Large terebratulid having a loop with long terminal points, inner hinge plates and long curved crural processes.

Specimens Studied.—Three, one excavated to show loop, several single valves.

Geologic Occurrence.—Pliocene.

Locality.—England.

Exterior.—Large, longer than wide, elongate oval, width 0.6–0.7 of length, valves nearly equal in depth and convexity. Lateral commissure nearly straight; anterior commissure faintly sulciplicate. Beak short, suberect, with slight labiation. Foramen small, round, mesothyridid to permesothyridid. Symphytium concave, completely visible. Surface marked by concentric growth lines only.

Interior.—Ventral valve interior with short excavate pedicle collar; teeth large, supported by thickening on shell wall. Muscle field large, triangular.

Loop and Cardinalia: The cardinal process is subcircular, somewhat tubular with an elevated rim around a median pit, the lateral parts of the rim not meeting posteriorly. The socket ridges are narrow, strongly elevated and have a narrow, distal hooklike tooth, an accessory of the articulation. The outer socket wall is thickened by a narrow ridge. The fulcral plates are buried by shell tissue. The outer hinge plates are narrow if they actually exist. The crural bases are obscured by narrow inner hinge plates that do not meet medially. The crura are unmeasurable because the crural processes originate at the distal ends of the socket ridges, as in *Liothyrella*. The crural processes are exceptionally long and slender, curved and with needlelike points directed anteromedially. The descending lamellae are short, straight and flare laterally. The transverse band is narrow, moderately bowed and medially protuberant. The terminal points are long for a terebratulid.

LOOP STATISTICS.—USNM 109709a: ∠ = 45°; Wl/Ll = 0.87; Ll/LD = 0.49; Wl/WD = 0.52; a/Ll = 0.54; b/Ll = 0.46; c/Ll = 0.54; d/Ll = 0.00; e/Ll = 0.16; f/Ll = 0.30; g/WD = 0.39; g/Wl = 0.75; h/f = 0.27; h/Ll = 0.08; WD/LD = 0.83.

USNM 109709a: *Apletosia maxima* (Charlesworth), Pliocene (Carolline Crag), Suffolk, England.

DISCUSSION.—This genus differs from *Terebratula* in the possession of inner hinge plates and long terminal points on the loop. The anterior commissure is less folded than that of the Italian genus. *Apletosia* differs from *Pliothyrina* in its modest development of the inner plates, longer terminal points and the less pointed crest to the transverse band.

That *Apletosia* is close to *Pliothyrina* cannot be questioned because the position of the crural processes is essentially the same in the two genera and the crural processes are long and slender in both. However, the loop of *Apletosia* occupies a greater part of the dorsal valve than that of *Pliothyrina*.

ETYMOLOGY.—From the Greek *apletos* (immense).

Ceramisia, new genus

PLATE 1: FIGURES 10–21; PLATE 69: FIGURES 7, 8

SUBFAMILY.—Aenigmathyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula meneghiniana* Seguenza, 1865:29, pl. 2: figs. 12, 13.

DIAGNOSIS.—Small, rounded, sulcate terebratulaceans with shingled exterior and dyscoliid type of loop.

SPECIMENS STUDIED.—Twenty, two excavated to show loop.

GEOLOGIC OCCURRENCE.—Pliocene.

LOCALITY.—Sicily.

EXTERIOR.—Small, subcircular, sides and anterior margins rounded; posterolateral margins meeting at about a right angle. Lateral commissure nearly straight for ⅔ its length, curved ventrally in anterior third. Anterior commissure broadly, strongly sulcate. Beak short, suberect, truncated by large mesothyridid foramen. Beak ridges strong, bounding narrow interareas. Symphytium thick, visible, notched posteriorly or mostly resorbed (Plate 1: figure 19). Surface marked by closely crowded concentric lamellae like roofing tiles.

INTERIOR.—Ventral valve with large cyrtomatodont teeth; pedicle collar short, excavate. Other details not seen.

Loop and Cardinalia: The cardinal process is wide, semielliptical and the myophore faces posteroventrally. The socket ridges are erect, thick and bound wide sockets floored by thick fulcral plates. The crural bases are welded to the socket ridges without a recognizable hinge plate. The poorly defined crural bases are elevated on the inner margin of the socket plates to form narrow troughs or pits with the socket ridges. The crura are flattened, broad and moderately long. They expand into low, acutely pointed crural processes located anterior to midloop. The descending lamellae are short, directed anteromedially and unite to form an anterodorsally directed, bluntly pointed loop. The transverse band connects with the anterior of the crural processes. There are no terminal points.

LOOP STATISTICS.—USNM 549406b: ∠ = 25°; Wl/Ll = 0.54; Ll/LD = 0.27; Wl/WD = 0.15; a/Ll = 0.62; b/Ll = 0.38; c/Ll = 0.39; d/Ll = 0.23; e/Ll = 0.26; f/Ll = 0.12; g/WD = 0.26; g/Wl = 1.72; h/f = 0.67; h/Ll = 0.08; WD/LD = 0.96.

USNM 549406b: *Ceramisia meneghiniana* (Seguenza), Pliocene, Messina Province, Sicily.

DISCUSSION.—Thomson (1927:191) referred this species to *Abyssothyris* because of its strongly sulcate anterior commissure. Compared to type *Abyssothyris wyvillei* (Davidson) the exterior shell surface and loop are unlike those of *Abyssothyris* which has the transverse band of the loop directed posteriorly, not anteriorly as in *Ceramisia*. Furthermore the anterolateral extremities of the loop of *Abyssothyris* are often not rounded as in *Ceramisia*.

Of described genera that most like *Ceramisia* is *Faksethyris* Asgaard (1971:385–389) from the Middle Danian of Denmark. *Faksethyris nielseni* Asgaard has a shingled exterior like that of *Ceramisia* and has a similar large foramen. The two figures of *Faksethyris* showing the anterior margin (Asgaard, 1971, pl. 1: fig. 6; pl. 2: fig. 1) indicate a rectimarginate anterior commissure. The cardinal process of *Faksethyris* is said to be transverse but feeble whereas that of *Ceramisia* is transverse and large. The socket ridges of *Ceramisia* are more rounded and concave than those of *Faksethyris*. The loops of the two genera are similar in form but that of the Danish genus is more slender and more pointed anteriorly. The measure a/Ll (position of the crural processes) is more than half (0.62) the loop in *Ceramisia* but less than a half (0.48) in *Faksethyris*. The measure of e+f/Ll is far greater in the Danish genus than in the one from Sicily. Although it is difficult to take accurate measurements from the illustrations of *Faksethyris* the proportions of the loop of the two genera appear to be unlike.

The loop of *Ceramisia* is like that of *Abyssothyris* but is more elongated anteriorly and has a narrowly rounded anterior that is directed dorsally. The loop and exterior of *Ceramisia* are like those of *Acrobelesia* but differ in not having radial capillae and in being strongly sulcate.

ETYMOLOGY.—From the Greek *keramis* (roofing tile).

Dolichosina, new genus

PLATE 7: FIGURES 1–5; PLATE 66: FIGURES 5, 6

SUBFAMILY.—Plicatoriinae?, new subfamily.

TYPE-SPECIES.—*Terebratula oamarutica* Boehm, 1904:149, pl. 15: figs. 6, 7a–c.

DIAGNOSIS.—Large terebratulaceans having a long loop with long flat crura.

SPECIMENS STUDIED.—Sixty-seven, five with loop.

GEOLOGIC OCCURRENCE.—Oligocene (Upper Ototaran).

LOCALITY.—New Zealand.

EXTERIOR.—Large, oval, maximum width at midvalve, sides broadly rounded, anterior margin somewhat narrowly rounded. Lateral commissure straight; anterior commissure rectimarginate to slightly uniplicate. Beak suberect, strongly truncated, moderately protuberant. Foramen large, permesothyridid to mesothyridid. Symphytium partially visible. Surface marked only by concentric lines of growth.

INTERIOR.—Ventral interior with small teeth and poorly developed pedicle collar. Muscle field not well defined.

Loop and Cardinalia: The loop is long and moderately expanded anteriorly. The cardinal process is stout, large and protuberant, half elliptical with its myophore facing posteroventrally. The socket ridges are thin, gently curved, and slightly inclined laterally. The sockets are narrow. The fulcral plates are thick and laterally extended for a short distance. The outer margin of the socket bears a longitudinal, narrow ridge that helps to strengthen to articulation of the valves. The outer hinge plates are thick, narrow, and are attached to the dorsal edge of the broad crural bases. The

TABLE 61.—Loop statistics for the genus *Dolichosina*

Proportions	USNM 87396	USNM 550915a	USNM 550915b
∠	30°	31°	32°
Wl/Ll	0.57	0.58	0.58
Ll/LD	0.38	0.41	0.41
Wl/WD	0.24	0.28	0.28
a/Ll	0.62	0.66	0.65
b/Ll	0.38	0.34	0.35
c/Ll	0.57	0.52	0.52
d/Ll	0.05	0.14	0.13
e/Ll	0.19	0.17	0.17
f/Ll	0.19	0.17	0.18
g/WD	0.26	0.23	0.27
g/Wl	1.04	0.94	1.00
h/f	0.53	0.53	0.33
h/Ll	0.10	0.09	0.06
WD/LD	0.89	0.85	0.90

USNM 87396, 550915a,b: *Dolichosina oamarutica* (Boehm), Oligocene (Upper Ototaran McDonald Consolidated Zone), Everetts Quarry, Kakanui, New Zealand.

anterior taper of the outer hinge plates is extended nearly to the crural processes. The crural bases form a high ridge along the inner margin of the outer hinge plates and form with the socket ridges bluntly V-shaped troughs. The crural bases form fairly long crura (d/Ll = 0.14) that rise beyond the middle of the loop into short, bluntly pointed crural processes. The descending lamellae are short flat blades. The transverse band is moderately broad and is abruptly and narrowly arched at its middle. The anterolateral extremities of the loop are angular but not extended anteriorly.

LOOP STATISTICS.—See Table 61.

DISCUSSION.—The loop of *Dolichosina* differs from that of *Liothyrella* and *Acrobrochus*, new genus, in the attachment of the outer hinge plates to the dorsal edge of the crural bases rather than the ventral part. The loop of *Dolichosina* differs from that of *Tanyoscapha*, new genus, and *Plicatoria*, new genus, in the less tapering and shorter outer hinge plates. The loop of the New Zealand genus differs from that of *Tichosina* in its generally wide loop angle, the proportion of the loop to the length of the dorsal valve, being greater in *Dolichosina*, and in the narrower transverse band and relatively shorter outer hinge plates making for a long crus in *Dolichosina*. The loop of *Dolichosina* differs from that of *Mimorina* in its greater length and width relative to those dimensions of the dorsal valve.

ETYMOLOGY.—From the Greek *dolichos* (long).

Embolosia, new genus

PLATE 59: FIGURES 1–10

SUBFAMILY.—Plicatoriinae, new subfamily.

TYPE-SPECIES.—*Embolosia sphenoidea*, new species.

DIAGNOSIS.—Elongate, narrow shells with crural processes located ¾ loop length from the posterior; loop like that of *Plicatoria*.

SPECIMENS STUDIED.—Two, one excavated for loop.

GEOLOGIC OCCURRENCE.—Eocene.

LOCALITY.—North Carolina.

EXTERIOR.—About medium size, ventral valve length nearly double its width; sides parallel, anterior margin narrowly rounded. Lateral commissure concave on ventral side. Anterior commissure broadly uniplicate. Beak moderately long, suberect, slightly labiate. Foramen large, mesothyridid. Symphytium visible. Surface marked by concentric lines of growth only.

INTERIOR.—Pedicle valve with short pedicle collar. Muscle field narrow, elongate. Pallial trunks narrow, subparallel.

Loop and Cardinalia: The loop is long and occupies 40% of the length and 30% of the width of the dorsal valve. The cardinal process is a flat, half elliptical shelf with shallow median depression and myophore facing ventrally. The socket ridges are thick and merge into the narrow hinge plates which are long and taper to disappearance on the dorsal side of the crural bases, extending to the crural processes. The crural bases are thick and form elevated ridges along the inside edges of the outer hinge plates. The inner hinge plates are narrow, elongate and extend almost to the crural processes which are located about ¾ the length of the loop. The descending lamellae are not distinguishable from the anterior slope of the crural processes. The transverse band is broad, narrowly and strongly arched with a subangular crest. There are no terminal points.

LOOP STATISTICS.—USNM 138055a: $\angle = 23°$; Wl/Ll = 0.44; Ll/LD = 0.43; Wl/WD = 0.31; a/Ll = 0.77; b/Ll = 0.23; c/Ll = 0.77; d/Ll = 0.00; e/Ll = 0.08; f/Ll = 0.15; g/WD = 0.38; g/Wl = 1.22; h/f = 0.87; h/Ll = 0.13; WD/LD = 0.62.

USNM 138055a: *Embolosia sphenoidea*, new species, Eocene (Castle Hayne Formation), near the National Cemetery, Wilmington, North Carolina.

DISCUSSION.—The unusual narrowness and the extreme anterior position of the crural processes make this genus unique. The loop is like that of *Plicatoria* and *Tanyoscapha* in having the crural processes far anterior and in having a broad transverse band. The shape of *Embolosia* is unlike that of the other shells from the Castle Hayne Formation. It is unlike *Plicatoria* in not having peripheral costae and its wedge-shape separates it from *Tanyoscapha*.

ETYMOLOGY.—From the Greek, *embolos* (a wedge).

Embolosia sphenoidea, new species

PLATE 59: FIGURES 1-10

DIAGNOSIS.—Terebratulacean with length almost twice width, sides parallel.

DESCRIPTION.—Exterior and interior as for genus. Details of valve below.

Ventral valve strongly convex in lateral profile, maximum convexity at midvalve; anterior view narrowly rounded. Sides steep. Beak truncated. Umbolateral slopes steep; posterior and median regions narrowly inflated. Anterior slope somewhat flattened, long. Tongue moderately long, broadly rounded.

Dorsal valve flatly convex in lateral profile, narrowly rounded like ventral valve in anterior view. Median region from umbo to anterior margin narrowly swollen. Fold low, visible only in anterior third, slightly elevated at anterior.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
138055a	35.8	32.1	19.8	21.4	38°
138055b	36.6	32.0	19.2	21.5	44°

OCCURRENCE.—Eocene (Castle Hayne Formation), near National Cemetery, Wilmington, North Carolina.

TYPES.—Holotype: USNM 138055a; paratype: USNM 138055b.

DISCUSSION.—Only two specimens of this brachiopod are known. Its elongate, narrow outline separates it from most species. Its shape is like that of *Liothyrella uva* (Broderip) and *Liothyrella oblonga* Cooper, the former from the Gulf of Tehuantepec, Mexico, the other from off Argentina. The long narrow loop of *Embolosia* is different from the rather short, wide loop of *Liothyrella*.

The method used to prepare the loop of *Embolosia* may be of interest. The umbonal region of the ventral valve was sawed off with a fine copper wire on which carborundum dust was fed. The cap thus obtained was excavated to show the muscle field and pedicle collar. The loop was then excavated. The kerf made in the sawing was so small that the cap can be cemented on and the exterior restored.

Faksethyris Asgaard, 1971

PLATE 62: FIGURES 3-8

Faksethyris Asgaard, 1971:385-389.

SUBFAMILY.—Aenigmathyridinae, new subfamily.

TYPE-SPECIES.—*Faksethyris nielseni* Asgaard, 1971:386, pls. 1, 2, new name for *Terebratula cincta* Nielsen, 1911:609, pl. 12: figs. 16-19; preoccupied by *T. cincta* Cotteau, 1857).

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Danian

LOCALITY.—Denmark.

EXTERIOR.—Small, roundly oval to subpentagonal, sides rounded, anterior margin somewhat truncate. Lateral commissure straight; anterior commissure rectimarginate. Beak straight, foramen large, submesothyridid. Deltidial plates narrow, conjunct. Surface marked by regular concentric lamellae.

INTERIOR.—Pedicle collar fairly long (Asgaard, 1971, pl. 1: fig. 3).

Loop and Cardinalia: The loop is dyscoliid, long and narrow, about twice as long as wide, occupying a third the length and a sixth the width of the dorsal valve. The cardinal process is described as transverse and feeble. The socket ridges are wide and thick. "Outer divided hinge plates are present; they are narrow and closely follow the curvature of the brachial [dorsal] valve." According to the figures on plate 1, the crural processes are posterior to midloop and the portion anterior to them is long, tapering and narrowly rounded.

LOOP STATISTICS (based on Asgaard, 1971, pl. 1: fig. 4; see Plate 62: figures 6, 7).—$\angle = 17°$; Wl/Ll = 0.52; Ll/LD = 0.32; Wl/WD = 0.16; a/Ll = 0.44; b/Ll = 0.56; c/Ll = 0.28; d/Ll = 0.16; e + f/Ll = 0.56; g/WD = 0.29; g/Wl = 1.80; h/f = 0.?; h/Ll = 0.02; WD/LD = 1.03.

Asgaard (1971, pl. 1: fig. 4): *Faksethyris nielseni* Asgaard, Danian, Fakse Quarry, Denmark.

DISCUSSION.—*Faksethyris* is similar externally to *Ceramisia* and *Acrobelesia*, new genera, both of which have strong concentrically marked shells; in addition *Acrobelesia* has faint radial capillae not seen on either of the other two. *Faksethyris* and *Acrobelesia* are uniplicate, while *Ceramisia* is strongly sulcate.

The structure interpreted here as an outer hinge plate seems rather an extension of the socket ridge welded to, and obscuring, the crural bases, rather than a true outer hinge plate. A similar arrangement appears in *Aenigmathyris*, *Ceramisia*, *Goniobrochus*, and *Acrobelesia*.

Ilyinella Jassjukevitch, 1973

Ilyinella Jassjukevitch, 1973:104.

FAMILY.—Placement uncertain.

TYPE-SPECIES.—*Ilyinella mangyschlakensis* Jassjukevitch, 1973:104–105, pl. 31: fig. 2.

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Lower Eocene (Gvimrovskaia Series).

LOCALITY.—Mangyschlak, Kazakstan, Russia.

DIAGNOSIS (Jassjukevitch, 1973).—Fine, smooth, elongate-oval shells with straight lateral and ventrally recurved anterior commissures in mature stages of development. There is a ventral median elevation. Cardinal process is small, divided into two lobes, each of which in turn is divided into three parts. The outer hinge plates are attached to the base of the curve of the internal socket ridge, by the delicate external margin. The loop is short and narrow.

COMPARISON (Jassjukevitch, 1973).—From the most similar *Dallithyris* Muir-Wood this genus is distinguished by a straight, not dorsally convex, lateral commissure (not inverted shells); by the presence of a median swelling on the ventral valve; by short crural bases which grow from the anterior part of the inner extremities of the hinge plates and do not extend along them; by a shorter and narrower loop; by a bilobed, though not depressed but not lamellate cardinal process.

COMMENTS.—In absence of an illustration of the loop, it is not possible to place this genus in its proper family. The exceptionally short and narrow loop indicated in the description of the type species (p. 105), 1 mm long and 1 mm wide in a specimen of 12 mm length is most unusual and unlike any described species.

Maltaia, new genus

PLATE 6: FIGURES 15–28; PLATE 64: FIGURES 7, 8

SUBFAMILY.—Terebratulinae Gray, 1840.

TYPE-SPECIES.—*Maltaia maltensis*, new species.

DIAGNOSIS.—Medium size, episulcate terebratulaceans having a wide loop having strongly protuberant transverse band.

SPECIMENS STUDIED.—Six, one excavated for loop.

GEOLOGIC OCCURRENCE.—Miocene

LOCALITY.—Island of Malta.

EXTERIOR.—Medium size, oval to subpentagonal, maximum width about midvalve. Valves nearly equally deep, ventral valve slightly deeper. Lateral commissure sigmoidal; anterior commissure episulcate. Beak erect. Foramen large, submesothyridid. Symphytium concave, visible. Surface marked by incremental lines of growth only.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The cardinal process is a protuberant half ellipse with its myophore facing posteriorly. The socket ridges are thick, curved, low and bound wide sockets floored by strong fulcral plates that are extended laterally. The outer hinge plates are fairly wide and are bounded along their inner margin by the crural bases, this combination producing moderately wide U-shaped troughs. The outer hinge plates attach to the dorsal edge of the crural bases and terminate on the outer sloping face of the crural processes. There are no inner hinge plates. The crural processes are narrow, acutely pointed, moderately long and are located at the junction of the crural bases and the outer hinge plates anterior to midloop. The descending lamellae are short, essentially the anterior slope of the crural processes. They flare widely and are connected by a narrow transverse band with crest subangular and strongly protuberant. In posterior view the apex of the transverse band protrudes beyond the ends of the crural processes.

LOOP STATISTICS.—USNM 551164a: $\angle = 55°$; Wl/Ll = 1.00; Ll/LD = 0.36; Wl/WD = 0.35;

a/Ll = 0.58; b/Ll = 0.42; c/Ll = 0.58; d/Ll = 0.00; e/Ll = 0.16; f/Ll = 0.26; g/WD = 0.43; g/Wl = 0.89; h/f = 0.38; h/Ll = 0.10; WD/LD = 0.98.

USNM 551164a: *Maltaia maltensis*, new species, Miocene, Island of Malta.

DISCUSSION.—The loop of *Maltaia* is similar to that of *Terebratula* in its great width, lack of inner hinge plates, and well defined terminal points. The loop of *Terebratula* however, has the transverse band flattened medially and not extended ventrally to form a protuberant tongue. The two genera are different externally, *Maltaia* being small and strongly biplicate.

ETYMOLOGY.—Named after the Island of Malta.

Maltaia maltensis, new species

PLATE 6: FIGURES 15–28

DIAGNOSIS.—Resembles small *Terebratula* but strongly plicated and subpentagonal. Loop wide and protuberant.

DESCRIPTION.—Exterior and interior as for genus. Valve details below.

Ventral valve fairly strongly convex in lateral profile, maximum convexity in posterior half; umbonal and lateral regions swollen. Sulcus originating in anterior third, shallow, deepest at anterior. Median plica in sulcus prominent and traceable posteriorly to beyond midvalve where it is low and inconspicuous. Ventral tongue bilobed; lobes subangular.

Dorsal valve moderately convex in lateral view, more evenly convex than ventral valve. Anterior profile a narrow dome with swollen sides in adult, flatter in young. Umbonal region swollen. Fold originating at about midvalve, narrowly depressed at or slightly before its inception by narrow sulcus that divides fold into two subangular plications.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
551164a	36.2	29.0	28.0	23.3?	65°
551164b	30.0	26.8	24.0	16.2	68°

OCCURRENCE.—Miocene, Island of Malta.

TYPES.—Holotype: USNM 551164a; paratypes: USNM 551164b,c.

DISCUSSION.—In his figures of Malta brachiopods, Davidson (1864, pl. 1) illustrates *Terebratula sinuosa* (Brocchi) showing large and small forms. The small specimens with their prominent subangular folding are distinct from the larger ones. Small forms like those figured by Davidson are also figured by Seguenza (1865, pl. 4: fig. 3). This type of terebratulid is fairly common but, until their interiors are described, it is difficult to separate them, or to be sure that they are the same. The specimens figured by Seguenza, referred to above, differ from the Malta specimens in more gentle folding of the anterior. *Terebratula costae* Seguenza (1871) is also similar but it is more laterally expanded, especially *T. costae dilatata* Seguenza, 1871. Small examples of *T. costae* are wider laterally and the folding on the ventral valve more pronounced than that of the Malta species. The loop of the Seguenza species (1871, pl. 5: fig. 10) is similar to that of *Maltaia* in size and outline but details are lacking.

Mimorina, new genus

PLATE 16: FIGURES 6–18; PLATE 59: FIGURES 15–21; PLATE 64: FIGURES 15, 16

SUBFAMILY.—Terebratulinae Gray, 1840.

TYPE-SPECIES.—*Mimorina ziczac*, new name for *Liothyrella gravida* Allan, 1932:4, pl. 12: fig. 2; preoccupied by *L. gravida* Suess, 1864.

DIAGNOSIS.—Large, uniplicate terebratulids having a triangular loop and exterior covered by zigzag capillae.

SPECIMENS STUDIED.—Four of *M. ziczac*, one excavated for loop; six of "*Liothyrella*" *skinneri*, one prepared to show loop, one cardinalia only; fourteen of *M. magna*, one with cardinalia only.

GEOLOGIC OCCURRENCE.—Oligocene to Pliocene.

LOCALITIES.—Chatham Island; South Island, New Zealand.

EXTERIOR.—Large to huge, roundly to elongate oval to subcircular; widest near midvalve; unequal in depth, ventral valve having greater

TABLE 62.—Loop statistics for the genus *Mimorina*

Proportions	USNM 551091a	USNM 551114a	USNM 551151a
∠	32°	32°	42°
Wl/Ll	0.68	0.66	0.71
Ll/LD	0.32	0.35	0.24
Wl/WD	0.20	0.23	0.19
a/Ll	0.65	0.64	0.52
b/Ll	0.35	0.36	0.48
c/Ll	0.65	0.64	0.43
d/Ll	0.00	0.00	0.09
e/Ll	0.16	0.18	0.48
f/Ll	0.19	0.18	
g/WD	0.26	0.33	0.25
g/Wl	1.22	1.43	1.33
h/f	0.42	0.50	?
h/Ll	0.08	0.09	?
WD/LD	1.03	0.98	1.09

USNM 551091a: *Mimorina ziczac*, new name, Pliocene (Opoitian), Mamoe-a-Toa, Chatham Island, E of South Island, New Zealand.

USNM 551114a: *Mimorina skinneri* Allan (= *M. ziczac*, new name), same as above.

USNM 551151a: *Mimorina magna* (Hamilton), Oligocene (Lower Kongahu Formation), along the coast one mile (1.6 km) S of Little Wanganui River, South Island, New Zealand.

depth. Lateral commissure straight; anterior commissure rectimarginate to gently uniplicate. Beak low, obliquely truncated, labiate. Foramen large, permesothyridid. Symphytium partially visible. Surface marked by concentric growth lines crossed by zigzag capillae like ornament of *Dyscolia*.

INTERIOR.—Ventral valve with short pedicle collar. Other details not seen.

Loop and Cardinalia: The loop as shown by *M. ziczac* is elongate triangular (32°). It occupies slightly more than a third the length and about a fifth the width of the dorsal valve. The cardinal process is large, thin, a semielliptical shelf facing posteriorly and having a roughened myophore. The socket ridges are slightly curved, stout and bound wide sockets. The fulcral plates are thick and laterally buttressed. The outer hinge plates are narrow, short and moderately concave. They attach to the dorsal edge of the crural bases and taper onto the side of the crural processes, terminating there. The crural bases form a ridge along the inside edge of the outer hinge plates. The crural processes are short and sharply pointed. The descending lamellae are short because they are the anterior slope of the crural processes. The transverse band is moderately broad, broadest at its junction with the descending lamellae and narrowing medially as it rises to a narrowly rounded crest. The band is nearly horizontal and is slightly protuberant but does not extend beyond the tips of the crural processes when seen in side view.

LOOP STATISTICS.—See Table 62.

DISCUSSION.—That the loop of this genus is related to that of *Liothyrella* is evident because the outer hinge plates taper onto the crural processes and the latter are located anterior to midloop. The loop is similar to that of *Liothyrella neozelanica* Thomson.

This genus is an external homeomorph of *Dyscolia* and *Goniobrochus* but all three have different loops, that of *Goniobrochus* being like that of *Dyscolia* rather than resembling that of *Mimorina.* The resemblance of *L. gravida* to *Dyscolia* misled Cooper (1973c:20) to suggest that the Chatham Island species belonged to *Dyscolia.* Allan (1960:249) in restudying the Chatham Island species decided that his *Liothyrella skinneri* and *L. gravida* constitute one variable species, now *Mimorina ziczac*, new name.

This genus is based on the homeomorphy with *Dyscolia*, the strong zigzag capillation combined with the liothyrellid type of loop. Another species with zigzag capillae (*Magellania magna* Hamilton, 1910) is referred here although its loop is not completely known.

ETYMOLOGY.—From the Greek, *mimos* (mimic (of *Dyscolia*)).

Mimorina magna (Hamilton), new combination

PLATE 59: FIGURES 15–21

Magellania magna Hamilton, 1910:18 [not figured].
Liothyrella magna (Hamilton).—Allan, 1932:5, pl. 2: fig. 1.

DISCUSSION.—Specimens of this poorly known species recently collected by Dr. Brian Mason, National Museum of Natural History, from the type locality permit notes and generic assignment, even though tentative. Allan's figure is that of a large dorsal valve. A complete specimen (USNM 551151a) in the Mason collection is smaller than Allan's and measures in mm: length 63.7; width 66.7; thickness 40; apical angle 108°. The largest specimen in the Mason collection measures 77.7 mm long and 86.3 mm wide, which exceeds the width of Allan's specimen. The complete undistorted specimen (USNM 551151a) is slightly transversely oval, biconvex, both valves with fairly even convexity, that of the ventral valve more so than that of the dorsal valve. The beak is strongly labiate and truncated at a right angle to the plane of articulation. The foramen is large, recessed and permesothyridid. The lateral commissure is straight and the anterior commissure is rectimarginate. The surface is marked by growth varices and is covered by fine zigzag capillae (USNM 551151b), usually worn off in the larger specimens. This species has the exterior characters of the *Mimorina* from Chatham Island.

I was not succcessful in preparing a complete loop of this species but specimen USNM 551151c shows the cardinal process, hinge plates and descending branches of the loop. The cardinal process is small for such a large shell. The socket ridges are stout and bound short sockets floored by small fulcral plates. The outer hinge plates are narrow and are marked by a narrow sharp fold adjacent to the socket ridge. The crural bases are reinforced by a longitudinal ridge just below the ventral edge. Thus the trough between the socket ridge and crural base is deep and narrow. The taper of the hinge plates reaches onto the crural process which is short and bluntly pointed. The crural process is located at the junction of the hinge plate and crural base. The descending branches of the loop are short and measure slightly more than half the loop length. The transverse band was not preserved.

This loop, when compared to that of *M. ziczac* (new name), has essentially the same W/L and relations to the dorsal valve, about a third the length and a fifth the width of the dorsal valve. The crural processes are somewhat more posterior and the terminal points longer (?). The relationship of the hinge to the loop and dorsal valve are similar in both species. Because of the unusual zigzag ornament and general similarity of the loops, this species in placed in *Mimorina*.

Mimorina ziczac, new name

Liothyrella gravida Allan, 1932:4, pl. 12: fig. 2 [preoccupied by *L. gravida* Suess, 1864].
Liothyrella skinneri Allan, 1932:8, pl. 1: fig. 3.

Oleneothyris Cooper, 1942

Plate 6: figures 1–14; Plate 31: figures 24, 25; Plate 73: figures 1, 2

Oleneothyris Cooper, 1942:233.—Feldman, 1977b:88.

Subfamily.—Oleneothyridinae, new subfamily.

Type-Species.—*Terebratula harlani* Morton, 1828:73–76, pl. 3: figs. 1–4, 7, 8.

Specimens Studied.—Many, five excavated for loop.

Geologic Occurrence.—Paleocene.

Localities.—New Jersey, North Carolina.

Exterior.—Large, elongate oval, inequivalve, ventral valve having greater convexity. Sides gently rounded, anterior margin narrowly rounded to subnasute. Lateral commissure straight; anterior commissure moderately sulciplicate. Beak erect, beak ridges strong. Foramen large, submesothyridid. Symphytium partially visible or concealed. Surface marked only by growth lines.

Interior.—Ventral valve greatly thickened in umboal region. Teeth buttressed by shell thickening. Pedicle collar long and tubular. Muscle field anterior in position, elongate triangular.

Dorsal valve interior with low, wide, ridge bearing a median groove. Adductor scars forming wide, round field.

Loop and Cardinalia: The cardinal process forms a half ellipse on the myophore face and is buttressed anteriorly by a round thickening that forms a short, thick shaft in some specimens.

TABLE 63.—Loop statistics for the genus *Oleneothyris*

Proportions	USNM 550910	USNM 551162a	USNM 559395a	USNM 559395b
∠	36°	32°	38°	29°
Wl/Ll	0.72	0.57	0.70	0.50
Ll/LD	0.26	?	0.33	?
Wl/WD	0.31?	0.32	0.33	0.39
a/Ll	0.38	0.43	0.43	0.50
b/Ll	0.62	0.57	0.57	0.50
c/Ll	0.38	0.43	0.43	0.38
d/Ll	0.00	0.00	0.00	0.12
e/Ll	0.18	0.19	0.13	0.12
f/Ll	0.44	0.38	0.44	0.38
g/WD	0.23	0.38	0.33	0.32
g/Wl	0.74	1.17	1.00	0.89
h/f	0.14	0.18	0.18	0.26
h/Ll	0.06	0.07	0.08	0.10
WD/LD	0.61?	?	0.70	?

USNM 550910: *Oleneothyris harlani* (Morton), Paleocene (Beaufort Formation), North Carolina highway 55 at Mosleys Creek, Lenoir-Craven County line, North Carolina.

USNM 551162a: *Oleneothyris harlani* (Morton), same as above.

USNM 559395a,b: *Oleneothyris harlani* (Morton), Paleocene (Hornerstown Formation), 0.7 mile (1.12 km) NW of New Egypt, New Jersey.

Myophore in some specimens bears a median ridge and is bilobed. The socket ridges are curved, inclined laterally and bound wide sockets. An elongate, narrow denticle forms the outer proximal posterior margin to the socket, becoming submarginal distally at the socket opening. Because of the extravagant shell thickening the fulcral plates are not seen in adults. The outer hinge plate is very narrow and concave forming a wash on the sloping face of the socket ridge and extended as a ridge along the dorsal side of the crural processes, a possible strengthening device for that part of the loop. The ridge formed by the extended end of the outer hinge plates terminates at about the middle of the outer sloping edge of the crural processes. Bounding the inner edge of the outer plates are the high crural bases which expand anteriorly at the distal ends of the outer hinge plates, virtually eliminating a crus. The crural bases slope posteriorly to form the inner wall of the incipient outer hinge plates. The crural processes form sharp angles of about 60° and have sharp needle-like points. The crural processes are inclined medially to a varying degree. The descending lamellae are broad, moderately long, straight or bowed slightly. The transverse band forms a short web where attached to the descending lamellae. It thins medially as it ascends to form an angular crest. The crest is more rounded in young specimens.

LOOP STATISTICS.—See Table 63.

DISCUSSION.—This is one of the few Tertiary genera with long terminal points on its loop. The loop was illustrated by Quenstedt (1868–1871, pl. 48: fig. 47, 47a) but was not illustrated accurately in this country. The supposed loop was illustrated by Whitfield (1885, pl. 1: fig. 23) and Weller (1907, pl. 28: fig. 8) but the proportions of the loop are not correct. The crural processes are depicted as more than half of the loop length and as more approximate than they are in the dissected loops. The hinge plates are too long and the transverse band thickens medially and has a median depression rather than a sharp angle. Furthermore, the transverse band does not closely approach the crural processes as shown by the specimens illustrated herein and in Cooper, 1944 (pl. 143: figs. 47, 49). The adult median angularity of the transverse band and its strong elevation, with long webbed terminal points are more suggestive of the Jurassic loop condition than that of the Tertiary.

Feldman (1977a, fig. 7) illustrates a young specimen of *Oleneothyris fragilis* (Morton) which has a loop with less elevated and more rounded arch of the transverse band. There is a thickening of the ventral margins of the crural bases indicated in his figures A and B that suggest incipient inner hinge plates.

Two medium sized specimens of *O. harlani* from Mosleys Creek, North Carolina (USNM 551162a,b) have very long cardinal processes while the loop was being excavated but, the loop being weathered and friable, broke off. The loop of the smaller of the two specimens (USNM 551162b) has rather short terminal points and a less elevated and angular transverse band. This suggests, with the information from Feldman's specimen, that young *Oleneothyris* had a less developed transverse band than the adult.

Plicatoria, new genus

PLATE 7: FIGURES 6–16; PLATE 66: FIGURES 7, 8

SUBFAMILY.—Plicatoriinae, new subfamily.

TYPE-SPECIES.—*Terebratula wilmingtonensis* Lyell and Sowerby, 1845:431, 432, fig. 7.

DIAGNOSIS.—Elongate oval terebratulaceans, strongly uniplicate, anterior third to half variably costate; outer hinge plates long; crural processes overhanging broad transverse band.

SPECIMENS STUDIED.—Many, seven excavated for loop.

GEOLOGIC OCCURRENCE.—Eocene.

LOCALITY.—North Carolina.

EXTERIOR.—Elongate oval, longer than wide, sides and anterior rounded, posterolateral margins forming angle of 40°–70°, commonly near 60°. Lateral commissure nearly straight, usually angulated in the anterior quarter or third; anterior commissure strongly uniplicate. Beak suberect, low, beak ridges rounded. Foramen moderately large, epithyridid to submesothyridid. Symphytium partially or wholly visible. Surface smooth in posterior third to half, variably costate to plicate in anterior third or half.

INTERIOR.—Ventral valve having long slender teeth parallel to shell margin. Pedicle collar short. Musculature not resolved.

Dorsal valve with faint, narrow euseptoidum. Musculature not resolved.

Loop and Cardinalia: The loop is long and nar-

TABLE 64.—Loop statistics for the genus *Plicatoria*

Proportions	USNM 549389a	USNM 549389g	USNM 549389m[1]	USNM 550875	USNM 550894a[2]	USNM 550914a[3]
∠	30°	30°	21°	25°	28°	28°
Wl/Ll	0.55	0.40	0.40	0.55	0.61	0.50
Ll/LD	0.36	0.48	0.37	0.31	0.39	0.38
Wl/WD	0.29	0.30	0.16	0.22	0.27	0.24
a/Ll	0.69	0.69	0.74	0.64	0.71	0.73
b/Ll	0.31	0.31	0.26	0.36	0.29	0.27
c/Ll	0.69	0.69	0.74	0.64	0.71	0.73
d/Ll	0.00	0.00	0.00	0.00	0.00	0.00
e/Ll	0.14	0.04	0.06	0.08	0.07	0.14
f/Ll	0.17	0.27	0.20	0.28	0.22	0.23
g/WD	0.25	0.35	0.26	0.22	0.26	0.24
g/Wl	0.88	1.16	1.66	1.00	0.94	1.09
h/f	0.59	0.59	0.65	1.07	0.82	0.61
h/Ll	0.10	0.16	0.13	0.30	0.18	0.14
WD/LD	0.70	0.77	0.83	0.77	0.86	0.89

[1] Specimen USNM 549389m (not figured) is a young individual 13 mm long with essentially adult loop; [2]USNM 550894a (Plate 7: figures 10, 11) is an anteriorly expanded form of the species; [3]USNM 550914a (Plate 7, figure 16) an example of the laterally compressed form.

USNM 549389a,g,m: *Plicatoria wilmingtonensis* (Lyell and Sowerby), Eocene (Castle Hayne Formation), county rock quarry, Wilmington, North Carolina.

USNM 550875: *Plicatoria wilmingtonensis* (Lyell and Sowerby), Eocene (Castle Hayne Formation), city rock quarry, Wilmington, North Carolina.

USNM 550894a: *Plicatoria wilmingtonensis* (Lyell and Sowerby), Eocene (Castle Hayne Formation), 4.5 miles (7.2 km) NE of Castle Hayne, New Hanover County, North Carolina.

USNM 550914a: Same as above.

row and has the crural processes located far forward to overhang the transverse band. The cardinal process is a narrow half ellipse with myophore facing ventrally. The socket ridges are slightly curved and slightly inclined toward the narrow sockets. The socket is proximally roofed. The fulcral plates are well defined in young specimens and have short lateral extensions. The outer hinge plates are wide, very long, and taper along the dorsal edge of the crural bases to the crural processes where the taper ends. Inner hinge plates appear sporadically and may be disjunct or coalesced (Plate 7: figure 9). The crural bases form a ridge along the inside border of the outer hinge plates, thus forming broad shallow troughs with the socket ridges. The crural bases expand anteriorly at about 70% of loop length from the posterior to form the crural processes. These are short and have blunt points. There are no descending lamellae because the transverse band is formed at the anterior end of the crural processes. The transverse band is variable and is usually broad in all specimens. It is low arched, angulated medially and produces sharp anterolateral angles at its junction with the crural processes.

LOOP STATISTICS.—See Table 64.

DISCUSSION.—*Plicatoria wilmingtonensis* is a very variable species; it exhibits two kinds of exterior form, one slender with subparallel sides, the other with expanded anterior half. The folding of both kinds is uniplicate and both show great variation in the peripheral costation or plication. Some specimens reach a large size before developing costation whereas others may initiate costation at an early stage (15 mm length). Costation of the anterior may include one to eight costae in the sulcus with one to three on the flanks. One specimen is marked by three angular plications.

The loop is unusual for the great length of the outer hinge plates and the sporadic development of inner hinge plates. The crural processes are located so far anterior that they overhang the transverse band. These features distinguish this genus from most other short-loop terebratulids. The loop of *Dolichosina* is suggestive of *Plicatoria* because of its long outer hinge plates but the loop proportions of the two are different. The loop of *Plicatoria* does not narrow anteriorly like that of *Epacrosina*, new genus, of the Recent fauna.

Plicatoria differs from *Tanyoscapha* in the presence of peripheral costation, even though the loops are similar. It differs from *Embolosia* in the presence of peripheral costation and wider shells but the two have similar loops.

The type specimen of *Plicatoria wilmingtonensis* (Lyell and Sowerby) is in the museum at Oxford University, England (catalog number LT58). It is an immature, noncostate individual but conforms in its exterior details with some of the young and noncostate specimens in the National Collection.

The specific name of *Terebratula wilmingtonensis* was the subject of a revision by Stenzel (1943) who selected specimens of *Terebratula canipes* Ravenel as "neotypes" for the species. Although Ravenel's name has priority, it is an unknown quantity, not having been illustrated and the types apparently lost. Beside this difficulty, Stenzel's selection of "neotypes" is illegal. He selected as "neotypes" specimens from Wilmington, North Carolina, but Ravenel's specimen came from South Carolina and its description does not conform either to the generality of Wilmington specimens nor to the largest known specimen from there. It seems best to recognize Lyell and Sowerby's immature specimen as type. This was Dall's (1903) solution of the problem.

ETYMOLOGY.—From the Latin *plico* (fold).

Pliothyrina Roy, 1980

PLATE 5: FIGURES 1–9

Pliothyrina Roy, 1980:2.

SUBFAMILY.—Terebratulinae Gray, 1840.

TYPE-SPECIES.—*Terebratula sowerbyana* Nyst, 1843:335–336, pl. 27: fig. 3a, b, (not pl. 28: fig. 3a).

SPECIMENS STUDIED.—Sixteen and literature.

GEOLOGIC OCCURRENCE.—Oligocene to Pliocene.

LOCALITIES.—Belgium, England, and Germany.

EXTERIOR.—Subpentagonal to oval, subequally convex, sides rounded; lateral commissure nearly straight, anteriorly curved dorsally; anterior commissure rectimarginate in young and middle aged specimens, moderately sulciplicate in adult. Beak suberect, strongly truncated, labiate. Foramen round, mesothyridid to submesothyridid. Symphytium partially or wholly visible, usually short. Surface marked by incremental growth lines and growth varices.

INTERIOR.—Ventral valve with short, excavate pedicle collar; narrowly elongate muscle field. Dorsal valve with retort-shaped adductors separated by low, anteriorly forked callosity.

Loop and Cardinalia: The loop is widely triangular, 40° plus, and occupies 35% of the dorsal valve length and 30% of its width. The cardinal process is semielliptical to nearly square, depressed medially and has raised lateral margins. The socket ridges are thick, curved, proximally covered. The fulcral plate is short, obsolescent from deposition of shell. The sockets are shallow and their outside wall is marked by a moderately thick elongate denticle. The outer hinge plates are very narrow or lacking. The crural bases bound the trough they make with the socket ridge. Inner hinge plates are small to prominent, disjunct or coalescing posteriorly, usually obscuring the crural base. The crural processes are unusually long and curved anteriorly and medially. They are located at or close to the opening of the socket. The descending lamellae are short, laterally bowed and thin. The transverse band is wide at its junction with the descending lamellae and narrows medially to form a subangular arch. The transverse band in lateral view is nearly horizontal to moderately inclined toward the posterior and is protuberant. The terminal points are variable from subangular without extension to short acutely angular and slightly extended.

LOOP STATISTICS.—USNM 550889b: ∠ = 43°; Wl/Ll = 0.79; Ll/LD = 0.35; Wl/WD = 0.30; a/Ll = 0.63; b/Ll = 0.37; c/Ll = 50; d/Ll = 0.13; e/Ll = 0.24; f/Ll = 0.13; g/WD = 0.28; g/Wl = 0.93; h/f = 0.16; h/Ll = 0.08; WL/WD = 0.92.

USNM 550889b: *Pliothyrina sowerbyana* Nyst, Diestian (Assize Bryozaire), Deurne, near Antwerp, Belgium.

DISCUSSION.—*Pliothyrina* differs from *Terebratula*, which it resembles, in the lesser degree of anterior folding, longer crural processes and presence of inner hinge plates. It differs from *Oleneothyris* in its wider shells, less angular transverse band and presence of inner hinge plates. *Pliothyrina* differs from *Tanyoscapha* in its wider loop and shorter descending branches. *Apletosia* is closely related to *Pliothyrina* and probably descended from it by exaggeration of loop, notably the great extension of the terminal points and somewhat tubular cardinal process.

Pycnobrochus, new genus

PLATE 12: FIGURES 6–10; PLATE 64: FIGURES 11, 12

SUBFAMILY.—Terebratulinae Gray, 1840.

TYPE-SPECIES.—*Liothyrella pulchra* Thomson, 1918:118; 1927:85, fig. 25. Allan, 1932:7, pl. 2: figs. 6–8.

DIAGNOSIS.—Sulciplicate shells having narrow outer hinge plates, crural processes at ¾ loop length and transverse band close to the crural processes.

SPECIMENS STUDIED.—Twenty-four, one excavated for loop. Allan's figure of loop (1932, pl. 2: fig. 6).

GEOLOGIC OCCURRENCE.—Oligocene.

LOCALITY.—New Zealand.

EXTERIOR.—Medium size, pentagonal, maximum width at or near midvalve, sides rounded; anterior somewhat narrowly rounded. Lateral commissure convex ventrally at anterior. Anterior commissure sulciplicate, plication continuing posteriorly to midvalve. Beak moderately protuberant beyond dorsal umbo, suberect, strongly truncated. Foramen large, mesothyridid to permesothyridid. Symphytium visible. Surface marked by strong concentric lines.

INTERIOR.—Ventral valve interior not seen.

Loop and Cardinalia: The loop is thick, wide, stout, occupying nearly 40% of the length and nearly a third the width of the dorsal valve. The

TABLE 65.—Loop statistics for the genus *Pycnobrochus*

Proportions	USNM 549585a	Allan, 1932
∠	36°	38°
Wl/Ll	0.71	0.74
Ll/LD	0.34	0.39
Wl/WD	0.26	0.29
a/Ll	0.75	0.74
b/Ll	0.25	0.26
c/Ll	0.57	0.58
d/Ll	0.18	0.16
e/Ll	0.04	0.05
f/Ll	0.21	0.21
g/WD	0.26	0.27
g/Wl	1.10	0.93
h/f	0.71	0.76
h/Ll	0.15	0.16
WD/LD	0.95	1.00

USNM 549585a: *Pycnobrochus pulchrus* (Thomson), Oligocene (Whaingaroan), Trig M, near Totara, Oamaru, New Zealand.

Allan (1932, pl 2: fig. 6): same as above.

cardinal process is a small half ellipse facing posteriorly. The socket ridges are stout and inclined laterally to bound narrow sockets that are proximally roofed. The outer hinge plates are so narrow as to be almost non-existent and join the crural bases at their dorsal edge. A low taper extends nearly to the cardinal processes. The crural bases are strongly elevated along the inside margin of the outer hinge plates, and form with them and the socket ridges, narrow V-shaped troughs. The crural processes are short, sharp points, approximate and almost overhanging the transverse band. There are no descending lamellae. The transverse band is a broad, fairly even arch with broadly rounded median crest. There are no terminal points.

LOOP STATISTICS.—See Table 65.

DISCUSSION.—This genus is based on loop characteristics and the strongly sulciplicate anterior which is a deviation from the usual rectimarginate to subdued uniplicate condition common to *Liothyrella* to which this species has hitherto been referred. The loop differs from that of *Liothyrella* (*Liothyrella*) in its stout and compact form. It agrees with the liothyrellid loop in having a wide angle but the crural processes are somewhat farther anterior than those of *Liothyrella*. The striking difference is in the brevity of the measurements of e and f which show the crural processes overhanging the broad transverse band.

ETYMOLOGY.—From the Greek *pyknos* (thick) plus *brochos* (noose or loop).

Rhytisoria, new genus

PLATE 53: FIGURES 1–7; PLATE 64: FIGURES 13, 14

SUBFAMILY.—Terebratulinae Gray, 1840.

TYPE-SPECIES.—*Rhytisoria alabamensis*, new species.

DIAGNOSIS.—Large, roundly oval, somewhat compressed terebratulaceans with sulciplicate anterior commissure; loop with nearly horizontal, broadly arched transverse band.

SPECIMENS STUDIED.—Nine, one excavated for loop.

GEOLOGIC OCCURRENCE.—Paleocene.

LOCALITY.—Alabama.

EXTERIOR.—Moderately large, roundly oval, length greater than width, sides rounded, anterior margin somewhat nasute, posterolateral margins forming angle of 77°–107°. Lateral commissure nearly straight, convex toward ventral valve at anterior; anterior commissure sulciplicate formed from rectimarginate condition in the young. Beak short, suberect; beak ridges subangular. Foramen round, large, submesothyridid. Symphytium visible. Surface marked by growth lines only.

INTERIOR.—Ventral valve with anteriorly excavated pedicle collar, small teeth. Musculature not seen. Dorsal valve interior with adductor scars having the shape of a retort.

Loop and Cardinalia: The loop occupies a third the length and less than a quarter of the width of the dorsal valve. The cardinal process is a small half elliptical shelf with myophore facing posteriorly. The socket ridges are thick, slightly curved, erect and bound moderately wide sockets. The fulcral plates are thick and not extended laterally. The outer hinge plates are narrow and extend anteriorly along the dorsal edge of the crural bases to terminate just posterior of the end of the crural processes. The crural bases are broad, elevated and form a high wall along the inner edge of the outer hinge plates, making deep troughs with them and the socket ridges. The crural processes are located at the distal end of the outer hinge plates and are acutely pointed, moderately long and slightly approximate. The anterior slope of the crural processes forms the fairly long, laterally bowed descending lamellae. The transverse band is moderately broad, gently and broadly arched and inclined slightly in a posterior direction. The terminal points are short.

LOOP STATISTICS.—USNM 549392b: ∠ = 36°; Wl/Ll = 0.68; Ll/LD = ?; Wl/WD = ?; a/Ll = 0.54; b/Ll = 0.46; c/Ll = 0.54; d/Ll = 0.00; e/Ll = 0.24; f/Ll = 0.22; g/WD = ?; g/Wl = 1.07; h/f = 0.23; h/Ll = 0.05; WD/LD = ?.

USNM 549392b: *Rhytisia alabamensis*, new species. Paleocene (Clayton Formation), well near depot, Brundidge, Pike County, Alabama.

DISCUSSION.—Externally this genus has some resemblance to *Oleneothyris* but is rounded and flatter and has a similar type of folding. The loops of the two are unlike, that of *Oleneothyris* has a difference in the position of the crural processes, longer terminal points and more elevated, angular transverse band. In the development of the anterior commissure of *R. alabamensis* 17 mm long, the commissure is rectimarginate with no trace of folding; a specimen 21 mm long shows an incipient indentation on the dorsal side of the anterior margin which is the beginning of the folding. There is no development of uniplication prior to the appearance of the dorsal sulcation.

The loop is different from other American tertiary brachiopods such as *Plicatoria* and *Tanyoscapha* which have a long loop with narrower angle, broader transverse bands and much longer outer hinge plates. The loop of *Rhytisoria* has a narrower, more broadly folded transverse band and proportionately longer outer hinge plates than these features of *Biplicatoria.*

ETYMOLOGY.—From the Greek *rhytis* (fold or wrinkle).

Rhytisoria alabamensis, new species

PLATE 53: FIGURES 1–7

DIAGNOSIS.—Compressed, widely and roundly oval terebratulacean having wide loop, narrow outer hinge plates tapering along the dorsal side or the crural bases to the crural processes.

DESCRIPTION.—Exterior and interior as for the genus. Details of the valves below.

Ventral valve moderately convex in lateral and anterior views with maximum convexity at midvalve. Umbonal region swollen; median region narrowly inflated from umbo to anterior margin forming prominent fold set off by two short sulci in anterior half. Flanks gently convex.

Dorsal valve in side view less convex than ventral valve, flattened in anterior half. Anterior profile somewhat narrowly convex at midvalve, with moderately steep, flattened sides. Umbo narrow swollen; median region somewhat swollen. Anterior third occupied by short sulcus margined by rounded plicae extending posteriorly to midvalve. Flanks bounding plicae gently concave.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
549392a	33.7	30.0	29.0	17.0	105°
549392c	36.8	31.9	29.4	19.6	90°
549392d	30.0	26.5	24.5	15.3	83°
549392e	28.8	25.7	23.0	14.3	74°

OCCURRENCE.—Paleocene (Midway - Clayton Formation), well at depot, Brundidge, Pike County, Alabama.

TYPES.—Holotype: USNM 549392a; paratypes: USNM 549392b–e.

DISCUSSION.—This species is unlike any other American Tertiary terebratulid. It differs from *Oleneothyris* in its compressed profile and different loop. It is distinguished from *Tanyoscapha* by its sulciplicate folding and wide loop with shorter outer hinge plates. No complete specimens, exterior or interior, are known of *Terebratula crassa* Kellum from the Eocene (Castle Hayne Formation) that can be compared. Only obese, incomplete cardinalia of *T. crassa* are known; these do not compare favorably with the cardinalia of *Rhytisoria.*

Tanyoscapha, new genus

SUBFAMILY.—Plicatoriinae, new subfamily.

TYPE-SPECIES.—*Tanyoscapha sigmanae*, new species.

DIAGNOSIS.—Large, biconvex, smooth terebratulaceans with loop reaching near midvalve; crural processes located nearly ¾ loop length; long outer hinge plates reaching to the crural processes.

SPECIMENS STUDIED.—Many, eight excavated for loop.

GEOLOGIC OCCURRENCE.—Eocene.

LOCALITY.—North Carolina.

EXTERIOR.—Large, variable, narrowly to widely oval, inequivalve, ventral valve slightly deeper than dorsal one. Lateral commissure straight or curved gently toward the ventral side anteriorly. Anterior commissure moderately uniplicate. Beak suberect; beak ridges subangular. Foramen large, submesothyridid. Symphytium visible. Surface smooth.

INTERIOR.—Ventral valve with narrow teeth, short pedicle collar. Dorsal interior without euseptoidum.

Loop and Cardinalia: The cardinal process is a small half ellipse with flat myophore facing posteroventrally. The socket ridges are curved, and inclined slightly toward the moderately wide socket which is roofed proximally. The outer hinge plates are wide, very long, and are attached to the dorsal side of the crural bases and terminate at the crural processes. The crural processes are located at about ¾ the loop length from the apex. They are short, acutely pointed and slightly approximate. The transverse band is attached to the very short descending lamellae. It is usually broad and nearly horizontal. The crest is low and wide.

LOOP STATISTICS.—See Table 66.

DISCUSSION.—The loop of this genus is exactly like that of *Plicatoria* and *Embolosia* but the valves are smooth, not peripherally costate like *Plicatoria.* No trace of costation has been seen in any specimens of the two species studied. The loop of *Tanyoscapha* is similar to that of *Dolichosina* but is narrower, has longer hinge plates and no crura.

TABLE 66.—Loop statistics for the genus *Tanyoscapha*

Proportions	USNM 549430e	USNM 550911e	USNM 550913g	USNM 550913h	USNM 550913i
∠	26°	23°	24°	23°	23°
Wl/Ll	0.56	0.44	0.50	0.50	0.52
Ll/LD	0.41	0.46	0.41	0.37	0.45
Wl/WD	0.32	0.23	0.23	0.20	0.26
a/Ll	0.75	0.71	0.72	0.75	0.76
b/Ll	0.25	0.29	0.28	0.25	0.24
c/Ll	0.75	0.71	0.72	0.75	0.76
d/Ll	0.00	0.00	0.00	0.00	0.00
e/Ll	0.06	0.09	0.07	0.06	0.12
f/Ll	0.19	0.20	0.21	0.19	0.12
g/WD	0.29	0.21	0.25	0.20	0.36
g/Wl	0.89	0.93	1.00	1.00	0.72
h/f	0.68	0.45	0.19	0.16	0.33
h/Ll	0.13	0.09	0.04	0.03	0.04
WD/LD	0.70	0.83	0.81	0.92	0.90

USNM 549430e: *Tanyoscapha glabra*, new species, Eocene (Castle Hayne Formation Basal Bryozoan Member), exposed surface of island in Lower Cape Fear River, 11 miles (17.6 km) S of Wilmington, North Carolina.

USNM 550911e: *Tanyoscapha sigmanae*, new species, Eocene (Castle Hayne Formation), due E of Campbell Island, due W of Mott Creek, 34°07.3′N, 77°55.8′W, Wilmington (7½′) quadrangle, New Hanover County, North Carolina.

USNM 550913g–i: *Tanyoscapha sigmanae*, new species, same as above.

ETYMOLOGY.—From the Greek *tanyo* (stretched out) plus *scapha* (anything hollowed out).

Tanyoscapha glabra, new species

PLATE 16: FIGURES 1–5

DIAGNOSIS.—Narrowly ovate *Tanyoscapha.*

DESCRIPTION.—Elongate oval, longer than wide, widest at midvalve, sides gently rounded; anterior margin narrowly rounded. Anterior commissure gently uniplicate. Foramen large. Densely punctate.

Ventral valve lateral profile moderately strongly convex, greatest convexity at midvalve. Anterior view moderately rounded. Median region inflated; anterior slope long and gentle. Sulcus scarcely defined, visible as slight depression with bounding ridges just inside flanks; tongue short, rounded. Flanks gently swollen.

Dorsal valve shallower than ventral valve, flatly convex in side view, broadly and moderately convex in anterior profile; lateral slopes short, abrupt, steep. Umbonal region narrowly convex, flattening medially. Fold inconspicuous, originating near midvalve and extending to anterior margin where it forms flattened elevated surface. Flanks bounding fold flattened, steep.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
549430a	41.0	35.8	29.0	23.2	79°
549430b	38.8	34.9	26.3	19.6	67°
549430c	34.9	32.5?	25.1	17.6	81°
540430d	33.2	30.0?	22.7	19.1	66°
549430e	?	38.4	26.9	?	?

OCCURRENCE.—Eocene (Castle Hayne Formation - Basal Bryozoan Member), from exposed surface of island in Lower Cape Fear River, 11 miles (17.6 km) south of Wilmington, North Carolina.

TYPES.—Holotype: USNM 549430a; paratypes: USNM 549430b–e.

COMPARISON.—This species differs from *Tanyoscapha sigmanae* new species, which it resembles, in its narrower oval outline and more convex valves. Although similar internally to *Plicatoria* it differs in not having peripheral costae. It differs from *Embolosia*, which has a similar interior, by its wider, more oval form.

Tanyoscapha sigmanae, new species

PLATE 7: FIGURES 17–28.

DIAGNOSIS.—Large, wide, *Tanyoscapha* having valves of low convexity.

DESCRIPTION.—Large, compressed, widely oval; biconvex, ventral valve having greater convexity than dorsal one. Sides rounded, anterior margin broadly rounded, posterolateral margins forming angle of 69°–91°. Lateral commissure nearly straight, slightly curved toward ventral valve at anterior. Anterior commissure broadly uniplicate. Beak short, suberect, labiate, truncated by large permesothyridid foramen. Symphytium concave, partially visible. Surface smooth, exfoliated patches having obscure radial lines.

Ventral valve evenly and moderately convex in side view with anterior somewhat flattened. Anterior profile broadly and evenly convex. Median and umbonal regions moderately swollen. Lateral slopes narrowly rounded forming beak ridges. Anterior flattening serving in lieu of sulcus.

Dorsal valve very gently convex in lateral profile, the umbonal region rounded, anterior third flattened. Anterior profile moderately convex. Umbonal and median regions swollen. Fold originating just anterior to midvalve, defined by slight depression of anterolateral flanks. Lateral slopes narrow.

Interior as for genus.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
550913a	37.3	32.0	30.2	20.9	80°
550913b	37.9	33.3	29.6	20.0	69°
550913c	48.1	41.6	36.5	28.1	75°
550911a	42.0	38.7	35.8	20.5	91°
550911b	41.5	37.0	35.5	21.4	90°
549428	41.3	36.6	34.0	22.9	82°

OCCURRENCE.—Eocene (Castle Hayne Formation), Wilmington, North Carolina: due east of Campbell Island, due west of Mott Creek, 34°07.3′N, 77°55.8′W, Wilmington (7½′) quadrangle, New Hanover County, North Carolina.

TYPES.—Holotype: USNM 550911a; paratypes: USNM 550911b–e, 550913a–i, 549528.

COMPARISON.—This species differs from *Tanyoscapha glabra*, new species, its nearest relative, in its greater width and flattish valves. It differs from large specimens of *Plicatoria* in its complete lack of peripheral costation.

ETYMOLOGY.—Named in honor of Miss Carolyn Sigman, of Wilmington, North Carolina, who presented the specimens.

Terebratula Müller, 1776

PLATE 4: FIGURES 8–19; PLATE 64: FIGURES 5, 6

Terebratula Müller, 1776:249.—Buckman, 1907:528.

SUBFAMILY.—Terebratulinae Gray, 1840.

TYPE-SPECIES.—*Anomia terebratula* Linné, 1758: 703.

SPECIMENS STUDIED.—Forty, three excavated for loop.

GEOLOGIC OCCURRENCE.—Miocene and Pliocene.

LOCALITIES.—Italy, Sicily, Malta, Mediterranean region.

EXTERIOR.—Large, subpentagonal to fairly widely oval. Sides rounded, apical angle large. Anterior broadly rounded. Lateral commissure straight to gently curved toward ventral side. Anterior commissure uniplicate to sulciplicate. Beak short, slightly labiate, erect, truncated by large foramen. Symphytium partially visible. Surface with incremental growth lines and varices.

INTERIOR.—Ventral valve interior with short pedicle collar. Muscle field narrowly elongated.

TABLE 67.—Loop statistics for the genus *Terebratula*

Proportions	USNM 109710	USNM 155098	USNM 550892
∠	51°	49°	54°
Wl/Ll	0.94	0.91	1.00
Ll/LD	0.31	0.33	0.34
Wl/WD	0.31	0.30	0.32
a/Ll	0.59	0.64	0.64
b/Ll	0.41	0.36	0.36
c/Ll	0.53	0.45	0.45
d/Ll	0.06	0.19	0.19
e/Ll	0.16	0.18	0.14
f/Ll	0.23	0.18	0.22
g/WD	0.23	0.23	0.25
g/Wl	0.75	0.75	0.79
h/f	0.30	0.33	0.32
h/Ll	0.07	0.06	0.07
WD/LD	1.00	1.02	0.88

USNM 109710: *Terebratula sinuosa* Brocchi, Miocene, Island of Malta.

USNM 155098, USNM 550892. *Terebratula ampulla* Brocchi, Pliocene, Monte Mario, near Rome, Italy.

Dorsal valve interior without euseptoidum. Adductor scars extended anterior to front end of loop for short distance.

Loop and Cardinalia: The loop is reminiscent of that of *Liothyrella*. It is nearly equal in length and width and the crural processes are located anterior to midloop. The cardinal process ranges from a flat half ellipse to a thick hemispherical plate with raised anterior and lateral borders, buttressed by a short shaft. The socket ridges are thick, erect, curved, and bound wide sockets. Along the margin of the shell wall bounding the outside of the socket is a low thin ridge or elongate denticle which does not reach the socket opening (Plate 4: figure 16). The fulcral plates are thick, wide and slightly extended laterally. The outer hinge plates are very narrow or lacking. The crural bases are usually welded to the socket ridges to form deep V-shaped troughs. The crural bases expand at about the socket opening to form the crural processes which are usually long and slender and needle-like and directed more or less strongly toward midvalve, never uniting, and pointing anteroventrally. The crura are variable, short and hard to measure. The crural processes do not quite overhang the transverse band. The descending lamellae are represented by the slightly narrowing anterior slopes of the crural processes. They are short and join the transverse band to produce acute angles. The transverse band is fairly narrow and forms a low arch flattened medially. The median flattened part or bridge is narrower than the lateral sloping elements that join the descending lamellae. The posterior side of the flattened bridge is gently concave toward the posterior. The terminal points are short or almost non-existent. No inner hinge plates were seen in the specimens studied nor in the loops of *Terebratula* figured by Seguenza (1871) or Sacco (1902).

LOOP STATISTICS.—See Table 67.

DISCUSSION.—The similarity to the loops of *Liothyrella* has already been noted and is based on the nearly equal length and width and the position of the crural processes opposite the socket openings. Compared to the loop of *Pliothyrina* differences appear in the presence of inner hinge plates in the northern European and British species and in the more elongated and approximate crural processes.

The findings of Buckman (1907) in searching for the type species of *Terebratula* have been generally accepted. He fixed a specimen (1907, pl. 12) for reference which is also figured in Muir-Wood, 1965: H744, fig. 635: 1a–c, and which is called *T. terebratula* (Linné). The specimen is said to come from the Pliocene of Monte Mario, near Rome, Italy. This specimen strongly resembles the large species of *T. sinuosa* Brocchi (1814) from the Miocene of Malta. It is also suggestive of some specimens of *T. ampulla* Brocchi that are moderately sulciplicate. These southern European and Mediterranean Terebratulas appear to form a distinctive stock paralleling that of northern Europe and England (*Pliothyrina* and *Apletosia*) which is characterized by inner hinge plates in the cardinalia.

Waisiuthyrina Beets, 1942

Waisiuthyrina Beets, 1942:342–347.

SUBFAMILY.—Discoliinae?, Fischer and Oehlert, 1891.

TYPE-SPECIES.—*Waisiuthyrina margineplicata* Beets, 1942:343, pl. 34: figs. 8–18 (dated 1943 in Muir-Wood, 1965).

SPECIMENS STUDIED.—Literature only.

GEOLOGIC OCCURRENCE.—Upper Pliocene.

LOCALITY.—Southeast Celebes, Indonesia.

DISCUSSION.—This is a large brachiopod strongly resembling *Dyscolia* and *Goniobrochus*, but not having the zigzag sculpture of those genera. Beets describes the exterior as without radial ornament. The length and width of the shell are about equal (43 mm). The dorsal value is more convex than the ventral valve and the inner valve margins are so thickned that there is an indentation around the commissures. A condition seen in some specimens of *Dyscolia.* The break is strongly truncated, labiate and has a large foramen. Unfortunately the interior is too poorly preserved to indicate the form of the loop. A small cardinal process is present. Muir-Wood (1965:H807) placed this genus in the Dyscoliidae.

Tertiary Genus and Species Undetermined

PLATE 55: FIGURES 22–24

SPECIMENS STUDIED.—Five, one excavated for loop, remainder fragmentary.

GEOLOGIC OCCURRENCE.—Miocene (Sahelian).

LOCALITY.—Algeria.

EXTERIOR.—Medium size, subpentagonal, sides rounded, posterolateral margins forming angle of 80°. Maximum width slightly anterior to midvalve. Anterior commissure episulcate. Ventral fold extending posterior to midvalve. Beak suberect. Foramen large, mesothyridid. Symphytium partially concealed. Surface smooth.

INTERIOR.—Details of ventral valve not seen.

Loop and Cardinalia: The loop angle is large, loop nearly as wide as long. Cardinal process large, a thin flattened half ellipse with slightly concave myophore. The socket ridges are slightly inclined and bound wide sockets. The outer hinge plates are narrow and taper to the crural processes. The crural bases extend as a low ridge along the inner edge of the outer hinge plates. Disjunct inner hinge plates are present. The crural processes are located a short distance anterior to the socket openings. The crural processes are fairly long and sharply pointed. The descending lamellae are short, inclined, and represent the descending anterior slope of the crural processes. The transverse band is fairly wide, moderately arched and medially protuberant.

LOOP STATISTICS.—USNM 551071a: $\angle = 48°$; Wl/Ll = 0.94; Ll/LD = 0.34; Wl/WD = 0.42; a/Ll = 0.78; b/Ll = 0.22; c/Ll = 0.78; d/Ll = 0.00; e/Ll = 0.11; f/Ll = 0.11; g/WD = 0.45; g/Wl = 1.05; h/f = 0.64; h/Ll = 0.07; WD/LD = 0.77.

USNM 551071a: Terebratulacean indeterminate, Miocene (Sahelian), Oran, Algeria.

DISCUSSION.—This brachiopod strongly resembles *Maltaia* externally. The loop is also wide like that of *Maltaia* but it has inner hinge plates that are lacking in *Maltaia*. Other terebratulaceans from the Mediterranean region, such as those from Italy, Sicily and Malta, do not have inner hinge plates.

Tertiary Genera Incorrectly Assigned to the Terebratulacea

Eogryphus Hertlein and Grant, 1944

Eogryphus Hertlein and Grant, 1944:88

TYPE-SPECIES.—*Eogryphus tolmani* Hertlein and Grant, 1944:89, pl. 5: figs. 1–3, 7; pl. 18: figs. 1, 9–11.

SPECIMENS STUDIED.—Six, one showing septum and cardinalia poorly.

GEOLOGIC OCCURRENCE.—Eocene.

LOCALITY.—California.

DISCUSSION.—This is a large, gently sulcate, strongly biconvex brachiopod with narrowly carinate beak having a very small foramen, wide palintrope and conjunct deltidial plates, the ensemble forming a hinge region unlike that of *Gryphus*. The original description of the genus gives no details of the interior. A specimen (USNM 551161a) from which the shell was dissolved to produce an internal mold (cast) revealed a thick median septum surmounted by thick plates forming a notothyrial chamber, the true nature of which is uncertain, whether terebrataloid or terebratelloid, certainly not terebratulid.

The whole expression of *Eogryphus* is like that of *"Waldheimia" hilarionis* Meneghini from the Eocene of Germany. That *Eogryphus* is not a terebratulid related to *Gryphus* seems certain. *Eogryphus* is undoubtedly a genus with long loop.

Miogryphus Hertlein and Grant, 1944

Miogryphus Hertlein and Grant, 1944:95.

TYPE-SPECIES.—*Miogryphus willeti* Hertlein and Grant, 1944:95, pl. 11: figs. 4–9.

SPECIMENS STUDIED.—Four, none with interior.

GEOLOGIC OCCURRENCE.—Miocene.

LOCALITY.—California.

DISCUSSION.—*Miogryphus* is of medium size, oval, anteriorly rounded and subnasute. The beak is short, suberect and has a large foramen. The surface is irregularly costate, the costae on the fold and in the sulcus being the most prominent. The posterior part of both valves is smooth. Hertlein and Grant (1944:95) remark that "its well developed median septum and strong plicae [costae] appear to separate it from *Gryphus*." The strong septum not only separates *Miogryphus* from *Gryphus*, it also separates it from the rest of the Terebratulacea. It is undoubtedly a genus having a long loop.

Recent TEREBRATULACEA

Abyssothyris Thomson, 1927

PLATE 2: FIGURES 1–15; PLATE 3: FIGURES 1–9; PLATE 16: FIGURE 19; PLATE 55: FIGURE 15; PLATE 64: FIGURES 1, 2

Abyssothyris Thomson, 1927:190.—Muir-Wood, 1960:522.—Cooper, 1972:9.

SUBFAMILY.—Aenigmathyridinae, new subfamily.

TYPE-SPECIES.—*Terebratula wyvilli* Davidson, 1878:436; 1880:27, pl. 2: fig. 7a–c.

SPECIMENS STUDIED.—Many, 10 loops. Literature.

GEOLOGIC OCCURRENCE.—Miocene to Recent.

LOCALITIES.—Abyssal in Pacific Ocean from Alaska to Antarctica; subantarctic Atlantic.

EXTERIOR.—Small to medium size, oval to pentagonal; biconvex, ventral valve having greater convexity. Lateral commissure nearly straight; anterior commissure sulcate. Beak small, suberect to erect, slightly labiate. Foramen fairly large, permesothyridid. Symphytium partially visible. Pedicle with frayed distal end. Color white to yellowish.

INTERIOR.—Ventral valve with small teeth; short pedicle collar. Musculature not resolved.

Loop and Cardinalia: The cardinal process is a narrow roughened band, half elliptical and slightly protuberant. The socket ridges are erect and bound narrow sockets. The fulcral plates are well marked and not laterally extended. The outer hinge plates are narrowly triangular, slope

TABLE 68.—Loop statistics for the genus *Abyssothyris*

Proportions	British Museum, ZB1163	USNM 110745a	USNM 550437a	USNM 550592b
∠	25°	26°	31°	23°
Wl/Ll	0.67	0.63	0.59	0.50
Ll/LD	0.32	0.33	0.30	0.34
Wl/WD	0.21	0.16	0.19	0.19
a/Ll	0.56	0.63	0.53	0.58
b/Ll	0.44	0.37	0.47	0.42
c/Ll	0.56	0.63	0.53	0.58
d/Ll	0.00	0.00	0.00	0.00
e/Ll	0.22	0.21		
			0.47	0.42
f/Ll	0.22	0.16		
g/WD	0.23	0.15	0.25	0.28
g/Wl	1.08	1.50	1.40	1.50
h/f	0.41	0.25	?	?
h/Ll	0.09	0.04	0.07	0.06
WD/LD	1.20	1.13	0.93	0.91

ZB1163: *Abssothyris wyvillei* (Davidson), Recent, at 1450 fm (2654 m), *Challenger* Station 302, 42°43′S, 82°11′W, off Chile.

USNM 110745a: *A.* cf. *A. wyvillei* (Davidson), Recent, at 2035 fm (3724 m), U.S. Fish Commission Station 4709, 10°15′S, 95°41′W, off the Galapagos Islands.

USNM 550437a: *A. elongata* Cooper. Recent, at 3601–3687 m, 31°19.7′N, 119°39.2′W to 31°08.2′N, 119°35.5′W, Baja California Abyssal Plain, off Baja California.

USNM 550592b: *A. atlantica* Cooper, Recent, at 2500–2590 m, 33°38.5′N, 75°50.5′W, off Cape Fear, South Carolina.

off the socket ridges and taper anteriorly to the crural processes. The crural processes are bluntly pointed and are located at about midloop. The crural bases are narrow and hold the scooplike anterior of the loop. The descending lamellae are the anterior slope of the cardinal processes. The transverse band is moderately broad and is moderately folded medially, the fold varying from broad and gentle to somewhat narrowly rounded. The loop is somewhat angulated or rounded anteriorly.

LOOP STATISTICS.—See Table 68.

DISCUSSION.—*Abyssothyris* is notable for its abyssal habit and its wide distribution. It has short-looped homeomorphs in the Mesozoic (*Nucleata* and *Linguithyris*). *Abyssothyris* is known from the Pacific and Atlantic oceans and at several stations in the Antarctic Ocean. Muir-Wood (1960) described the homeomorphy of *Neorhynchia* and *Abyssothyris* which occur together in some localities in the Pacific and Antarctic oceans. She also figured the loop (1960, pl. 7: fig. 2) of *A. wyvillei*, which has a moderately folded transverse band and subangular anterolateral extremities, unlike the loop *A. elongata* and *A. atlantica* and an example from the Tasman Sea, all of which have a loop with well rounded anterolateral extremities.

The anterior part of the loop of *Abyssothyris* as noted above is variable. The specimen from off Chile in the Davidson Collection of the British Museum (Natural History) has well-marked subangular anterolateral extremities, as does the specimen from off the Galapagos (Plate 2: figures 4, 7). A specimen in the National Collection (USNM 551224b) from the Tasman Sea has well rounded anterolateral extremities as does *A. atlantica*.

LOPHOPHORE.—As shown by *A. elongata* the lophopore of *Abyssothyris* is unlike that of most short-looped brachiopods in its tight coiling in contrast to the long horse-shoe shaped plectolophe with its median coil. The lophophore of *A. elongata* consists of two short, tight coils forming a spiral the distal ends of which are tied by a thin membrane (Figure 12A). The lophophore is confined to the posterior of the dorsal valve. Seen from the dorsal side it consists of two subparallel, wide smooth lobes laterally fringed by long filaments. When viewed from the ventral side these lobes curve dorsally and form a tight spiral. From the side (Plate 16: figure 19) the lophophore is fringed laterally in its proximal half with the filaments on the inside of the coil. The fringed narrow, distal coils are united by a thin membrane that holds the coils apart. If hydrostatically unrolled two long, subparallel filter channels would result. Helmcke (1940:255, 257, figs. 17e, 20) figured a similar lophophore in "*Liothyrella*" *winteri* (Blochmann), shown as a tight coil terminating in short spirals united by a membrane.

Zezina (1975:255, 256) regards the short lophophore one of the most noteworthy characters of deep-water brachiopods. She states that "If we bear in mind that the lophophore is not only an apparatus for [collecting] suspended food particles, but is an organ of respiration, then obviously the energy exchange of the organism is closely connected with an increase in its size. Reduction of the lophophore surface in deep water forms apparently represents a mechanism for regulating the exchange under conditions of great hydrostatic pressure and a sufficiently high oxygen content in the water." She states also that reduced organs of respiration have been noted in deep water molluscs and echinoids, in comparison with related shallow water forms.

Few fossils of abyssal brachiopods have been found. Specimens of *Abyssothyris* taken from sediments replete with Globigerina were reported by Cooper (1979:7) from Miocene beds on Fiji. *Terebratula meneghiniana* Sequenza from the Pliocene of Sicily was referred by Thomson (1927:191) to *Abyssothyris*. This species proves to have a different loop and different exterior details and is here placed in a new genus, *Ceramisia*. Elliott (1960) identified *Abyssothyris* from Pliocene-Pleistocene rocks of Fiji but these proved to have a long loop and were referred to a new genus *Dicrosia* by Cooper (1978:12).

TABLE 69.—Loop statistics for the genus *Acrobelesia*

Proportions	d'Hondt 1976	MNHN-BRA-78-11
∠	40°	34°
Wl/Ll	0.64	0.63
Ll/LD	0.26	0.27
Wl/WD	0.16	0.20
a/Ll	0.57	0.58
b/Ll	0.43	0.42
c/Ll	0.43	0.42
d/Ll	0.14	0.16
e +f/L	0.43	0.42
g/WD	0.24	0.29
g/Wl	1.56	1.49
h/Ll	0.08	0.07
WD/LD	1.07	0.85

d'Hondt (1976, fig. 2e): *Acrobelesia cooperi* (d'Hondt), Recent, Gulf of Gascogne, France.

MNHN-BRA-78-11: *Acrobelesia cooperi* (d'Hondt), Recent at 580–545 m, 44°06.5'N, 04°45.2'W to 44°06.5'N, 04°45.0'W, Gulf of Gascogne, France.

Acrobelesia, new genus

PLATE 60: FIGURES 2–8

SUBFAMILY.—Aenigmathyridinae, new subfamily.

TYPE-SPECIES.—*Gryphus cooperi* d'Hondt, 1976:6, fig. 2a–e.

DIAGNOSIS.—Small dyscoliid brachiopod with concentric undulations and faint radial capillae on the exterior, disjunct deltidial plates and loop with crural processes anterior to midloop.

SPECIMENS STUDIED.—Three, one with loop, one with cardinalia only.

GEOLOGIC OCCURRENCE.—Recent.

LOCALITY.—Gulf of Gascogne, France.

EXTERIOR.—Small roundly oval to subpentagonal, sides and anterior margin rounded, posterolateral margins forming angle of about 90°. Lateral commissure straight, anterior commissure rectimarginate (see below). Beak short, suberect, truncated, worn. Foramen large, submesothyridid. Deltidial plates disjunct. Surface marked by fairly regular and even undulations crossed by faint radial capillae. Pedicle short, distally frayed.

INTERIOR.—Ventral valve with short pedicle collar anteriorly excavated. Teeth large. Muscle field small; diductor scars long and narrow, adjustors small and round, posterior to diductors. Vascula myaria short, direct.

Loop and Cardinalia: The loop is short and narrow as it occupies a quarter of the length and a sixth to a fifth of the dorsal valve width. The socket ridges are short, elevated, distally truncated and bound wide sockets. The cardinal process is a thickening along the posterior margin marked by a bilobed myophore. The fulcral plates are thick. The crural bases are distally flattened, thickened and resemble the outer hinge plates in a young specimen. The crura are short, thin and ribbonlike. The crural processes are situated anterior to midloop, are short, broadly acute and face medially. The descending lamellae are short, directed medially and form an angular junction pointing anteriorly, suggesting the loop of *Eucalathis*.

LOOP STATISTICS.—See Table 69.

DISCUSSION.—This brachiopod strongly resembles *Ceramisia* and *Faksethyris* with its strongly and evenly spaced concentric undulations. D'Hondt related his species to *Gryphus africanus* Cooper (type-species of *Xenobrochus* Cooper, 1981; herein p. 274) because of the similarity of the loops, both having an anteriorly pointed distal extremity. The African species, however, is smooth and has a completely visible symphytium, not disjunct deltial plates as in *Acrobelesia*.

Although *Faksethyris* and *A. cooperi* strongly resemble each other because of their strong concentric ornament, the loop of *Faksethyris* has different proportions, the crural processes being farther posterior (a/Ll = 0.44) and the anterior attenuated part of the loop being much longer. The deltidial plates of *Faksethyris* are conjunct. *Faksethyris* does not have radial capillae over the concentric undulations.

Ceramisia and *Acrobelesia* are similar in external appearance although the Sicilian genus lacks radial capillae. *Ceramisia* is strongly sulcate whereas the anterior commissure of *Acrobelesia* is slightly uniplicate according to d'Hondt's figure (1976, fig. 2d); a specimen in the National Collection (USNM 551147a) is faintly sulcate. The loops of the two are similar but that of *Ceramisia* has a smaller angle. The crural processes are slightly more anterior and the anterior portion of the loop in front of the crural processes is shorter than in *Acrobelesia*.

ETYMOLOGY.—From the Greek *acrobeles* (pointed at the end).

Acrobrochus, new genus

PLATE 8: FIGURES 13–16, 28; PLATE 9: FIGURES 1–5; PLATE 12: FIGURES 1–5; PLATE 62: FIGURE 23

SUBFAMILY.—Terebratulinae Gray, 1840.

TYPE-SPECIES.—*Liothyrella? vema* Cooper, 1973c:17, pl. 1: figs. 21–36.

COMPOSITION.—*Terebratula tateana* Tenison-Woods (1878), *T. aldingi* Tate (1880), *T. blochmanni* Jackson (1912), *Liothyrella? vema* Cooper (1973c), *L. hendleri* Cooper (1982).

SPECIMENS STUDIED.—Many, many with loop exposed.

DIAGNOSIS.—Terebratulaceans having outer hinge plates tapering onto posteroventral edges of crural process; narrow loop and broad transverse band.

GEOLOGIC OCCURRENCE.—Miocene to Recent.

LOCALITIES.—Miocene, Australia; Recent, Pacific Ocean off South America, Antarctic Ocean.

EXTERIOR.—Medium to large, oval to roundly pentagonal; lateral commissure nearly straight; anterior commissure uniplicate. Beak suberect, truncated, short, labiate. Foramen moderately large. Symphytium partially visible. Surface marked by concentric growth lines only. White to yellowish.

INTERIOR.—Ventral valve interior with short, excavate pedicle collar.

Loop and Cardinalia: The loop is subtriangular with an angle of 20° to 30°, occupying a third the length and about a fifth or less of the width of the dorsal valve. The cardinal process is a transverse half ellipse, roughened on its posteroventrally facing surfaces. The fulcral plates are stout and variably extended laterally, rather strongly so in *A. blochmanni* (Jackson). The socket ridges are thin and bound moderately wide sockets. The outer hinge plates are narrowly triangular and flattened, but make shallow troughs with the socket ridges and crural bases. The tapered anterior of the outer hinge plates rises anteriorly to become flush or nearly so with the posteroventral edges of the crural process, as seen in some examples of *Liothyrella*. The crural bases are moderately elevated along the inner edges of the outer hinge plates. The crural processes are well developed and taper to short, acute points. The junction of the crural processes with the tapered ends of the outer hinge plates eliminates a crus. The descending lamellae are short, representing the anteriorly descending part of the crural processes. The crural processes are located anterior of midloop and anterior of the socket openings. The transverse band is broad in both directions and is fairly strongly and broadly swollen. The antero-

TABLE 70.—Loop statistics for the genus *Acrobrochus*

Proportions	USNM 87467b	USNM 549693	USNM 550001-1	USNM 550480a	USNM 550919a	Jackson, 1912
∠	29°	21°	25°	30°	29°	22°
Wl/Ll	0.56	0.43	0.43	0.44	0.57	0.29
Ll/LD	0.28	0.33	0.31	0.30	0.30	0.27
Wl/WD	0.19	0.16	0.15	0.14	0.18	0.12
a/Ll	0.64	0.50	0.57	0.61	0.64	0.67
b/Ll	0.36	0.50	0.43	0.39	0.36	0.33
c/Ll	0.64	0.50	0.50	0.47	0.57	0.56
d/Ll	0.00	0.00	0.07	0.14	0.07	0.11
e/Ll	0.12	0.22	0.21	0.17	0.14	0.16
f/Ll	0.24	0.28	0.22	0.22	0.21	0.17
g/WD	0.24	0.23	0.23	0.20	0.24	0.18
g/Wl	1.12	1.50	1.50	1.55	1.37	1.43
h/f	0.63	0.79	0.41	0.77	0.67	0.41
h/Ll	0.15	0.22	0.09	0.17	0.14	0.07
WD/LD	0.82	0.92	0.87	0.97	0.96	0.86

USNM 87467b: *Acrobochus tateana* (Tenison-Woods), Miocene, Morgan, South Australia.
USNM 549693: *Acrobrochus* species, Recent, at 321 m, 25°44′S, 85°25′W, off Peru.
USNM 550001-1: *Acrobrochus blochmanni* (Jackson), Recent, at 2275–2342 m, 74°05.6′S, 175°05.2′W to 74°06.5′S, 174°57.8′W off Antarctica.
USNM 550480a: *Acrobrochus vema* (Cooper), Recent at 1814–1919 m, 54°44′S, 55°39′W, off end of Burdwood Bank, east of Argentina.
USNM 550919a: *Acrobrochus aldingi* (Tate), Miocene (Aldingian), Aldinga, South Australia.
Jackson (1912, pl. 1: fig. 6): *Acrobrochus blochmanni* (Jackson), Recent, 71°22′S, 16°34′W, off Coats Land, Antarctica.

lateral extremities of the loop are angular but not extended. The anterior of the loop of *A. vema* (Cooper) has a small point on each side of the fold which defines a modest anterior tongue.

LOOP STATISTICS.—See Table 70.

DISCUSSION.—*Acrobrochus* differs from *Liothyrella* in having a narrow loop, in having the crural processes located anterior of the socket openings (seen also in some individuals of *Liothyrella*), and in having a broad transverse band. The loop of *Acrobrochus* is most like that of *Tichosina* but differs in the tapering of the outer hinge plates toward the posteroventral edge of the cural processes in *Acrobrochus* but to the dorsal edge in *Tichosina*.

Foster (1974:60, fig. 19) shows the variation of the loop in *Acrobrochus blochmanni* in ventral view but no side views are given. His figures show variation in the transverse band and small differences in the position of the crural processes and loop angle.

ETYMOLOGY.—From the Greek *akron* (top) plus *brochos* (noose or loop).

Acrobrochus hendleri (Cooper), new combination

PLATE 58: FIGURES 23–35

Liothyrella hendleri Cooper, 1982:12, fig. 2; pl. 4: figs. 1–6.

DIAGNOSIS.—Large *Liothyrella* with subequally convex valves, thin shell, faintly uniplicate anterior commissure in the adult and rather narrow loop for the genus.

EXTERIOR.—Large, thin-shelled, elongate oval, maximum width at about midvalve. Values subequal in depth, sides rounded, anterior margin somewhat narrowly rounded, posterolateral margins forming angle of 67°–90°. Beak moderately long, suberect, narrowly labiate. Foramen rather small permesothyridid. Lateral commissure straight; anterior commissure rectimarginate to slightly uniplicate. Surface smooth. White to pale yellow.

Ventral valve moderately convex in lateral view, fairly strongly domed with steep slopes in anterior view. Beak narrow convex, anterior slope slightly flattened to form slight anterior tongue.

Dorsal valve moderately convex in side view, fairly strongly and somewhat narrowly domed in anterior view. Umbonal and median regions swollen, swelling continued to anterior margin as faint fold.

INTERIOR.—Ventral valve interior with small teeth; pedicle collar short.

Loop and Cardinalia: The loop is short, stout, and occupies a third the length and about a fifth the width of the dorsal valve. The cardinal process is small, somewhat rectangular, narrow, with roughened myophore facing ventrally. The socket ridges are high, slender and curved. The fulcral plates are thick and laterally extended. The outer hinge plates are narrow, concave and taper anteriorly to the ventral side of the crural bases. The crural bases are strongly elevated along the inner edge of the outer hinge plates. The crural processes are anterior of midloop, bluntly angular with distal extremities approximate. The transverse band is fairly strongly arched with a flattened bridge occupying a third of the loop width. The transverse band is variable and all specimens have a more or less deep reentrant on the posterior side. The anterolateral extremities are rounded.

MEASUREMENTS (in mm).—Holotype: length 35.0; dorsal valve length 31.5, width 26.5, thickness 20.0, apical angle 67°.

OCCURRENCE.—Recent, at 415–612 m, 57°-39.4'S, 0.26°26.7'W, off South Sandwich Islands, Antarctica.

LOOP STATISTICS.—See Table 71.

TYPES.—Holotype: USNM 551141a; paratypes: USNM 55114Ib–l.

DISCUSSION.—The exterior of this species is most like that of *Liothyrella notorcadensis* (Jackson) but is smaller, more delicate, has a smaller foramen as well as a different loop. It is about the same size as *L. fosteri*, new species, but has much more convex valves.

Five complete or nearly complete dorsal valves reveal the loop of this species. The loops are variable in minor details. Except for a variation of 5° in the loop angle most of the variation is within 0.10. There is variation in the transverse band, the posterior reentrant being deeper in some than others, thus affecting the measurement of h. Variation is also seen in the taper of the outer hinge plates. In specimen 551141e these extend to the crural processes and eliminate the ratio of d/Ll. At the anterior of the loop of specimen 551141c there are minute points. In specimen 551141g the anterolateral extremities are well rounded.

The relative narrowness of the loop and the position of the crural processes anterior to the socket openings make assignment of this species to *Acrobrochus* necessary.

TABLE 71.—Loop statistics for *Acrobrochus hendleri*

Proportions	USNM 551141c	USNM 551141e	USNM 551141f	USNM 551141g	USNM 551141h
∠	31°	27°	26°	29°	31°
Wl/Ll	0.57	0.53	0.61	0.58	0.61
Ll/LD	0.31	0.32	0.31	0.29	0.32
Wl/WD	0.21	0.21	0.23	0.22	0.23
a/Ll	0.67	0.63	0.67	0.63	0.64
b/Ll	0.33	0.37	0.33	0.37	0.36
c/Ll	0.56	0.63	0.56	0.53	0.54
d/Ll	0.11	0.00	0.11	0.10	0.10
e/Ll	0.16	0.23	0.22	0.16	0.23
f/Ll	0.17	0.14	0.11	0.21	0.11
g/WD	0.27	0.28	0.27	0.24	0.26
g/Wl	1.29	1.38	1.18	1.09	1.08
h/f	0.41	0.34	0.63	0.47	1.00
h/Ll	0.07	0.04	0.07	0.09	0.11
WD/LD	0.86	0.81	0.83	0.89	0.86

USNM 551141c,e–h: *Acrobrochus hendleri* (Cooper), Recent, at 415–612 m, 57°39.4'S, 26°26.7'W, off South Sandwich Islands, Antarctica.

Arctosia, new genus

PLATE 58: FIGURES 1–8; PLATE 60: FIGURE 9; PLATE 65: FIGURES 7, 8

SUBFAMILY.—Tichosininae, new subfamily.

TYPE-SPECIES.—*Terebratula arctica* Friele, 1877: 221, pl. 1, fig. 1a–c.

DIAGNOSIS.—Terebratulacean with loop having subparallel sides, narrow, nearly horizontal transverse band and crural processes anterior to mid-loop.

SPECIMENS STUDIED.—Twenty-three, two with loop.

GEOLOGIC OCCURRENCE.—Recent.

LOCALITY.—Off Greenland.

EXTERIOR.—Small, roundly pentagonal, biconvex, ventral valve slightly more convex than dorsal valve. Length and width nearly equal. Posterolateral margins forming angle of 75°–80°. Lateral commissure straight; anterior commissure rectimarginate. Beak short, suberect, labiate. Beak ridges rounded. Foramen small, permesothyridid. Symphytium partially hidden. White to pale yellowish brown; smooth.

INTERIOR.—Ventral valve with long excavate, somewhat tubular pedicle collar. Muscle scars not resolvable on thin shell.

Loop and Cardinalia: The cardinal process is small, myophore is roughened and faces posteroventrally. The loop is short and wide, occupying a third the length and nearly a quarter the width of the dorsal valve. The socket ridges are thin, high, inclined over the sockets. The outer hinge plates are fairly long, narrow, deeply concave and extend to the crural processes. The fulcral plates are thick and have short lateral extensions. The outer hinge plates are attached to the dorsal edge of the crural bases and have an anteriorly tapered edge extending in a ventral direction onto the crural processes. The crural bases and edge of the outer hinge plates in side view make a narrow stem holding the scooplike ensemble of crural processes and transverse band. The crural processes are low, obtusely angular and broad and form the short, wide descending lamellae. The transverse band is narrow, nearly horizontal and forms a right angle with the descending lamellae.

TABLE 72.—Loop statistics for the genus *Arctosia*

Proportions	USNM 551144	USNM 551146c
∠	25°	31°
Wl/Ll	0.58	0.59
Ll/LD	0.33	0.30
Wl/WD	0.27	0.20
a/Ll	0.63	0.65
b/Ll	0.37	0.35
c/Ll	0.63	0.65
d/Ll	0.00	0.00
e/Ll	0.29	0.32
f/Ll	0.08	0.03
g/WD	0.33	0.24
g/Wl	1.18	1.30
h/f	0.50	1.00
h/Ll	0.04	0.03
WD/LD	0.93	0.97

USNM 551144: *Arctosia arctica* (Friele), Recent, at 240 m, 74°30.5′N, 14°20′W, off the E coast of Greenland.

USNM 551146c: *Arctosia arctica* (Friele), Recent at 500 m, 73°27.1′N, 016°02′W, SE of Shannon Island, E coast of Greenland.

LOOP STATISTICS.—See Table 72.

DISCUSSION.—The loop of this genus resembles that of *Tichosina* in having outer hinge plates attached dorsally but differs in its wider, squarish loop with its nearly horizontal and thin transverse band. Although the loop has a dyscoliid appearance, it differs from *Dyscolia* in having well formed outer hinge plates that are bounded by the crural bases. Davidson's figure (1886–1888, pl. i: fig. 18) of *Terebratula arctica* shows a much stouter and wider loop than the specimens figured herein.

ETYMOLOGY.—From the Greek *arctos* (north).

Dallithyris Muir-Wood, 1959

PLATE 10: FIGURES 13–19; PLATE 65: FIGURES 29, 30

Dallithyris Muir-Wood, 1959:302.

SUBFAMILY.—Gryphinae Sahni, 1929.

TYPE-SPECIES.—*Dallithyris murrayi* Muir-Wood, 1959:305, pl. 2: figs. 1, 4–8; pl. 3: figs. 1–4; pl. 5: fig. 8.

SPECIMENS STUDIED.—Three, one prepared to show loop.

GEOLOGIC OCCURRENCE.—Eocene – Pleistocene, Recent.

LOCALITY.—Uncertainly identified fossils from Eocene, Pliocene-Pleistocene from Southern Pacific islands: Eua and Fiji. Recent, off Maldive Islands, Indian Ocean.

EXTERIOR.—Medium to large, roundly triangular, widest in anterior third; inequivalve, ventral valve deeper than dorsal valve. Lateral commissure forming broad curve concave toward ventral side. Anterior commissure rectimarginate to broadly, gently uniplicate. Beak suberect, short, labiate. Foramen large, submesothyridid. Symphytium partially visible. Surface smooth. White to yellowish white.

INTERIOR.—Ventral valve with small, elongate teeth, pedicle collar short. Muscles lightly impressed. Dorsal valve interior with faint euseptoidum.

Loop and Cardinalia: The loop is scoop-shaped in side view and is variable, particularly the transverse band. The loop occupies about a third of the length and 20% or less of the width of the dorsal valve. The cardinal process is a small half ellipse with myophore directed posteriorly. The socket ridges are thin and erect and curve slightly away from the shell margin to bound wide sockets. The fulcral plates are well developed and are extended slightly laterally as a short ridge on the shell wall. The proximal part of the socket is roofed. The outer hinge plates are usually broadly triangular and taper anteriorly to the short, thin rounded crus. The outer hinge plates are very slightly concave, thin and delicate. The inner margins of the outer hinge plates are not bordered by conspicuous elevated crural bases as in *Tichosina* and *Liothyrella.* The crural bases are difficult to identify and the inner edge of the outer hinge plates passes into the ventral edge of the crural bases. The crural bases are represented by only a slight marginal ridge along the free edge of the outer hinge plates. The crural processes are located anterior of midloop and have bluntly acute points which are slightly approximate and located near the transverse band. The crural processes with the transverse band form a scoop-shaped ensemble attached to the crural bases as in *Gryphus.* The anterior descending part of the crural processes embraces the broad transverse band. It is a low arch with median crest varying from a gentle fold (USNM 550332) to what approximates a septum (Muir-Wood, 1959, pl. 3: fig. 2b). The median crest is extended as a short point in the median reentrant of the posterior side of the band. The anterior margin is variable with the anterior end narrowed (Muir-Wood, 1959, pl. 3: figs. 1, 2b) and with the anterior having parallel or slightly expanded sides (Muir-Wood 1959, pl. 3: fig. 4a; USNM 550332). A specimen in the National Collection (USNM 550332) has two small lateral points defined by small angular reentrants and a slight median concavity at the median crest, an arrangement strongly suggestive of a well preserved loop of *Gryphus* (Plate 10: figure 17).

LOOP STATISTICS.—See Table 73.

DISCUSSION.—*Dallithyris murrayi* has a variable loop anterior to the crural processes. No two of the four loops figured by Muir-Wood (1959) are alike and one specimen belonging to the National Collection deviates from the others although it was taken from the same lot studied by Muir-Wood. The loop of USNM 550332 is anteriorly broader and has a lower median fold of the

TABLE 73.—Loop statistics for the genus *Dallithyris*

Proportions	USNM 550332	British Museum ZB1570	British Museum ZB1572	British Museum ZB1574
∠	20°	15°	20°	19°
Wl/Ll	0.46	0.40	0.41	0.38
Ll/LD	0.32	0.30	0.31	0.33
Wl/WD	0.19	0.12	0.13	0.13
a/Ll	0.67	0.60	0.59	0.65
b/Ll	0.33	0.40	0.41	0.35
c/Ll	0.54	0.53	0.53	0.59
d/Ll	0.13	0.07	0.06	0.06
e/Ll	0.12	0.07	0.17	0.11
f/Ll	0.21	0.33	0.23	0.23
g/WD	0.30	0.28	0.25	0.24
g/Wl	1.54	2.17	1.85	1.85
h/f	1.00	0.76	1.00	0.78
h/Ll	0.21	0.25	0.23	0.18
WD/LD	0.82	0.92	0.94	0.96

USNM 550332: *Dallithyris murrayi* Muir-Wood, Recent, 120 fm (219 m), *John Murray* Expedition Station 157, 4°43′48″N, 72°55′24″E to 4°44′00″N, 72°54′18″E, off the Maldive Islands, northern Indian Ocean.

British Museum (Natural History) ZB1570, ZB1572, ZB1574: Same as above.

transverse band than the specimens figured by Muir-Wood and is like the loop of *Gryphus*. Her specimen (pl. 3: fig. 2b) has a moderately indented transverse band and narrowed anterior. Her specimen (pl. 3: fig. 4a) has an indented and slightly narrowed anterior but in addition is laterally serrated like some specimens of *Gryphus* (see Plate 10: figure 12) although the anterior of the loop is variable, that part of the loop posterior to the crural processes is much less deviating.

Muir-Wood referred *Terebratula cubensis* (Pourtales) to *Dallithyris*; the two are similar externally. The Caribbean species, as detailed by Cooper (1977:67) belongs to the genus *Tichosina* which has an entirely different loop. *Terebratula cubensis* was early confused with *Terebratula sphenoidea*, another external homeomorph of *Dallithyris*, which Muir-Wood placed in her genus.

Terebratula sphenoidea Philippi and *T. sphenoidea* Jeffreys (not Philippi) the former a Miocene species, the other living in the eastern Atlantic, are similar to *Dallithyris* and were so assigned to the genus Muir-Wood (1959). The loops of these two are similar in their posterior parts but the anterior is so narrowly pinched and serrated that assignment to *Dallithyris* is not possible. Of the five known loops of *Dallithyris* not one of them is like the loop of *T. sphenoidea*. *Terebratula sphenoidea*, both fossil and Recent, are here referred to *Stenosarina* Cooper (1977) which has a similar external form and occurs in the Caribbean Sea and the Gulf of Mexico.

A large brachiopod from north of Madagascar is a homeomorph of *Dallithyris*, having cardinalia like *Dallithyris* but a more narrowed loop.

Dolichozygus, new genus

PLATE 12: FIGURES 15–20; PLATE 66: FIGURES 9, 10

SUBFAMILY.—Plicatoriinae, new subfamily.

TYPE-SPECIES.—*Terebratula stearnsi* Dall and Pillsbry, 1891:165, pl. 4: figs. 1–3.

DIAGNOSIS.—Large terebratulacean having long loop, long outer hinge plates, unusually broad transverse band.

SPECIMENS STUDIED.—Five, three with loop.

GEOLOGIC OCCURRENCE.—Pliocene to Recent.

LOCALITY.—Off Japan.

EXTERIOR.—Large, elongate subtriangular, ventral valve more convex than dorsal. Anterior commissure broadly uniplicate. Beak narrow, long, suberect, labiate. Foramen large, submesothyridid. Symphytium visible. White.

INTERIOR.—Ventral valve with elongate teeth; pedicle collar long, excavate.

Loop and Cardinalia: The loop is long, has subparallel sides and truncated anterior. The cardinal process is small and forms a flattened half ellipse with roughened myophore surface facing ventrally. The socket ridges are thin, slightly inclined laterally and bound a long narrow socket. The fulcral plate is small and not laterally extended. The outer hinge plates are long, narrow and taper anteriorly. They are attached proximally to the dorsal edge of the crural bases, the taper extending as a ridge along the outside of the crural bases, climbing ventrally and terminating on the crural processes slightly dorsad of their points. The broad crural bases form a wall along the inside margin of the outer hinge plates, and with them and the socket ridges, form shallow U-shaped troughs. The crural processes occur at more than half loop length and are short but sharp points closely approximate and almost overhanging the transverse band. There are no descending lamellae because the transverse band is attached to the anterior sloping edge of the crural processes. The transverse band is very broad, actually occupying 25% of the loop length. The posterior margin of the transverse band forms a gentle curve dorsally. The transverse band is folded medially. The anterior margin is roundly notched at the median fold and the lateral extremities bear two small, short points set off by small subangular reentrants.

LOOP STATISTICS.—USNM 549451: $\angle = 25°$; Wl/Ll = 0.48; Ll/LD = 0.31; Wl/WD = 0.19; a/Ll = 0.65; b/Ll = 0.35; c/Ll = 0.61; d/Ll = 0.04; e/Ll = 0.08; f/Ll = 0.27; g/WD ; 0.28; g/Wl = 1.52; h/f = 0.93; h/Ll = 0.25; WD/LD = 0.80.

USNM 549451: *Dolichozygus stearnsi* (Dall and

Pillsbry), Recent, Sagami Bay, Japan. Hatai (1940:261) reports its depth at 101–219 meters.

DISCUSSION.—Its large size and elongated outer hinge plates suggest *Plicatoria* and *Tanyoscapha* or *Dolichosina*, but close comparison shows it to be unlike all three. The outer hinge plates of *Dolichozygus*, although long, are proportionally shorter than those of *Plicatoria* and *Tanyoscapha*. The loop angle of *Dolichozygus* is less than that of *Dolichosina* and there is a fairly long crus in the loop of *Dolichosina*.

ETYMOLOGY.—From the Greek *dolichos* (long) plus *zygos* (yoke).

Dyscolia Fischer and Oehlert, 1890

PLATE 1: FIGURES 22–32; PLATE 44: FIGURES 26, 27; PLATE 66: FIGURES 20, 21

Dyscolia Fischer and Oehlert, 1890:70; 1891:23.—Thomson, 1927:199.—Helmcke, 1940:260.

SUBFAMILY.—Dyscoliinae Fischer and Oehlert, 1891.

TYPE-SPECIES.—*Terebratulina wyvillei* Davidson, 1878:432, 436, 437; 1880:32, pl. 1: figs. 1–3; 1886–1888:32, pl. 3: figs. 1–3.

SPECIMENS STUDIED.—One each of Recent species, two with loop; eighteen of the Pliocene species, 2 excavated to show loop.

GEOLOGIC OCCURRENCE.—Pliocene to Recent.

LOCALITY.—Pliocene of Sicily; living off France, Spain, northwest Africa; Caribbean Sea and Indian Ocean; Antarctic?

EXTERIOR.—Medium to large, rounded triangular to elongate oval; often thick-shelled with thickened anterior rims. Valves nearly equally convex, ventral valve deeper. Lateral commissure straight; anterior commissure rectimarginate. Beak short, suberect to erect, obliquely truncated, labiate or not. Foramen large, epithyridid to submesothyridid. Surface marked by concentric growth and radial lines, usually interrupted, often zigzag. White, yellow or pale brown.

INTERIOR.—Teeth small, hooklike, pedicle collar long, anteriorly excavated. Muscle field small, lightly impressed. Diductor scars aubrectangular.

Loop and Cardinalia: The loop and cardinalia are distinctive in their simplicity. The loop occupies a third or less of the length and slightly more or less than a quarter of the width of the dorsal valve. There is no protuberant cardinal process; the adductor muscles are attached in a roughened and depressed transverse pit at the apex. The socket ridges are thick, short, curved and slightly inclined to bound fairly wide sockets. The fulcral plates are thick and laterally extended. The outer hinge plates are scarcely identifiable and seem to be welded intimately to the socket ridges and their identity may be obscured by a deeply impressed pedicle muscle scar. The crural bases appear as an extension of the anteriorly tapering socket ridge, are narrowly rounded and bear crural processes and the anterior part of the loop which is scooplike. The crural bases are indistinct along the inside margin of the socket ridges. The crural processes are low, blunt, poorly defined expansions at the end of the crural bases and do not bear sharp points. The part of the loop anterior to the crural processes consists of laterally bowed, short descending lamellae that are united medially in a flattened curve constituting the transverse band. This may be slightly waved medially or extended as a blunt point facing anteriorly. In the type-species and *D. johannis-davisi* (Alcock) the transverse band is thin; in the Pliocene specimens of *D. guiscardiana* (Seguenza) the transverse band is a fairly wide ribbon.

LOOP STATISTICS.—See Table 74.

DISCUSSION.—The loop and internal structures are well described and illustrated by Fischer and Oehlert (1891:23, pl. 6). They figure two loops (pl. 6: fig. 3f,g), the former tapering anteriorly and with a narrow median fold suggestive of *Aenigmathyris* of the Eocene. The other figure shows a loop with nearly horizontal transverse band narrowly folded medially. The Recent specimen of *D. wyvillei* in the National Collection (USNM 549271) has no median fold on the transverse band.

The loop of *D. guiscardiana* from the Pliocene of Sicily differs from that of the living species. One specimen (USNM 173727) is abnormal as it has virtually no development of a crus and the crural processes and descending lamellae are broad and

TABLE 74.—Loop statistics for the genus *Dyscolia*

Proportions	USNM 130336	USNM 173727	USNM 549271	USNM 550904c	Fischer and Oehlert, 1891	Helmcke, 1940
∠	30°	30°	32°	31°	29°	ca 20°
Wl/Ll	0.54	0.62	0.62	0.59	0.58	0.66
Ll/LD	0.29	0.30	0.24	0.48	?	0.19
Wl/WD	0.17	0.21	0.17	0.27	?	0.12
a/Ll	0.57	0.56	0.61	0.71	0.68	0.67
b/Ll	0.43	0.44	0.39	0.29	0.32	0.33
c/Ll	0.39	0.50	0.42	0.41	0.47	0.44
d/Ll	0.19	0.06	0.20	0.30	0.21	0.23
e + f/Ll	0.42	0.44	0.38	0.29	0.32	0.33
g/WD	0.27	0.29	0.23	0.43	?	0.20
g/Wl	1.57	1.40	1.33	1.60	1.74	1.66
h/Ll	0.08	0.17	0.06	0.04	0.08	0.05
WD/LD	0.91	0.90	0.88	1.05	?	1.00

USNM 130336: *Dyscolia subquadrata* (Jeffreys), Recent, at 500–600 fm (915–1098 m), off Setubal, Portugal.

USNM 173727: *Dyscolia guiscardiana* (Seguenza), Pliocene, Messina, Sicily.

USNM 549271: *Dyscolia wyvillei* (Davidson), Recent, 765–785 fm (1400–1437 m), off NW coast of Africa.

USNM 550904c: *Dyscolia guiscardiana* (Seguenza), Pliocene, Messina, Sicily.

Fischer and Oehlert, 1891, pl. 6: fig. 3g: *Dyscolia wyvillei* (Davidson), same as 549271.

Helmcke, 1940:264, fig. 22: *Dyscolia johannis-davisi* (Alcock), 719 fm (1316 m), off the Maldive Islands, northern Indian Ocean.

thick. The anterior extremity is somewhat protuberant anteroventrally. The posterior margin of the median angle of the transverse band bears a posteriorly directed projection 2 mm long, undoubtedly a pathological development. The second specimen (USNM 550904c) appears to be normal. The cardinalia are so overgrown with shell tissue that the plates are not distinguishable. The crura are broad and flat and the crural processes low and obtusely angular. The loop anterior to them tapers anteriorly to a blunt point and the apex of the point is protuberant. This part of the loop suggests that of *Eucalathis* or *Acrobelesia*. The loop of these two Mediterranean fossil specimens proves to be variable from anteriorly pointed to nearly straight. Helmcke (1940:264, fig. 22) figures a loop of *D. johannis-davisi* from the Indian Ocean. It is strongly rounded anteriorly with a low narrow median fold.

Davidson (1880, pl. 1: fig. 2; 1886–1888, pl. 3: fig. 2) in his description and figure of the type of *Dyscolia wyvillei* from off Culebra Island in the West Indies provided his specimen with the loop of *Terebratulina*, an evident mistake based on the external similarity of *Dyscolia* to *Terebratulina*, the name used in his description.

Fischer and Oehlert (1891, pl. 6) show a transverse structure at the apex of the dorsal valve which is probably the frayed and torn ends of the diductor muscles. The shell, completely devoid of fleshy remnants, has no such structure.

According to Fischer and Oehlert (1891, pl. 6: fig. 3i) the lophophore like the loop, is a simple partial, fringed ring, a trocholophe. Such a primitive loop is unusual in such a large adult (50 mm). The lophophore of *Abyssothyris* which has a dyscoliid loop, is a short, tightly coiled structure unlike that of *Dyscolia*. One is bound to wonder how such a primitive organ could serve adequately such a large shell, when most brachiopods, even small ones, have a lophophore filling the entire mantle cavity.

The loop of *Dyscolia* figured by Fischer and Oehlert (1892, pl. 2; fig. 3d, e) shows a strong median anterior projection. The specimens are from off the Azores at depths of 1100 to 1300 m. These loops are similar to those of *Eucalathis* and *Acrobelesia*. A similar loop is seen in *Dyscolia guiscardiana* from the Pliocene of Sicily (Plate 44: figures 26, 27).

The remnants of the cardinalia and exterior of *Waisiuthyrina* Beets are similar to those of *Dyscolia*. The species is from the Oligocene of Indonesia.

Dysedrosia, new genus

PLATE 10: FIGURES 20–27; PLATE 65: FIGURES 23, 24

SUBFAMILY.—Tichosininae, new subfamily.

TYPE-SPECIES.—*Gryphus borneoensis* Dall, 1920: 314 (not illustrated).

DIAGNOSIS.—Large, biconvex, uniplicate; loop parallel-sided, outer hinge plates wide; crural bases broad; crural processes anterior; transverse band broad.

SPECIMENS STUDIED.—Two, one with loop.

GEOLOGIC OCCURRENCE.—Recent.

LOCALITY.—Off Borneo.

EXTERIOR.—Large, biconvex, ventral valve deeper than dorsal valve. Lateral commissure oblique; anterior commissure strongly, broadly uniplicate. Beak truncated, labiate. Foramen fairly small, mesothyridid. Smooth, white.

INTERIOR.—Ventral valve with short pedicle collar, small teeth. Muscle field small, roundly elliptical and situated posterior to midvalve.

Loop and Cardinalia: The loop is rather short and narrow and has parallel sides. The cardinal process is a small thin shelf. The socket plates are erect, thin and bound proximally roofed, narrow sockets. The fulcral plates are well defined and have short lateral extensions. The outer hinge plates are concave, widely triangular and have a long taper attached to the dorsal edge of the wide crural bases, and rises along the crural processes nearly to the points. The crural bases form a wall along the inner margin of the outer hinge plates. The crural processes are long with sharp points, located anterior to midloop. The descending lamellae are the anterior slope of the crural processes. The transverse band is a low arch with narrow median fold. It is broad with a slight concave curvature on the anterior side that produces small, sharp terminal points. The posterior side of the transverse band is strongly and broadly concave because lateral extensions of the band extend posteriorly on the posterodorsal side of the crural processes.

LOOP STATISTICS.—USNM 229297a: ∠ = 24°; Wl/Ll = 0.48; Ll/LD = 0.28; Wl/WD = 0.14; a/Ll = 0.64; b/Ll = 0.36; c/Ll = 0.57; d/Ll = 0.07; e/Ll = 0.14; f/Ll = 0.22; g/WD = 0.24; g/Wl = 1.70; h/f = 0.77; h/Ll = 0.17; WD/LD = 0.93.

USNM 229297a: *Dysedrosia borneoensis* (Dall), Recent, at 305 fms (= 558 m), 4°12′44″N, 115°27′44″E, Sibuko Bay, south of Silungen Island, Borneo.

DISCUSSION.—The exterior of *Dysedrosia* is like that of a number of terebratulid genera such as *Gryphus*, *Tichosina*? *bartletti*, and large *Liothyrella*. It differs from *Gryphus* in having a moderate sized foramen, and strongly uniplicate anterior commissure. It differs from the other two mainly in loop characters. The loop of *Liothyrella* has a wide angle and narrow transverse band while *Dysedrosia* has a broad transverse band and narrow parallel-sided loop. The widely triangular hinge plates constitute a significant difference from *T*? *bartletti*.

The loop of *Dysedrosia* is similar to that of *Dallithyris* which also has wide outer hinge plates, but the *Dallithyris* loop has narrow crural bases. Moreover, the exteriors of the two are unlike in folding, convexity and general form.

ETYMOLOGY.—From the Greek *dysedros* (not fitting).

Epacrosina, new genus

PLATE 14: FIGURES 8, 20–29; PLATE 65: FIGURES 21, 22

SUBFAMILY.—Gryphinae Sahni, 1929.

TYPE-SPECIES.—*Liothyrina fulva* Blochmann, 1906:698; 1908:612, pl. 38: fig. 22a,b; pl. 39: fig. 26 (lectotype).

COMPOSITION.—*Liothyrina fulva* Blochmann (1906), *Tichosina elongata* Cooper (1977).

DIAGNOSIS.—Elongate oval, rectimarginate terebratulaceans with broad-banded, anteriorly narrowed loop with outer hinge plates attached to the dorsal side of the crural bases.

SPECIMENS STUDIED.—Seven, one with loop exposed.

GEOLOGIC OCCURRENCE.—Recent.

LOCALITIES.—Waters off southern Australia and Tasmania.

EXTERIOR.—Elongate oval, with narrowly rounded anterior and gently convex sides. Apical angle near 60°. Lateral commissure nearly straight; anterior commissure rectimarginate. Beak moderately long, slightly labiate, suberect, strongly truncated. Foramen large, permesothyridid. Symphytium partially visible. Smooth; white to pale yellow.

INTERIOR.—Ventral valve with small, narrow, elongate teeth. Pedicle collar short. Muscle field posterior in position.

Loop and Cardinalia: The loop is long and slender and has a broad transverse band that narrows anteriorly. The cardinal process is a thin, half elliptical shelf with the myophore facing posteriorly. The socket ridges are thin and bound narrow sockets. The sockets are proximally roofed. The fulcral plates are thin and laterally extended. The outer hinge plates are thin, gently concave and taper anteriorly to join the crural bases along their dorsal edge. The tapered anterior rises onto the ventral edge of the crural processes. The crural bases narrow posteriorly and form a low wall along the inner edge of the outer hinge plates. The combination of low crural bases, outer hinge plates and socket ridges, forms shallowly broad U-shaped troughs. The crural processes are bluntly pointed, strongly approximate and located anterior of midloop. There are no descending lamellae because the transverse band is embraced by the sloping anterior edges of the crural processes. The transverse band is broad and is angularly folded medially. The fold produces a V-shaped reentrant, the sides of which are minutely serrated.

TABLE 75.—Loop statistics for the genus *Epacrosina*

Proportions	USNM 333011	USNM 550664	USNM 550924
∠	19°	14°	15°
Wl/Ll	0.48	0.43	0.36
Ll/LD	0.36	0.32	0.34
Wl/WD	0.23	0.18	0.14
a/Ll	0.57	0.57	0.56
b/Ll	0.43	0.43	0.44
c/Ll	0.57	0.43	0.56
d/Ll	0.00	0.14	0.00
e/Ll	0.09	0.14	0.19
f/Ll	0.34	0.29	0.25
g/WD	0.30	0.29	0.27
g/Wl	1.30	1.50	1.80
h/f	0.71	0.76	0.68
h/Ll	0.24	0.22	0.17
WD/LD	0.76	0.75	0.88

USNM 333011: *Epacrosina fulva* (Blochmann), Recent, at 90–150 fm (165–275 m), off Cape Everard, Australia.

USNM 550664: *Epacrosina? elongata* (Cooper), Recent at 350 fm (641 m), 25°59′N, 79°43′W, N of La Isabella, Cuba.

USNM 550924: *Epacrosina* species, Recent, at 640 m, 39°45.3′S, 148°54′E, Bass Strait, off SE end of Australia.

LOOP STATISTICS.—See Table 75.

DISCUSSION.—*Epacrosina* has a loop similar in appearance to that of *Stenosarina* and *Stenobrochus*. Its loop differs from that of *Stenosaria* in its broader outer hinge plates and, on the exterior, its more strongly truncated beak and larger foramen. The loop of *Stenobrochus* differs in its much broader outer hinge plates, more narrowly folded transverse band and the slight marginal elevation of the crural bases along the inner margins of the outer hinge plates. The external shapes of the two are different.

Tichosina elongata Cooper has the external appearance of *Tichosina* but its loop, which is anteriorly narrowed, resembles that of *Epacrosina*. This species is therefore tentatively placed here, although it is widely separated from the Australian waters in which the type-species occurs.

ETYMOLOGY.—From the Greek *epacros* (pointed at the end).

Erymnia Cooper, 1977

PLATE 15: FIGURES 18–32; PLATE 65: FIGURES 1–4

Erymnia Cooper, 1977:92.

SUBFAMILY.—Tichosininae, new subfamily.

TYPE-SPECIES.—*Erymnia muralifera* Cooper, 1977:94, pl. 12: figs. 3, 4; pl. 13: figs. 1–22; pl. 14: figs. 1–10.

SPECIMENS STUDIED.—Seven, four with loop exposed.

GEOLOGIC OCCURRENCE.—Recent.

LOCALITIES.—Grand Bahama Bank and Virgin Islands, Caribbean Sea.

EXTERIOR.—Roundly oval, valves unequal in depth, ventral valve deeper. Lateral commissure nearly straight; anterior commissure broadly uniplicate. Beak suberect, truncated, labiate. Foramen small, submesothyridid. Symphytium partially visible. Surface smooth. White.

INTERIOR.—Ventral valve with small teeth; pedicle collar short, excavate. Muscle field located at midvalve.

Loop and Cardinalia: The cardinal process is a roughened half ellipse. The socket ridges are stout and erect in *E. muralifera*, inclined in *E. angustata*. The sockets are wide and defined by fulcral plates that are slightly extended laterally. The proximal part of the socket is roofed. The outer hinge plates are triangular, fairly wide and concave near the sockets but flat or convex where they make contact with the crural bases. Unlike the outer hinge plates of *Tichosina* those of *Erymnia* unite with the crural bases at their ventral edge, thus resembling the arrangement of the hinge plates in the Cretaceous *Gibbithyris*. In *E. muralifera* the anterior part of the outer hinge plate is convex but the entire plate of *E. angustata* is faintly convex. The anterior tapering ends of the outer hinge plates of *E. muralifera* actually extend onto the crural processes and cover the posterior edge of the crural process points. This is not so of a young specimen in which the tapering end of the outer hinge plates is not extended so far forward. The crural processes of *E. angustata* are not so affected by the forward growth of the anterior ends of the outer hinge plates. There is no well defined crus because the outer hinge plates cover its margin. The crural base is visible as it forms a suture along the junction of the outer hinge plates and the crural bases, but the latter are not elevated along the inner margins of the outer hinge plates.

The crural processes of both species are broadly and obtusely angular and are located at more than half the loop length. There are no descending lamellae because the transverse band is attached on the inside of the crural processes. The transverse band is attached on the inside of the crural processes. The transverse band is broad and is narrowly folded medially to form a narrow crest or bridge. At the anterior of the loop of *E. muralifera* there is a broad reentrant. Near the junction of the band and the crural processes, small notches normally setting off a short median tongue appear, but in *E. muralifera* are barely discernible. In *E. angustata* these features are clearly visible but in the loop which is anteriorly narrower than that of *E. muralifera* the median crest is higher and more angular and the anterior aberrations of the loop are more pronounced.

The unique feature of the loop of *Erymnia* is the buttress plates or struts that extend from the dorsal edge of the crural bases to the floor of the valve. These serve as strong partitions on each side of the body wall.

TABLE 76.—Loop statistics for the genus *Erymnia*

Proportions	USNM 550520	USNM 550608	USNM 550624
∠	22°	19°	15°
Wl/Ll	0.50	0.38	0.50
Ll/LD	0.26	0.29	0.25
Wl/WD	0.14	0.12	0.16
a/Ll	0.57	0.57	0.60
b/Ll	0.43	0.43	0.40
c/Ll	0.43	0.43	0.50
d/Ll	0.14	0.14	0.10
e/Ll	0.04	0.14	0.10
f/Ll	0.39	0.28	0.30
g/WD	0.25	0.22	0.21
g/Wl	1.70	1.80	0.60
h/f	0.51	0.68	0.67
h/Ll	0.20	0.19	0.20
WD/LD	0.92	0.83	0.95

USNM 550520: *Erymnia muralifera* Cooper, Recent, at 555–575 m, 26°28′N, 78°37′W to 26°28′N, 78°43′W, off Grand Bahama.

USNM 550608: *Erymnia angustata* Cooper, Recent at 100–200 fm (183–366m), 23°36′N, 75°25′W, off Rum Cay, Bahama Islands.

USNM 550624: *Erymnia muralifera* Cooper, Recent, at 366–275 m, 26°29′N, 78°40′W, S side of Grand Bahama.

LOOP STATISTICS.—See Table 76.

DISCUSSION.—The loop of *Erymnia* is suggestive of that of the Cretaceous genus *Gibbithyris* in which the outer hinge plates are often attached to the ventral edge of the crural bases and vary from slightly concave to ventrally convex. The two differ because the very broad crural bases of *Gibbithyris* do not reach the valve floor. The folding of the anterior commissure of *Erymnia* is moderately uniplicate whereas that of *Gibbithyris* is usually sulciplicate, a type of folding rare in Recent brachiopods.

Serial sections of *Iberithyris rionensis* Kvakhadze (1971) show the crural bases supported by plates attached to the valve floor as in *Erymnia*. I have seen a large terebratulid from Hawaii with the crural bases supported by struts as in *Erymnia*. These are interesting examples of parallel development. The Hawaiian specimen is probably a development in a stock unrelated to the Caribbean genus.

Middlemiss (1976:69) remarks on the sporadic presence of struts under the loop of some Cretaceous genera and indicates that they are secondary features. Unfortunately no juveniles of *Erymnia* are known that might indicate whether or not the struts are a secondary character seen only in adults.

Vörös genus *Viallithyris* is another brachiopod with complicated struts supporting the crural bases.

Eurysina, new genus

PLATE 8: FIGURES 1–5, 6–10, 12; PLATE 9: FIGURES 6–11; PLATE 11: FIGURES 8–12, 13–19, 28–35; PLATE 13: FIGURES 1–8, 15–20, 35–39; PLATE 65: FIGURES 5, 6, 9, 10, 15, 16

SUBFAMILY.—Tichosininae, new subfamily.

TYPE-SPECIES.—*Tichosina ovata* Cooper, 1977: 79, pl. 30: figs. 1–20.

COMPOSITION.—*Terebratula minor* Philippi (1836), *T.? bartletti* Dall (1882), *Tichosina bullisi*, *T. dubia*, *T. labiata*, *T. obesa*, *T. ovata*, *T. pillsburyi*, *T. plicata*, *T. solida*, all Cooper (1977).

DIAGNOSIS.—*Tichosina* with loop angle greater than 25°.

SPECIMENS STUDIED.—Many, all species with loop exposed.

GEOLOGIC OCCURRENCE.—Eocene? to Recent.

LOCALITIES.—West Indies and Caribbean.

STRUCTURE.—The exterior of this genus is like that of *Tichosina* and details of the loop have been described under that genus. Discussion of relationships and other features of the two are discussed below.

LOOP STATISTICS.—See Table 77.

DISCUSSION.—The species of *Tichosina* are divided into two on variation of the loop, the narrow looped forms being assigned to *Tichosina* while the wider looped forms are placed in *Eurysina*. The former group has a loop less than 25°, narrow outer hinge plates, Wl/Ll usually less than 0.50, the crural processes well anterior and the deeply indented transverse band broad. The anterior of the transverse band is not usually very broad. *Eurysina* has a loop angle generally greater than 25° as the loops flare slightly and are generally triangular in outline. Although some loops suggest that of *Liothyrella* in their triangular form, the transverse band of *Eurysina* is generally much broader, the outer hinge plate has a longer taper, and the crural processes are located anterior of the socket openings. *Eurysina pillsburyi*, *E. solida* and *E. ovata* deviate somewhat from the others. The outer hinge plates are like those of the others but the transverse band is somewhat more strongly folded and has a marked concavity at its anterior edge. There is also a slight tendency of the anterior of the loop to produce indistinct terminal points. Specimens of *E. ovata* and *E. solida* because of some other peculiarities may be mentioned separately.

Two specimens of *E. ovata* have a strongly concave anterior of the transverse band and also a posteriorly directed point on the crest of the band (USNM 549434n; Plate 11: figure 13) Specimen USNM 550434m has a straight anterior margin of the transverse band with a small development of a flat tongue like that of *Gryphus* (Plate 11: figure 33). The loop with concave anterior (Plate 11: figure 32) may be a young stage.

TABLE 77.—Loop statistics for the genus *Eurysina*

Proportions	USNM 109754a	USNM 549393a	USNM 549433b	USNM 549434m	USNM 549434n	USNM 549434o
∠	29°	25°	28°	26°	27°	26°
Wl/Ll	0.66	0.46	0.54	0.50	0.50	0.58
Ll/LD	0.26	0.32	0.28	0.26	0.27	0.27
Wl/WD	0.16	0.16	0.17	0.15	0.15	0.17
a/Ll	0.65	0.65	0.62	0.67	0.62	0.60
b/Ll	0.35	0.35	0.38	0.33	0.38	0.40
c/Ll	0.65	0.45	0.58	0.61	0.50	0.53
d/Ll	0.00	0.20	0.04	0.06	0.12	0.07
e/Ll	0.22	0.10	0.15	0.08	0.12	0.13
f/Ll	0.13	0.25	0.23	0.25	0.26	0.27
g/WD	0.24	0.21	0.29	0.23	0.14	0.25
g/Wl	1.45	1.33	1.71	1.66	1.63	1.48
h/f	0.92	0.52	0.83	0.88	0.73	0.74
h/Ll	0.12	0.13	0.19	0.22	0.19	0.20
WD/LD	0.94	0.90	0.89	0.88	0.85	0.87

USNM 109754a: *Eurysina minor* (Philippi), Recent, Adriatic Sea. This species differs from the others in the relationships of e and f/Ll.

USNM 549393a: *Eurysina? bartletti* (Dall), Recent, at 140 fms (256 m), 18°05′N, 64°33′W, SW of St. Thomas, West Indies.

USNM 550433b: *Eurysina solida* (Cooper), Recent, at 125 fms (229 m), Sand Key, Florida.

USNM 549434m–o: *Eurysina ovata* (Cooper), Recent, at 200 fms (366 m), 28°02′N, 90°15′W, S of New Orleans, Louisiana. Gulf of Mexico.

Eurysina solida shows an aberrant development of the outer hinge (Plate 13: figures 6–8) In this specimen the anterior taper is unusually long and deep and is extended anteriorly beyond the point where the taper normally ends. The extension is attached just under the anterior end of the crural processes.

Eurysina? bartletti (Dall) is an aberrant form quite unlike *Tichosina* in the form of the loop and some aspects of its exterior. It is not wholly in accordance with the generality of species of *Eurysina*. Its loop is long and narrow and its crura (d/Ll = 0.20) are unusually long. The anterior plication is stronger than that of most species in this subgenus and the beak is narrower, more labiate and has a small foramen. The transverse band is more convex than usual in the genus, nevertheless it seems closest to *Eurysina ovata*.

ETYMOLOGY.—From the Greek *eurys* (broad or wide), in allusion to the wider loop angle of this genus.

***Goniobrochus*, new genus**

PLATE 2: FIGURES 30–38; PLATE 66: FIGURES 22, 23

SUBFAMILY.—Dyscoliinae Fischer and Oehlert, 1891.

TYPE-SPECIES.—*Dyscolia ewingi* Cooper, 1973c:19, pl. 2: figs. 1–26; pl. 3: figs. 1–8.

DIAGNOSIS.—Externally suggestive of *Dyscolia* with zigzag capillae and wide, squarish loop.

SPECIMENS STUDIED.—Four, three with loop exposed.

GEOLOGIC OCCURRENCE.—Recent.

LOCALITY.—Off Argentina.

EXTERIOR.—Large, subcircular with strongly rounded sides and anterior. Posterolateral extremities obtuse. Lateral commissure straight; anterior commissure rectimarginate. Beak strongly truncated, suberect, labiate. Foramen large, mesothyridid to permesothyridid. Surface marked by concentric growth lines and radial, zigzag capillae. White.

TABLE 77.—continued

Proportions	USNM 550577a	USNM 550585e	USNM 550588a	USNM 550607e	USNM 550609b	USNM 550614a
∠	28°	27°	30°	30°	27°	29°
Wl/Ll	0.54	0.66	0.64	0.68	0.55	0.64
Ll/LD	0.30	0.36	0.28	0.30	0.30	0.32
Wl/WD	0.16	0.26	0.19	0.22	0.18	0.22
a/Ll	0.69	0.66	0.68	0.64	0.65	0.64
b/Ll	0.31	0.34	0.32	0.36	0.35	0.36
c/Ll	0.62	0.56	0.59	0.64	0.50	0.59
d/Ll	0.07	0.10	0.09	0.00	0.15	0.05
e/Ll	0.07	0.16	0.09	0.08	0.10	0.09
f/Ll	0.24	0.18	0.23	0.28	0.25	0.27
g/WD	0.29	0.26	0.25	0.24	0.24	0.22
g/Wl	1.57	1.22	1.28	1.06	1.36	1.14
h/f	0.79	0.78	1.09	0.71	0.64	0.59
h/Ll	0.19	0.14	0.25	0.20	0.16	0.16
WD/LD	1.00	0.94	0.92	0.91	0.92	0.94

USNM 550577a: *Eurysina labiata* (Cooper), Recent, at 231–258 m, 13°13.9′N, 61°04.7′W, off E side of St. Vincent, West Indies.

USNM 550585e: *Eurysina obesa* (Cooper), Recent, at 68–60 m, 11°01.8′N, 65°34.2′W to 11°01.0′N, 65°36.3′W, off W side of Isla Tortuga, Venezuela.

USNM 550588a: *Eurysina plicata* (Cooper), Recent, at 93–115 m, 10° 32′N, 60°23′W, off E side of Trinidad, West Indies.

USNM 550607e: *Eurysina plicata* (Cooper), Recent, at 56 fms (102 m), 10°52′N, 68°08′W, off Puerto Cabello, Venezuela.

USNM 550609b: *Eurysina bullisi* (Cooper), Recent, at 110 fms (201 m), 12°28′N, 82°28′W, off Nicaragua.

USNM 550614a: *Eurysina dubia* (Cooper), Recent, at 183 m, 08°26′N, 58°11′W, N of Georgetown, Guyana.

INTERIOR.—Ventral valve with thick cyrtomatodont teeth. Pedicle collar short, not excavated. Muscle field elongated, extending nearly to midvalve.

Loop and Cardinalia: The loop is short with squarish outline, subparallel sides and wide angle. A cardinal process is not developed, the diductor muscles being attached to a pit at the apex. The socket ridges are moderately stout, inclined, and bound wide sockets. The fulcral plates are stout and extend laterally as short shelves. There is a slight development of very narrow outer hinge plates. The crural bases form narrow troughs with the incipient outer hinge plates and socket ridges. The crura are short and narrow. The crural processes are located anterior of midloop, are small, sharply pointed, but not elongated. They are slightly approximate. The descending lamellae are short and widen anteriorly where they curve abruptly at about a right angle into the transverse band. The arching of the transverse band is low. It narrows medially and protrudes slightly toward the ventral valve at its middle.

LOOP STATISTICS.—See Table 78.

DISCUSSION.—This genus resembles *Waisiuthyrina* Beets (1942) from the Upper Oligocene of Indonesia. That the dorsal interior of *Waisiuthyrina* is similar to that of *Dyscolia* and *Goniobrochus* is indicated in Beets' description in which he expresses difficulty in placing the pedicle muscles because there are no clearly definable hinge plates. *Waisiuthyrina*, according to Beets' 1942 figure (pl. 34: fig. 15) has a well marked but small cardinal process, a structure lacking in *Goniobro-*

TABLE 78.—Loop statistics for the genus *Goniobrochus*

Proportions	USNM 550461a	USNM 550461b	USNM 550461d
∠	43°	38°	50°
Wl/Ll	0.95	0.80	1.00
Ll/LD	0.29	0.30	0.26
Wl/WD	0.28	0.20	0.22
a/Ll	0.62	0.63	0.63
b/Ll	0.38	0.37	0.37
c/Ll	0.43	0.48	0.56
d/Ll	0.19	0.15	0.07
e/Ll	0.36	0.33	0.34
f/Ll	0.02	0.05	0.03
g/WD	0.23	0.22	0.22
g/Wl	1.00	1.13	1.00
h/f	1.00	0.80	1.00
h/Ll	0.02	0.04	0.03
WD/LD	1.12	1.06	1.16

USNM 550461a,b,d: *Goniobrochus ewingi* (Cooper), Recent, at 595–642 m, 38°58′S, 55°17′W, SE of Mar del Plata, Argentina.

chus. Unfortunately the loop of *Waisiuthyrina* is unknown which makes total comparison impossible. The exterior of *Waisiuthyrina* is smooth without zigzag capillae.

The external similarity of *Goniobrochus* to *Mimorina ziczac*, new name, from Chatham Island misled Cooper to suggest a relationship between the two (Cooper, 1973c:20). Preparation of the loop of the Chatham Island form revealed a loop and cardinalia completely unlike those of *Goniobrochus*. The dorsal interiors assigned by Foster (1974, pl. 6: figs. 23, 26, 27) to *Dyscolia* have a cardinal process. The presence of narrow outer hinge plates shown in his fig. 27 is unlike the arrangement in *Goniobrochus* or *Dyscolia*.

ETYMOLOGY.—From the Greek *gonia* (angle) plus *brochos* (noose or loop).

Gryphus Megerle von Mühlfeldt, 1811

PLATE 3: FIGURES 33–38; PLATE 10: FIGURES 1–12; PLATE 12: FIGURES 27–31; PLATE 55: FIGURE 6; PLATE 65: FIGURES 27, 28

Gryphus Megerle von Mühlfeldt, 1811:64.—Philippi, 1836, loop figured pl. 6: fig. 6.—Hertlein and Grant, 1944:90 [for extended synonymy].

SUBFAMILY.—Gryphinae Sahni, 1929.

TYPE-SPECIES.—*Anomia vitrea* Born, 1778:104.

SPECIMENS STUDIED.—Over one hundred, ten with loops exposed.

GEOLOGIC OCCURRENCE.—Recent.

GEOLOGICAL OCCURRENCE.—Eocene to Recent (doubtfully reported from the Cretaceous).

LOCALITIES.—Eocene to Recent in Caribbean; Miocene to Recent in Mediterranean; eastern Atlantic; ?Japan.

EXTERIOR.—Small to large, roundly oval, inequivalve, ventral valve greater in depth and convexity. Lateral commissure straight; anterior commissure rectimarginate. Beak short, suberect, labiate; beak ridges rounded. Foramen small to moderately large, often minute, epithyridid. Symphytium partially visible. Smooth, white to yellowish; gray.

INTERIOR.—Ventral valve interior with small, knobby teeth; pedicle collar short. Muscle field narrow, confined to posterior quarter. Dorsal valve interior without euseptoidum (myophragm) separating retort-shaped adductor scars.

Loop and Cardinalia: The cardinal process in the young is a flattened half elliptical shelf at the apex with myophore facing posteriorly or posteroventrally. In adults the margins of the cardinal process are elevated and the myophore is in a pit. In extreme cases (USNM 550824b, Plate 10: figure 8) the margins of the myophore fold inward almost meeting at the middle and a low ridge appears medially. This extreme form is bilobed and the myophore considerably restricted. In old specimens the cardinal process is strongly thickened on its anterior side.

The socket ridges are only slightly inclined toward the sockets and they bear a thickened free margin that articulates with the cyrtomatodont teeth. There is also a thin denticular submarginal ridge on the outer wall of the sockets. With growth of the shell the proximal portion of the socket is roofed over with shell tissue. In one old specimen (USNM 109732) the free posterior angle of the socket ridge is produced into a toothlike projection bearing a small denticle that interlocks with the tooth. The fulcral plates are thin in young adults. In old shells they are buttressed

TABLE 79.—Loop statistics for the genus *Gryphus*

Proportions	USNM 64255	USNM 109717b	USNM 109770	USNM 204669	USNM 334759	USNM 550824a	USNM 550824b
∠	27°	24°	29°	32°	31°	33°	36°
Wl/Ll	0.52	0.60	0.59	0.62	0.58	0.60	0.65
Ll/LD	0.27	0.26	0.35	0.27	0.32	0.36	0.43
Wl/WD	0.13	0.14	0.19	0.16	0.18	0.23	0.31
a/Ll	0.55	0.60	0.61	0.58	0.63	0.58	0.58
b/Ll	0.45	0.40	0.39	0.42	0.37	0.42	0.42
c/Ll	0.55	0.50	0.42	0.50	0.37	0.42	0.42
d/Ll	0.00	0.10	0.19	0.08	0.26	0.16	0.16
e/Ll	0.22	0.30	0.06	0.17	0.16	0.18	0.19
f/Ll	0.23	0.10	0.33	0.25	0.21	0.24	0.23
g/WD	0.23	0.17	0.19	0.19	0.21	0.21	0.31
g/Wl	1.82	1.16	1.33	1.20	1.09	1.22	1.18
h/f	0.70	0.80	0.73	0.52	0.76	0.54	0.65
h/Ll	0.16	0.08	0.24	0.13	0.16	0.13	0.15
WD/LD	1.05	1.05	0.89	1.07	0.98	0.84	0.92

USNM 64255: *Gryphus? marticinensis* Dall, Recent, at 169 fm (309 m), 14°43′48″N, 61°11′25″W, off Martinique, West Indies.

USNM 109717b: *Gryphus vitreus* (Born), Recent, at 346 fm (633 m), Porcupine Station 26, S of Portugal.

USNM 109770: *Gryphus vitreus* (Born), Recent, off Sardinia, Mediterranean.

USNM 204669: *Gryphus? dalli*, new species, Recent, at 302 fm (583 m), 35°03′35″N, 130°37′42″E, Joga Shima Light, off Hondo, Uraga Strait, Japan.

USNM 334759: *Gryphus vitreus* (Born), Recent, Mediterranean (no other data).

USNM 550824a,b: *Gryphus vitreus* (Born), Recent, at 150 m, off Corsica, Mediterranean.

by a thick deposition of shell substance on their under or anteriorly facing edge, partially or wholly obscuring the plate.

The outer hinge plates are narrowly triangular, expanding slightly anteriorly then tapering onto the crura as a low, narrow ridge. In specimen (USNM 334759) the anterior end of the outer hinge plate does not meet the crural bases and there forms a reentrant. In other specimens this junction is marked by a moderate curve. There are no inner hinge plates.

The crural bases are narrow and are usually flush with the inner margin of the outer hinge plates. This combination gives the appearance of a moderately wide, flat plate. This is in contrast to other genera such as *Liothyrella* and *Tichosina* in which the inner margin of the outer hinge plates is walled by a thin elevated crural base that forms a trough with the socket ridge.

The crura of *Gryphus* are distinctive in their narrowness and their round or narrowly elliptical cross-section. They are thickest proximally where they receive the tapering end of the outer hinge plates. This tapering ridge actually extends beyond the crus to part way onto the outer surface of the crural processes.

The crural processes and associated structures are narrowly attached to the crus and take the form of a scoop in side view. The crural processes are located more than half the loop length, are triangular, acutely pointed, gently bowed toward the median and short. The points are not elongated as in *Pliothyrina* or *Apletosia*. The points of the crural processes are at variable distances from the posterior margin of the transverse band. In one specimen (USNM 109770, Plate 10: figures 4, 5) they almost overhang the posterior margin of the wide transverse band but in another (USNM, 550824b, Plate 10: figure 8) they are 2 mm posterior of the transverse band.

The transverse band is fairly uniformly broad and gently arched in all specimens. It is angulated medially, the degree of angulation and its height are variable but not greatly so. More variable are the margins of the transverse band. The posterior margin is usually broadly and fairly strongly concave toward the posterior and often bears a small pointed projection in the middle of the curve. The inner margin may or may not be uniform because one specimen is marked by slight angulation pointed to the posterior on each side of the median protuberance (USNM 109770, Plate 10: figure 4).

The anterior margin of the loop may be laterally rounded at its extremities but with a gentle median reentrant (Plate 10: figure 4). In specimen (USNM 550824b, Plate 10: figure 8) the median angulation of the transverse band is set forward as a convex tongue emphasized by angular notches just inside the anterolateral extremities. This arrangement, in varying degree of perfection appears, in several specimens of *Gryphus* and also in several other genera, *Dolichozygus* for example. It may be completely worn off or not developed in some specimens (USNM 109770, Plate 10: figure 4).

LOOP STATISTICS.—See Table 79.

DISCUSSION.—The loops of *Dallithyris* and *Gryphus* are similar in having narrow crural bases with the outer hinge plates attached to their lateral margin in such a way that the side view appears narrowly rounded and the crural processes and transverse band are scooplike. The exterior details of the two genera are quite unlike. *Gryphus? dalli*, new species, differs from *G. vitreus* (Born) in having narrower outer hinge plates and the crural bases slightly elevated along the inner margins of the outer hinge plates. The crural bases however are narrow, giving the loop a scooplike appearance in side view. The shells of this Japanese form are nearly circular in outline. The foramen differs markedly from that of *Gryphus*: minute in *Gryphus*, large in *G.? dalli*. These differences and the remoteness of Japan from the Mediterranean make it necessary to question the generic assignment.

The *Gryphus* loop differs from that of *Tichosina* in having narrow crural bases and a scooplike loop. The loop of *Gryphus* is unlike that of *Liothyrella (Liothyrella)* in its broader transverse band, less triangular form and narrow crural bases.

Gryphus? dalli, new species

PLATE 3: FIGURES 33–38

Gryphus tokionis Dall, 1920:319 [part; not illustrated].

DIAGNOSIS.—Nearly circular *Gryphus*? with depressed convex valves and large foramen.

EXTERIOR.—About medium size, nearly circular, valve subequal in depth, ventral valve slightly deeper than dorsal valve. Lateral commissure straight; anterior commissure rectimarginate. Beak short, only slightly protuberant, truncated. Foramen moderately large, mesothyridid. Symphytium short, visible. Smooth.

Ventral valve moderately convex in side view, broadly domed in anterior view; umbonal region narrow, swelling passing anteriorly into convexity of midvalve. Anterior slope long and gentle; lateral slopes short, gently convex.

Dorsal valve gently convex in both profiles; beak narrowly pointed; umbonal and median regions gently swollen.

INTERIOR.—Ventral valve interior with small stubby teeth, small pedicle collar. Muscle area small, posterior.

Dorsal valve interior with short subtriangular loop, occupying 27% of length and 17% of width. Cardinal process small, roughened boss. Socket ridges thin, erect bounding narrow sockets. Fulcral plates small, not extended laterally. Outer hinge plates reduced nearly flush with crural bases. Anterior of loop scooplike, attached to narrow crural bases. No descending lamellae. Crural processes low, rather bluntly pointed. Transverse band gently swollen medially in gentle arch. No terminal points.

LOOP STATISTICS.—See Table 79.

MEASUREMENTS (mm).—USNM 204669: length 25.1, dorsal valve length 22.8, width 24.1, thickness 11.5, apical angle 104°.

OCCURRENCE.—Recent at 302 fms (= 533 m), 25°03′25″N, 139°37′42″E, Joga Shima Light, off Hondo, Uraga Strait, Japan.

TYPE.—Holotype: USNM 204669.

DISCUSSION.—This specimen was a paratype of Dall's *Gryphus tokionis* but the two differ in shape and loops. *Gryphus tokionis* is oval rather than nearly circular and has a L/W of 1.19. The beak is longer and the symphytium completely exposed. The species is also more convex than *G.? dalli*. The loop of *G.? dalli* is like that of *Gryphus* while the loop of *G. tokionis* has wider outer hinge plates that attach on the ventral edge of the crural processes, as in *Acrobrochus*.

ETYMOLOGY.—Named in honor of Dr. W.H. Dall, in recognition of his work in living brachiopods.

Liothyrella Thomson, 1916

PLATE 3: FIGURES 39, 40 (*tokionis*); PLATE 4: FIGURES 1–7 (*oblonga*); PLATE 8: FIGURE 11 (*vitrioides*), 17–21 (*notorcadensis*), 22–27 ("*uva*"); PLATE 11: FIGURES 1, 2 (*antarctica*); PLATE 12: FIGURES 11, 12 ("*uva*"), 13, 14 (*uva georgiana*), 21, 22 (*clarkeana*); PLATE 30: FIGURES 18–22 (*neozelanica*); PLATE 40: FIGURES 25–28 (*expansa*); PLATE 54: FIGURES 9–11 (*uva*), 16–21 (*delsolari*); PLATE 55: FIGURE 16 ("*uva*"), 17–21 (*fosteri*); PLATE 60: FIGURES 10–18 (*neozelanica*); PLATE 64: FIGURES 3, 4 (*notorcadensis*), 9, 10 (*neozelanica*)

Liothyrella Thomson, 1916:44.—Jackson, 1918:73–79.—Thomson, 1927:197.—Allan, 1932:1.—Foster, 1974:56.

SUBFAMILY.—Terebratulinae Gray, 1840.

TYPE-SPECIES.—*Terebratula uva* Broderip 1833: 142, pl. 22: fig. 2; Plate 54: figures 9–11.

SPECIMENS STUDIED.—Numerous specimens from the Antarctic, southern South America, west coast of Central and South America, New Zealand, Australia, many with loop exposed.

GEOLOGIC OCCURRENCE.—Miocene to Recent.

LOCALITIES.—West coast of Central and South America, southern South America, Falkland Islands, southern Indian Ocean, ?Japan, off Australia and New Zealand. Fossil in Australia and New Zealand, not corroborated elsewhere.

EXTERIOR.—Small to large, usually elongate oval to roundly oval and subpentagonal. Ventral valve more convex than dorsal valve. Sides and anterior rounded. Lateral commissure usually straight; anterior commissure usually rectimarginate with a tendency toward uniplication. Beak usually short, suberect to erect, beak ridges rounded, often labiate. Foramen usually large, usually submesothyridid. Symphytium visible wholly or in part. Surface usually smooth, occasional specimens with radial capillae. White to pale yellow.

INTERIOR.—Ventral interior with narrowly triangular teeth; pedicle collar short. Muscle field rounded to elongate. Dorsal valve interior with low myophragm separating the adductor scars in some species.

Loop and Cardinalia: The loop is usually widely triangular but may be somewhat squarish; loop angle usually 30° or more. It occupies a third to ⅖ the length and a quarter to slightly more of the width of the dorsal valve. The cardinal process is a flattened half ellipse with myophore facing posteriorly or posteroventrally. No specimens were seen in which it was conspicuously thickened or in which a marginal rim was well developed, although some specimens show a tendency in this direction. The socket ridges are erect, slightly curved and vary in thickness depending on species or age. In *L. "uva"* Broderip from off Guayaquil, Ecuador (USNM 110851, Plate 12: figures 11, 12) they are thick for a small shell. More usually in others the socket ridges are slender and curved and bound wide sockets. On the outer socket wall a marginal denticle appears but terminates before reaching the socket opening. The proximal part of the socket may be roofed. The fulcral plates are well defined and are not usually laterally extended. They have wide, flat extensions in *L. notorcadensis* (Jackson, 1912:375).

The outer hinge plates are variable in width and length and attach at or near the dorsal edge of the crural bases and are usually extended as a ridge on the crural bases. A vary narrow outer hinge plate characterizes *L. "uva"* from Ecuador (USNM 110851) and many of the smaller somewhat triangular shells from the Antarctic referred to that species. The crural processes are located a short distance anterior to or opposite the open end of the sockets. The crural processes are narrowly triangular, acutely pointed at the apex,

TABLE 80.—Loop statistics for the genus *Liothyrella*

Proportions	USNM 87466	USNM 110851	USNM 550017A	USNM 550040A	USNM 550491	USNM 550493	USNM 550498	USNM 550895a	USNM 550896a
∠	35°	38°	36°	30°	31°	33°	33°	27°	29°
Wl/Ll	0.70	0.68	0.61	0.67	0.63	0.61	0.67	0.60	0.72
Ll/LD	0.34	0.30	0.30	0.29	0.30	0.30	0.37	0.31	0.36
Wl/WD	0.23	0.26	0.19	0.24	0.21	0.21	0.32	0.23	0.26
a/Ll	0.61	0.63	0.69	0.67	0.63	0.64	0.72	0.65	0.62
b/Ll	0.39	0.37	0.31	0.33	0.37	0.36	0.28	0.35	0.38
c/Ll	0.61	0.63	0.69	0.67	0.63	0.64	0.72	0.65	0.62
d/Ll	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
e/Ll	0.23	0.21	0.15	0.17	0.18	0.21	0.17	0.20	0.23
f/Ll	0.16	0.16	0.16	0.16	0.18	0.15	0.11	0.17	0.15
g/WD	0.23	0.27	0.24	0.32	0.25	0.27	0.38	0.27	0.28
g/Wl	1.00	1.06	1.25	1.33	1.17	1.29	1.17	1.00	1.00
h/f	0.63	0.50	0.50	0.50	0.33	0.27	0.45	0.24	0.53
h/Ll	0.10	0.08	0.08	0.08	0.06	0.04	0.05	0.04	0.08
WD/LD	1.00	0.93	0.98	0.71	0.92	0.89	0.75	0.74	1.00

USNM 87466: *Liothyrella vitrioides* (Tenison-Woods), Miocene, Table Cape, Tasmania.

USNM 110851: *Liothyrella "uva"* (Broderip), Recent, off Guyaquil, Ecuador.

USNM 550017A: *Liothyrella uva georgiana* Foster, Recent, at 220–320 m, 54°41′S, 38°38′W, Antarctica.

USNM 550040A: *Liothyrella antarctica* (Blochmann), Recent, at 165 m, 74°39′S, 165°52′E, off Cape Washington, Ross Sea, Antarctica.

USNM 550491: *Liothyrella "uva"* (Broderip), Recent, at 108 m, 52°53.3′S, 65°35′W, Strait of Magellan, SSW of West Falkland Island.

USNM 550493: *Liothyrella "uva"* (Broderip), Recent, at 424–428 m, 47°09′S, 60°39′W, ENE of Puerto Desado, Argentina.

USNM 550498: *Liothyrella oblonga* Cooper, Recent, at 75 m, 54°23′S, 65°35′W, NE of Tierra del Fuego, N of Cabo San Diego, Argentina.

550895a: *Liothryella notorcadensis* (Jackson), Recent, at 22–55 m, 64°46′53″S, 64°03′35″W to 64°46′53″S, 64°04′04″W, off Palmer Peninsula, Antarctica.

USNM 550896a: *Liothyrella "uva"* (Broderip), Recent, at 86 m, 53°06′S, 67°04′W, ESE of Strait of Magellan.

with the point needle-sharp in some specimens. The apical part of the triangle is more or less strongly curved toward midvalve.

The descending lamellae are flat ribbons, short and slightly bowed laterally or straight. These end in the barest suggestion of terminal points. The transverse band is narrow, moderately arched and with a broadly flattened crest. The posterior margin usually bears a small reentrant or occasionally a short, sharp median point. The anterior margin may be notched near the anterolateral extremities to demarcate tiny points (USNM 550017A, Plate 12: figures 13, 14).

LOOP STATISTICS.—See Table 80.

DISCUSSION.—The species of this genus are largely confined to the southern hemisphere. The name *Liothyrella* has been used more or less indiscriminately for any of the smooth short-looped brachiopods in the southern Pacific, southern Atlantic and Antarctic oceans. It is also applied to most of the oval, smooth, short-looped forms occurring as fossils in New Zealand and Australia. The loop in its typical form is readily recognized by its widely triangular form, lack of a well extended crus, crural processes located at or near the socket openings, and relatively narrow transverse band.

A less characteristic group is characterized by a usually smaller angle, the outer hinge plates usually extending along the median or ventral

TABLE 80.—Continued

Proportions	USNM 550918a	USNM 551061	USNM 551069	USNM 551070	USNM 551153b	Thomson, 1918b	British Museum ZB1319	Blochmann, 1908
∠	32°	37°	30°	35°	36°	32°	32°	42°
Wl/Ll	0.67	0.67	0.67	0.68	0.72	0.63	0.64	0.83
Ll/LD	0.34	0.26	0.36	0.27	0.28	0.30	0.39	0.27
Wl/WD	0.28	0.17	0.26	0.20	0.23	0.22	0.27	0.23
a/Ll	0.69	0.58	0.63	0.65	0.62	0.64	0.64	0.55
b/Ll	0.31	0.42	0.37	0.35	0.38	0.36	0.36	0.45
c/Ll	0.69	0.58	0.63	0.65	0.59	0.64	0.64	0.55
d/Ll	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
e/Ll	0.24	0.25	0.20	0.23	0.26	0.18	0.21	0.31
f/Ll	0.07	0.17	0.17	0.12	0.12	0.18	0.15	0.14
g/WD	0.35	0.20	0.36	0.19	0.24	0.28	0.33	0.22
g/Wl	1.24	1.12	1.40	0.96	1.07	1.28	1.22	0.92
h/f	0.57	0.76	0.41	0.75	0.50	0.50	0.60	0.50
h/Ll	0.04	0.13	0.07	0.09	0.06	0.09	0.09	0.07
WD/LD	0.81	1.02	0.93	0.89	0.94	0.89	0.94	0.96

USNM 550918a: *Liothyrella notorcadensis* (Jackson), Recent, at 20–200 m, near Palmer Research Station, Arthur Harbor, Palmer Peninsula, Antarctica.

USNM 551061: *Liothyrella delsolari* Cooper, Recent, at 760–1000 m, 4°00′S, 80°30′W, between Mancora and Chicama, Peru.

USNM 551069: *Liothyrella "uva"* (Broderip), Recent, at 104–115 m, 53°54′S, 64°36′W to 53°55′S, 64°52′W, ESE of Rio Grande, Argentina.

USNM 551070: *Liothyrella fosteri* Cooper, Recent, at 220–240 m, 61°18′S, 56°09′W to 61°20′S, 56°10′W, off Elephant Island, Scotia Sea, Antarctica.

USNM 551153b: *Liothyrella expansa* Cooper, Recent, at 225–265 m, 54°44.2′S, 037°11.2′W, S of South Georgia, Antarctica.

Thomson, 1918b, pl. 16: fig. 38: *Liothyrella neozelanica* Thomson, Recent, at 200 fm (366 m), Cook Strait, off Wellington, New Zealand.

British Museum, ZB1319: *Liothyrella "uva"* (Broderip), Recent, off the Falkland Islands.

Blochmann (1908, pl. 39: fig. 25): Recent, from Nordenskiöld Glacier, South Georgia, Antarctica.

side of the bases to climb onto the posterior margin of the crural processes. This group is commonly provided with a broad transverse band. Placed in this group and called *Acrobrochus* are *L. blochmanni* (Jackson), *L.? vema* Cooper, *L. tateana* (Tenison-Woods), *L. aldingi* (Tate), and *Terebratula moseleyi* Davidson.

Although the specimen designated as type species, *Terebratula uva* Broderip, is externally unlike most specimens assigned to that species, the discussion following will be in accordance with the present interpretation of the type species and genus (Blochmann, 1908:616; Foster, 1974:56). Broderip's specimen (1833a, pl. 22: fig. 2) designated as the type is a fairly large, narrowly elongate-oval specimen having a large foramen (herein Plate 54: figures 9–11) Davidson (1886–1888, pl. 2: figs. 5–7) figures Broderip's specimen and another elongate oval specimen said to be from the same locality, Gulf of Tehuantepec, Pacific side of Mexico. Davidson also figures an interior showing a loop (1886–1888, pl. 2: fig. 7) but does not indicate to which specimen the loop belongs. Although this figure of the loop is crude it conforms in its proportions to those of *Liothyrella* as now conceived. Blochmann regarded Broderip's (type) specimen as deformed but conspecific with its smaller associates and other more triangular forms from the Antarctic. The only figures known to me that show the loop of *L. uva* is that by Davidson of an elongate specimen suggestive of the type specimen. The type specimen (Plate 54: figures 9–11, BM ZB1352) is imperfect because the loop is broken. The loop of *L. uva* figured in Muir-Wood (1965:H782, fig. 643a–c) is from off the Falkland Islands, not from the Gulf of Tehuantepec, Mexico. The Antarctic species called *L. uva*, with their triangular form and smaller foramen seem to me to be different specifically from Broderip's specimen.

The loop of *Liothyrella* although variable, is distinctive, its width is usually about 60% of its length or more and the hinge plates taper onto the side of the crural bases and may extend to the ventrad edge of the crural processes as in *Acrobrochus*. The crural processes are located more than half the loop length and occur opposite or a slight distance in advance of the socket openings. The loop angle is generally large and usually in excess of 30°, and the transverse band is usually narrow (h/Ll = 0.10) or less. In these respects the loop differs from that of *Gryphus, Tichosina* and *Acrobrochus* which externally resemble *Liothyrella*.

The *Liothyrella* loop in some of its features varies as much as 20%. The Wl/Ll varies between 0.60 and 0.83. The latter figure was derived from the loop figured by Blochmann (1908, pl. 39: fig. 25) which is unusually wide and represents Blochmann's concept of *Terebratula uva*. None of Foster's subspecies of *L. uva* have as wide a loop and the specimen from Falkland Islands figured by Muir-Wood (1965:H782) is not as wide or as short as Blochmann's. The relative width of loop to shell width (Wl/WD) varies by 15%. The position of the crural processes in the loop varies between 0.55 and 0.72 but is always anterior to midloop. The transverse band, as in most genera is variable (see *L. neozelanica* below).

The type specimen of *Gryphus tokionis* Dall, which is externally like *Liothyrella* has a deformed loop which exaggerates the angle and the first and third statistic of the usual list. The outer hinge plates are narrow and taper onto the anteroventral edge of the crural processes. The ensemble of loop and exterior suggest relationship to *Liothyrella*. The paratype of *G. tokionis* is referred to *Gryphus?* as discussed above.

Although the loop of *"Gryphus" clarkeana* Dall (1895, pl. 31: figs. 9, 10) from the Gulf of Panama is broken the species is tentatively assigned to *Liothyrella*. The outer hinge plates are narrow and taper to the crural processes. There is a lateral flare on one side (left) of the loop suggesting a rather wide anterior. The small complete specimen (pl. 31: fig. 9) resembles the smaller specimens found with Broderip's type specimen of *L. uva* (Davidson, 1886–1888, pl. 2: fig. 1).

Liothyrella neozelanica Thomson

PLATE 30: FIGURES 18–22; PLATE 60: FIGURES 10–18; PLATE 65: FIGURES 9, 10

Liothyrella neozelanica Thomson, 1918:17, pl. 16: figs. 37–38; pl. 17: figs. 51, 52; pl. 18: figs. 61, 62, 64.

LOOP STATISTICS.—See Table 81.

DISCUSSION.—Through the kindness of Drs. Joyce Richardson and Elliott W. Dawson, several lots of this large brachiopod were made available for study. The loop was exposed in specimens varying from 27 to 45 mm in length of the ventral valve. All are adults and two are very old, obese individuals. These specimens give some idea of the variation of the loop in this species. The loop angle varies by 12°, from 33° to 45°. The Wl/Ll varies from 0.62 to 0.83. The crural processes maintain their anterior position in the loop from 0.56 to 0.66. The distance from the posterior margin of the loop to the tips of the crural processes, e/Ll varies from 0.20 to 0.28, while f/Ll varies from 0.11 to 0.19.

The statistics do not show some of the more striking variation especially that of the transverse band. In young specimens the band is gently arched and nearly horizontal with narrowly rounded anterolateral extremities. The band itself is very thin (USNM 551148b) and there are definable terminal points. In specimen USNM 551149g the transverse band is directed anteriorly in a broad curve. Specimen USNM 551148d has

TABLE 81.—Loop statistics for *Liothyrella neozelanica*

Proportions	USNM 550976a	USNM 550976f	USNM 551148a	USNM 551148b	USNM 551148d	USNM 551148e	USNM 551149a	USNM 551149c	USNM 551149d	USNM 551149g
∠	34°	36°	34°	45°	38°	33°	35°	40°	43°	45°
Wl/Ll	0.68	0.63	0.66	0.88	0.75	0.62	0.63	0.74	0.83	0.82
Ll/LD	0.32	0.21	0.27	0.37	0.38	0.31	0.20	0.31	0.33	0.38
Wl/WD	0.22	0.15	0.19	0.24	0.30	0.20	0.16	0.23	0.28	0.29
a/Ll	0.64	0.64	0.66	0.57	0.66	0.65	0.56	0.57	0.59	0.59
b/Ll	0.36	0.36	0.34	0.43	0.34	0.35	0.44	0.43	0.41	0.41
c/Ll	0.48	0.48	0.57	0.57	0.63	0.62	0.56	0.52	0.59	0.52
d/Ll	0.16	0.16	0.09	0.00	0.03	0.03	0.00	0.05	0.00	0.07
e/Ll	0.20	0.20	0.23	0.28	0.22	0.24	0.28	0.26	0.25	0.22
f/Ll	0.16	0.16	0.11	0.15	0.12	0.11	0.16	0.17	0.16	0.19
g/WD	0.25	0.19	0.21	0.27	0.32	0.24	0.18	0.21	0.24	0.25
g/Wl	1.12	1.29	1.04	1.13	1.13	1.16	1.12	1.23	0.87	0.86
h/f	0.50	0.39	0.36	0.13	0.42	0.45	0.38	0.47	0.38	0.53
h/Ll	0.08	0.06	0.04	0.02	0.05	0.05	0.06	0.08	0.06	0.10
WD/LD	0.96	0.98	0.96	0.88	0.95	0.93	0.88	1.00	1.00	1.00

USNM 550976a,f: *Liothyrella neozelanica* Thomson, Recent, at 402 m, 44°07′S, 179°13′W, E of New Zealand.

USNM 551148a,b,d,e: *Liothyrella neozelanica* Thomson, Recent, at 3–30 m, Dusky Sound, Wet Jacket Arm, W side South Island, New Zealand.

USNM 551149a,c,d,g: *Liothyrella neozelanica* Thomson, Recent, at 6 m, 46°04.8′S, 166°37.6′,E off South Island, New Zealand.

a moderately stout transverse band with small points set off by slight anterolateral notches like the loop of *Gryphus*. On the posterior of the transverse band of this specimen there is a median notch occupied by a prominent small projection. Although there is considerable variation in the loop of this species it maintains its liothyrellid characteristics except for the position of the crural processes anterior to the socket openings.

Stenobrochus, new genus

PLATE 14: FIGURES 1–7; PLATE 65: FIGURES 25, 26

SUBFAMILY.—Gryphinae, new subfamily.

TYPE-SPECIES.—*Stenobrochus crosnieri*, new species.

DIAGNOSIS.—Large, resembling *Dallithyris*, rectimarginate, truncated beak, long, narrow tapering, scooplike loop.

SPECIMENS STUDIED.—Fifteen, four showing loop.

GEOLOGIC OCCURRENCE.—Recent.

LOCALITY.—Indian Ocean, north, off Malagasy Republic (Madagascar).

EXTERIOR.—Large, resembling *Dallithyris*, roundly triangular to broadly pentagonal. Unequally biconvex, ventral valve more strongly convex than dorsal valve. Sides rounded, anterior margin gently convex; posterolateral extremities forming an acute angle. Lateral commissure broadly concave toward ventral side; anterior commissure rectimarginate to faintly sulcate. Beak moderately protuberant, suberect, without beak ridges. Foramen small to moderately large, submesothyridid. Smooth; translucent white.

INTERIOR.—Ventral valve interior with short, excavate pedicle collar, small elongate teeth parallel to hinge margin. Muscle field small, semicircular; diductor scars anterior; pedicle muscles lateral.

Loop and Cardinalia: The loop is short and narrow and occupies a third of the length and less than a fifth of the width of the dorsal valve. The cardinal process is a small half elliptical plate

TABLE 82.—Loop statistics for the genus *Stenobrochus*

Proportions	USNM 550923b	USNM 550923c	USNM 550923d
∠	10°	10°	9°
Wl/Ll	0.31	0.35	0.41
Ll/LD	0.28	0.33	?
Wl/WD	0.13	0.12	?
a/Ll	0.59	0.53	0.50
b/Ll	0.41	0.47	0.50
c/Ll	0.40	0.41	0.43
d/Ll	0.19	0.12	0.07
e/Ll	0.12	0.15	0.14
f/Ll	0.29	0.32	0.36
g/WD	0.27	0.24	?
g/Wl	2.45	2.00	2.10?
h/f	0.66	0.72	0.69
h/Ll	0.19	0.23	0.25
WD/LD	0.84	0.96	?

USNM 550923b,c,d: *Stenobrochus crosnieri*, new species. Recent, at 430–700 m, 13°45′S, 47°38.5′E, off the NW side of the Malagasy Republic (Madagascar).

facing posteriorly. The socket ridges are slender, slightly inclined and bound narrow sockets. The fulcral plates are stout and are not extended laterally. The outer hinge plates are thin and wide, and are attached to the ventral edge of the crural bases and taper onto the side of the crural processes. The outer hinge plates are so thin that they appear as narrow rods in side view. They support an elongate scooplike ensemble that consists of the crural processes and transverse band. The crural bases form a low wall along the inside margin of the outer hinge plates. The crural processes are low, obtusely angular and slightly approximate. There are no descending lamellae because the transverse band is attached to the anterior end of the crural processes. The transverse band is broad but narrows anteriorly because of loop taper. The transverse band is not a wide arch as it is angulated to form a narrow fold that extends laterally to the inward slope of the crural processes. The crest of the fold may be extended posteriorly into a small point (Plate 14: figure 4) At the anterior, the sides of the steep fold may be smooth or bear one or two small projections set off by tiny notches (Plate 14: figure 6).

LOOP STATISTICS.—See Table 82.

DISCUSSION.—The four specimens of *S. crosnieri* with loop show little variation except for the serrations at the anterior and posterior of the transverse band. The serrations seem to be an age character. The smallest specimen (USNM 550923d, Plate 14: figure 7) has strong anterior points but no serrations. A somewhat larger specimen (USNM 550923c, Plate 14: figure 4) has one notch on each side. The largest specimen (USNM 550923b, Plate 14: figure 6) has three serrations on each side.

The loop of *Stenobrochus* is rather like that of *Dallithyris*, as seen in the narrow crural bases and wide, thin outer hinge plates. The uniform narrowness of the *Stenobrochus* loop and the deep, V-shaped reentrant at the anterior preclude inclusion in *Dallithyris*, even though the loop proportions are similar. The exterior of *S. crosnieri* is also similar to that of *Dallithyris*.

Stenobrochus resembles *Stenosarina* in its exterior but the loops are different, that of *Stenosarina* has deeply concave hinge plates that attach to the dorsal edge of a fairly narrow crural base. The outer hinge plates of *Stenobrochus* are broad and flattish, more like those of *Dallithyris*,while those of *Stenosarina* are narrow and tapering, except for *S. expansa* Cooper, which has fairly wide outer hinge plates.

ETYMOLOGY.—From the Greek *stenos* (narrow) plus *brochos* (noose or loop).

Stenobrochus crosnieri, new species

PLATE 14: FIGURES 1–7; PLATE 65: FIGURES 25, 26

DIAGNOSIS.—Large roundly triangular shells having narrow, anteriorly tapering, spatulate loop.

DESCRIPTION.—Exterior and interior as for the genus. Valve details below.

Ventral valve in lateral view most convex medially; anterior profile forming broad, high dome with steeply sloping sides. Umbonal region narrowly swollen, swelling widening and flattening anteriorly, becoming gently convex at the anterior margin of adult, with a slight ventrad wave.

Dorsal valve most convex medially, anterior half somewhat flattened and slightly bent toward ventral valve to form feeble sulcus. Umbonal region broadly swollen; sides with short gentle slopes.

MEASUREMENTS (mm).—

USNM	*length*	*dorsal valve length*	*width*	*thickness*	*apical angle*
USNM 550923a	32.2	30.0	27.3	19.8	75°
USNM 550923e	36.4	32.8	32.4	25.4	67°

OCCURRENCE.—Recent, at 430–700 m, 13°45′ S, 47°38.5′ W, off northwest side of Malagasy Republic (Madagascar).

TYPES.—Holotype: USNM 550923a; paratypes: USNM 550923b–e.

DISCUSSION.—The interior and exterior of *S. crosnieri* are similar at first glance to *Dallithyris murrayi* Muir-Wood but there are significant differences. Foremost is the anteriorly narrowed and often serrated loop of the Madagascar shell as compared to the anteriorly wider loop of *Dallithyris.* The Madagascar shell has a tendency to sulcation whereas *Dallithyris* has distinct, gentle uniplication. The anterior third of the ventral valve of *Dallithyris murrayi* is flattened to gently concave to form an indistinct sulcus whereas the same part of the ventral valve of *Stenobrochus crosnieri* is moderately convex.

ETYMOLOGY.—Named for Dr. A. Crosnier, Laboratory of Zoology, Muséum National Histoire Naturelle, Paris.

Stenosarina Cooper, 1977

PLATE 9: FIGURES 12–14, 17; PLATE 14: FIGURES 9–19; PLATE 15: FIGURES 1–9; PLATE 61: FIGURE 34; PLATE 62: FIGURE 34; PLATE 65: FIGURES 19, 20

Stenosarina Cooper, 1977:95.

SUBFAMILY.—Tichosininae, new subfamily.

TYPE-SPECIES.—*Stenosarina angustata* Cooper, 1977:96, pl. 31: figs. 26–33.

SPECIMENS STUDIED.—Nine, of four species, one specimen of each species showing the loop.

GEOLOGICAL OCCURRENCE.—Pliocene to Recent.

LOCALITIES.—Pliocene of Sicily; Recent in Gulf of Mexico, Caribbean and eastern Atlantic.

EXTERIOR.—Elongate, subtriangular, greatest width anterior to midvalve; ventral valve slightly deeper than strongly umbonate dorsal valve. Lateral commissure weakly to strongly concave toward the ventral side; anterior commissure rectimarginate. Beak suberect, labiate, slightly protuberant. Foramen small to moderate in size, mesothyridid to permesothyridid. Symphytium partially visible. Dorsal umbo strongly swollen. White to translucent.

INTERIOR.—Ventral valve interior with small, narrowly elongate teeth; pedicle collar short, excavate. Muscle field long and narrow.

Loop and Cardinalia: The loop is long and narrow with parallel sides and narrowly tapering anterior. It occupies a third to a quarter of the length and less than a fifth of the width of the dorsal valve. The cardinal process is a small roughened half ellipse. The socket ridges are stout, curved and bound a wide socket that is roofed at its proximal end. The fulcral plates are slightly extended laterally. The outer hinge plates are narrow, concave and extend anteriorly to join the crural bases at their dorsal edge just posterior to midloop. The outer hinge plates are triangular and taper anteriorly along the dorsal edge of the crural bases. In side view the crus is thin and bears the crural processes and transverse band that form a scooplike appendage to the crura. The crural bases form a low wall along the inside edge of the outer hinge plates. The crural processes are low, approximate and form a blunt angle. The crural processes are located more than half the length of the loop. The descending lamellae are short, and broad, widening into the broad (laterally) and long (longitudinally) transverse band. This is sharply and strongly folded medially and has a deep angular reentrant at its anterior margin. The transverse band may be notched on each side of the reentrant and the notch is bounded laterally by a sharp point. All specimens are not so notched because the median reentrant of some is bounded by acute points. The transverse band is strongly tapered anteriorly making a strong discrepancy between the widest part of the loop which is just anterior to the crural processes, and the width between the terminal

TABLE 83.—Loop statistics for the genus *Stenosarina*

Proportions	USNM 109702b	USNM 130335	USNM 549943	USNM 550594	USNM 550596	USNM 550610	USNM 550763	Fischer and Oehlert, 1891
∠	14°	10°	10°	13°	13°	14°	13°	11°
Wl/Ll	0.36	0.39	0.39	0.34	0.30	0.29	0.43	0.30
Ll/LD	0.31	0.35	0.30	0.31	0.32	0.25	0.28	0.33
Wl/WD	0.13	0.15	0.13	0.12	0.13	0.08	0.13	0.12
a/Ll	0.61	0.55	0.55	0.63	0.60	0.60	0.63	0.52
b/Ll	0.39	0.45	0.45	0.37	0.40	0.40	0.37	0.48
c/Ll	0.42	0.47	0.43	0.50	0.47	0.52	0.50	0.48
d/Ll	0.19	0.08	0.12	0.13	0.13	0.08	0.13	0.04
e/Ll	0.11	0.14	0.22	0.12	0.13	0.08	0.16	0.13
f/Ll	0.28	0.31	0.23	0.25	0.27	0.32	0.21	0.35
g/WD	0.25	0.23	0.23	0.19	0.21	0.21	0.22	0.28
g/Wl	1.85	1.57	2.00	1.60	1.60	2.55	1.72	2.30
h/f	0.79	0.61	0.74	0.76	0.74	0.75	1.05	0.63
h/Ll	0.22	0.19	0.17	0.19	0.20	0.24	0.22	0.22
WD/LD	0.82	0.92	0.93	0.83	0.82	0.93	0.97	0.86

USNM 109702b: *Stenosarina sphenoidea* (Philippi), Pliocene, Rometta, Messina, Sicily.

USNM 130335: *Stenosarina sphenoidea?* (Jeffreys, not Philippi), Recent, at 277 fm (507 m), Bay of Biscay, France.

USNM 549943: *Stenosarina sphenoidea* (Philippi), Lower Pliocene, Milazzo, Messina, Sicily.

USNM 550594: *Stenosarina angustata* Cooper, Recent, at 205 fm (375 m), 24°18′N, 87°50′W, on the Campeche Shelf, N of Yucatan Peninsula, Mexico.

USNM 550596: *Stenosarina parva* Cooper, Recent, at 240–300 fm (439–549 m), 18°02′N, 67°51′14″W to 18°03′45″N, 67°48′10″W, near Mona Island, between Puerto Rico and Dominican Republic.

USNM 550610: *Stenosarina expansa* (Cooper), Recent, at 548 m, 20°44′N, 73°43′W, S side of Great Inagua, Caribbean.

USNM 550763: *Stenosarina nitens* Cooper, Recent, at 322 fm (608 m), 15°36′N, 61°13′W, on the NW side of the Island of Dominica.

Fischer and Oehlert (1891, pl. 3: fig. 8f,g): *Stenosarina sphenoidea?* (Jeffreys, not Philippi), eastern Atlantic from Bay of Biscay to NW Africa.

points. The serrated edge of the transverse band of some specimens is exactly like that of the well preserved loop of *Gryphus* but much narrowed. The posterior side of the transverse band may bear a small point given off from the crest of the median ridge of the transverse band. (Plate 14: figures 4, 6). In the side view the transverse band protrudes as a short tongue anterior to the slope of the crural processes.

LOOP STATISTICS.—See Table 83.

DISCUSSION.—The eastern Atlantic *Terebratula sphenoidea* Jeffreys, 1878 (not Philippi, 1844) has long been identified with Philippi's fossil species of the same name. The two, however, are quite different, the fossil form usually attaining a larger size and being more narrowed anteriorly than the Recent form which needs a new name. This conclusion was also reached by Muir-Wood (1959:304). The loops of the two species are fairly close. The fossil form is well illustrated by Seguenza (1865, pl. 2: fig. 2, 2a). It has the V-shaped reentrant at the anterior of the loop just like that of the Recent specimens and the side view shows the tongue-like projection of the transverse band and the outer hinge plate attached near the ventral edge of the crural base. The two specimens of the loop of the fossil form (Plate 14: figures 12–14) are young ones with not completely developed loop.

The loop of *S. sphenoidea* (Jeffreys, not Philippi), the Recent species, is well illustrated by Fischer and Oehlert (1891, pl. 3: fig. 8f,g,l). These show an attenuated loop with deep, V-shaped notch in the broad transverse band. The outer hinge plates are more concave and narrower than those of *Stenobrochus crosnieri*, new species, and they are attached near the ventral edge of the narrow crus in the same manner as that of the Madagascar species. Fischer and Oehlert's figures show the recent species as a more rounded form than the fossil one. The loop of USNM 130335 in the National Collection (Plate 14: figures 15, 16) is anteriorly serrate like that of *Stenosarina nitens* Cooper.

The four species of *Stenosarina* from the Gulf of Mexico and Caribbean show some exterior differences from that of the eastern Atlantic. The beaks of these are less extended beyond the swollen umbonal region of the dorsal valve than the beak of *S. sphenoidea.* The exterior of these is more like that of *Najdinothyris* of the Cretaceous than that of *S. sphenoidea.*

A species from the Eocene of Cuba (Cooper, 1979:12), *S. cuneata* Cooper, has the external form of *Stenosarina.*

The loop of *Stenosarina* is like that of *Stenobrochus* but differs in the narrower and more concave outer hinge plates in *Stenosarina* and the less narrowly anteriorly contracted loop of *Stenobrochus.* These two genera are very close and also similar to *Dallithyris.* Inasmuch as Caribbean genera (*Chlidonophora*, *Dyscolia* and *Ecnomiosa*) occur in the Indian Ocean, it is possible that *Dallithyris* and *Stenobrochus* have been derived from *Stenosarina*, or vice versa.

Tichosina Cooper, 1977

PLATE 3: FIGURES 26–32; PLATE 9: FIGURES 15, 16; PLATE 11: FIGURES 3–7, 20–22, 23–27; PLATE 12: FIGURES 23–26; PLATE 13: FIGURES 21–34; PLATE 65: FIGURES 11, 12, 17–18

Tichosina Cooper, 1977:61.

SUBFAMILY.—Tichosininae, new subfamily.

TYPE-SPECIES.—*Tichosina floridensis* Cooper, 1977:73, pl. 11: figs. 1–15; pl. 12: figs. 19–24.

DIAGNOSIS.—*Tichosina* with loop angle 25° or less.

SPECIMENS STUDIED.—Many, loops of all species.

GEOLOGIC OCCURRENCE.—Oligocene to Recent.

LOCALITIES.—Caribbean Sea, Gulf of Mexico.

EXTERIOR.—Small to large, usually triangular to ovate, wide to narrow, inequivalve, ventral valve having greater convexity. Lateral commissure straight to slightly curved; anterior commissure rectimarginate to fairly strongly, usually widely uniplicate. Beak usually suberect, labiate; beak ridges rounded. Foramen small to large, mesothyridid to permesothyridid. Symphytium usually partially visible. Surface marked only by concentric growth lines. Punctae counts variable.

INTERIOR.—Ventral valve with oblique, elongate oval, narrow teeth; pedicle collar short; muscle field short, narrow, usually well impressed and with usual terebratulacean arrangement. Pallial system with well marked pair of median and lateral trunks. Dorsal valve interior with usual adductor scars and paired pallial trunks. Dorsal valve interior with usual adductor scars and paired pallial trunks, without septa or euseptoidea.

Loop and Cardinalia: The shape of the loop is variable elongate rectangular with nearly parallel sides. The cardinal process in all species is a half elliptical, flattened shelf with myophore facing posteriorly or posteroventrally. In some specimens an adventitious thickening of shell substance may be added to its anterodorsal surface. The fulcral plates are usually visible and may have a slight to moderate lateral extension. The socket ridges are stout, inclined slightly toward the socket which is narrow to fairly wide. The proximal part of the socket is roofed by shell substance.

The outer hinge plates are variable, usually fairly strongly to deeply concave and of variable length. They are bounded on their inner margins by a strongly elevated crural base. The outer hinge plates taper anteriorly and are attached to the dorsal edge of the crural bases often with extension onto the outer surface of the crural processes. The crural bases are flat laterally or very slightly concave, with concavity facing medially.

The crural processes are expansions of the

TABLE 84.—Loop statistics for the genus *Tichosina*

Proportions	USNM 87378g	USNM 110856	USNM 336848	USNM 431002	USNM 550524a	USNM 550525d	USNM 550526a	USNM 550622c	USNM 550737e	USNM 550738b
∠	17°	23°	20°	22°	24°	14°	19°	21°	22°	20°
Wl/Ll	0.45	0.47	0.50	0.45	0.43	0.34	0.47	0.46	0.52	0.43
Ll/LD	0.32	0.28	0.33	0.27	0.35	0.31	0.28	0.29	0.30	0.30
Wl/WD	0.16	0.16	0.18	0.15	0.17	0.14	0.14	0.16	0.18	0.15
a/Ll	0.64	0.67	0.67	0.68	0.57	0.64	0.69	0.64	0.72	0.71
b/Ll	0.36	0.33	0.33	0.32	0.43	0.36	0.31	0.36	0.28	0.29
c/Ll	0.45	0.50	0.67	0.50	0.43	0.55	0.57	0.57	0.56	0.50
d/Ll	0.19	0.17	0.00	0.18	0.14	0.09	0.12	0.07	0.14	0.21
e/Ll	0.09	0.13	0.16	0.09	0.14	0.14	0.10	0.14	0.16	0.14
f/Ll	0.27	0.20	0.17	0.23	0.29	0.21	0.21	0.22	0.12	0.15
g/WD	0.26	0.19	0.33	0.24	0.26	0.13	0.26	0.25	0.26	0.24
g/Wl	1.60	1.42	1.84	1.60	1.50	2.00	1.60	1.53	1.53	1.66
h/f	0.74	1.15	0.71	1.00	0.66	1.15	0.72	0.64	1.00	1.00
h/Ll	0.20	0.23	0.12	0.23	0.19	0.23	0.15	0.14	0.12	0.15
WD/LD	0.91	0.95	0.91	0.85	0.87	0.92	0.92	0.83	0.88	0.89

USNM 87378g: *Tichosina bahamiensis* Cooper, Recent, at 338 fm (= 619 m), 27°22′N, 78°07′30″W, N side of Grand Bahama.

USNM 110856: *Tichosina cubensis* (Pourtales), Recent, Florida Strait, Florida.

USNM 336848: *Tichosina abrupta* Cooper, Recent, at 90 fm (165 m), off Key West, Florida.

USNM 431002: *Tichosina bartschi* Cooper, Recent, 90–500 fm (165–915 m), 18°50′30″N, 64°43′W to 18°51′N, 64°33′W, Atlantic side of the Virgin Islands.

USNM 550524a: *Tichosina truncata* Cooper, Recent, at 353–348 m, 21°02′N, 86°24′W, S side Yucatan Channel, Mexico.

USNM 550525d: *Tichosina erecta* Cooper, Recent, at 622–695 m, 26°28′N, 78°40′W to 26°27′N, 78°43′W, off Grand Bahama.

USNM 550526a: *Tichosina rotundovata* Cooper, Recent, at 201–210 m, 24°29′N, 80°54′W to 24°32′N, 80°48′W, off Key West, Florida.

USNM 550622c: *Tichosina pillsburyi* Cooper, Recent, at 165–130 m, 18°21.4′N, 69°08.7′W, off San Pedro de Marcos, Dominican Republic.

USNM 550737e: *Tichosina floridensis* Cooper, Recent, at 65 fm (119 m), 25°13′N, 85°55′W, W of Cape Sable, Gulf of Mexico, Florida.

USNM 550738b: Same as above.

crural bases usually more than half way of the length of the loop toward the anterior. The free ends of the crural processes are never drawn to needle-like points but are acutely pointed. In most species the crural processes are close to the posterior side of the transverse band and in all of them the points are approximate.

The transverse band is broad, usually h/Ll = 0.10 or greater. It is a gentle arch having a subangular crest. The longitudinal measure of the band is variable and its lateral junction with the descending part of the crural processes is variable from narrowly rounded to angular but never with long terminal points. There are no descending lamellae because the transverse band is connected to the anterior part of the crural processes. In some specimens the crural processes nearly overhang the transverse band.

LOOP STATISTICS.—See Table 84.

DISCUSSION.—See *Eurysina*, p. 259.

Xenobrochus Cooper, 1981

PLATE 2: FIGURES 16–29; PLATE 3, FIGURES 10–15; PLATE 13: FIGURES 9–14; PLATE 69: FIGURES 5, 6

SUBFAMILY.—Aenigmathyridinae, new subfamily.

TYPE-SPECIES.—*Gryphus africanus* Cooper, 1973a:8, pl. 4: figs. 31-38.

SPECIMENS STUDIED.—Twenty-one specimens of four species, seven with loop.

GEOLOGIC OCCURRENCE.—Recent.

LOCALITIES.—Indian Ocean; Pacific off the Philippines.

EXTERIOR.—Small, oval, inequivalve, ventral valve greater in convexity. Lateral commissure straight; anterior commissure rectimarginate. Beak moderately long, erect, truncated by a fairly large submesothyridid to permesothyridid foramen. Symphytium wholly or partially visible. Surface with concentric lines of growth.

INTERIOR.—Ventral valve with large teeth and short pedicle collar. Dorsal valve without euseptoidum.

Loop and Cardinalia: The cardinal process forms a small half ellipse. The socket ridges are erect and bound wide sockets floored by stout fulcral plates. The outer hinge plates are narrow and not clearly separable from the socket ridges.

TABLE 85.—Loop statistics for the genus *Xenobrochus*

Proportions	USNM 291010a	USNM 550366a	USNM 550375a	USNM 550593b
∠	23°	18°	23°	24°
Wl/Ll	0.50	0.42	0.50	0.45
Ll/LD	0.31	0.34	0.36	0.33
Wl/WD	0.17	0.18	0.21	0.16
a/Ll	0.56	0.69	0.67	0.60
b/Ll	0.44	0.31	0.33	0.40
c/Ll	0.50	0.50	0.42	0.50
d/Ll	0.06	0.19	0.25	0.10
e/ +-f/Ll	0.44	0.31	0.33	0.40
g/WD	0.26	0.29	0.25	0.28
g/Wl	1.50	1.63	1.17	1.80
h/Ll	0.03	0.15	0.08	0.10
WD/LD	0.88	0.81	0.85	0.97

USNM 291010a: *Xenobrochus translucidus* (Dall), Recent, at 540 fm (988 m), 4°53′45″S, 121°29′00″E, Gulf of Boni, off Lamulu Point, Philippines.

USNM 550366a: *Xenobrochus indianensis* (Cooper), Recent, at 67-72 m, 11°37′N, 51°27′E, SE of Cape Guardafui, Somali Republic.

USNM 550375a: *Xenobrochus africanus* (Cooper), Recent, at 366 meters, 29°19′S, 32°00′E, Durban Bay, South Africa.

USNM 550593b: *Xenobrochus? parvus* (Cooper), Recent, at 445 fm (814 m), 31°58′N, 77°18′W, E of Savannah, Georgia, USA.

They taper anteriorly to join narrow crural bases and extend to the crural processes. The crus is narrow and bears the scooplike anterior part of the loop. The crural processes are low, bluntly pointed with a large acute angle. The points are short, not drawn into needlelike extensions. There are no descending lamellae because the transverse band is attached to the anterior descending elements of the crural processes. The transverse band is convex anteriorly, somewhat angulated medially in some, but well rounded in other specimens. The band is moderately broad and has a slight median fold.

LOOP STATISTICS.—See Table 85.

DISCUSSION.—This genus of very small shells is characterized by its rectimarginate anterior commissure and a loop with its transverse band convex toward the anterior. In this latter respect it is like *Abyssothyris*, new genus, but *Xenobrochus* is rectimarginate, not sulcate as is *Abyssothyris*. The Atlantic species *X? parvus* (Cooper) is placed here because it has the essential characters of the genus but is from the Atlantic Ocean and may represent a different stock. Beside the species mentioned above *Liothyrina agulhasensis* Helmcke from off South Africa has a similar loop.

Xenobrochus? affinis (Calcara) figured herein (Plate 13: figures 9-14) has an anteriorly directed transverse band, although not as strong as in the species cited above and is rectimarginate. It varies also in its wider loop angle, somewhat shorter loop, but its loop details agree closely with those of the other species.

LOOP STATISTICS.—USNM 109758a: ∠ = 28°; Wl/Ll = 0.58; Ll/LD = 0.24; Wl/WD = 0.17; a/Ll = 0.67; b/Ll = 0.33; c/Ll = 0.58; d/Ll = 0.09; e + f/Ll = 0.33; g/WD = 0.30; g/Wl = 1.72; h/Ll = 0.08; WD/LD = 0.97.

USNM 109758a: *Xenobrochus? affinis* (Calcara), Recent, Bay of Naples, Mediterranean.

Zygonaria, new genus

PLATE 3: FIGURES 16-25; PLATE 65: FIGURES 13, 14

SUBFAMILY.—Tichosininae, new subfamily.

TYPE-SPECIES.—*Gryphus joloensis* Dall, 1920:313 (not illustrated).

COMPOSITION.—*Terebratula davidsoni* Adams (1867), *Gryphus joloensis* Dall (1920).

DIAGNOSIS.—Small, roundly oval terebratulaceans having an anteriorly rounded and narrowed loop.

SPECIMENS STUDIED.—Five of two species, three with loop.

GEOLOGIC OCCURRENCE.—Recent.

LOCALITY.—Philippines and Japan.

EXTERIOR.—Small, roundly oval, biconvex, ventral valve slightly deeper than dorsal valve. Lateral commissure nearly straight; anterior commissure rectimarginate. Beak short, suberect to erect, labiate. Beak ridges moderately developed. Symphytium not visible. Foramen of medium size, mesothyridid. Surface marked by concentric lines of growth only.

INTERIOR.—Ventral valve interior with large cyrtomatodont teeth; pedicle collar well developed. Muscle field narrow. Dorsal valve interior with short muscle field, narrow retort-shaped adductor scars separated by a faint euseptoidum.

TABLE 86.—Loop statistics for the genus *Zygonaria*

Proportions	USNM 110791	USNM 111062a	USNM 111062b
∠	15°	18°	15°
Wl/Ll	0.40	0.58	0.46
Ll/LD	0.32	0.28	0.29
Wl/WD	0.14	0.17	0.13
a/Ll	0.60	0.63	0.69
b/Ll	0.40	0.37	0.31
c/Ll	0.50	0.63	0.69
d/Ll	0.10	0.00	0.00
e/Ll	0.10	0.18	0.15
f/Ll	0.30	0.19	0.16
g/WD	0.30	0.29	0.26
g/Wl	2.00	1.00	2.00
h/f	0.47	1.00	1.00
h/Ll	0.14	0.19	0.16
WD/LD	0.87	0.93	1.05

USNM 110791: *Zygonaria davidsoni* (A. Adams), Recent, at 103 fm (188 m), 30°54′40″N, 130°37′30″E, Sata Misaki Light, Kagoshima Gulf, Eastern Sea, Japan.

USNM 111062a,b: *Zygonaria joloensis* (Dall), Recent, at 318 fm (582 m), 06°03′15″N, 120°35′30″E, Jolo Light, off Jolo, Philippines.

Loop and Cardinalia: The loop occupies about a third of the valve length and only about 15% of its width. The cardinal process is unusually large and is a half elliptical shelf with roughened myophore facing posteriorly. The socket ridges are thick, slightly inclined and bound wide sockets that are proximally roofed over. The fulcral plates are thick. The outer hinge plates are triangular, fairly large, and concave, and are attached to the ventral part of the crural bases. They taper anteriorly and extend just posterior of the crural processes, where the taper rises along the outer slope of the crural processes, thickening them but terminating before reaching the points. The crural processes are located more than half the loop length and are directed medially. No sharp points were seen in the three loops available for study. The transverse band unites the anterior ends of the crural processes without extended descending lamellae. The transverse band is broad, nearly horizontal or directed slightly anteroventrally. It bears a low, narrow median fold. The lateral extremities of the loop are not drawn into terminal points but are narrowly rounded. The anterior of the loop is much narrowed.

LOOP STATISTICS.—See Table 86.

DISCUSSION.—The much narrowed anterior part of the loop embracing the crural processes and transverse band separate this genus from all others described herein. The loop of *Tichosina abrupta* Cooper is contracted in a similar manner to that of *Zygonaria* but it differs in its broad crural bases and the attachment of the outer hinge plates to the dorsad side of the crural bases.

ETYMOLOGY.—From the Greek *zygos* (yoke).

Genera Known Only by Description or Serial Sections

The subjoined list gives the names of genera, the interior of which is known from serial section and description only, without reconstruction of the loop from the sections. A few of these are discussed in the text above, but most of them cannot be satisfactorily assigned to families or subfamilies. A shorter list records the genera of which the interiors are completely unknown. In each of the lists information is given as to age and where illustrations of their exterior may be seen.

Bejrutella Tchorszhevsky, 1972:40. Jurassic (Oxfordian), Lebanon and Syria. Serial sections incomplete.

Cheniothyris Buckman, 1917:128. Jurassic (Bajocian), England. Muir-Wood 1965:H800, with incomplete serial sections.

Dundrythyris Almeras, 1971:188. Jurassic (Bajocian), England, France. See text for discussion. A junior synonym of *Loboidothyris.*

Dyscritothyris Cooper, 1979:15. Cretaceous, Cuba. Serial sections incomplete.

Ferrythyris Almeras, 1971:218. Jurassic (Bajocian-Bathonian), England and France.

Goniothyris Buckman, 1917:117. Jurassic (Bajocian), England and Europe. Muir-Wood, 1965:H779; Almeras, 1971:127 (serial sections incomplete, loop broken).

Holcothyris Buckman, 1917:125. Jurassic (Bathonian), Europe, Asia. Muir-Wood, 1965:H780. See text for discussion.

Inversithyris Dagis, 1968:292. Jurassic (Upper), northeastern SSSR.

Karadagithyris Tchorszhevsky, 1974:54. Jurassic (Bajocian), Crimea.

Laevithyris Dagis, 1974:198. Triassic (Carnic), northeastern SSSR; Pearson, 1977.

Linguithyris Buckman, 1917:99. Jurassic (Bajocian), England. Muir-Wood, 1965:H802, H805.

Lobothyroides Xŭ, 1978:307. Triassic (Upper), China.

Longithyris Katz and Popov, 1974a:30. Cretaceous (Upper Cenomanian), Russia. Interior not illustrated by serial sections.

Mamemtothyris Smirnova, 1969b:34. Cretaceous (Upper Albian), northwest Kamchatka.

Millythyris Almeras, 1971:245. Jurassic (Bajocian), France.

Moutonithyris Middlemiss, 1976:63. Cretaceous (Berriassian—Upper Albian), Europe.

Muirwoodella Tchorszhevsky, 1974:51. Jurassic (Upper Bajocian), Transcarpathia, Russia. Serial sections incomplete.

Musculina Schuchert and LeVene, 1929a:120 (substitute for *Musculus* Quenstedt, 1869). Middlemiss, 1976:52. Cretaceous (Hauterivian—Aptian), Europe, Caucasus, Turkmenistan. Muir-Wood, 1965:H793.

Naradanithyris Tokuyama, 1958a:2. Jurassic (Bajocian-Bathonian), Japan. Serial sections incomplete. Muir-Wood, 1965:H793.

Neumayrothyris Tokuyama, 1958b:120. Upper Jurassic, Japan. Serial sections incomplete. Muir-Wood, 1965:H785.

Odarovithyris Tchorszhevsky, 1971c:62, Jurassic (Middle), Transcarpathians Russia.

Orientothyris Katz and Popov, 1974a:28. Cretaceous (Maastrichtian), Crimea. Described but not illustrated by serial sections.

Pachythyris Boullier, 1976:154. Jurassic (Oxfordian), France.

Pamirothyris Dagis, 1974:195. Late Triassic, Pamir, Russia.

Paracapillithyris Katz and Popov, 1974a:27. Cretaceous (Upper Cenomanian), Russian Platform, Donbass, Crimea and Caucasus, Russia. Interior not illustrated by serial sections.

Peculneithyris Smirnova, 1972a:76. Cretaceous (Barremian Aptian), Karabovskii Region, Russia.

Penzhinothyris Smirnova 1969b:36. Cretaceous (Upper Albian), northwest Kamchatka, Russia.

Perrierithyris Almeras, 1971:243. Jurassic (Callovian – Lower Oxfordian), France, Switzerland, Germany, and Portugal.

Psebajithyris Tchorszhevsky 1974:48. Jurassic (Callovian – Oxfordian), Caucasus and Crimea, Russia.

Pseudowattonithyris Almeras, 1971:303. Jurassic (Bathonian), France.

Rhapidothyris Tuluweit, 1965:345. Jurassic (Lias), Germany.

Rocheithyris Almeras, 1971:345. Jurassic (Bajocian-Bathonian), France.

Rugithyris Buckman, 1917:127. Jurassic (Bajocian), England. Muir-Wood 1965:H787. Serial sections inadequate.

Sardope Dieni, Middlemiss, and Owen, 1973:196. Cretaceous (Middle Albian), Sardinia, France. Serial sections incomplete.

Somalithyris Muir-Wood, 1935:124. Jurassic (Upper), Somali Republic. Muir-Wood, 1965:H787. Serial sections incomplete.

Taurothyris Kiansep, 1961:28, Jurassic (Oxfordian), Crimea, Russia. Muir-Wood, 1965:H789, H791. Serial sections incomplete.

Triadothyris Dagis, 1968:187. Triassic (Upper), Crimea, Carpathians, Russia: Alps, Europe. See Pearson, 1977:47, for reconstruction; this monograph Plate 66: figures 11, 12.

Trigonithyris Muir-Wood, 1935:131. Jurassic (Oxfordian), Somali Republic. Muir-Wood, 1965:H807. Serial sections incomplete.

Tropeothyris Smirnova, 1972b:70, Cretaceous (Hauterivian, Barremian and Berriassian), Crimea, Russia; Valanginian, Switzerland. Also identified in the Jurassic (Tithonian)

Tchegemithyris Tchorszhevsky, 1972:35–41. Jurassic (Callovian), north Caucasus, Russia. Transverse band not shown in serial sections.

Weldonithyris Muir-Wood, 1952:130. Jurassic (Bajocian), England. Muir-Wood, 1965:H791, H792. Serial sections incomplete, not reaching beyond the crura.

Genera with Unknown Interior

Jaisalmeria Sahni and Bhatnagar, 1958:421. Jurassic (Upper), India. Muir-Wood, 1965:H740.

Magharithyris Farag and Gatinaud, 1960:77. Jurassic (Bathonian), northern Sinai.

Moisseevia Makridin, 1964:243. Jurassic (Late Oxfordian), Russian Platform, Caucasus, Crimea, western Europe.

Moraviatura Sahni, 1960:19. Cretaceous (Cenomanian), southern India. Muir-Wood 1965:H805, H806.

Phymatothyris Cooper and Muir-Wood, 1951:195, substitute name for *Pallasiella* Renz, 1932:41. Jurassic (Lias), Italy, Albania, Alps, and Corfu. Muir-Wood, 1965:H813.

Svaljavithyris Tchorszhevsky, 1975:54, 55. Jurassic (Tithonian), Chekoslovakia, Switzerland, Poland, and Transcarpathia, Russia.

Trichothyris Buckman, 1917:125. Jurassic (Callovian), Pakistan, Muir-Wood, 1965:H789.

Nomina Nuda in the Terebratulacea

Abichia Askerov, 1964:6; 1965:18.
Ajukuzella Ovcharenko, 1977:38.
Almerasithyris Tchorszhevsky, 1973:13, 21, 22.
Araxinia Askerov, 1965:18.
Azerithyris Askerov, 1964:6; 1965:18.
Bazardella Ovcharenko, 1977:38.
Borszhaviella Tchorszhevsky, 1973:17, 22.
Caucasithyris Askerov, 1964:6; 1965:18.
Euterebratula Makridin, 1954:103.
Goniothyrella Tchorszhevsky, 1973:18, 19, 22; 1974:54.
Karabachia Askerov, 1965:18.
Karabaghia Askerov, 1964:6.
Kardonikithyris Tchorszhevsky, 1973:9.
Karpathothyris Tchorszhevsky, 1973:21, 22.
Kendzhilgithyris Ovcharenko, 1977:38.
Kilethyris Yasamanov, 1977:59.
Lobothyrella Tchorszhevsky, 1971a:44.
Lobothyropsis Tchorszhevsky, 1974:43.
Muirwoodellopsis Tchorszhevsky, 1973:20, 21, 22.
Orthotomoides Tchorszhevsky, 1971a:44.
Perennithyris Tchorszhevsky, 1973:12, 18, 22.
Postlobothyrella Tchorszhevsky, 1971a:44.
Postrhapidothyris Tchorszhevsky, 1973:22.
Praegoniothyris Ovcharenko, 1977:38.
Praenucleata Tchorszhevsky, 1973:17, 22.
Septocrurethyris Askerov, 1964:6; 1965:18.
Szajnochiella Tchorszhevsky, 1973:19, 21, 22.
Triseptalia Makridin, 1954:103.
Walkeria Haas, 1890:102.

Literature Cited

Adams, A.

1867. Description of New Shells from Japan. *Proceedings of the Zoological Society of London,* 1867: 309-315.

Ager, D.V.

1956. Some New Liassic Terebratulids. *Proceedings of the Geologists Association, London,* 67(1):1-14, plate 1.

1965. Serial Grinding Techniques. *In* B. Kumel and D. Raup, editors, *Handbook of Paleontological Techniques,* pages 212-224, 7 figures. San Francisco and London.

Allan, R.S.

1932. The Genus *Liothyrella* in New Zealand. *Transactions of the New Zealand Institute,* 63(1):1-10, plates 1-3.

1960. The Succession of Tertiary Brachiopod Faunas in New Zealand. *Records of the Canterbury Museum* (New Zealand), 7(3):233-268.

Almeras, Y.

[1970] 1971. Les Terebratulidae du Dogger dans le Maconnais le Mont d'Or Lyonnais et le Jura Meridional. Étude Systematique et Biostratigraphique. *Documents des Laboratoires de Géologie de la Faculté des Sciences de Lyon,* 1970, 39(1-2): 609 pages, 121 figures, 211 plates.

Almeras, Y., and B. Peybernès

1979. Les Brachiopodes du Dogger des Pyrénées Navarro-Languedociennes. *Documents des Laboratoires de Géologie de la Faculté des Sciences de Lyon,* 76:23-133, 32 figures, 7 plates.

Arcelin, F. and P. Roché.

1936. Les Brachiopodes Bajociens du Monsard. *Travaux Laboratoire Géologique Faculté de Science Lyon,* fascicule 30, memoire 25, 107 pages, 30 figures, 19 plates.

Archiac. See d'Archiac, Vicomte E.J.A.D.

Arkell, W.J.

1931. The Upper Great Oolite, Bradford Beds and Forest Marble of South Oxfordshire, and the Succession of Gastropod Faunas in the Great Oolite. *Quarterly Journal of the Geological Society of London,* 87(4):563-629, 4 figures, plates 47-51.

Asgaard, V.

1970. The Syntypes of *Carneithyris incissa* (Buch, 1835). *Meddelelser fra Dansk Geologisk Forening,* 19:361-367, 2 plates.

1971. *Faksethyris nielseni* n. g. et n. sp. (Terebratulacea) from the Middle Danian of Denmark. *Geological Society of Denmark Bulletin,* 20:385-389, 6 figures, 2 plates.

1975. A revision of Sahni's Types of the Brachiopod Subfamily Carneithyridinae, *Bulletin of the British Museum (Natural History), Geology,* 25(5):319-365, plates 1-8.

Askerov, R.B.

1964. O Sistematicheskom Sostabe Pozdneiurckikh Brakhiopod Azerbaidzhanskoi Chasti Malogo Kavkaza [On the Classification of the Late Jurassic Brachiopods of the Azerbaidzhan Part of the Little Caucasus]. 3 pages. [Abstract of papers for the Fifth Transcaucasus Conference of Young Scientific Workers of the Geological Institute of the Academy of Sciences of the Armenian Gruzinsk and Azerbaidzhan Institute of Geology.]

1965. *Pozdneiurskie Brakhiopody Azerbaidzhanskoi Chasti Malogo Kavkaza i ikh Stratigraficheskoe Znachenie* [Late Jurassic Brachiopods of the Azerbadzhian Part of the Little Caucasus and Their Stratigraphic Significance]. 20 pages. Baku: Akademia Nauk Azerbaidzhanskoi SSR, Institut Geologii in Akademia I.M. Gubnika.

1967. [Some New Data on the Systematics of Late Jurassic Brachiopods.] *Doklady Akademii Nauk Azerbaidzhanskoi SSR,* 23(7):48-51. [In Russian.]

Babanova, L.I.

1965. [A New Genus of Terebratulid Brachiopods from the Middle Jurassic of the Crimean Range.] *Palaeontologicheskii Zhurnal,* 1965(4):94-97, 3 figures. [In Russian.]

Bague, M.

1955. Contribution a l'étude des Brachiopodes du Bathonien Supérieure et du Callovien de la Côte d'Or. *Bulletin Scientifique de Bourgogne,* 15:213-240, 7 figures, 2 tables.

Barczyk, W.

1969. Upper Jurassic Terebratulids from the Mesozoic Border of the Holy Cross Mountains in Poland. *Prace Muzeum Ziemi,* 14:3-82, 74 figures, 18 plates.

1972. On the Representatives of the Genus *Nucleata* Quenstedt (Brachiopoda) from the Tithonian and Berriasian of the Environs of Czorsztyn, Poland. *Prace Muzeum Ziemi,* 20:151-158, 1 plate.

1979. Brachiopods from the Jurassic/Cretaceous Boundary of Rogoźnik and Czorsztyn in the Pieniny Klippen Belt. *Acta Geologica Polonica,* 29(2):207-214, plates 1, 2.

Bayle, C.E.

1878. Fossiles prinipaux des terrains de la France. In

Explication de Carte Géologique de la France, 4(1):158 plates.

Beecher, C.C.
1893. Revision of the Families of Loop-bearing Brachiopoda. *Transactions of the Connecticut Academy of Arts and Sciences*, 9:376–399, 3 plates.

Beets, C.
1942. A New Articulate Brachiopod Genus from the Upper Oligocene of Buton (S.E. Celebes), Dutch East Indies. *Leidsche Geologische Mededeelingen*, 13:341–347, plates 33, 34.

Benecke, E.W.
1866. *Geognostisch-Paläontologische Beiträge*. Volume 1, 713 pages, Atlas, 34 plates.

Bilinkevich, T., and E. Popiel-Barczyk
1979. On the Representatives of the Brachiopod Genus *Capillithyris* Katz from the Cenomanian Deposits of the Cracow Region. Poland and Podolia, USSR. *Prace Muzeum Ziemi*, 32:3–19, 8 figures, plate 1.

Bittner, A.
1890. Brachiopoden der Alpinen Trias. *Abhandlungen der Kaiserlich-Königlichen Geologischen Reichsanstalt*, 14: 325 pages, 41 plates.

Blochmann, F.
1906. Neue Brachiopoden der *Valdivia* und *Gauss* Expedition. *Zoologische Anzeiger*, 30:690–702, 3 figures.
1908. Sur Systematik und Geographischen Verbreitung der Brachiopoden. *Zeitschrift für Wissenschaftliche Zoologie*, 90:596–644, plates 36–40.

Boehm, G.
1904. Über Tertiäre Brachiopoden von Oamaru Neuseeland. *Zeitschrift Deutschen Geologischen Gesellschaft Mitteilung*, 15:146–150, plate 15.

Bolton, J.F.
1798. *Museum Boltenianum*. Part 2, 199 pages. Hamburgi.

Born, I.E.
1778. *Index Rerum Naturalium Musei Caesarei Vindobonensis*, Part 1: Testacea.–*Verzeichnis der natürlichen Seltenheiten des Kaiserlich Königlichen Natüralien Cabinets zu Wien, 1, Schaltiere.* 458 pages, 1 plate. Vindobonae (Vienna).

Böse, E., and M. Schlosser
1900. Ueber die Mittelliassische Brachiopodenfauna von Südtyrol. *Palaeontographica*, 46:175–212, plates 17, 18.

Boullier, A. (nee Rollet)
1976. Les Terebratulides de l'Oxfordien du Jura et de la bordure sud du bassin de Paris. *Annales Scientifiques de l'Université de Besançon, Géologie*, series 3, 27: 457 pages, 212 figures, 25 plates, 28 tables.
1981. *Le Gerne Postepithyris* Makridin (Terebratulides, Brachiopodes) dans L'Oxfordien et le Kimméridgien Francais. *Geobios*, 14:29–68, 14 figures, 2 plates, 1 table.

Brill, K.G.
1940. Brachiopods of the Whithorse Sandstone. *In* N.D. Newell, The Invertebrate Fauna of the Late Permian Whitehorse Sandstone. *Geological Society of America Bulletin*, 51:316–319, plate 10.

Brocchi, G.
1814. *Conchiliologia Fossile Subapennina; con Osservazone Geologische sugli Apennini e sul Suolo Adiacent.* 2 volumes, 712 pages, atlas of 15 pates. Milan.

Broderip, W.J.
1833a. Description of Some Species of Cuvier's Family of Brachiopoda. *Proceedings of the Zoological Society, London*, 1:124, 125, plates 22, 23.
1833b. Description of Some Species of Cuvier's Family of Brachiopoda. *Transactions of the Zoological Society, London*, 1:141–144, plate 23.

Buch, L. von
1834. *Über Terebrateln, mit einem Versuch, sie zu Classificiren und zu Beschreiben.* 124 pages, 3 plates. Berlin.

Buckman, J.
1845. Descriptions of the New Species of Fossils in the Foregoing List. *In* J. Buckman and H.E. Strickland, editors, *Outline of the Neighbourhood of Cheltenham.* Second edition, 109 pages, 14 plates, map. Lond.

Buckman, S.S.
1890. Some New Species of Brachiopoda, from the Inferior Oolite of the Cotteswolds. *Proceedings of the Cotteswold Naturalists Field-Club*, 9:38–43, 3 plates.
1895. The Bajocian of the Mid-Cotteswolds. *Quarterly Journal of the Geological Society, London*, 51:388–462, plate 14.
1901. Homeomorphy among Jurassic Brachiopoda. *Proceedings of the Cotteswold Naturalists Field-Club*, 13(4):231–290, plates 12, 13.
1906. Brachiopod Nomenclature: *Epithyris*, *Hypothyris*, *Cleiothyris* Phillips, 1841. *Annals and Magazine of Natural History*, series 7, 19:321–327.
1907. Brachiopod Nomenclature: The Genotype of Terebratula. *Annals and Magazine of Natural History*, series 7, 19:523–531, plate 12.
1910. On Certain Jurassic (Inferior Oolite) Species of Ammonites and Brachiopoda. *Quarterly Journal of the Geological Society of London*, 66:90–108, plates 11, 12.
1914. *Genera of Some Jurassic Brachiopoda.* 2 pages, London: W. Wesley.
1917. The Brachiopoda of the Namyau Beds, Northern Shan States, Burma. *Palaeontologica Indica*, new series, 3(2): 299 pages, 21 plates. [This publication bears the date 1917 on its title page. It is, however, dated 1918 by Williams et al., 1965, and 1919 by Schuchert and LeVene, 1929b. The Geological Survey of India (letter of 30 July 1979) and the British Museum (Natural History) library (letter

of 11 September 1979) confirm the 1917 date. Makridin (1960) records the Buckman genera of the publication as originating in 1917, as does Almerass (1971). This publication was cited in the Zoological Record for 1919 as published in 1917. The Buckman genera of this publication are cited as of 1917 in Neave (1935–1940).]

Catullo, T.A.
1851. On the Epiolitic Rocks of the Venetian Alps. *Geological Society of London, Quarterly Journal* 7:66–76, 4 figures.

Catzigras, F.
1948. Sur une Èspece Hauterivienne de Térébratulides Suisse et Mediterranéenne. *Bulletin de la Société Géologique de France*, series 5, 18:391–394, figure 1.

Charlesworth, E.
1837. Observations upon *Volùta Lamberti*, with a Description of a Gigantic Species of *Terebratula* from the Coralline Crag. *The Magazine of Natural History and Journal of Zoology, Botany, Mineralogy, Geology and Meteorology*, new series, 1:90–97, figures 13, 14.

Ching, Y., and S. Ye
1979. *In* S. Ye and S. Yang, Brachiopods from the Bagon Lake Series, Northern Tibet. *Acta Palaeontologica Sinica*, 18(1):64–72, plate 1.

Choffat, F.
1883. *In* H. J. Haas, Nachträge zu den Brachiopoden des Reichsländischen Jura. *Neues Jahrbuch für Mineralogie, Geologie und Palaeontologie*, 2:253–254.

Cloud, P.E.
1942. Terebratuloid Brachiopoda of the Silurian and Devonian. *Geological Society of America, Special Paper*, 38: 182 pages, 16 figures, 26 plates.

Contini, D. and A. Rollet
1970. Sur Quelques Térébratules Bajocien Supérieur et du Bathonien Inférieur. *Annales Scientifiques de l' Université de Besançon, Géologie*, series 3, 9:28–44, 4 figures, plate A.

Cooper, G.A.
1942. New Genera of North American Brachiopods. *Washington Academy of Sciences, Journal*, 32(8):228–235.
1944. Phylum Brachiopoda. *In* H.W. Shimer, and R.R. Shrock, *Index Fossils of North America*: 227–365, plates 105–143. New York: John Wiley and Sons.
1955. New Cretaceous Brachiopoda from Arizona. *Smithsonian Miscellaneous Collections*, 131(4):18 pages, 4 plates.
1956a. Chazyan and Related Brachiopods. *Smithsonian Miscellaneous Collections*, 127(1):1–1024; 127(2): 1025–1245, 269 plates.
1956b. New Pennsylvania Brachiopods. *Journal of Paleontology*, 30(3):521–530, 1 figure, plate 61.
1971. Eocene Brachiopods from Eua, Tonga. *United States Geological Survey Professional Paper*, 640F:F1–F9, 1 plate.
1972. Homeomorphy in Deep-Sea Brachiopods. *Smithsonian Contributions to Paleobiology*, 11:1–16, 4 plates.
1973a. New Brachiopoda from the Indian Ocean. *Smithsonian Contributions to Paleobiology*, 16: 42 pages, 8 plates.
1973b. Fossil and Recent Cancellothyridacea (Brachiopoda). *Science Reports of the Tohoku University* (Sendai, Japan), series 2 (Geology), 6 (Hatai Memorial Volume):371–390, 2 figures, plates 42–46.
1973c. Vema's Brachiopoda (Recent). *Smithsonian Contributions to Paleobiology*, 17:1–50, 5 figures, 9 plates.
1977. Brachiopods from the Caribbean Sea and Adjacent Waters. *Studies in Tropical Oceanography*, 14: 212 pages, 35 plates.
1978. Tertiary and Quaternary Brachiopods from the Southwest Pacific. *Smithsonian Contributions to Paleobiology*, 38: 1–23, 2 plates.
1979. Tertiary and Cretaceous Brachiopods from Cuba and the Caribbean, *Smithsonian Contributions to Paleobiology*, 37:1–45, 7 plates.
1981. Brachiopoda from the Southern Indian Ocean. *Smithsonian Contributions to Paleobiology*, 43:1–93, 30 figures, 14 plates.
1982. New Brachiopods from the Southern Hemisphere and *Cryptopora* from Oregon (Recent). *Smithsonian Contributions to Paleobiology*, 41:1–43, 4 figures, 7 plates.

Cooper, G.A., and R.E. Grant
1976. Permian Brachiopods of West Texas, V. *Smithsonian Contributions to Paleobiology*, 24:2609–3159, plates 663–780.

Cooper, G.A., and H.M. Muir-Wood
1951. Brachiopod Homonyms. *Washington Academy of Sciences, Journal*, 41(6):195–196.

Coquand, M.H.
1862. Géologie et Paléontologie de la region sud de la province [sic] de Constantine. *Mémoires de la Société D'Émulation de la Provence*, 366 pages, atlas of 35 plates.

Cotteau, G.
1857. *Etudes sur les Mollusques de Départment de L'Yonne.* 141 pages, Paris.

Cottreau, J.
1928. Types du Prodrome de Paléontologie Universelle d'A. d'Orbigny: Oxfordien. *Annales de Paléontologie, Paris*, 17:65–96, plates 5–9.

Couffon, O.
1917 [1918]. Le Callovien du Chalet, commune de Montreuil-Bellay (M. et L.). *Bulletin de la Société D'Études Scientifiques D' Angers*, new series, 1917:65–133,

Cowen, R.
1981. Homonymy between Brachiopods and Moths. *Journal of Paleontology*, 55(3):680.

Cox, M.M., and F.A. Middlemiss
1978. Terebratulacea from the Cretaceous Shenley Limestone. *Palaeontology*, 21(2):411–441, plates 40–42, 13 figures.

Dagis, A.S.
1963. *Verkhnetriasovie Brakhiopody Yuga S.S.S.R.* [Upper Triassic Brachiopods of Southern USSR.] 248 pages, 104 figures, 31 plates. Moscow: Akademia Nauk SSSR, Sibirskoe Otdelenie.
1965. *Triasovie Brakhiopody Sibiri.* 186 pages, 66 figures, 26 plates. Moscow: Akademia Nauk SSSR, Sibirskoe Otdelenie, Institut Geologii i Geofiziki.
1968. [Jurassic and Early Cretaceous Brachiopods of Northern Siberia.] *Akademiia Nauk SSSR, Sibirskoe Otdelenie, Trudy Institut Geologii i Geofiziki*, 41: 167 pages, 81 figures, 26 plates. [In Russian.]
1972. [The Postembryonic Development of the Brachidia in Late Paleozoic and Early Mesozoic Terebratulida.] *In* Morfologicheskie i Filogeneticheskie Voprosy Paleontologii. *Akademie Nauk SSSR, Sibirskoe Otdelenie, Trudy Institut Geologii i Geofiziki*, 112:22–58, 27 figures, 1 plate. [In Russian.]
1974. Triasovie Brakhiopody (Morfologia, Sistema, Filogenii, Stratigraficheskoe Znachenie i Biogeografiia). *Akademia Nauk SSSR, Sibirskoe Otdelenie, Institut Geologii i Geofiziki, Trudy*, 214:1–386, 49 plates.

Dall, W.H.
1870. A Revision of the Terebratulidae and Lingulidae with Remarks on and Descriptions of Some Recent Forms. *American Journal of Conchology*, 6(2):88–168, figures 1–38, plates 6–8.
1882. American Work on Recent Mollusca in 1881. *American Naturalist*, 16(11):874–887.
1895. Report on Mollusca and Brachiopoda Dredged in Deep Water, Chiefly near the Hawaiian Islands, with Illustrations of Hitherto Unfigured Species from Northwest America. *United States National Museum, Proceedings*, 17:675–733, plates 23–32.
1903. Contributions to the Tertiary Fauna of Florida. *Transactions of the Wagner Free Institute of Science*, 3(6):1533–1540, plate 58.
1920. Annotated List of the Recent Brachopoda in the Collection of the United States National Museum, with Descriptions of Thirty-three New Forms. *Proceedings of the United States National Museum*, 57(2314):261–377.

Dall, W.H., and H.A. Pilsbry
1891. On Some Recent Japanese Brachiopoda, with a Description of a Species Believed to be New. *Proceedings of the Philadelphia Academy of Natural Sciences*, 1891:165–171, plate 4.

d'Archiac, Vicomte E.J.A.D.
1847. Rapport sur les Fossiles du Tortia. *Mémoire Société Géologique de France*, series 2, 2(2):291–351, plates 13–25.

Davidson, T.
1850. On the Internal Structure of *Terebratula pectunculoides*, Schl., *Terebratula pulchella*, Nils., and *Terebratula Deslongchampsi* Nob. *Annals and Magazine of Natural History*, series 2, 5:449–450, plate 15.
1851–1852. The Oolitic and Liasic Brachiopoda. *In* T. Davidson, *A Monograph of the British Fossil Brachiopoda*, volume 1, part 3, pages 1–100, plates 1–18. London: Palaeontographical Society.
1852–1855. The Cretaceous Brachiopoda. *In* T. Davidson, *A Monograph of the British Fossil Brachiopoda*, volume 1, part 2, pages 1–117, plates 1–12. London: Palaeontographical Society.
1864. On the Brachiopoda of the Maltese Islands. *Annals and Magazine of Natural History*, series 3, 14:5–11, plate 1.
1874–1882. Supplement to the Recent, Tertiary, and Cretaceous Species. *In* T. Davidson, *A Monograph of the British Fossil Brachiopoda*, volume 4, part 1, pages 1–72, plates 1–8. London: Palaeontographical Society.
1876–1878. Supplement to the Jurassic-Triassic Species. *In* T. Davidson, *A Monograph of the British Fossil Brachiopoda*, volume 4, part 2, 1, pages 73–242, plates 9–29. London: Palaeontographical Society.
1877. On the Species of Brachiopoda That Occur in the Inferior Oolite at Bradford Abbas and Its Vicinity. *Proceedings of the Dorset Natural History and Antiquity Field Club*, 1:73–88, plates 1–6.
1878. Extract from Report to Professor Wyville Thomson, F.R.S., Director of the Civilian Scientific Staff, on the Brachiopoda Dredged by H.M.S. *Challenger. Proceedings of the Royal Society*, 27(188): 428–439.
1880. Report on the Brachiopoda Dredged by H.M.S. *Challenger* during the Years 1873–1876. *Report of Scientific Results of the* Challenger (*Zoology*), 1: 67 pages, 4 plates.
1884. Appendix to Supplement, General Summary, with Catalogue and Index of the British Species. *In* T. Davidson, *A Monograph of the British Fossil Brachiopoda*, volume 5, part 3, pages 243–476, plates 18–31. London: Palaeontographical Society.
1886–1888. A Monograph of Recent Brachiopoda. *The Transactions of the Linnean Society of London*, series 2, (Zoology): 248 pages, 30 plates.

Davidson, T., and W. H. Dalton
1886. Bibliography of the Brachiopoda. *In* T. Davidson, editor, *A Monograph of the British Fossil Brachiopoda*, volume 6, 163 pages. London: Palaeontographical Society.

Delance, J. H., and H. Tintant
1965. Les *Dictyothyris* du Jurassic de Bourgogne. *Annales des Paléontologie (Invertébrés) Paris*, 51(2):117–150, plate 1.

Deslongchamps, E. Eudes-

1856. Catalogue des Brachiopodes de Montreuil-Bellay. *Bulletin de la Société Linnéenne de Normandie*, 1:95–102, plate 5.

1859. Mémoire sur les Brachiopodes du Kelloway-Rock ou Zone Ferrugineuse du Callovien dans le Nord-ouest de la France. *Mémoire de la Société Linnéenne de Normandie, 1856–1859*, 11: 54 pages, 2 figures, 6 plates.

1862–1884. Études critiques sur des Brachiopodes nouveaux, ou peu connus. *Société Linnéenne de Normandie, Bulletins*, series 3, 7: 378 pages, 28 plates.

1862–1885. Brachiopodes. *In* A.D. d'Orbigny, *Paleontologie Francaise, Terrains Jurassiques*, part VI. 448 pages, 131 plates. Paris.

d'Hondt, J-L.

1976. Sur quelques brachiopodes actuels (Océan Atlantique, Mediterranée, Kerguelen). *Bulletin du Muséum National d'Histoire Naturelle* (Paris), series 3, 350 (243, Zoologie):350–363, 4 figures.

Dieni, I., F.A. Middlemiss, and E.F. Owen

1973. The Lower Cretaceous Brachiopods of East-Central Sardinia. *Bolletino della Società Paleontologica Italiana*, 12(2):166–216, figures 1–18, plates 32–38.

d'Orbigny, A.

1845. *In* R.I. Murchison, E. Verneuil, and A. Keyserling, *Geologie de la Russie d'Europe et des Montagnes de l'Oural, System Jurassique: Mollusques, Lamellibranchs ou Acephales*, 2:419–488, plates 38–42. London and Paris.

1847. *Paléontologie Francaise: Description des Animaux Invertébrés Terrain Crétacé*, Volume 4: 390 pages, plates 490–525.

Douvillé, H.

1879. Note sur la Bathonien des environs de Toul et Neufchateau. *Bulletin de la Société Géologique de France*, series 3, 7:251–277, 19 figures.

1886. Sur quelques Brachiopodes du Terrain Jurassique. *Bulletin de la Société des Sciences Historiques et Naturalles de L'Yonne*, 39:43–102, plates 1–4.

1916. Les Terrains Secondaires dans le Massif de Moghara a l' Est de l'Isthme Suez. *Académie de Science Paris, Mémoire*, 54: 184 pages, 21 plates.

Dubar, G.

1925. Études sur le Lias des Pyrénées Francaises. *Mémoire Société Géologique du Nord*, 9(1): 332 pages, 51 figures, 7 plates.

1942. Études paléontologiques sur le Lias du Maroc: Brachiopodes térébratules et zeilléries multiplissées. *Notes et Mémoires du Service Géologique*, 57: 103 pages, 51 figures, 10 plates, 1 table.

Dzik, J.

1979. Some Terebratulid Populations from the Lower Kimmeridgian of Poland and Their Relations to the Biotic Environment. *Acta Palaeontologia Polonica*, 24(4):473–492, 9 figures, plates 11, 12.

Elliott, G.F.

1952. The Internal Structure of Some Western Australian Cretaceous Brachiopods. *Royal Society of Western Australia, Journal*, 36: 21 pages, 2 plates.

1960. Appendix. *In* H.M. Muir-Wood, Homoeomorphy in Recent Brachiopoda: *Abyssothyris* and *Neorhynchia*. *Annals and Magazine of Natural History*, series 13, 521–528, plate 7.

Etallon, A.

1859–1862. *Lethaea Bruntrutana ou Etudes Paleontologiques et Stratigraphiques sur le Jura Bernois et en Particular les Environs de Porrentruy* (par J. Thurmann). [Posthumous work completed and published by A. Etallon.] 500 pages, 65 plates.

Etheridge, R., Jr.

1913. Palaeontological Contributions to the Geology of Western Australia. *West Australia Geological Survey, Bulletin,* 55:9–34, 4 plates.

Farag, I.A.M., and W. Gatinaud

1960. Un Nouveau Genre de *Térébratulidés* dans le Bathonien d'Egypte. *Journal of Geology of the United Arab Republic*, 4(1):77–79, plate 1.

Fahrenkohl, A.

1855–1856. Flüchtiger Blick auf Bergkalk und Jura Bildung in der Umgebung Moskwas. *Verhandlungen der Kaiserlichen Rüssischen Mineralogischen Gesellschaft*, 10:219–236, plate 3. St. Petersburg.

Feldman, H.R.

1977a. Notes on and Description of *Oleneothyris fragilis* (Morton) 1828 (Brachiopoda, Terebratulidae). *American Museum Novitates*, 2621: 16 pages, 10 figures.

1977b. Paleoecology and Morphologic Variation of a Paleocene Terebratulid Brachiopod (*Oleneothyris harlani*) from the Hornerstown Formation of New Jersey. *Journal of Paleontology*, 51(1):86–107, 6 figures, 3 plates.

Felix, J.

1891. Versteinerungen aus der Mexicanischen Jura and Kreideformation. *Palaeontographica*, 37:140–194, plate 27.

Felix, W.

1967. Über das Armgerüst von *Loboidothyris*. *Neues Jahrbuch für Geologie, Palaontologie, Abhandlung*, 127(2): 133–143, plates 13–16.

Fischer de Waldheim, G.

1809. *Notice des fossiles du gouvernement de Moscou*. 35 pages, 3 plates. Moscow.

Fischer, P., and D.P. Oehlert

1890. Diagnoses de nouveaux Brachiopodes. *Journal de Conchiliologie*, series 3, 38(1):70–74.

1891. Brachiopodes. *In* A. Milne-Edwards, editor, *Expedition scientifique du* Travailleur *et du* Talisman (*1880–1883*). 139 pages, 8 plates. Paris.

1892. Études des Brachiopodes recueilles dans le Golfe de Gascogne, aux Açores et a Terre-Neuve, In *Résultats de Campagne scientifiques accomplies sur son yacht* (l'Hirondelle) *par le Prince Albert I^er^, Souverain de Monaco.* Volume 3, 30 pages, 2 plates.

Foster, M.W.

1974. Recent Antarctic and Subantarctic Brachiopods. *Antarctic Research Series*, 21: 189 pages, 39 figures, 25 plates.

Friele, H.

1877. Jan Mayen Mollusca from the North Atlantic Expedition in 1877. *Nyt Magazin for Naturvidenskaberne*, Brachiopoda, 24(3):221–222, figures 1a–c, plate 1.

Gabb, W.M.

1864. Description of the Triassic Fossils of California and the Adjacent Territories. *California Geological Survey, Paleontology*, 1:17–243, plates 3–32.

Gray, J.E.

1840. *Synopsis of the Contents of the British Museum.* 42nd Edition, 370 pages. London.

Grote, A.R., and C.T. Robinson

1867. Lepidopterological Contributions. *Annals of the Lyceum of Natural History of New York*, 8:361-363.

Hass, H.J.

1890. Kritische Beiträge zur Kenntniss der jurassischen Brachiopodenfauna des schweizerischen Juragebirges und seiner angrenzenden Landestheile [part 2]. *Abhandlungen der Schweizerischen Paläontologischen Gesellschaft*, 17:35–102, plates 3–5.

1893. Kritische Beiträge zur Kenntniss der jurassischen Brachiopodenfauna des schweizerischen Juragebirges und seiner angrenzenden Landestheile [part 3]. *Abhandlungen der Schweizerischen Paläontologischen Gesellschaft*, 20:103–147, plates 11–23.

Hadding, A.

1919. Kritische Studien über die Terebratula-Arten der Schwedischen Kreideformation. *Palaeontographica*, 63:1–24, plates, 1–9.

Hamilton, A.

1910. *In* E.J.H. Webb, The Geology of the Mount Radiant Subdivision, Westport Division. *New Zealand Geological Survey, Bulletin*, new series, 11:1–46, 3 maps.

Hatai, K.M.

1940. The Cenozoic Brachiopoda from Japan. *Science Reports of The Tohuku Imperial University*, series 2 (Geology), 20: 413 pages, 25 figures, 12 plates.

Helmcke, J.G.

1940. Die Brachiopoden der deutschen Tiefsee-Expedition. In *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer* Valdivia, *1898–1899*, 24(3):217–316, 43 figures.

Hertlein, L.G., and U.S. Grant IV

1944. The Cenozoic Brachiopoda of Western North America. *University of California Publications in Mathematical and Physical Sciences*, 3: 236 pages, 21 plates.

Hondt. See d'Hondt, J-L.

Hoover, P.R.

1979. Early Triassic Terebratulid Brachiopods from the Western Interior of the United States. *United States Geological Survey Professional Paper*, 1057:1–21, plates 1–4.

International Commission on Zoological Nomenclature

1961. *International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology.* 176 pages. London: International Trust for Zoological Nomenclature.

Jackson, J.W.

1912. The Brachiopoda of the Scottish National Antarctic Expedition. *Transactions of the Royal Society of Edinburgh*, 48(2):367–390, 2 plates.

1918. The New Brachiopod Genus *Liothyrella*, of Thomson. *Geological Magazine* (London), new series, decade 6, 5:73–79.

Jassjukevitch, L.P.

1973. *In* Novye Vidy Drevnikh Rastenii i Bespozvonochnykh. *Vsesoiuznyi Nauchno-Issledovatelskii Geologo-Razvedochnyi Neftianoi Institut (VNIGRI), Trudy*, 318: 1–179, 34 plates.

Jeffreys, G.

1978. On the Mollusca Procured during the *Lightning* and *Porcupine* Expeditions, 1868–1870, Part 1. *Proceedings of the Zoological Society of London*, 1:394–416, plates 22, 23.

Katz, Y.

1962. [New Genera of Late Cretaceous Brachiopods of the Tadzhik Depression and Adjacent Regions.] *Zapiski Geologicheskogo Otdelenie Kharkhovskogo Gosudorstvennogo Universiteta*, 15:132–154, 16 figures, 2 plates. [In Russian.]

1971. Parallel'noe razvitie i filogeneticheskya sistema otryada Terebratulida, In *Tezisky doklady II Vsesoiva Konferentsia po Mesozoiskim i Kainozoiskim Brachiopodam*, 20–23.

1974. *In* M.Y. Blank, G.Y. Krymholz, D.P. Naidin, and O.V. Savchinskaya, editors, *Atlas Verkhnemelovoi Fauny Donbassa*, pages 240–275. Moscow: Ministerstvo Vysshevo i Srednego Spetsial'nogo Obrazovania USSR; Kommunarskii Gornometallurgicheskii Institut.

Katz, Y. and A.M. Popov

1974a. [New Data of Mesozoic and Cenozoic Loop-bearing Brachiopods.] *Vestnik Khar'khovskogo Universiteta (Geologii)*, 108(5):22–32. [In Russian.]

1974b. [New Data on the Structure of the Shells of Loop-bearing Brachiopods]. *Vestnik Kar'khovskogo Universiteta (Geologii)*, 108(5):33–42. [In Russian.]

Kiansep, N.P.

1961. [Terebratulids of the Lusitanian and Lower Kimmeridgian of Southwestern Crimea.] *Akademiia Nauk SSSR, Geologicheskii Musei Imeni A. P. Karpinskogo, Trudy*, 8: 102 pages, 41 figures, 8 plates. [In Russian.]

King, W.
1850. Monograph of the Permian Fossils of England. *Palaeontographical Society Monograph*, 3: 258 pages, 29 plates.

Kitchin, F.L.
1897. Zur Kenntniss der Jurassischen Brachiopoden von Kutch. 56 pages. Inaugural Dissertation Doktorwürde Philosophie Fakultie Kaiserlichen Ludwid-Maximillain Universitie. München.
1900. Jurassic Fauna of Cutch. *Memoirs of the Geological Survey of India*, series 9, 3(1): 87 pages, 15 plates.

Kvakhadze, N.N.
1971. [New Data on the Morphology of the Shells and the Systematic Composition of the Early Cretaceous Brachiopods of Georgia.] In *Vtoraia Vsesoiuznaia Konferentsia po Mesozoikim i Cainozoiskim Brakhipodam Kharkhov*, Nov. 15–20, page 32. [In Russian.]
1972. [*Iberithyris*, a New Brachiopod Genus from Lower Cretaceous Deposits of Western Georgia.] *Paleontologicheskii Zhurnal*, 1972 (4):75–78, 2 plates. [In Russian.]

Lamarck, J.P.B.A. de M. de
1819. *Histoire naturelle des animaux sans vertébrés.* Volume 6, part 1, 343 pages. Paris: A. Berlin.

Lamplugh, G.W., and J.F. Walker.
1903. A Fossiliferous Band at the Top of the Lower Greensand near Leighton Buzzard. *Quarterly Journal of the Geological Society of London*, 59:234-265, plates 16–18.

Leymerie, A.
1846. *Statistique Géologique et Minéralogique de Départment de L'Aube.* 676 pages, 10 plates, atlas. Troyes, France.

Link, H.F.
1830. *Handbuch der Physikalischen Erdbeschreibung.* Volume 2, part 1, 498 pages. Berlin: Dummler.

Linné, C. von
1758. *Systema Naturae.* 10th Edition, 823 pages.

Loriol, F. de
1866. Description des Fossiles de L'Oolite Corallien de l'Étage Valanginien et de l'Étage Urgonien du Mont Saleve. *In* E. Favre, *Recherches Géologiques dans les Parties de la Savoie, du Piémont et de la Suisse Voisines du Mont Blanc.* 100 pages, plates A-F.
1876–1878. Monographie Paléontologique des couches de la zone à *A. tenuilobatus* (Badnerschichten) de Baden (Argovie). *Mémoire Société Paléontologique Suisse*, 3–5: 200 pages, 23 plates.
1893. Description des Mollusques et Brachiopodes des Couches Sequaniennes de Tonnere (Yonne), accompagnée d'une Étude Stratigraphique par J. Lambert. *Mémoire Société Paléontologique Suisse*, 20: 213 pages, 11 plates.

Lyell, C., and J. Sowerby
1845. *In* C. Lyell, Observations on the White Limestone and Other Eocene or Older Tertiary Formations of Virginia, South Carolina, and Georgia. *Quarterly Journal of the Geological Society of London*, 1:429–442.

Makridin, V.P.
1954. [Some New Data on the Jurassic Brachiopods of the European Part of the USSR.] *Biullete' Moskovskogo Obshchestva Ispytatelei Priody, Otdelenie Geologeskii*, 2:102, 103. [In Russian.]
1960. *In* B.K. Licharev, V.P. Makridin, and M.A. Rzonsnitzkaya, Terebratulidae. *In* T.G. Sarycheva, editor, Otryad Terebratulida. *In* Y.A. Orlov, editor, *Osnovy Paleontologii*, pages 286–324. Moscow: Ledatel'stvo Akademii Nauk SSSR.
1964. *Brakhiopody Iurskikh Otlozhenii Russkoi Platformy i Nekotorukh Prilezhashchikh k nei Oblasti.* 395 pages, 123 figures, 25 plates. Moscow: Ministerstvo Vysshego i Srednego Spetsialnogo Obrazovania USSR; Kharkovskii Gosudarstvennyi Universitet imeni A.M. Gorkogo Nauchno-Issledovatelskii Sektor.

Mantell, G.A.
1822. *The Fossils of the South Downs; or Illustrations of the Geology of Sussex.* 327 pages, 42 plates. London.

Megerle von Mühlfeldt, J.K.
1811. Entwurf eines neuen System's der Schaltiergehäuse. *Gesellschaft Naturforschenden Freunde, Magazin*, 5:38–72, plate 3.

Meyer, J.A.
1864. Notes on Brachiopods from the Pebble-Bed of the Lower Greensand of Surrey. *Geological Magazine*, series 1, 1(6):249–257, plates 11, 12.

Middlemiss, F.A.
1959. English Aptian Terebratulidae. *Palaeontology*, 2(1):94–142, 20 figures, plates 15–18.
1968. Brachiopodes du Crétacé Inférieures des Corbières Orientales (Aude). *Annales de Paléontologie Invertébrés*, 54(2):173–197, 3 plates.
1976. Lower Cretaceous Terebratulidina of Northern England and Germany and Their Geological Background. *Geologisches Jahrbuch*, A30:21–104, 30 figures.
1978. The Genus *Platythyris* (Brachiopoda) and Its Relationship to the Pygopidae. *Paläontologische Zeitschrift*, 52(1, 2):28–46, 16 figures.
1980. Lower Cretaceous Terebratulidae from Southwestern Morocco and Their Biogeography. *Palaeontology*, 23(3):515–556, 28 figures, plates 55–61.

Mitra, K.C., and D.N. Ghosh
1973. Emended Diagnosis of One Terebratulid and Two Rhynchonellid Genera of Buckman from Jurassic of Kutch, Gujarat. *The Quarterly Journal of the Geo-*

logical and Mining Metallurgical Society of India, 45(4):175–190, 4 figures.

Moerch, O.A.L.

1853. *Catalogus Conchyliorum que reliquit D. Alphonso d'Aguirra & Gadea Comes de Yoldi, 2: Acephala, Echinodermata*. 74 pages. Havniae [Copenhagen].

Moesch, C.

1867. Der Argauer Jura und die Nördlichen Gebiete des Kantons Zürich: Geologische Untersucht und Beschrieben. *Materiaux pour la Carte Géologique de la Suisse*, 4: 87 pages, 7 plates, 3 maps.

Moisseiev, A.S.

1934. [Brachiopods of the Jurassic Deposits of the Crimea and the Caucasus.] *Vsesoiuznyi Geologo-Razvedochnyi Obedineniya SSSR, Trudy*, 203:1–213, 19 plates. [In Russian.]

Morris, J., and T. Davidson

1847. Descriptions of Some Species of Brachiopoda (*Leptaena liasina, L. bouchardii, L. pearcei, Terebratula rugulosa . . .*). *Annals and Magazine of Natural History*, 20:250–257, plates 18, 19.

Morton, S.G.

1828. Description of the Fossil Shells Which Characterize the Atlantic Secondary Formation of New Jersey and Delaware; Including Four New Species: *Journal of the Academy of Natural Science of Philadelphia*, 6:72–100.

Mühlberg, M.

1900. Vorlauf Mitteilungen Brauner Jura. *Eclogae Geologicae Helvetiae*, 6(4):312.

Müller, O.F.

1776. *Zoologiae Danicae prodromus seu animalium Daniae et Norvegiae indigenarum characteres, nomina, et synonyma imprimis popularium*. 282 pages. Havniae [Copenhagen].

Muir-Wood, H.M.

1934. On the Internal Structure of Some Mesozoic Brachiopoda. *Philosophical Transactions of the Royal Society of London*, series B, 223:511–567, plates 62, 63.

1935. Jurassic Brachiopoda. *In* W.A. McFadyen et al. *The Mesozoic Geology and Palaeontology of British Somaliland*, 2:75–147, 33 figures, plates 8–13.

1936. A Monograph on the Brachiopoda of the British Great Oolite Series, Part 1: The Brachiopoda of the Fuller's Earth. *Palaeontographical Society Monograph*, 89: 144 pages, 34 figures, 5 plates.

1952. Some Jurassic Brachiopoda from the Lincolnshire Limestone and Upper Estuarine Series of Rutland and Lincolnshire. *Geologists Association, Proceedings*, 63(2):113–142, plates 5, 6.

1959. Report on the Brachiopoda of the *John Murray* Expedition. In *John Murray Expedition 1933–1934, Scientific Reports*, 10(6):283–317, 4 figures, 5 plates.

1960. Homoeomorphy in Recent Brachiopoda: *Abyssothyris* and *Neorhynchia*. *Annals and Magazine of Natural History*, series 13, 3:521–528, plate 7.

1965. Mesozoic to Recent Terebratulidina. *In* R.C. Moore, editor, *Treatise on Invertebrate Paleontology*, 2(H):H762–H818, figures 622–695. Lawrence: The University of Kansas Press.

Muller, S.W., and H.G. Ferguson

1939. Mesozoic Stratigraphy of the Hawthorne and Tonopah Quadrangles, Nevada. *Bulletin of the Geological Society of America*, 50:1573–1624, 5 plates.

Nalivkin, W.

1910. Die Fauna des Dontez-Jura, 2: Brachiopoda. *Mémoires du Comité Géologique*, new series, 55:1–62 [in Russian]; 63–84 [in German], 5 plates.

Nekvasilova, O.

1980. Terebratula (Brachiopoda) from the Lower Cretaceous of Stramberk (North-east Moravia), Czechoslovakia. *Sbornik Geologickych Ved (Paleontologie)*, 23:49–81, 17 figures, 12 plates.

Nielsen, K.B.

1911. Brachipoderne i Faxe. *Meddelelser fra Dansk Geologisk Forening*, 3(17):599–618, plate 12.

Nilsson, S.

1827. *Petrifacta Suecana; Formations Cretaceae, Descripta Iconibus illustrata*. 40 pages, 10 plates. Lund and Gotha.

Nyst, P.H.

1843. Description des Coquilles et des Polypiers fossiles des Terrains Tertiaires de la Belgique. *Mémoires Couronnés des Savants Étrangers, Academie Royale de Belgique*, 17: 697 pages, 49 plates.

Ochoterena, F.H.

1960. Variacion Intraspecifica en *Parathyridina mexicana*, N. Sp., Terebratulido del Oxfordiano de Mexico. *Universidad Nacional Autonoma de Mexico, Paleontologia Mexicana*, 9: 40 pages, 4 plates.

Oppel, A.

1856–1858. Die Juraformation Englands, Frankreichs, und Südwestlichen Deutschlands. *Württembergische Naturwissenschaftliche Jahreshefte des Vereins für Vaterländische Naturkunde*, 12(2):121–312; (3):313–556; 13:141–396, map 1857; 14(2, 3):129–291.

1860. Ueber die weissen und rothen Kalke von Vils in Tyrol. *Jahresbeheft des Vereins für Vaterländische Naturkunde in Württemberg*, 17:355–361, plates 2, 3.

Orbigny. *See* d'Orbigny, A.

Ovcharenko, V.N.

1963. [On the Little Known Genus of Brachiopods *Holcothyris* Buckman.] *Doklady Akademii Nauk Tadzhikskoi SSR*, 6(7):31–34. [In Russian.]

1967. [On the Taxonomic Status of Some Generic Names of Jurassic Terebratulids]. *Doklady Akademii Nauk Tadzhikskoi SSR*, 10(2):27–30. [In Russian.]

1969. [Transitional Forms and Species Differentiation of Brachiopods.] *Paleontologicheskii Zhurnal*, 3:57–63, 6 figures, plate 7. [In Russian.]

1971. [Some Notes on the Systematics of Jurassic Brachiopods.] In *Vtoraia Vsesoiuznaia Konferentsiia po Mesozoikim i Cainozoiskim Brakhipodam Kharkhov*, Nov. 15–20, Tezisy Dokladov, page 32. [In Russian.]

1975. [A New Genus of Jurassic Brachiopods and Some Questions of Terminology.] *Paleontologicheskii Sibirskoi Lemberg*, 12(1, 2):114–118, 4 figures. [In Russian.]

1977. [Features in the Development of Early Cretaceous Brachiopods and Their Geographic Differentiation.] *Kharkhovskia Ordena Trudobogo Krasnogo Znameni Gosudarstvennii Universitet i A. M. Gor'kogo. Nauchnyi Sovet po Problemam Evolutsonnoi Paleontologii pri Odetelenii Biologii an USSR* [Third All Union Conference on Mesozoic and Cenozoic Brachiopods, November 15–18, 1977], pages 37–40. [In Russian.]

Parkinson, J.

1811. *Organic Remains of a Former World: An Explanation of the Mineralized Remains of the Vegetables and Animals of Antediluvian World Generally Termed Extraneous Fossils.* Volume 3, 461 pages, 22 plates. London.

Parona, C.F.

1880. Il Calcare Liassico Gozzano ei suoi Fossili. *Atti della Royal Accademia dei Lincei*, series 3, 8:187–216, 3 plates.

Pearson, A.B.

1977. Rhaetian Brachiopods of Europe. *Neue Denkschriften des Naturhistorischen Museums in Wien*, 1: 85 pages, 22 figures, 7 plates.

Philippi, R.A.

1836. *Enumeratio Molluscorum Sicilliae.* 267 pages, 12 plates. Berlin.

1844. *Fauna Molluscorum Viventium et in tellure Tertia via Fossilium Regni utriusque Sicilliae.* 303 pages, plates 13–28.

Phillips, J.

1841. Figures and Descriptions of the Palaeozoic Fossils of Cornwall, Devon, and West Somerset. *Geological Survey of Great Britain, Memoir*, 1:1–231, 60 plates.

Popiel-Barczyk, E.

1968. Upper Cretaceous Terebratulids (Brachiopoda) from the Middle Vistula Gorge. *Prace Muzeum Ziemi*, 12: 86 pages, 20 plates.

1972. Albian-Cenomanian Brachiopods from the Environs of Annapol on the Vistula with Some Remarks on Related Species from Cracow Region. *Prace Muzeum Ziemi*, 20:119–149, 4 plates.

Prosorovskaya, E.L.

1962. [Some New Brachiopods from the Upper Jurassic of Western Turkmen.] *Vestnik Leningradskogo Universiteta (Geologii i Geografia)*, 12(2):108–114, plates 11, 12, 31, 37, 40. [In Russian.]

1968. *Iurskie Brakhipody Turkmenii* [The Jurassic Brachiopods of Turkmen]. 196 pages, 91 figures, 20 plates.

Quenstedt, F.A.

1858. *Der Jura.* 842 pages, Atlas of 100 plates, Tübingen.

1868–1871. Brachiopoden. In *Petrefactenkunde Deutschlands*, 2: 748 pages, atlas, plates 37–61. Tübingen and Leipzig.

Renz, C.

1932. Brachiopods of the Southern Swiss and West Grecian Lias (Lower Jurassic). *Schweizerische Palaeontological Gesellschaft*, 52: 61 pages, 3 plates.

Roché, P.

1939. Aalenien et Bajocien du Macconais et de quelques Regions Voisines. *Travaux du Laboratoire de Géologie de la Faculté des Sciences de Lyon*, 29(25): 343 pages, 13 plates.

Roemer, F.A.

1841. *Die Versteinerungen des Norddeutschen Kreidegebirges.* 145 pages, 16 plates. Hanover.

Roger, J.

1952. Brachiopoda. *In* J. Piveteau, *Traité de Paléontologie*, 2:3–160, 121 figures, 12 plates.

Rollet, A.

1964. Etude des térébratules des Marnes dites a *Rhynchonella varians* du jura septentrional. *Annales Scientific de l'Université de Besançon*, series 2, 19:27–44, 2 plates.

1966. Definition d'un genre Térébratulides: *Galliennithyris. Compte Rendu sommaire des Seances de la Société Géologique de France*, 8:304–306.

1968. Etude de *Galliennithyris galliennei galliennei* (d'Orbigny) et des formes Voisines (Brachiopodes). *Annales de Paléontologie*, 54:137–165, 8 figures, plates A, B, 4 serial sections.

1972. *Argovithyris* nov. gen. et *A. birmensdorfensis* (Brachiopoda) des couches a spongiaires de l'oxfordien moyen du Jura. *Geobios*, 5(1):91–119, 14 figures 1 plate.

Rollier, L.

1911. Fossiles nouveaux ou peu connus des terrains secondaires (Mesoziques) du Jura et des contrés environantes. *Mémoir Société Paléontologique de la Suisse*, 37:1–37, 4 plates.

1918. Synopsis des spirobranches (Brachiopodes) Jurassiques celto-souabes. *Mémoire de Société Paléontologique de la Suisse*, 43:185–275.

1919. Synopsis des spirobranches (Brachiopodes) Jurassiques celto-souabes. *Mémoire de Société Paléontologique de la Suisse*, 44:279–422.

Rothpletz, A.

1886–1887. Geologisch-Palaeontologische Monographie der Vilser Alpen. *Palaeontographica*, 33: 180 pages, 16 plates.

Rousselle, L.

1965a. Sur la Mise en Évidence par Sections Transversales, du Septalium des Rhynchonellidae Brochiopodes (sic). *Compte Rendu Sommaire des Séances de la Société Géologique de France*, 6:207.

1965b. Rhynchonellidae, Terebratulidae et Zeilleriidae du Dogger Marocain (Moyen-Atlas Septentrional, Hauts-Plateaux, Haut Atlas). *Notes et Mémoires du*

Service Géologique, 187: 168 pages, 16 plates.

Roy, A. van

1980. *Pliothyrina*, Genre Terebratulide (Brachiopode) Nouveau du Neogene. *Bulletin Institut Royale Science Naturelle de Belgique*, 52(3): 9 pages, 2 plates.

Sacco, F.

1902. *Brachiopodi dei Terreni Tertziarii del Piemonte e della Liguria*. 50 pages, 6 plates. Turin.

Sahni, M.R.

1925. Morphology and Zonal Distribution of Some Chalk Terebratulids. *Annals and Magazine of Natural History*, series 9, 15:335–385, plates 23–26.

1928. Morphology and Evolution of Certain Jurassic Terebratulids. *Annals and Magazine of Natural History*, series 10, 2:114–138, 17 figures.

1929. A Monograph of the Terebratulidae of the British Chalk. *Palaeontographical Society, Monograph*, 1927:1–62, 10 plates.

1960. Supplement to a Monograph of the Terebratulidae of the British Chalk. *Monograph of the Palaeontological Society of India*, 1958. 22 pages, 6 plates.

Sahni, M.R., and N.C. Bhatnagar

1958. New Fossils from the Jurassic Rocks of Jaisalmer, Rajasthan. *Records of the Geological Survey of India*, 87:418–437, 2 plates.

Say, T.

1820. Observations on Some Species of Zoophytes, Shells, etc., Principally Fossil. *American Journal of Science*, 2:34–45.

Schlotheim, E.F. von

1820. *Die Petrefactenkunde auf ihrem jetzigen Standpunkte durch die Beschreibung einer Sammlung versteinerter und fossiler Überreste der Tier- und Pflanzenreichs der Vorwelt Erläutert*. Volume 1, 378 pages, 54 plates. Gotha.

Schmidt, M.

1905. Über oberen Jura in Pommern: Beiträge zur Stratigraphie und Paläontologie. *Abhandlungen der Königlichen Preussischen Geologischen Landesanstalt und Bergakademie*, new series, 41: 222 pages, 10 plates.

Schuchert, C.

1897. A Synopsis of American Fossil Brachiopoda, Including Bibliography and Synonymy. *United States Geological Survey Bulletin*, 87: 464 pages.

1913. Brachiopoda. *In* K.A. von Zittel, *Text-Book of Paleontology* (translated by C.R. Eastman). 2nd edition, volume 1, 839 pages, 1594 figures. London.

Schuchert, C., and C.M. LeVene

1929a. New Names for Brachiopod Homonyms. *American Journal of Science*, series 5, 17:119–122.

1929b. *Fossilium Catalogus, 1: Animalia, part 42: Brachiopoda*. 140 pages. Berlin: W. Junk.

Seguenza, G.

1865. Paleontologia Malacalogia dei Terreni Terziarii del Distretto di Messina, Classe Brachiopodi. *Memoir Societa Italiana di Sienza Naturale*, 1: 88 pages, 8 plates.

1871. Studii Paleontologici sui Brachiopodi Terziarii dell' Italia Meridional. *Bolletino Malacologico Italiano*, 4: 79 pages, 6 plates.

Seifert, I.

1963. Die Brachiopoden des oberen Dogger der schwäbischen Alb. *Palaeontographica*, series A, 121(4–6):156–203, 51 figures, plates 10–13.

Singeisen-Schneider, V.

1976. Interpretation von Serienschliffen bei Brachiopoden, am Beispiel von Dogger-Terebratuliden aus dem Basler Jura. *Eclogae Geologicae Helvetiae*, 69(1):91–110, 10 figures.

1979. Interpretation von Serienschliffen, Wertigkeit taxonomischer Merkmale und Ökologie von Terebratuliden aus dem Mittleren Dogger des Basler Jura. *Bulletin der Naturforschenden Gesellschaft Freiburg*, 68(1/2): 94 pages, 45 figures.

Smirnova, T. N.

1969a. [A New Tithonian-Valanginian Terebratulid Genus.] *Paleontologicheskii Zhurnal*, 1969 (3):418–420, 2 figures. [Reprint, pages 144–146. Original in Russian.]

1969b. *In* T.N. Smirnova and M.A. Pergament, [New Early Cretaceous Brachiopods from Kamchatka]. *Paleontologicheskii Zhurnal*, 3:478–484, 3 figures, 1 plate. [Reprint pages 34–40. Original in Russian.]

1972a. *In* T.N. Smirnova and G.P. Terekhova, [First Finds of Early Cretaceous Brachiopods in the Anadyr' River Basin]. *Paleontologicheskii Zhurnal*, 1972 (2):71–81, 5 figures, Plate 12. [Translated in *Paleontological Journal*, 6(2):207–216, 1972.]

1972b. *Rannemelovye Brakhiopody Kryma i Severnogo Kavkaza* [Early Cretaceous Brachiopods of Crimea and Northern Caucasus]. 137 pages, 56 figures, 13 plates. Moscow: Akademia Nauk SSSR, Nauchnyi Sovet po Probleme "Puti i Zakonomernosti Istoricheskogo Razvitiia Zhivotnykh i Rastitelnykh Organizmov."

1975a. [New Berriasian and Lower Hauterivian Terebratulids of the Russian Platform.] *Paleontologicheskii Zhurnal*, 3:70–82. [In Russian.]

1975b. Revision of the Upper Tithonian Brachiopods from Inwald (Polish Carpathians). *Acta Geologica Polonica*, 25(1):115–139, 17 figures, 4 plates.

1977. [Features in the Development of Early Cretaceous Brachiopods and Their Geographic Differentiation.] *Kharkhovskia Ordena Trudobogo Krasnogo Znameni Gosudarstvennii Universitet in A. M. Gorky Nauchnyi Sovet po Problemam Evolutsonnoi Paleontologii pri Otdelenie Obschei Biologii an USSR* [Third All Union Conference on Mesozoic and Cenozoic Brachiopods, November 15–18, 1977]. [In Russian.]

Smith, J.P.

1927. Upper Triassic Marine Invertebrate Faunas of North America. *United States Geological Survey Professional Paper*, 141: 262 pages, 121 plates.

Sowerby, J.
1812–1815. *The Mineral Conchology of Great Britain.* Volume 1, 234 pages, 102 plates.
Sowerby, J.deC.
1821–1825. *The Mineral Conchology of Great Britain.* Volume 4, 160 pages, 99 plates; Volumes 5, 171 pages, 97 plates.
Steinich, G.
1965. Die Artikulaten Brachiopoden der Rügener Schreibkreide (Unter Maastrict). *Paläontologische Abhandlungen,* 2(1): 220 pages, 297 figures, 21 plates.
Stenzel, H.B.
1943. *Type Invertebrate Fossils of North America* (cards 122–148). Austin, Texas: Bureau of Economic Geology.
Sučić-Protić, Z.
1971. Mesozoic Brachiopoda of Yugoslavia, Middle Liassic Brachiopoda of the Yugoslav Carpatho-Balkanids (part 2). *University of Belgrade Monograph,* 5:1–63, 41 plates.
Suess, E.
1855. Ueber die Brachiopoden der Halstätter Schichten. *Denkschrift Kaiserlichen Akademie der Wissenschaften Wien,* 9:23–32, plates 1, 2.
1864. Brachiopoden. *In* K.A. Zittel, Fossil Mollusken und Echinodermen. *Reise der Oesterreichischen Fregatte* Novara, *Geologischer Theil, Paläontologie von Neu-Seeland.* 1(2):56–61, plates 9, 10, 14. Wien [Vienna].
Szajnocha, L.
1879. Die Brachiopoden-Fauna der Oolithe von Balin bei Krakau. *Denkschrift der Kaiserlichen Akademie von Wissenschaften Wien,* 41(2):197–240, 7 plates.
1881. Ein Beitrag zur Kenntniss der jurassischen Brachiopoden aus der Karpathischen Klippen. *Sitzungsbericht der Kaiserlichen Akademie der Wissenschften Wien,* 84(1):69–84, plates 1, 2.
Tate, R.
1880. On the Australian Tertiary Palliobranchs. *Transactions of the Royal Society of South Australia,* 3:140–170, plates 7–11.
Tchorszhevsky, E.S.
1970. [New Data on the Jurassic Brachiopods of the Peninsk Rock Zone of the Transcarpathians.] *Vestnik Khar'kovskogo Universiteta, (Seriia Geologicheskaia),* 55:48–61, 6 figures, 1 plate. [In Russian.]
1971a. [Jurassic Terebratulid Brachiopods on the Zone of the Peninsk Rocks (Transcarpathia).] In *Vtoraia Vsesoiusnaia Konferentsia po Mesozoikim i Cainozoiskim Brakhipodam Kharkhov,* Nov. 15–20, page 44. [In Russian.]
1971b. [Data on the Internal Structure of the Shells and the Systematics of Jurassic Brachiopods.] In *Vtoraia Vsesoiusnaia Konferentsia po Mesozoikim i Cainozoiskim Brakhipodam Kharkhov,* Nov. 15–20, page 45. [In Russian.]
1971c. [A New Genus of Jurassic Terebratulid from the Peninsk Slope (Zakarpat) Zone.] *Vestnik Khar-kov'skogo Universiteta (Geologii),* 72:62–65, 2 figures, [In Russian.]
1972. [A New Family of Jurassic Terebratulid Brachiopods.] *Vestnik Kharkov's kogo Universiteta (Geologii),* 86(3):35–41, 3 figures, 2 tables. [In Russian.]
1973. [Jurassic Terebratulid Brachiopods of the Peninsk Rock Zone of the Carpathians and their Stratigraphic Significance. Author's Abstract.] *Ministertsvo Vysshego i Srednego Spetsial'nogo Obrzsvaniia USSR. Khar'kovskii Orden Trudovovo Krasnovo Znameni Gosudarstvennii Universitet imeni A.M. Gor'kogo. Geologo-Geograficheski Facul'tet,* 24 pages, 2 charts, 1 table. [In Russian.]
1974. [New Data on the Internal Structure of the Shells and Systematics of the Jurassic Terebratulid Brachiopods of the Superfamilies Terebratuloidea [sic] Gray, 1840, and Loboidothyroidea [sic] Makridin 1964.] *Vestnik Kharkovs'kogo Universiteta (Geologii),* 108(5):42–58, 9 figures. [In Russian.]
Tchoumatchenko, P.V.
1976–1977. Brachiopodes du Jurassique Moyen des Environs du Village Doln Dom, District de Vidin (Bulgarie du Nord-ouest). *Annuaire de l'Université de Sofia* (Faculté de Géographie, Géologie), 69(1): 193–232, 18 figures, plates 1, 2.
1978. Brachiopodes du Callovien et du Jurassique Supérieur d'une Partie du Prébalkan Occidental, Bulgarie du Nord-ouest. *Bulgarian Academy of Sciences, Palaeontology, Stratigraphy and Lithology,* 8:3–54, 18 figures, 4 plates.
Tenison-Woods, J.E.
1878. On the Tertiary Deposits of Australia. *Journal of the Proceedings of the Royal Society of New South Wales,* 2:65–82.
Thomson, J.A.
1916. Additions to the Knowledge of the Recent and Tertiary Brachiopoda of New Zealand and Australia. *Transactions and Proceedings of the New Zealand Institute,* 48:41–47, plate 1.
1918a. Brachiopoda. *In* J. Park, The Geology of the Oamaru Districts, North Otago. *New Zealand Geological Survey Bulletin,* new series, 20:117–119.
1918b. Australasian Antarctic Expedition, 1911–1914. *Scientific Reports,* series C (Zoology and Botany), 4(3):1–76, 4 plates, map.
1926. A Revision of the Subfamilies of the Terebratulidae (Brachiopoda). *Annals and Magazine of Natural History,* series 9, 18:523–530.
1927. Brachiopod Morphology and Genera (Tertiary and Recent). *New Zealand Board of Science and Art, Manual,* 7:338 pages, 103 figures, 2 plates.
Tokuyama, A.
1958a. On Some Terebratuloids from the Middle Jurassic Naradani Formation in Shikoku, Japan. *Japanese*

Journal of Geology and Geography, 29(1–3):1–10, plate 1.

1958b. On Some Terebratuloids from the Late Jurassic Torinosu Series in Shikoku, Japan. *Japanese Journal of Geology and Geography*, 29(1–3):119–131, plate 9.

Trautschold, H.

1877. Ergänzung zur Fauna des Russischen Jura. *Verhandlungen St. Petersburg Mineralogischen Gesellschaft*, series 2, 12:79–113, 6 plates.

Tuluweit, K.

1965. Die Terebratulidae und Zeilleriidae (Brachiopoda) des mittleren Lias Nordwestdeutschlands. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, 122:50–126, 36 figures, 5 plates.

Vantchurov, A.I.

1966. [The Horizon with *Gibbithyris* from the Top of the Turonian of Kopet-Dag and Badkhyza.] *Isvestiia Akademii Nauk Turkmenskoi SSSR. Seria Fisiko-Tekhnicheskikh Khimicheskikh i Geologicheskikh Nauk*, 3: 118–121. [In Russian.]

Vantchurov, A.I., and V.P. Kalugin

1966. [Stratigraphic Distribution of Dalsko-Mouski Brachiopods of Kopet-Dag.] *Isvestiia Akademii Nauk Turkmenskoi SSSR, Seria Fisiko-Tekhnichiskikh, Khimicheskikh, i Geologicheskikh Nauk*, 4:114–122, 4 figures. [In Russian.]

Vialli, G.S., and G. Cantaluppi

1967. I Nuovi Fossili di Gozzano (Prealpi Piemontesi). *Memoire della Societa Italiana di Scienza Naturali Museo Civico di Storia Naturale di Milano*, 16(2): 128 pages, 30 figures, 8 plates.

Vincent, E. G.

1893. Contribution a la Paléontologie des terrains tertiares de la Belgique. *Annales de la Société Royale Malacologique de Belgique*, 28:38–64, plates 3, 4.

Vörös, A.

1978. *Viallithyris* gen. n. (Terebratulida, Brachiopoda) from the Mediterranean Lower Jurassic. *Annales Historico-Naturales Musei Nationalis Hungarici*, 70:61–67, plate 1.

Waagen, W.H.

1883. Salt Range Fossils, part 4(2): Brachiopoda. *Paleontologia Indica, Memoir*, series 13, 3:547–610, plates 50–57.

Walker, J.F.

1868. On the Species of Brachiopoda Which Occur in the Lower Greensand at Upware. *Geological Magazine*, 5:399–407.

Weber, G.F.

1949. Brachiopoda. In *Atlas rukorodiashchikh form iskopaemikh faun SSSR, Nizhnii otdel Melovoi Sistemi Gosgeolizdal*, 10:108–119. [In Russian.]

Weller, S.

1907. A Report of the Cretaceous Paleontology of New Jersey, Based on the Stratigraphic Studies of George N. Knapp. *New Jersey Geological Survey (Paleontology)*, 4: 1106 pages, 111 plates.

Westphal, K.

1970. Die Terebratulidae (Brachiopoda) des tieferen Weissjura der schwäbischen Alb. *Jahresbericht und Mitteilungen Oberrheinische Geologische Verein*, new series, 52:33–70, plates 1–4.

White, C.A.

1879. Paleontological Papers, No. 9; Fossils of the Jura-Trias of Southeastern Idaho. *United States Geological and Geographical Survey of the Territories* (Hayden), Bulletin, 5:105–117.

1883. Triassic Fossils of Southeastern Idaho. *Twelfth Annual Report for 1878, United States Geological Survey of the Territories*, Part 1:105–118, plates 31–32.

Whitfield, R.P.

1875. Descriptions of New Species of Fossils. *In* W. Ludlow, *Report of a Reconnaissance of the Black Hills of Dakota*. 141 pages, 10 figures, 2 plates, 3 maps. Washington, D.C.

1885. Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey. *United States Geological Survey, Monograph*, 9: 338 pages, 35 plates.

Williams, A., et al.

1965. Brachiopoda. *In* R.C. Moore, editor, *Treatise on Invertebrate Paleontology*, part H (2 volumes), 927 pages, 746 figures. Lawrence, Kansas: University of Kansas Press.

Williams, A., and A.D. Wright

1961. The Origin of the Loop in Articulate Brachiopods. *Palaeontology*, 4:149–176.

Xu, Jin-Jian

1978. In *Xi Nan Di Qu Gu Sheng Wu Tu Ce, Si-Chuan Feng Ce, Yi Zhen Dan Ji Zhi Ni Peng Ji* [Paleontological Atlas of Southwestern China, Sichuan Province, Volume 2.] Edited by the Southwestern Geological Research Institute. 684 pages, 191 plates. Peking: Geological Press. [In Chinese.]

Ye, Song-Ling, and Yang, Shen-qiu

1979. [Brachiopods from the Bagon Lake Series, Northern Tibet.] *Acta Palaeontologica Sinica*, 18(1):64–72, plate 1. [In Chinese.]

Zezina, O.N.

1975. [Deep-Sea Brachiopods from the Southwest Pacific and Scotia Sea.] *Akademia Nauk SSSR. Trudy Instituta Okeanologii*, 103:247–258. [In Russian.]

Zieten, C.H.V.

1830. *Die Versteinerungen Württembergs*. 102 pages, 72 plates. Stuttgart: Verlag Expedition des Werkes Unsere Zeit.

Zugmayer, H.

1880. Über Rhätische Brachiopoden. *Beiträge zur Paläontologie und Geologie Osterreich-Ungarns*, 1(1): 42 pages, 4 plates, table.

PLATES

PLATE 1

FIGURES 1–9.—*Aenigmathyris stearnsi* Cooper: 1–3, Side, anterior, and dorsal views, × 1, of holotype USNM 550447a; 4, 6, side and ventral views, × 3, of loop showing rounded anterolateral extremities, paratype USNM 549414e; 5, loop of another paratype, × 3, USNM 549414d; 7, 8, ventral and side views of loop of young specimen, × 3, hypotype USNM 550891a; 9, dorsal view of loop showing slender, more narrowly pointed structure, × 2, of adult, hypotype USNM 550891b. All from Eocene Limestone, 400 feet (122 m) above sea-level, N of Vaingana, Island of Eua, Tonga Group, Pacific Ocean.

FIGURES 10–21.—*Ceramisia meneghiniana* (Seguenza): 10–12, Side, anterior, and dorsal views, × 1, of specimen with conjunct deltidial plates, hypotype USNM 549406a; 13–17, posterior dorsal, side, ventral, and anterior views, × 2, of large specimen with conjunct deltidial plates and strongly developed concentric lamellae, hypotype USNM 549404a; 18, interior of dorsal valve showing short, rounded loop (enlargement not given but about × 2, from Seguenza, 1865, pl. 2: fig. 13); 19, dorsal view, × 1, of specimen showing complete resorption or wearing away of deltidial plates, hypotype, USNM 109706; 20, 21, partial side and ventral views of loop and cardinalia, × 5, hypotype USNM 549406b. All from Pliocene, Messina Province, Sicily: figure 18 from Rometta, figures 13–17 from Milazzo.

FIGURES 22, 23, 32.—*Dyscolia subquadrata* (Jeffreys): 22, Dorsal view of exterior, × 2, lectotype USNM 130336; 23, loop of preceding specimen, × 3; 32, side view of same loop, × 2. Recent, 500–600 fms (= 915–1098 m), off Setubal. Portugal.

FIGURES 24–27.—*Dyscolia guiscardiana* (Seguenza): 24, Dorsal view of complete specimen, × 1, having radial ornament and large labiate beak, hypotype USNM 550904a; 25, interior of dorsal valve showing loop, × 1, hypotype USNM 173727; 26, 27, ventral and side views, × 2, of loop and cardinalia of preceding specimen, loop with aberrant growth on transverse band. Pliocene, Messina, Sicily.

FIGURES 28–31.—*Dyscolia wyvillei* (Davidson); 28, Exterior of complete specimen, × 1, hypotype USNM 549271; 29, side view of dorsal valve interior of preceding specimen, × 0.9, showing narrow crus of loop; 30, ventral view of same specimen, × 1; 31, loop of preceding, × 2, showing cardinalia without outer hinge plates and rounded anterolateral extremities of loop. Recent, 765–785 fms (=1400–1437 m), off NW coast of Africa, *Talisman* Expedition, 1883.

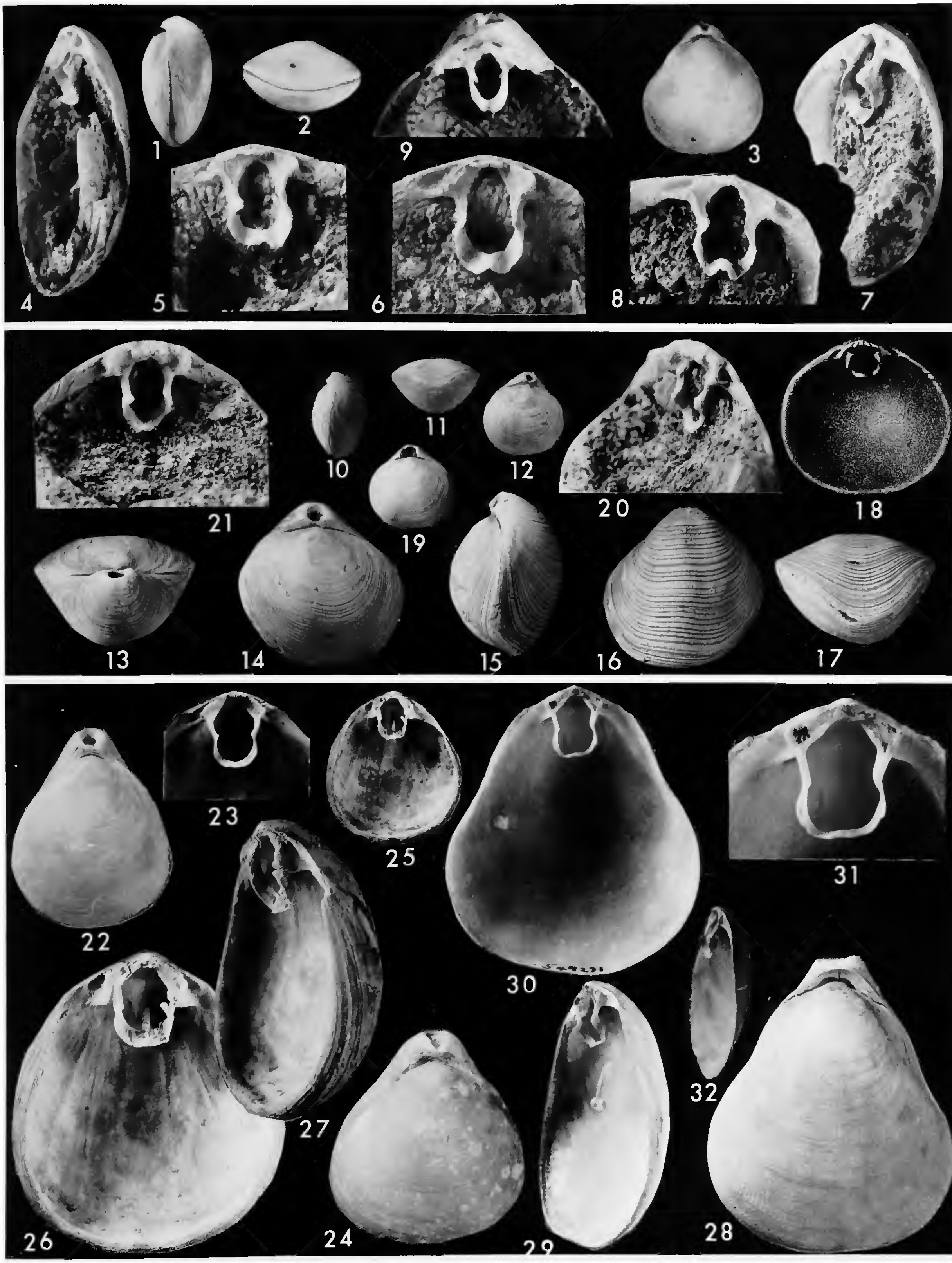


PLATE 2

FIGURES 1–4.—*Abyssothyris wyvillei* (Davidson): 1–3, Anterior, side, and dorsal views, × 2, showing narrow, deep sulcus and strong fold, paratype, B12501 (figured by Davidson, 1886–1888, pl. 2: fig. 10, 10a–c; Muir-Wood, 1960, pl. 7: fig. 3a–c). Recent, *Challenger* Station 160, 2600 fms (= 4758 m), 42° 42′S, 134°10′E, off Australia.

4, Interior of dorsal valve showing loop with roundly pointed anterolateral extremities, × 2, paratype B1163. Recent, *Challenger* Station 302, at 1450 fms. (= 2654 m), 42°43′S, 82°11′W; off Chile (from Muir-Wood, 1960, pl. 7: fig. 2a). Both by permission of British Museum (Natural History).

FIGURES 5–7.—*Abyssothyris* cf. *A. wyvillei* (Davidson): 5, 6, Anterior and dorsal views of young specimen, × 3, showing fainter sulcation than above, hypotype USNM 110745b; 7, interior of dorsal valve, × 2, showing loop with short angular anterolateral extremities, × 4, hypotype USNM 110745a. Recent, U.S. Fish Commission Station 4709, at 2035 fms (= 3724 m), 10°15′S, 95°41′W, SW Galapagos Islands.

FIGURES 8–15.—*Abyssothyris elongata* Cooper: 8–10, Anterior, dorsal, and side views, × 1, of complete specimen showing broad ventral sulcation, paratype USNM 550397e; 11, interior of dorsal valve, × 2, showing loop of young adult having rounded anterolateral extremities, paratype USNM 550437a; 15, anteriorly rounded loop of another young adult, × 2, paratype USNM 550437c. Recent, Scripps Institution of Oceanography locality S1070-22, 3601–3687 m, 31°19.7′N, 119°32.2′W to 31°08.2′N, 119°35.5′W, off northern Baja California.

12, Posterior of dorsal valve of adult showing anteriorly rounded loop, × 3, paratype USNM 550398x; 13, loop seen from dorsal side, × 2, paratype USNM 550398i; 14, broken specimen showing scooplike loop in side view, × 2, paratype USNM 550398n. Recent, Scripps Institution locality 1066-547, at 3777–3792 m, 32°05′N, 120°28.4′W to 32°03′N, 120°30′W, SW of Los Angeles, California. (See Plate 55: figure 15 for enlargement of loop.)

FIGURES 16–19.—*Xenobrochus translucidus* (Dall): 16–18, Anterior, dorsal, and side views, × 3, of lectotype USNM 294903a. Recent, U.S. Bureau of Fisheries (*Albatross*) Station 5236, 494 fms (= 904 m), 8°50′45″N, 126°26′52″E, off Magabao Island, east coast of Mindanao, Philippines.

19, Interior of dorsal valve, × 4, showing anteriorly rounded loop, hypotype USNM 291010a. Recent, U.S. Bureau of Fisheries (*Albatross*) Station 5650, 540 fms (= 988 m), 4°53′45″S, 121°29′00″E, Gulf of Boni, off Lamulu Point, Celebes.

FIGURES 20–23.—*Xenobrochus africanus* (Cooper): 20–22, Anterior, side, and dorsal views, × 4, of holotype USNM 550375a; 23, interior of dorsal valve of holotype, × 6, showing anteriorly directed transverse band of loop. Recent, *Anton Bruun* Cruise 7, Station 358A, 366 m, 29°19′S, 32°00′E, Durban Bay, South Africa.

FIGURES 24–29.—*Xenobrochus indianensis* (Cooper): 24, Dorsal view, × 1, of holotype USNM, 550366a; 25–27, anterior, dorsal, and side views, × 2, of holotype; 28, interior of dorsal valve, × 4, of paratype USNM 550366c; 29, side view of preceding specimen, × 3. Recent, *Anton Bruun* Cruise 9, Station 465, 67–72 m, 11°37′N, 51°27′E, SE of Cape Guardafui, Somali Republic.

FIGURES 30–38—*Goniobrochus ewingi* (Cooper): 30–32, Anterior, side, and dorsal views, × 1, of paratype USNM 550461b; 33, interior of dorsal valve, × 1, of preceding paratype; 34, 38, ventral and side views of same dorsal valve, × 2, showing wide, slightly angulated loop; 35, interior of dorsal valve, × 2, of young specimen showing wide laterally rounded loop, paratype USNM 550461d; 36, 37, dorsal interior of holotype, × 1, × 2, showing wide loop with narrowly rounded anterolateral extremities, and no outer hinge plates, USNM 550461a. Recent, Lamont-Doherty Geological Observatory of Columbia University, R/V *Vema* Station V-17-RD14, 595–642 m, 38°58′S, 55°17′W, SE of Mar del Plata, Argentina.

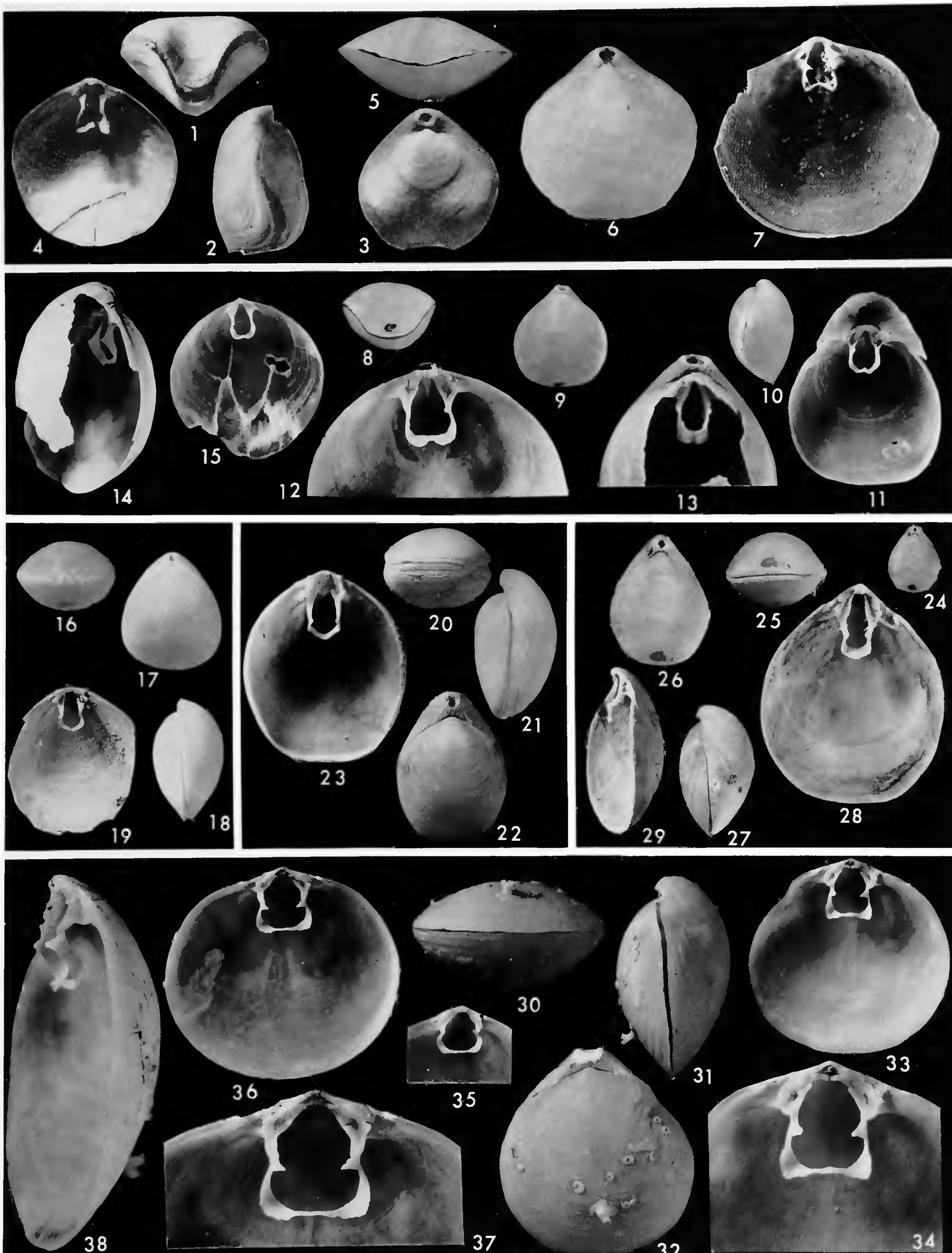

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38

PLATE 3

FIGURES 1–9.—*Abyssothyris? atlantica* Cooper: 1–3, Dorsal, anterior, and side views, × 1, of holotype USNM 550592a; 4–6, same views of holotype, × 3, showing broadly sulcate anterior commissure; 7, interior of broken specimen seen from side and showing tightly coiled lophophore, × 4, paratype USNM 550592c; 8, interior of dorsal valve, × 4, showing rounded, anteriorly directed transverse band, paratype USNM 550592b; 9, side view of preceding, × 3, showing narrow crus. Recent, Hydro Station 5809, 2500–2590 m, 33°38.5′N, 75°50.5′W, off Cape Fear, South Carolina, USA.

FIGURES 10–15.—*Xenobrochus? parvus* (Cooper): 10, Dorsal view of complete specimen, × 1, holotype USNM 550593a; 11–13, anterior, side, and dorsal views, × 3, of rectimarginate holotype; 14, 15, side and ventral views of dorsal valve showing loop with anteriorly directed transverse band, × 6, × 4, paratype USNM 550593b. Recent, *Atlantis* Station A-266-2, 445 fms (= 814 m), 31°58′N, 77°18′W, E of Savannah, Georgia.

FIGURES 16–23.—*Zygonaria joloensis* (Dall): 16, Dorsal view of complete specimen, × 1, paratype USNM 111062b; 17–19, anterior, dorsal, and side views, × 2, of preceding paratype; 20, interior of same paratype, × 2, showing anteriorly narrowed loop; 21, side view, × 3, of dorsal valve interior; 22, 23, ventral and side views, × 2, of loop of holotype USNM 111062a. Recent, U.S. Bureau of Fisheries (*Albatross*) Station 5172, 318 fms (= 582 m), 6°03′15″N, 120°35′30″E, Jolo Light, off Jolo, Philippines.

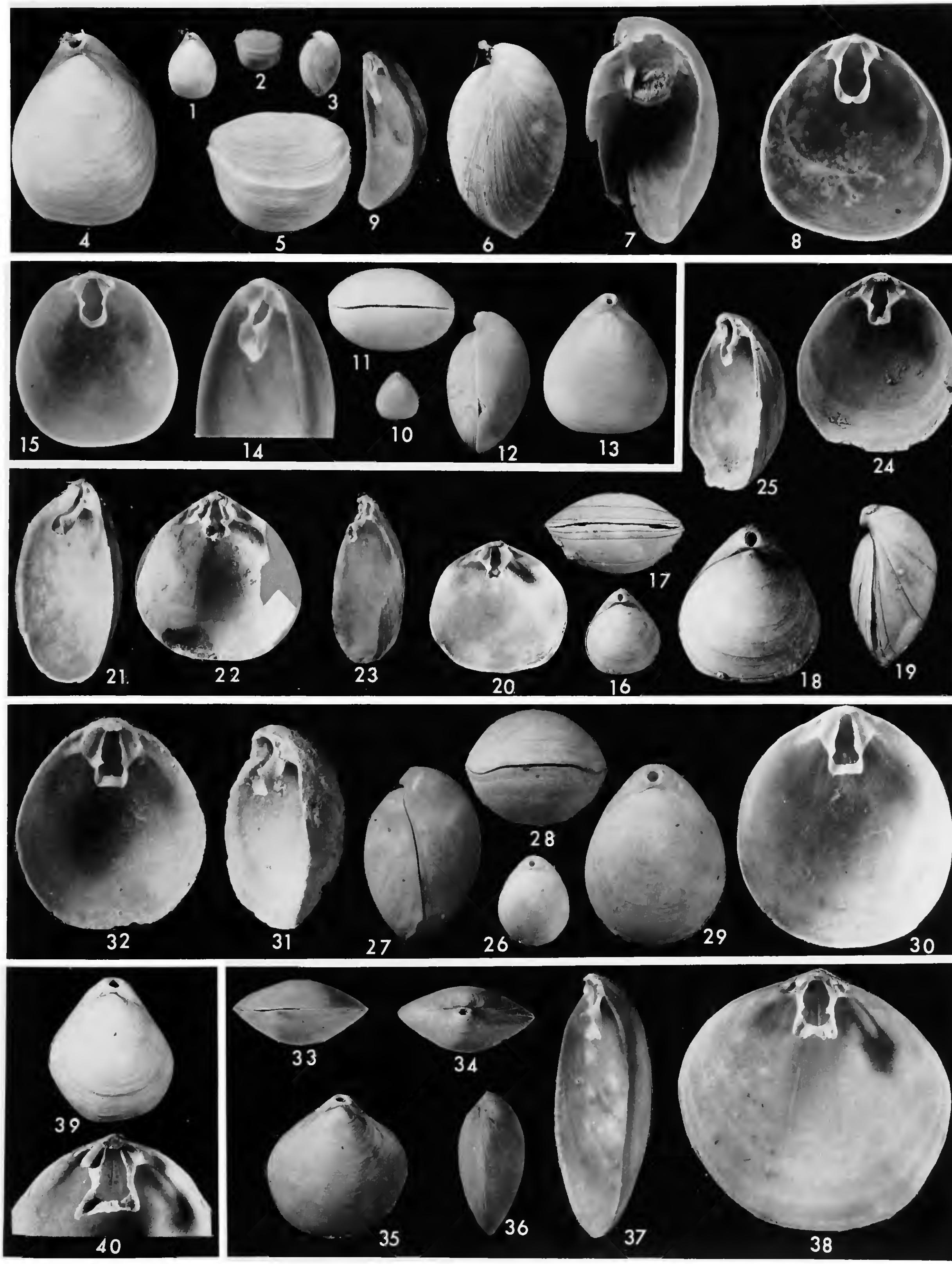
FIGURES 24, 25.—*Zygonaria davidsoni* (A. Adams): Ventral and side views, × 3, showing anteriorly narrowed loop, hypotype USNM 110791. Recent, U.S. Bureau of Fisheries (*Albatross*) Station 4936, 103 fms (= 188 m), 30°54′40″N, 130°37′30″E, Sata Misaki Light, off Kagoshima Gulf, Eastern Sea, Japan.

FIGURES 26–32.—*Tichosina abrupta* Cooper: 26, Dorsal view, × 1, of holotype USNM 550599; 27–29, side, anterior, and dorsal views, × 2, of holotype; 30, interior of dorsal valve of holotype, × 3, showing stout loop and exaggerated outer hinge plates. Recent, 125 fms (= 229 m), off Sand Key, Florida.

31, 32, Side and ventral views, × 3, of another dorsal valve with exaggerated, dorsally attached outer hinge plates, paratype USNM 336848. Recent, 90 fms (= 165 m), off Key West, Florida.

FIGURES 33–38.—*Gryphus tokionis* Dall (= *G.? dalli*, new species): 33–36, Anterior, posterior, dorsal, and side views of complete specimen, × 1, paratype USNM 204669 (now holotype of *G.? dalli*); 37, 38, side and ventral views of dorsal valve interior of preceding specimen, × 2, showing loop with its narrow crus. Recent, U.S. Bureau of Fisheries (*Albatross*) Station 5093, 302 fms (= 583 m), 35°03′35″N, 139°37′42″E, Joga Shima Light, off Hondo, Uraga Strait, Japan.

FIGURES 39, 40.—*Liothyrella? tokionis* (Dall): Exterior and dorsal interior of holotype, × 1, ×2, showing pathologic loop, USNM 107731. Recent, U.S. Bureau of Fisheries (*Albatross*) Station 3661, 169 fms (= 399 m), off Uki Shima, Gulf of Tokyo, Japan. (Compare outline of this shell with that of *G.? dalli*, new species.)



1
2
3
4
5
9
6
7
8
15
14
11
10
12
13
25
24
21
22
23
20
17
16
18
19
32
31
27
28
26
29
30
39
40
33
34
35
36
37
38

PLATE 4

FIGURES 1–7.—*Liothyrella oblonga* Cooper: 2–5, Anterior, side, posterior, and dorsal views, × 1, of holotype USNM 550498; 1, interior of dorsal valve of holotype, × 1; 6, 7, ventral and side views, × 2, of dorsal valve of holotype showing wide loop with crural processes in advanced anterior position and long outer hinge plates. Recent, Lamont-Doherty Geological Observatory of Columbia University, R/V *Vema* Station V-14-14, 75 m, 54°23'S, 65°35'W, NE of Tierra del Fuego, north of Cabo San Diego, Argentina.

FIGURES 8–16.—*Terebratula ampulla* Brocchi: 8–10, Side, anterior, and dorsal views of a complete specimen, × 1, hypotype 155098; 11, dorsal interior of preceding specimen showing loop, × 1; 12, 13, ventral and side views of preceding dorsal valve anterior, × 2, showing short crura and wide transverse band (note absence of inner hinge plates and nearly obsolete outer hinge plates); 14, dorsal view of specimen larger than preceding, × 1, hypotype USNM 550892; 15, 16, interior of the dorsal valve of preceding hypotype, × 1, × 2, showing wide loop and absence of definable outer hinge plates. Pliocene, Monte Mario, near Rome, Italy.

FIGURES 17–19.—*Terebratula sinuosa* Brocchi: 17, dorsal view, × 1, of large complete specimen, hypotype USNM 109710; 18, 19, interior of dorsal valve of preceding specimen, × 1, × 2, showing short, wide loop and lack of inner hinge plates. Miocene, Island of Malta.

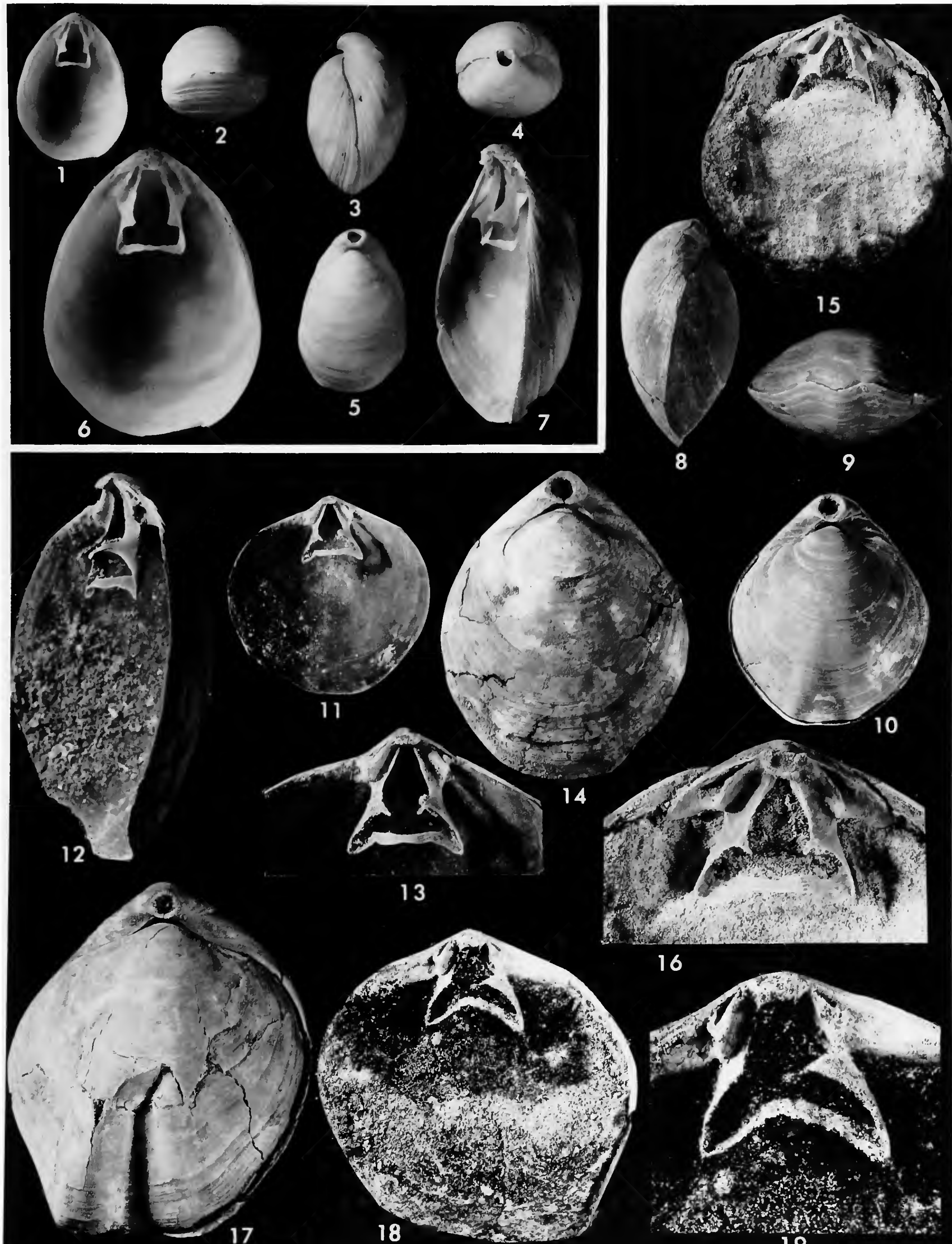

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

PLATE 5

FIGURES 1–4.—*Pliothyrina sowerbyana* (Defrance): 1, Exterior of large complete specimen, × 1, hypotype USNM 550889a; 2, interior of dorsal valve with loop, × 1, hypotype 550889b; 3, 4, ventral and side views of loop of preceding specimen, × 2, showing long, needle-sharp crural processes, lack of terminal points, incipient outer hinge plates, well-developed inner hinge plates, and elongate accessory teeth on outer wall of socket. Miocene (Diestien – Assize bryozoaires), Deurne, near Antwerp, Belgium.

FIGURES 5, 6.—*Pliothyrina grandis* (Blumenbach): 5, Exterior in dorsal view, × 1, hypotype USNM 550906a. Upper Oligocene, Doberg, Bünde, Westfallen, Germany.

6, Side view of imperfect loop of another specimen, hypotype USNM 550907a, showing inner hinge plates and incipient outer hinge plates, × 2. Oligocene, Bünde, near Osnabrück, Germany.

FIGURES 7, 8.—*Pliothyrina harmeri* (A. Bell): 7, Exterior of complete specimen, × 1, hypotype USNM 550908; 8, interior of dorsal valve of preceding specimen, × 2, showing conjunct inner hinge plates, and incipient outer hinge plates. Pliocene (Red Crag), Suffolk, England.

FIGURE 9.—*Pliothyrina orfordi* Muir-Wood: Posterior of interior of dorsal valve showing nearly conjunct inner hinge plates, × 2, hypotype USNM 550893. Pliocene (Coralline Crag), Suffolk, England.

FIGURES 10, 11.—*Apletosia maxima* (Charlesworth): Side and ventral views of interior of dorsal valve, × 1, showing wide loop, excessively long needle-sharp crural processes, inner hinge plates, and incipient outer hinge plates, hypotype USNM 109709a. Pliocene (Coralline Crag), Suffolk, England.

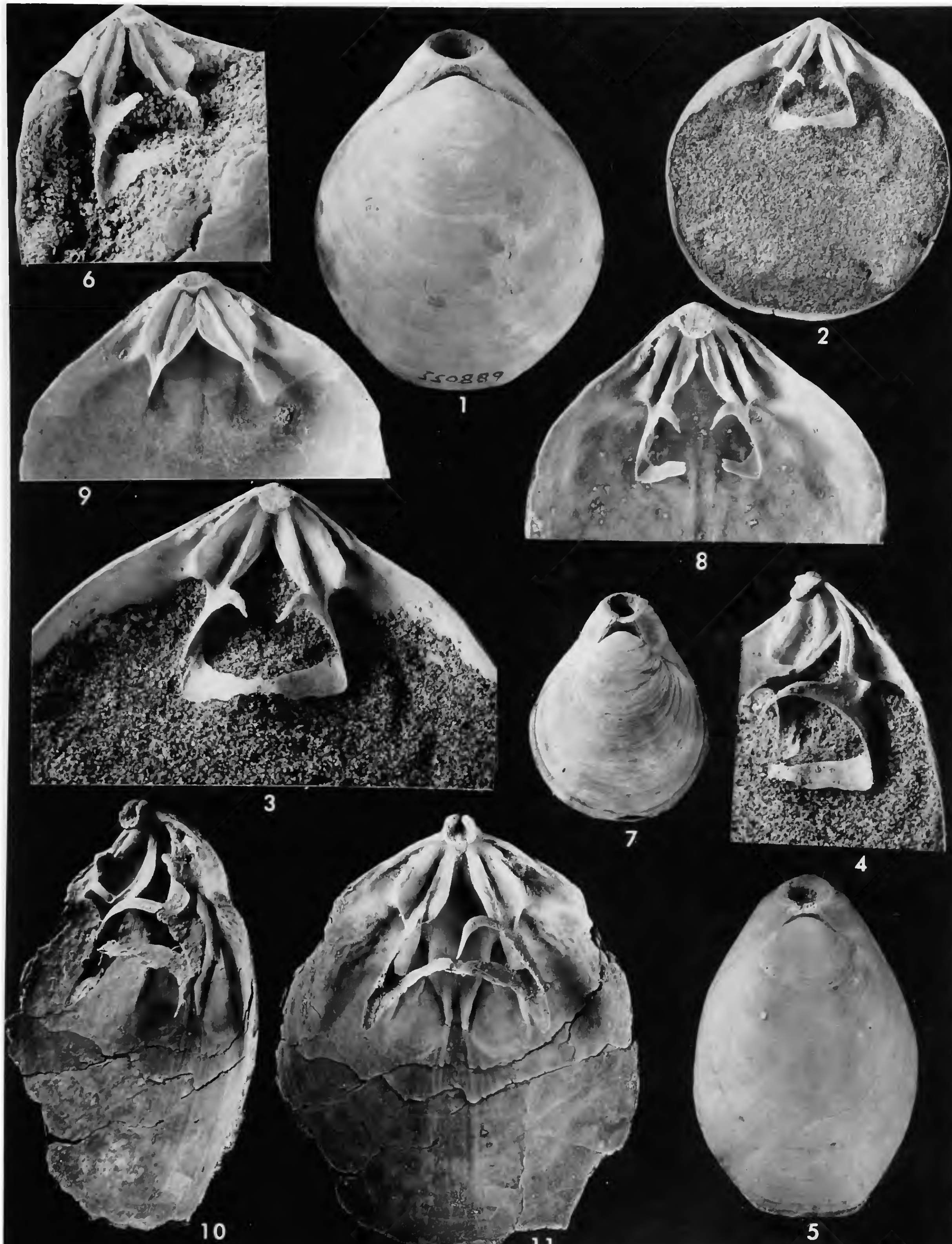


PLATE 6

FIGURES 1–14.—*Oleneothyris harlani* (Morton): 1–3, Anterior, side, and dorsal views, × 1, of large adult, hypotype USNM 559396a; 13, interior of fragmentary dorsal valve, × 1, showing thick, divided median ridge, hypotype USNM 559396b. Paleocene (Hornerstown Formation), tributary on W side of Crosswicks Creek, C.J. Lewis Farm, 2.6 miles (4.2 km) N of New Egypt, New Jersey.

4, 5, Ventral, and side views, × 1, of fragment showing imperfect loop, hypotype USNM 550910. Paleocene (Beaufort Formation), North Carolina highway 55 at Mosleys Creek, Lenoir-Craven County line, North Carolina.

6, 7, Side and ventral views of loop, × 1, hypotype USNM 559395b; 8, same, × 2, showing loop and cardinalia in more detail; 9, 10, side, and ventral views of another, narrower loop, × 1, hypotype USNM 559395a. Paleocene (Hornerstown Formation), 0.7 mile (1.1 km) NW of New Egypt, New Jersey.

11, Interior of dorsal valve, × 1, with divided median ridge, hypotype USNM 550912a; 14, same enlarged, × 2, to show narrow hinge plates and accessory denticle on inner wall of socket; 12, another dorsal valve interior, × 1, hypotype USNM 550912b. Paleocene (Hornerstown Formation), 0.6 mile (0.97 km) W of railroad station, New Egypt, New Jersey. (For view of young loop see Plate 31: figures 24, 25.)

FIGURES 15–28.—*Maltaia maltensis*, new species: 15–18, Side, anterior, ventral, and dorsal views, × 1, of complete sulciplicate specimen, paratype USNM 109710c; 19, 20, ventral and dorsal views, × 1, of cast of complete specimen, holotype USNM 551164a; 21–23, anterior, dorsal, and side views, × 1, of another complete specimen, paratype USNM 551164b; 24–28, ventral view × 1, and ventral, side, posterior views, and anteriorly tilted dorsal valve, × 2, showing wide loop with protuberant transverse band, holotype USNM 551164c (cast in figures 19 and 20 are of this specimen). Miocene, Island of Malta.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28

PLATE 7

FIGURES 1–5.—*Dolichosina oamarutica* (Boehm): 1, Dorsal view, × 1, of complete specimen, hypotype USNM 550915b; 2, interior, × 1, of specimen preserving loop, hypotype 550915a; 3, 4, ventral and side views, × 2, of preceding specimen; 5, interior, × 2, of another specimen smaller than preceding, hypotype USNM 87396. Oligocene (Upper Ototaran – McDonald Consolidated Zone), Everetts Quarry, Kakanui, New Zealand.

FIGURES 6–16.—*Plicatoria wilmingtonensis* (Lyell and Sowerby): 6–8, Side, dorsal, and anterior views, × 1, of large, characteristic specimen, hypotype USNM 549389d; 12, interior of dorsal valve, × 2, showing form of cardinal process and rare coalescing inner hinge plates, hypotype USNM 550389g; 13, 14, posterior part of dorsal valve in ventral and side views showing loop, × 1, × 2, with elongated outer hinge plates, hypotype USNM 549389a; 15, ventral view of posterior part of another dorsal valve, × 1, hypotype USNM 549389b. Eocene (Castle Hayne Formation), rock quarry, Wilmington, North Carolina.

9, Interior of dorsal valve, × 3, showing long outer hinge plates and well-developed, nearly coalesced inner hinge plates, hypotype USNM 550914b; 10, 11, side and ventral views of large individual showing loop with elongate outer hinge plates, × 2, hypotype USNM 550894a; 16, interior of another specimen showing long, wide, outer hinge plates, × 2, hypotype USNM 550914a. Eocene (Castle Hayne Formation), Ideal Cement Company quarry, S of junction of Island Creek with Northeast Cape Fear River, 34°22′30″N, 77°50′00″W, Scotts Hill and Mooretown (7½′) quadrangles, North Carolina.

FIGURES 17–28.—*Tanyoscapha sigmanae*, new species: 17–19, Side, dorsal, and anterior views, × 1, of medium-sized specimen, paratype USNM 550913a; 20–22, dorsal, anterior, and ventral views, × 1, of large specimen, holotype USNM 550911a; 23, dorsal view of cast of complete specimen excavated to show loop, paratype USNM 550911e; 24, dorsal valve of preceding paratype showing an old, thickened loop, × 1; 25, 27, ventral and side views of preceding, × 2, showing loop in more detail; 26, posterior of another dorsal valve, × 2, showing long, wide, outer hinge plates, paratype USNM 550913h; 28, posterior of young specimen, × 2, showing immature loop with long outer hinge plates, paratype USNM 550913i. Eocene (Castle Hayne Formation) 34°07′N, 77°55.8′W, due E of Campbell Island, and due W of Mott Creek, Wilmington (7½′) quadrangle, North Carolina.

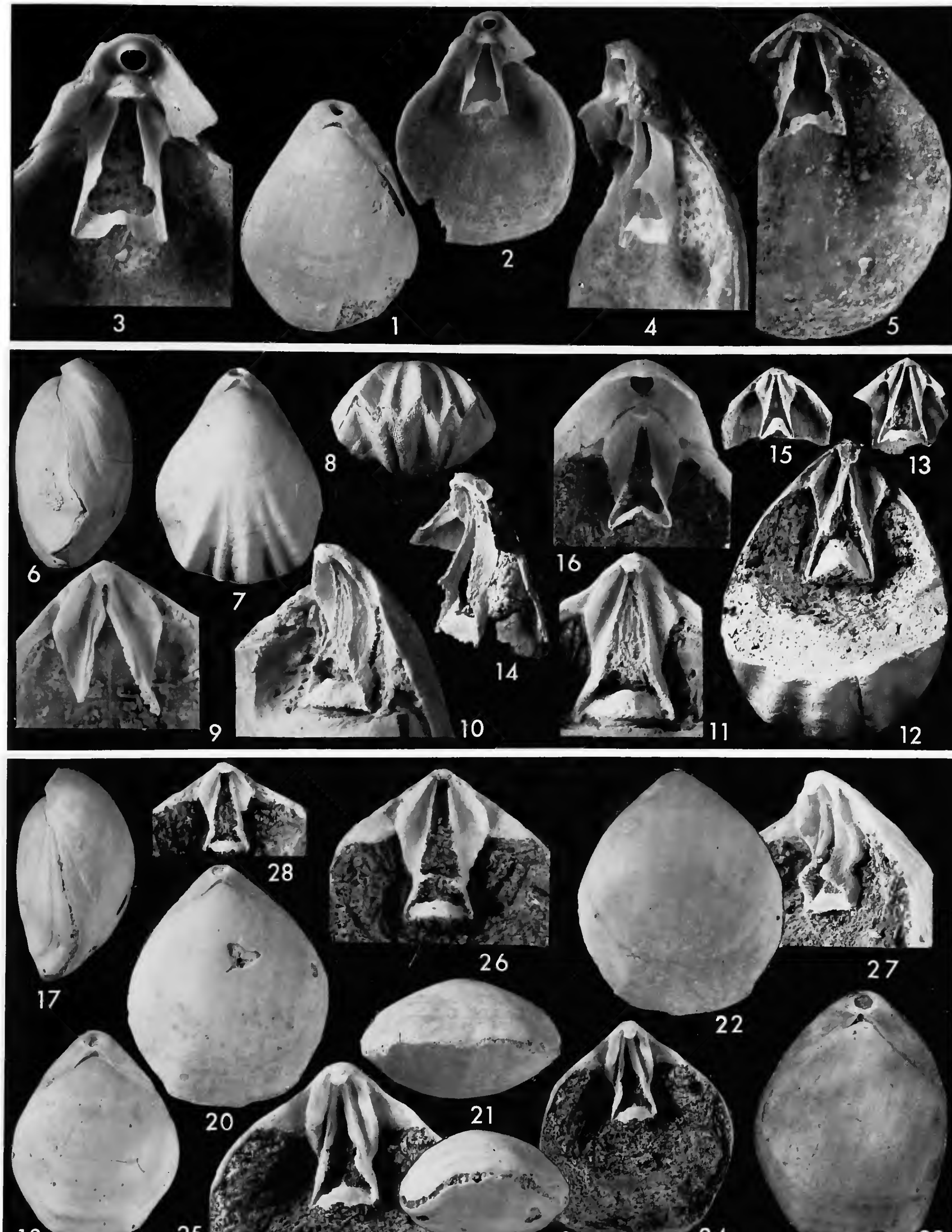

3
1
2
4
5
6
7
8
9
10
14
16
15
13
11
12
17
28
26
22
27
20
21
18
25
19
24
23

PLATE 8

FIGURES 1–5.—*Eurysina bullisi* (Cooper): 1–3, Dorsal. anterior, and side views, × 1, of holotype USNM 550609a; 4, 5, side and ventral views, × 2, of loop, paratype USNM 550609b, showing wide crural base. Recent, at 110 fms (= 201 m), 12°28′N, 82°28′W, off Nicaragua.

FIGURES 6–10.—*Eurysina minor* (Philippi): 6–8, Dorsal, side, and anterior views, × 1, of complete specimen, hypotype USNM 109749a. Recent, off Sardinia.

9, 10, Ventral and side views, × 3, of loop, hypotype USNM 109754a. Recent, Adriatic. (No more specific data.)

FIGURE 11.—*Liothyrella vitrioides* (Tenison-Woods): Interior of dorsal valve showing wide loop and crural processes at junction with outer hinge plates, × 2, hypotype USNM 87466. Miocene, Table Cape, Tasmania.

FIGURE 12.—*Eurysina minor* (Philippi): interior of dorsal valve, × 3, showing mineralized loop, hypotype USNM 550916. Pliocene, Rometta, Messina, Sicily.

FIGURES 13–16.—*Acrobrochus tateana* (Tenison-Woods): 13, 14, side and dorsal views of complete young specimen, × 1, hypotype USNM 87467a; 15, 16, side and ventral views, × 2, of dorsal valve interior showing loop, hypotype USNM 87467b. Miocene, Morgan, South Australia.

FIGURES 17–21.—*Liothyrella notorcadensis* (Jackson): 17, 18, side and dorsal views of large specimen, × 1, hypotype USNM 550917. Recent, at 30 m, 64°36′S, 64°03′29″W, Arthur Harbor, Antarctica.

19 and upper 21, Ventral and side views of loop, × 2, hypotype USNM 550895a. Recent, at 25–55 m, *Hero* Cruise 731, Station 1912, 64°46′53″S, 64°03′35″W, to 64°46′52″S, 64°04′04″W, off Palmer Peninsula, Antarctica.

20 and lower 21, Ventral and side views, × 3, of loop, showing forward position of crural processes and lack of definable crura, hypotype USNM 550918a. Recent, at 20–200 m, near Palmer Research Station, Arthur Harbor, Antarctica.

FIGURES 22–27.—*Liothyrella "uva"* (Broderip): 22–24, Anterior, side, and dorsal views of complete specimen, × 1, hypotype USNM 550493; 25, dorsal valve interior, × 1, of same specimen; 26, 27, side and ventral views of dorsal valve interior, × 2, of same specimen showing wide loop, narrow transverse band, and lack of crura. Recent, at 424–428 m, 47°09′S, 60°38″W, ENE of Puerto Desado, Argentina.

FIGURE 28.—*Acrobrochus aldingi* (Tate). Interior of dorsal valve, × 3, hypotype USNM 550919a. Miocene (Aldingian), Aldinga, South Australia.

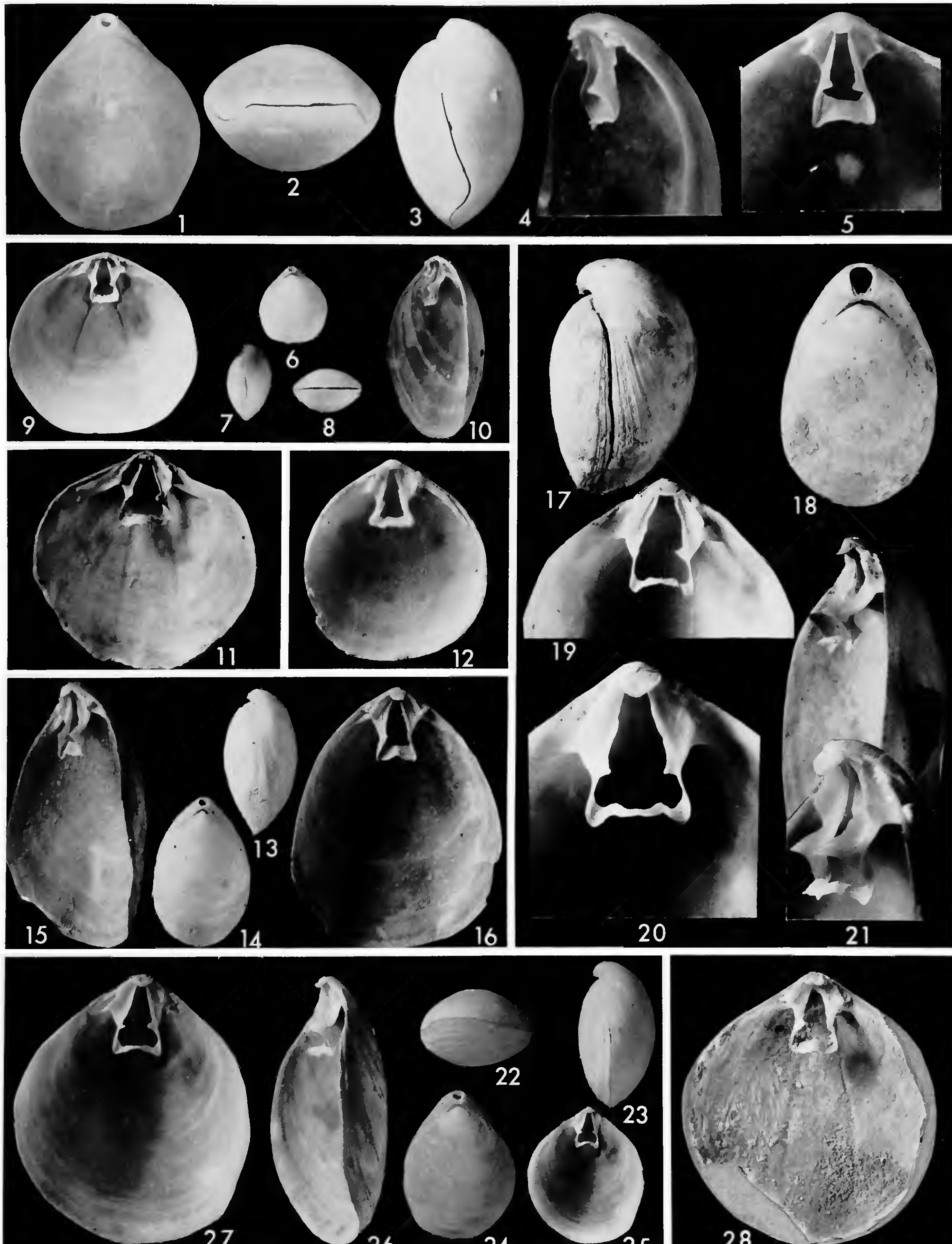

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28

PLATE 9

FIGURES 1–5.—*Acrobrochus vema* (Cooper): 1–3, Anterior, side, and dorsal views of complete specimen, × 1, paratype 550480b; 4, ventral view of dorsal valve, × 1, × 2, showing narrow loop, holotype USNM 550480a; 5, side view of same, × 2. Recent, at 1814–1919 m, 55°44'S, 55°39'W, off E end of Burdwood Bank, Argentina.

FIGURES 6–11.—*Eurysina plicata* (Cooper): 6–8, Side, dorsal, and anterior views, × 1, of complete specimen showing strong anterior plication, holotype USNM 550607a; 10, 11, interior of dorsal valve, × 2, showing wide, stout loop, paratype USNM 550607e. Recent, at 56 fms (= 102 m), 10°52'N, 68°08'W, off Puerto Cabello, Venezuela.

9, Interior of another dorsal valve, × 2, hypotype USNM 550588. Recent, at 93–115 m, 10°32'N, 60°23'W, off east coast of Trinidad.

FIGURES 12–14, 17.—*Stenosarina expansa* (Cooper): 12–14, Anterior, side, and dorsal views, × 1, of holotype USNM 550610; 17, ventral view of dorsal valve interior of holotype, × 2. Recent, at 300 fms (= 549 m), R/V *Silver Bay* Station 3499, 20°44'N, 73°43'W, S side of Great Inagua, Caribbean.

FIGURES 15, 16.—*Tichosina* species: Ventral and side views of loop of small specimen formerly referred to *S. expansa* but without deep reentrant and sharp anterolateral points of transverse band, × 1.5, USNM 550770. Recent, at 353–348 meters, 21°02'N, 86°24'W, Yucatan Channel, Mexico.

FIGURES 18–22.—*Eurysina? bartletti* (Dall): 18–20, Anterior, dorsal, and side views, × 1, of holotype showing strong anterior folding, USNM 110852. Recent, at 73 fms (= 134 m), off Barbados.

21, 22, Side and ventral views of dorsal valve, × 2, showing loop with long crura, hypotype USNM 549393a. Recent, at 140 fms (= 256 m), Johnson-Smithsonian Expedition Station 102, 18°05'N, 64°33'W, SE of St. Thomas, West Indies.

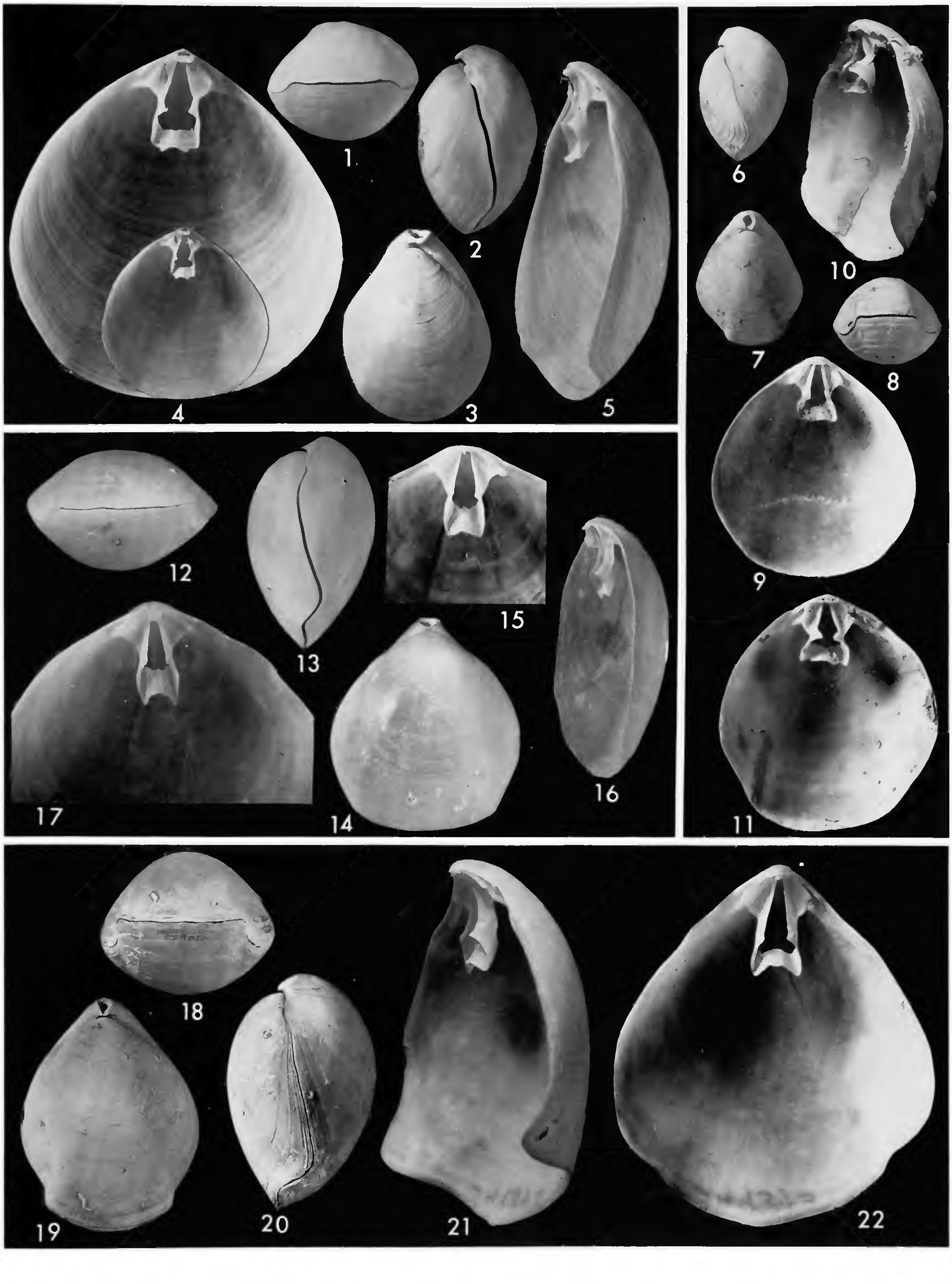

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

PLATE 10

FIGURES 1–12.—*Gryphus vitreus* (Born): 1–3, Anterior, side, and dorsal views of average specimen, × 1, hypotype USNM 109734a (note small foramen). Recent, Bay of Naples, Mediterranan.

4, 5, Ventral and side views of dorsal valve showing narrow loop with narrow, rounded crura and rounded anterolateral extremities, × 2, hypotype USNM 109770. Recent, off Sardinia, Mediterranean.

6, 7, Ventral and side views, × 2, of another dorsal valve showing broad transverse band of loop, rounded crura, narrow hinge plates and scooplike form, hypotype USNM 550824a; 8, loop, × 3, of another individual showing lateral indentations of transverse band setting off short terminal points, hypotype USNM 550824b. Recent, at 150 m, off Calvi, Corsica, Mediterranean.

9, Immature dorsal valve, × 4, showing not yet completed loop, hypotype USNM 550920. Recent, at 500–509m, 23°57′N, 15°08.2′E, Mediterranean, off Libya.

10–12, Interior of three dorsal valves, × 4, having complete but immature loops, hypotypes respectively USNM 109717c,b,a. Recent, at 346 fms (= 633 m), Porcupine Station 26, off Portugal.

FIGURES 13–19.—*Dallithyris murrayi* Muir-Wood: 13–15, Side, anterior, and dorsal views, × 1, of typical specimen, hypotype USNM 550332b; 16, 18, ventral and side views, × 1, of dorsal valve interior, hypotype USNM 550332a; 17, 19, same views of same dorsal valve, × 2, showing narrow crura, broad flattened outer hinge plates and spatulate form of loop in side view. Recent, *John Murray* Expedition Station 157, 4°43′48″N, 72°55′24″E, to 4°44′00″N, 72°54′18″E, off Maldive Islands, Indian Ocean.

FIGURES 20–27.—*Dysedrosia borneoensis* (Dall): 20–23, Posterior, side, dorsal, and anterior views of holotype, × 1, USNM 229297a; 24, interior of holotype, × 1; 25–27, ventral, side, and posteriorly tilted views of same dorsal valve, × 2, showing broad outer hinge plates, broad crural base, and broad transverse band. Recent, at 305 fms (= 558 m). U.S. Bureau of Fisheries (*Albatross*) Station 5592, 4°12′44″N, 118°27′44″E, off Silungan Island, Sibuku Bay, Borneo.

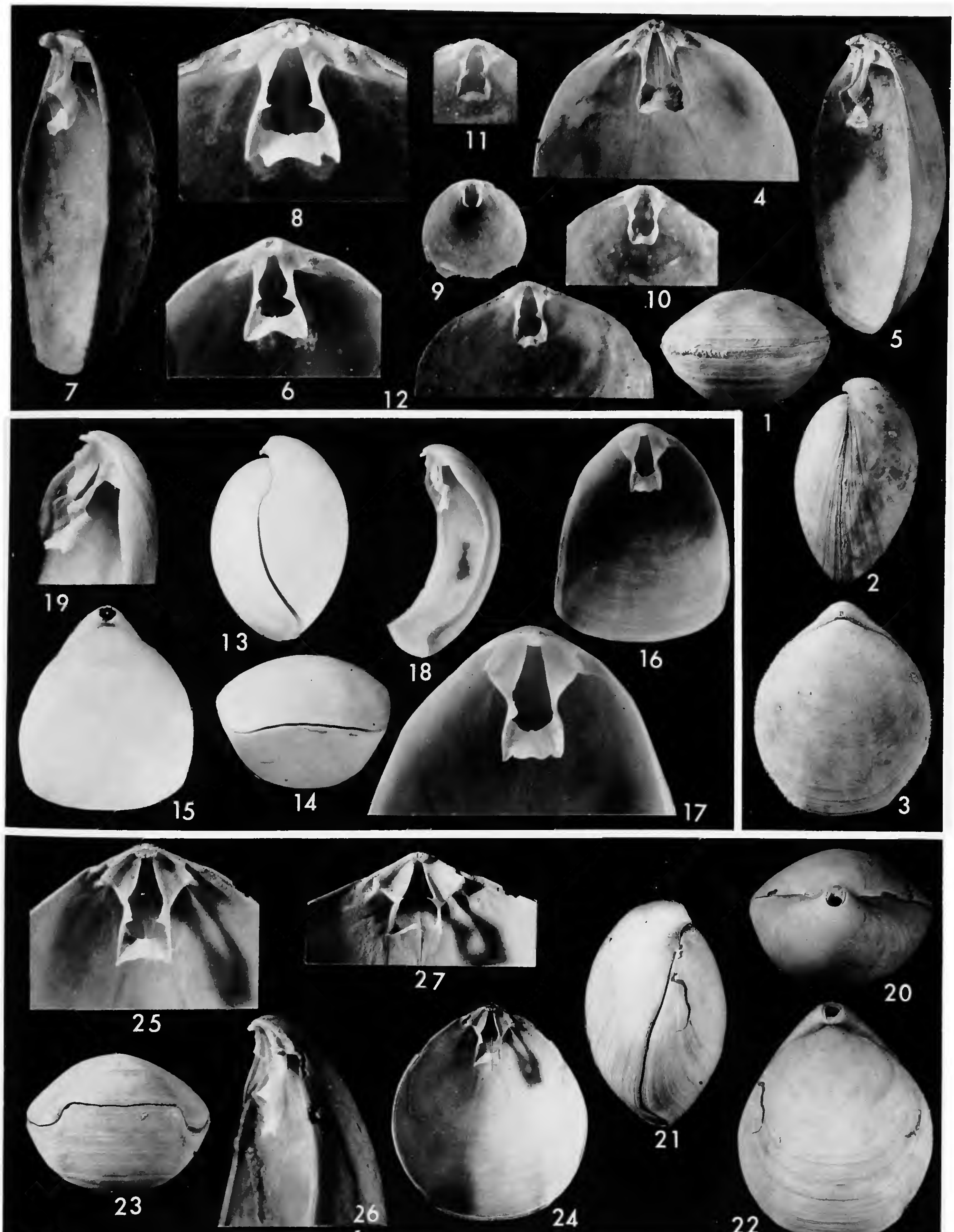

7
8
11
4
5
9
10
6
12
1
19
13
18
16
2
15
14
17
3
25
27
20
21
23
26
24
22

PLATE 11

FIGURES 1, 2.—*Liothyrella antarctica* (Blochmann): Ventral and side views, × 2, of dorsal valve showing wide loop with narrow transverse band, hypotype USNM 550040A. Recent, at 165 m, 74°39′S 165°52′E, off Cape Washington, Ross Sea, Antarctica.

FIGURES 3–7.—*Tichosina subtriangulata* Cooper: 3–5, Dorsal, side, and anterior views, × 1, of complete individual, paratype USNM 226290-5; 6, 7, ventral and side views, × 2, of dorsal valve showing loop, paratype USNM 226290a. Recent, at 220–225 fms (= 403–412 m), R/V *Fishhawk* Station 6070, Mayaguez Harbor, E ⅝, S, 9 miles (14.6 km) Puerto Rico.

FIGURES 8–12.—*Eurosyna pillsburyi* (Cooper): 8–10, Anterior, dorsal, and side views, × 1, of complete specimen, paratype USNM 550622c; 11, 12, side and ventral views of dorsal valve interior, × 2, of preceding specimen (note point on posterior side of transverse band). Recent, at 165–130 m, R/V *Pillsbury* Station 1387, 18°21.4′N, 69°08.7′W, off San Pedro de Macoris, Dominican Republic.

FIGURES 13–19.—*Eurysina dubia* (Cooper): 13–15, Anterior, side, and dorsal views, × 1, of complete individual, paratype USNM 550603; 17, loop, × 2, of preceding specimen. Recent, at 46–50 m, R/V *Pillsbury* Station 658, 07°10′N, 53°36′W, NNE of Mano, French Guiana.

16, Loop of another individual, × 2, paratype USNM 64261. Recent, at 250 fms (= 458 m), R/V *Blake* Station 147, 17°19′27″ N, 62°15′30″W, off W side of St. Christopher (= St. Kitts), West Indies.

18, 19, Side and ventral views of stout loop, × 2, paratype USNM 550614a. Recent, at 100 fms (= 183 m), R/V *Oregon II* Station 10513, 08°26′N, 58°11′W, N of Georgetown, Guyana.

FIGURES 20–22.—*Tichosina bahamiensis* Cooper: 20, Dorsal view of complete specimen, × 2, paratype USNM 87378c; 21, 22, side and ventral views of loop, × 3, paratype USNM 87378g. Recent, at 338 fms (= 619 m), R/V *Albatross* Station 2655, 27°22′N, 78°07′30″W, N of Grand Bahama Island.

FIGURES 23–27.—*Tichosina cubensis* (Pourtales): 23–25, Dorsal, anterior, and side views of complete specimen, × 1, hypotype USNM 149405. Recent, Straits of Florida (depth not given). (Note similarity in shape and profile to those of *Dallithyris*.)

26, 27, Side and ventral views, × 2, of loop, hypotype USNM 64624. Recent, at 175 fms (= 320 m), R/V *Blake* Station 167, 16°09′40″N, 61°29′25″W, S of Guadaloupe, West Indies. (Note differences of loop from those of *Dallithyris*.)

FIGURES 28–35.—*Eurysina ovata* (Cooper): 28–30, Anterior, side, and dorsal views, × 1, of strongly uniplicate individual, paratype USNM 549434b; 31, loop, × 2, showing broad transverse band, and wide outer hinge plates, paratype USNM 549434o; 32, 35, posterior of dorsal valve and side view of another specimen showing outer hinge plates narrower than preceding, and showing dorsad attachment of outer hinge plates, paratype USNM 549434m; 33, 34, ventral and side views of another dorsal valve showing dorsad attachment of outer hinge plates, × 2, × 3, paratype USNM 549434m. Recent, at 200 fms (= 366 m), *Oregon* Station 1408, 28°02′N, 90°15′W, S of New Orleans, Gulf of Mexico.

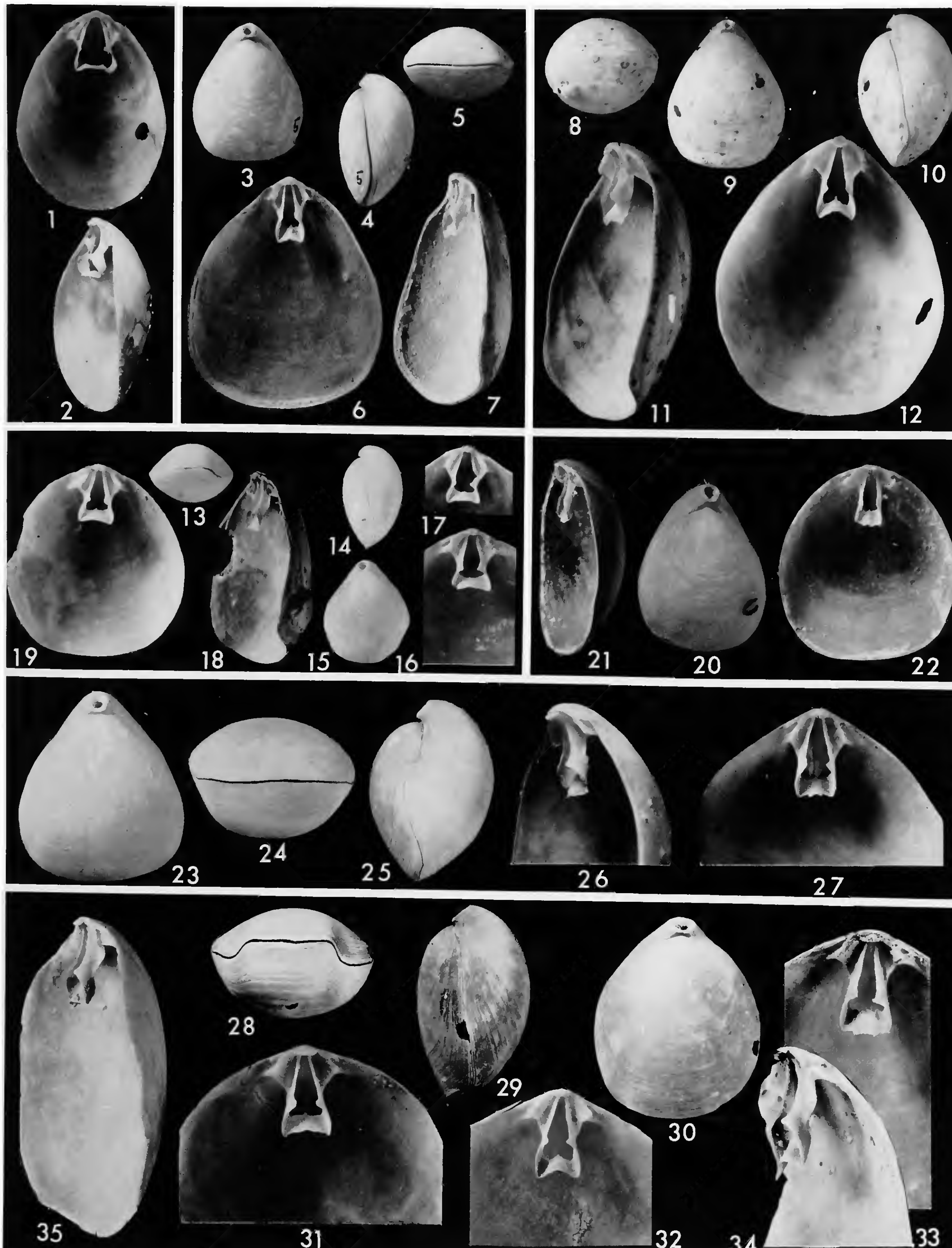

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35

PLATE 12

FIGURES 1–5.—*Acrobrochus blochmanni* (Jackson): 1–3, Dorsal, side, and anterior views of complete specimen, × 1, hypotype USNM 550001b; 4, 5, ventral and side views, × 2, of loop, hypotype USNM 550001-1. Recent, Harvard University locality HU 32-51, at 2275–2342m, 74°05.6′S, 175°05.2′W to 74°06.5′S, 174°57.8′, Antartica.

FIGURES 6–10.—*Pycnobrochus pulchrus* (Thomson): 6–8, Side, dorsal, and anterior views, × 1, showing strong biplicate folding, hypotype USNM 550921b; 9, 10, side and ventral views of stout loop, × 2, hypotype USNM 549585. Oligocene (Whaingaroan), Trig M, near Totara, Otago, New Zeland.

FIGURES 11, 12.—*Liothyrella "uva"* (Broderip): Side and ventral views of dorsal valve interior, × 2, showing wide loop, and crural processes at junction with outer hinge plates, hypotype USNM 180851. Recent, off Guyaquil, Ecuador (no depth recorded).

FIGURES 13, 14.—*Liothyrella uva georgiana* Foster: Side and ventral views of dorsal valve interior, × 2, showing short, stout loop, holotype USNM 550017A. Recent, at 220–320 m, University of Southern California Station 671, 54°41′S, 38°38′W to 54°38′S, 38°31′W, Antarctica.

FIGURES 15–20.—*Dolichozygus stearnsi* (Dall and Pillsbry): 15–17, Anterior, side, and dorsal views, × 1, of complete individual, hypotype USNM 549451; 18, interior of dorsal valve of preceding, × 1; 19, 20, loop, × 2, of preceding specimen, showing narrow, nearly parallel sides, long outer hinge plates, and broad transverse band. Recent, Sagami Bay, Kanagawa Prefecture, Japan.

FIGURES 21, 22.—*Liothyrella? clarkeana* (Dall): 21, Dorsal view, × 4, of complete specimen, hypotype USNM 110742. Recent, at 2035 fms (= 3724 m), U.S. Fish Commission (*Albatross*) Station 4709, 10°15′S, 95°41′W, SW of Galapagos.

22, Interior of dorsal valve, × 3, holotype USNM 107275. Recent, at 1175 fms (= 2150 m), U.S. Fish Commission (*Albatross*) Station 3362, 05°56′N, 85°10′30″W, off Cocos Island, Gulf of Panama.

FIGURES 23–26.—*Tichosina truncata* Cooper: 23, 24, Dorsal and side views, × 1, paratype USNM 550587. Recent, at 308–329 m, R/V *Pillsbury* Station P594, 21°0.5′N, 86°23′W, SW side of Yucatan Channel, Mexico.

25, 26, Ventral and side views of dorsal valve interior, × 2, showing loop with broad transverse band, holotype USNM 550524a. Recent, at 353–348 m, R/V *Pillsbury* Station P548, 21°02′N, 86°24′W, SW side of Yucatan Channel, Mexico.

FIGURES 27–31.—*Gryphus? martinicensis* Dall: 27–29, Side, dorsal, and anterior views of round species, × 1, holotype USNM 64255; 30, 31, side and ventral views of dorsal valve of holotype, × 2, showing narrow crura and scooplike form of loop. Recent, at 169 gms (= 309 m), R/V *Blake* Station 193, 14°43′48″N, 61°11′25″W, off Martinique, West Indies.

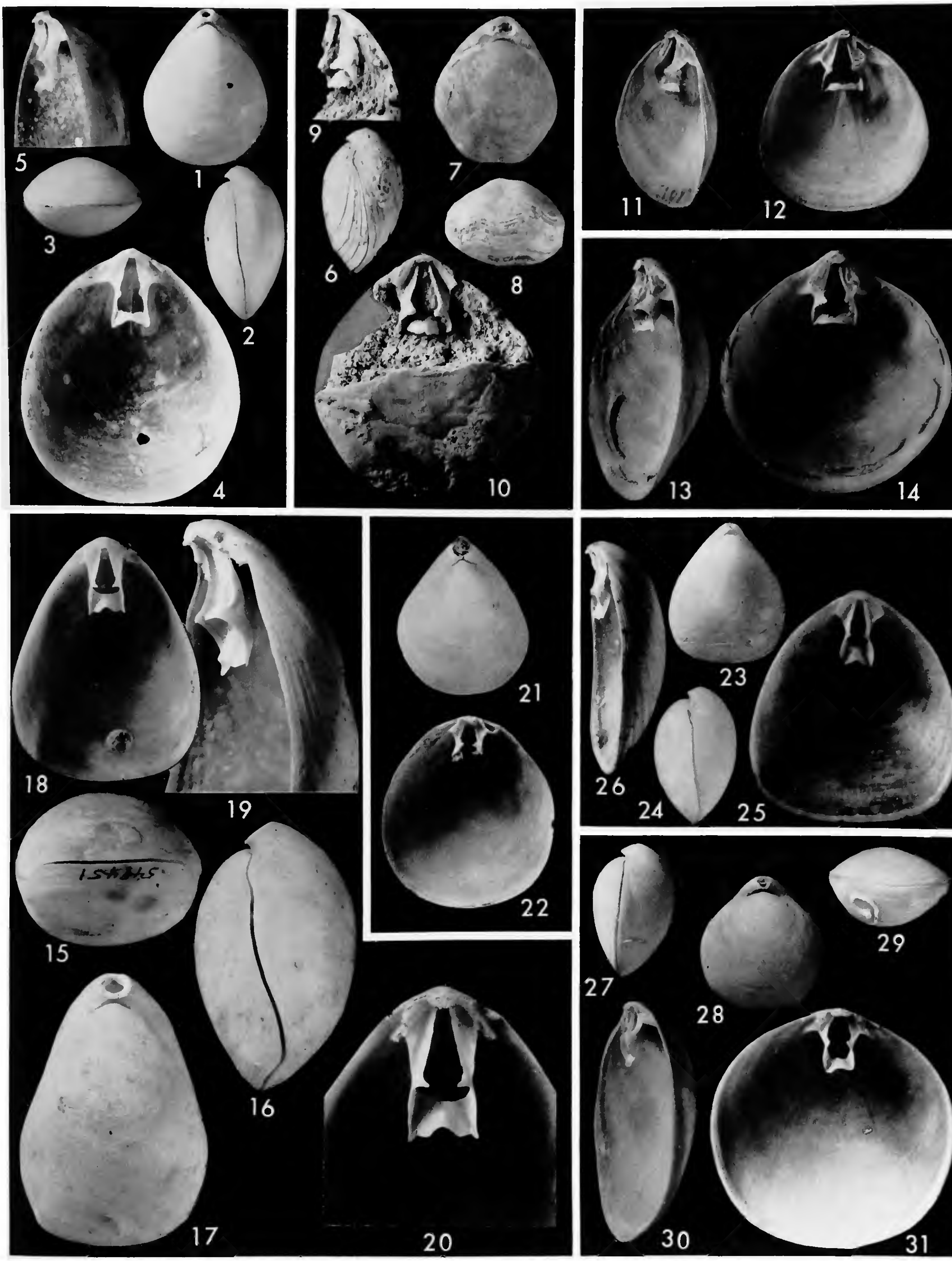

5
1
3
2
4
9
7
6
8
10
11
12
13
14
18
19
15
16
17
21
22
20
26
23
24
25
27
28
29
30
31

PLATE 13

FIGURES 1–8.—*Eurysina solida* (Cooper): 1–3, Side, dorsal, and anterior views, × 1, of holotype USNM 549433a; 4, interior of dorsal valve, × 1, paratype USNM 549433b; 5, same specimen enlarged, × 2, showing broad transverse band. Recent, at 125 fms (= 229 m), Sand Key, Florida.

7, 8, Partial side views, × 2, of dorsal valve having pathologic loop, × 2, paratype USNM 550619; 6, same in ventral view, × 3. Recent, at 291–302 m, R/V *Gerda* Station G1029, 24°17′N, 81°11′W, SW of Key West, Straits of Florida, Florida.

FIGURES 9–14.—*Xenobrochus*? *affinis* (Calcara): 9–11, Side, dorsal, and anterior view, × 1, of full-grown specimen, hypotype USNM 109758a. Recent, Bay of Naples, Mediterranean.

12, 13, Interior of dorsal valve in side and ventral views, × 2, hypotype USNM 109763; 14, same enlarged, × 3, showing anterior bend of transverse band with posteromedian projection. Recent, at 100 fms (= 183 m), Benzert Roads, Tunis, Tunisia.

FIGURES 15–20.—*Eurysina labiata* (Cooper): 15–17, Dorsal, side, and anterior views, × 1, holotype USNM 550577a; 18, interior of dorsal valve of holotype, × 1; 19, 20, ventral and side views, × 2, of dorsal valve interior of holotype. Recent, at 231–258 m, R/V *Pillsbury* Station P876, 13°13.9′N, 61°04.7′W, off E side of St. Vincent, West Indies.

FIGURES 21–25.—*Tichosina rotundovata* Cooper: 21–23, Anterior, side, and dorsal views, × 1, holotype USNM 550526f; 24, 25, ventral and side views, × 2, of dorsal valve interior, paratype USNM 550526a. Recent, at 201–210 m, R/V *Gerda* Station 482, 24°29′N, 80°54′W to 24°32′N, 80°48′W, E of Key West, Florida.

FIGURES 26–29.—*Tichosina erecta* Cooper: 26, Dorsal view of complete specimen, × 1, holotype USNM 550525a; 27, 28, ventral and side views, × 2, of dorsal valve interior, paratype USNM 550525d; 29, loop of another dorsal valve, × 3, paratype USNM 550525c. Recent, at 622–695 m, R/V *Gerda* Station 694, 26°28′N, 78°40′W to 26°27′N, 78°43′W, off Grand Bahama Island.

FIGURES 30–34.—*Tichosina floridensis* Cooper: 30–32, Anterior, side, and dorsal views, × 1, paratype USNM 550737-20; 33, 34, ventral and side views, × 2, of dorsal valve showing loop with broad transverse band, paratype USNM 550738b. Recent, at 65 fms (= 119 m), R/V *Oregon* Station 1025, 25°13′N, 83°55′W, W of Cape Sable, Gulf of Mexico, Florida.

FIGURES 35–39.—*Eurysina obesa* (Cooper): 35–37, Anterior, dorsal, and side views, × 1, of complete specimen, paratype USNM 550541b. Recent, at 60–73 m, R/V *Pillsbury* Station 737, 10°44′N, 66°07′W to 10°45′N, 66°08′W, NE of Caracas, Venezuela.

38, 39, Ventral and side views, × 3, of interior of dorsal valve showing wide, stout loop, paratype USNM 550585e. Recent, at 60–80 m, R/V *Pillsbury* Station P734, 11°01′N, 65°43.7′W to 11°01′N, 65°36.3′W, W side of Isla Tortuga, Venezuela.

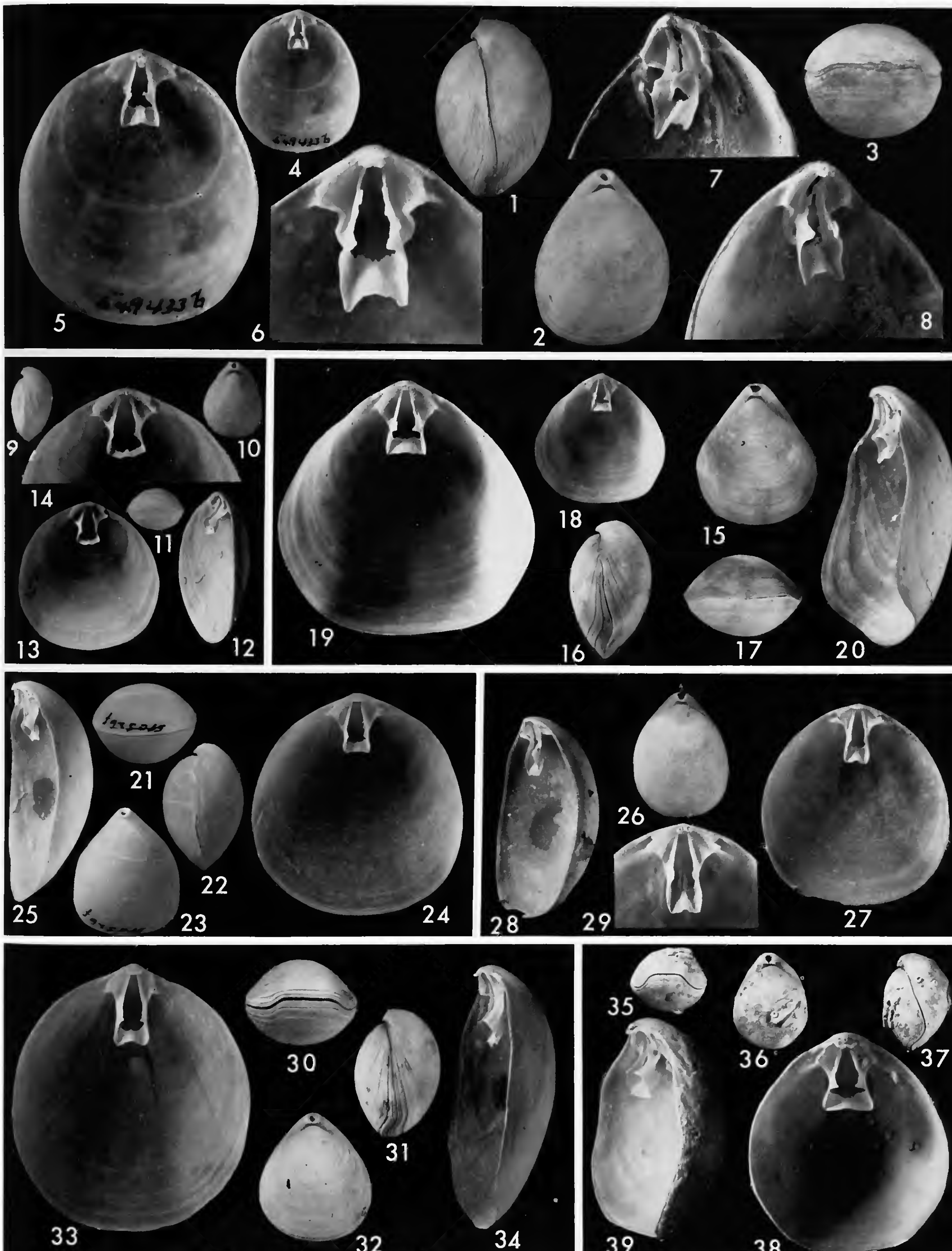

5
4
6
1
7
3
2
8
9
10
14
11
12
13
19
18
15
16
17
20
25
21
22
23
24
28
26
29
27
33
30
31
32
34
35
36
37
39
38

PLATE 14

FIGURES 1–7.—*Stenobrochus crosnieri*, new species: 1–3, Side, dorsal, and ventral views, × 1, of complete specimen, holotype USNM 550923a; 4, 5, ventral and side views, × 2, of narrow, pointed, scooplike loop, showing narrow crura, paratype USNM 550923c; 6, loop of another paratype USNM 550923b, with serrate anterior margin; 7, loop enlarged, × 3, showing broad, flat outer hinge plates, paratype USNM 550923d. Recent, at 430–700 m, 13°45′S, 47°38.5′E, off N end of Madagascar (Malagasy Republic).

FIGURE 8.—*Epacrosina* species: Interior of dorsal valve, × 2, showing long, narrow loop, and long outer hinge plates, USNM 550924. Recent, at 640 m, HMAS *Kimbla*, 39°45.3′S, 148°54′E, Bass Strait, off SE Australia.

FIGURES 9–14.—*Stenosarina sphenoidea* (Philippi): 9–11, Dorsal, side, and anterior views, × 1, of complete individual, hypotype USNM 109702a; 13, 14, ventral and side views, × 3, showing long, slender loop, hypotype USNM 109702b. Pliocene, Rometta, Messina Province, Sicily.

12, Interior of dorsal valve of young specimen, × 2, hypotype USNM 550943. Pliocene (Lower), Milazzo, Messina Province, Sicily.

FIGURES 15–19.—*Stenosarina? sphenoidea* (Jeffreys) (not Philippi): 15–17, Side, dorsal, and anterior views, × 1, of complete specimen, hypotype MNHN-Bra-78-57. Recent, at 1331 m, 47°41.8′N, 08°18.7′W, Bay of Biscay, France.

18, 19, Ventral and side views of dorsal valve, × 3, showing narrow loop, hypotype USNM 130335. Recent, at 277 fms (= 507 m), Bay of Biscay, France.

FIGURES 20–24.—*Epacrosina fulva* (Blochmann): 20–22, Anterior, side, and dorsal views, × 1, of complete specimen, hypotype USNM 550925a. Recent, at 128 m, B.A. N.Z. A.R.E. Station 15, 41°03′S, 148°65′(sic)E, NE of Tasmania, Bass Strait.

23, 24, Ventral and side views of dorsal valve, × 2, showing loop with broad transverse band, hypotype USNM 333011. Recent, at 90–150 fms (= 165–275 m), off Cape Everard, Australia.

FIGURES 25–29.—*Epacrosina? elongata* (Cooper): 25–27, Anterior, dorsal, and side views, × 1, holotype USNM 550664; 28, 29, interior of dorsal valve of holotype, × 2, showing tapered loop with rounded anterolateral extremities. Recent, at 350 fms (= 641 m), R/V *Combat* Station 450, 23°59′N, 79°43′W, N of La Isabella, Cuba.

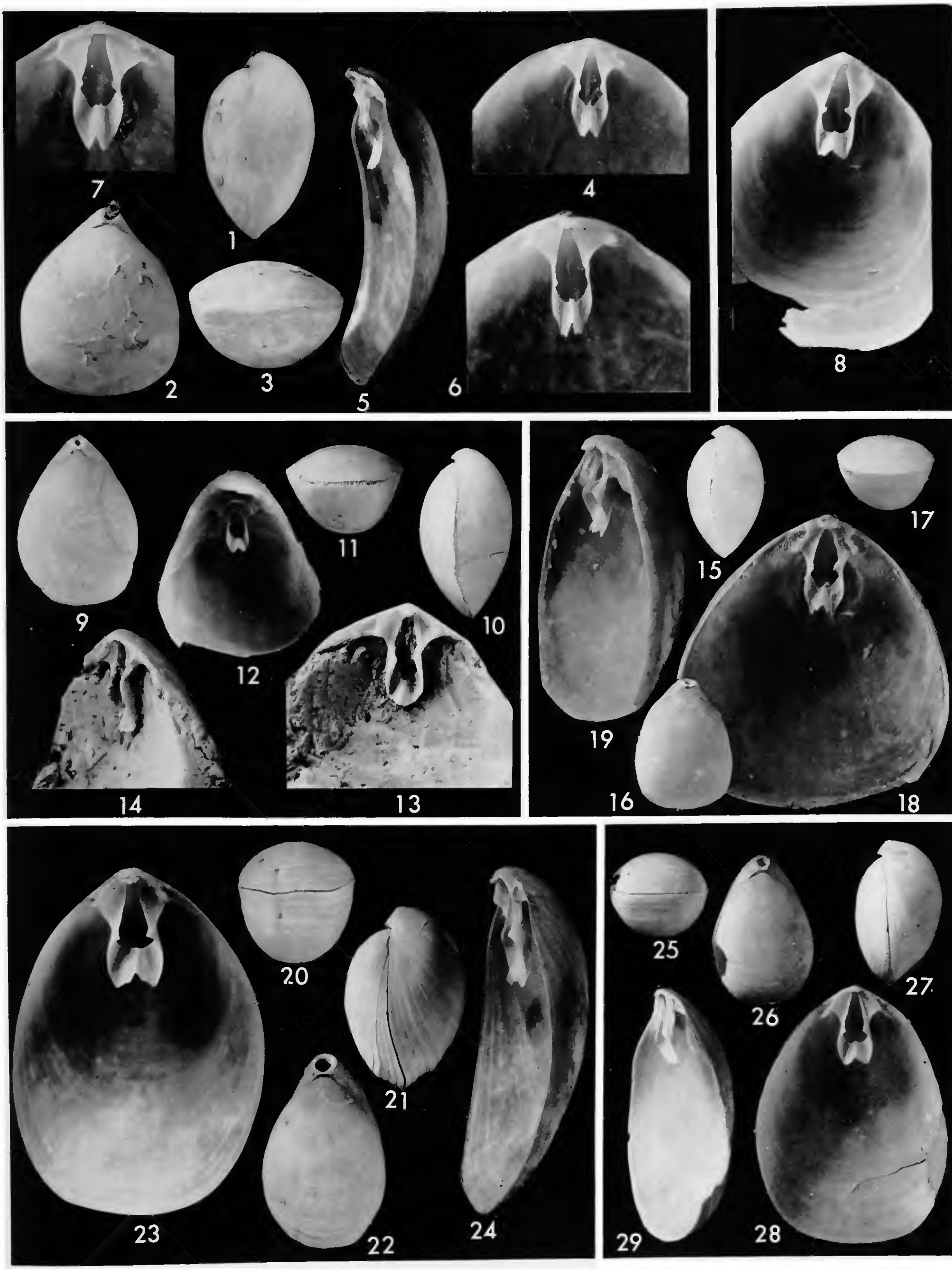


PLATE 15

FIGURES 1-4, 7, 8.—*Stenosarina nitens* Cooper: 1-4, Dorsal, posterior, anterior, and side views, × 1, of complete specimen showing typical form, holotype USNM 550763; 7, side view, × 2, of dorsal valve interior of holotype showing narrow form of loop; 8, ventral view of same loop, × 3, showing narrow, tapering form. Recent, at 332 fms (= 608 m), R/V *Oregon* Station 5927, 15°36′N, 61°13′W, on NW side of Island of Dominica.

FIGURE 5.—*Stenosarina oregonae* Cooper: Side view of holotype, × 1, USNM 550595a. Recent, at 210 fms (= 384 m), R/V *Oregon* Station 4574, 23°13′N, 87°50′W, in Campeche Shelf, NW of Cape San Antonio, west end of Cuba.

FIGURES 6, 9.—*Stenosarina angustata* Cooper: Interior of dorsal valve, × 3, × 1, showing narrow, tapering loop, holotype USNM 550594. Recent, at 205 fms (= 375 m), R/V *Oregon II* Station 11163, 24°18′N, 87°50′W, on Campeche Shelf, N of Yucatan Peninsula, Mexico.

FIGURES 10-15.—*Najdinothyris becksi* (Roemer): 10-12, Side, anterior, and dorsal views, × 1, of complete specimen having shape like that of *Stenosarina*, hypotype USNM 550926a; 13, interior of dorsal valve, × 1, showing long slender loop, hypotype USNM 550927a; 14, 15, ventral and side views, of preceding specimen, × 3. Cretaceous (Turonian - Galeriten Beds), Graes, near Ahaus, Germany.

FIGURES 16, 17.—*Najdinothyris* species: Ventral and side views, × 3, of small specimen showing long slender loop, USNM 550928a. Cretaceous (Turonian), quarry in east outskirts of Wüllen, Germany, S of Entschede, Netherlands.

FIGURES 18-20, 24-26.—*Erymnia angustata* Cooper: 18-20, Anterior, dorsal, and side views, × 1, holotype USNM 550608; 24, 25, ventral and side views, × 2, of dorsal valve interior of holotype showing slender loop supported by struts; 26, same as preceding, × 1. Recent, at 100-200 fms (= 183-366 m), R/V *Silver Bay* Station 3494, 23°36′N, 75°25′W, off Rum Cay, Bahama Islands.

FIGURES 21-23, 27-33.—*Erymnia muralifera* Cooper: 21-23, Anterior, side, and dorsal views, × 1, of large paratype USNM 550578. Recent, at 205-380 m, R/V *Pillsbury* Station P991, 18°47′N, 64°46.8′W, N of Virgin Islands, West Indies.

27, 28, Side and ventral views, × 3, of dorsal valve interior, showing loop with supporting struts, holotype USNM 550520; 29, dorsal valve of holotype tipped toward posterior to show supporting struts, × 2; 33, interior of dorsal valve of holotype, × 1. Recent, at 555-575 m, R/V *Gerda* Station G695, 26°28′N, 78°37′W to 26°28′N, 78°43′W, off Grand Bahama Island.

30, Side view, × 2, of loop of another dorsal valve showing struts, paratype USNM 550624. Recent, at 366-275 m, R/V *Gerda* Station G704, 26°29′N, 78°40′W, S side of Grand Bahama Island.

31, 32, Ventral and tilted views of dorsal valve with broken loop showing supporting struts, × 2, paratype USNM 550523. Recent, at 522-489 m 26°27′N, 78°40′W, S side of Grand Bahama Island.

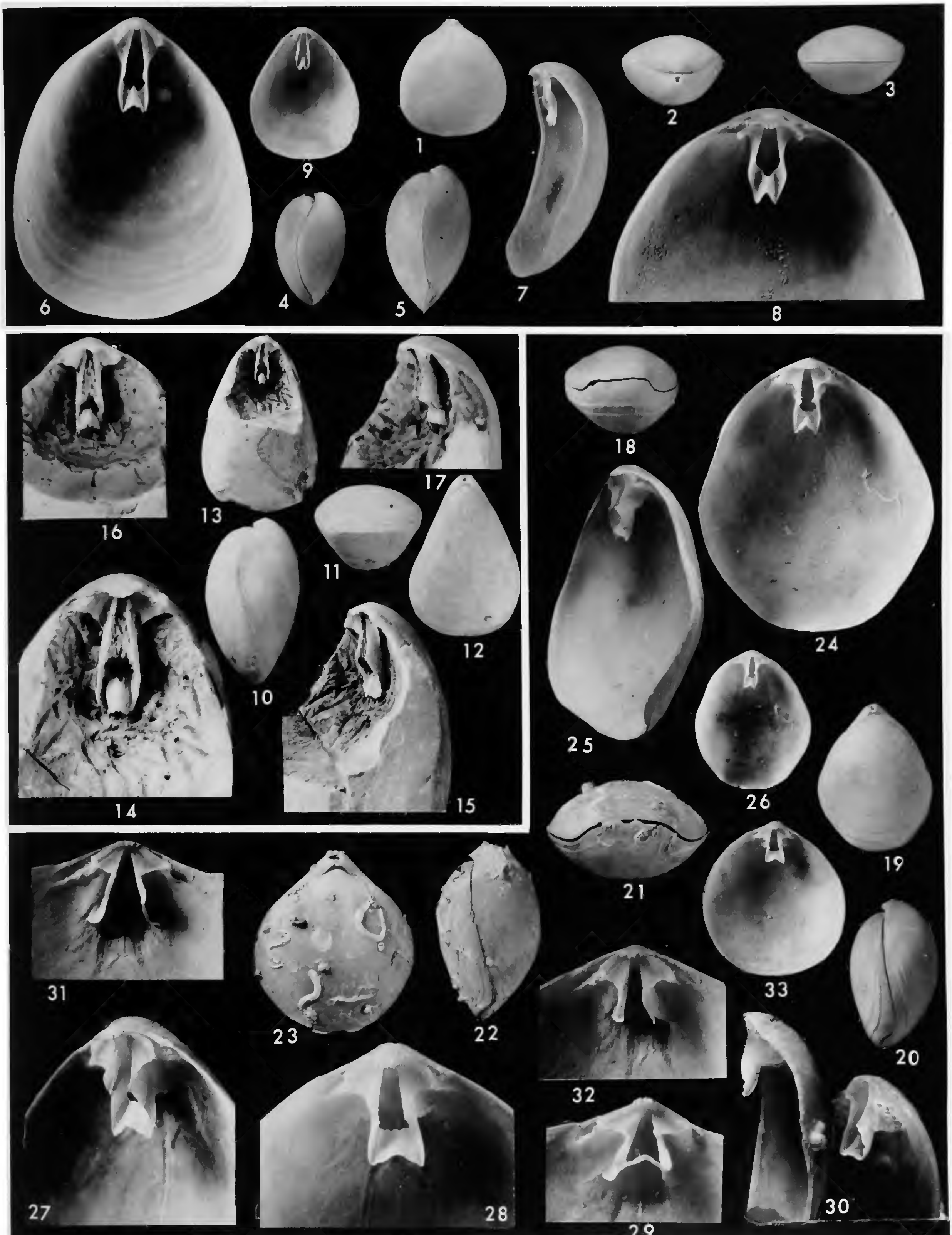

6
9
1
7
2
3
4
5
8
16
13
17
18
24
11
12
10
14
15
25
26
19
21
31
23
22
33
20
32
27
28
29
30

PLATE 16

FIGURES 1–5.—*Tanyoscapha glabra*, new species: 1–3, Anterior, side, and dorsal views, × 1, of holotype USNM 549430a; 4, 5, ventral and side views, × 2, of loop showing long outer hinge plates, paratype USNM 549430e. Eocene (Castle Hayne Formation – basal Bryozoan Member), island in lower Cape Fear River, 11 miles (17.7 km) S of Wilmington, North Carolina.

FIGURES 6–10.—*Mimorina ziczac*, new name: 6, Dorsal view of large specimen, × 1, hypotype USNM 551091a; 7, ventral view, × 1, of preceding specimen excavated to show the loop; 8, 9, partial side and ventral views of same loop, × 2; 10, exterior of another specimen showing zigzag capillae × 3, hypotype USNM 551140. Pliocene (Opoitian), Mamoe-a-Toa, Chatham Island, E of New Zealand.

FIGURES 11–18.—*Mimorina skinneri* (Allan) (= *M. ziczac*, new name): 11–13, Dorsal, anterior, and side views of complete specimen, × 1, hypotype USNM 551114c; 14, dorsal view of another specimen, × 1, hypotype USNM 551114a; 15, ventral, view, × 1, of preceding excavated to show loop; 16, 17, ventral and partial side views, × 2, of preceding loop; 18, cardinalia in ventral view, × 2, hypotype USNM 549581a. Geologic occurrence and locality as above.

FIGURE 19.—*Abyssothyris elongata* (Cooper): Side view of tightly coiled lophophore, × 2.5, USNM 550437a. Recent, at 3601–3687 m, 31°19.7′N, 119°35.5′W to 31°08.2′N, 119°35.5′W, off Baja, California, Mexico.

FIGURES 20–22.—*Sellithyris?* species: 20, Specimen in ventral view showing excavated loop, × 1, USNM 550937; 21, 22, side and ventral views of same specimen, × 2, showing loop with rounded anterolateral extremities. Cretaceous (Aptian – Hythe) Willesborough Pit, SE of Ashford, Kent, England.

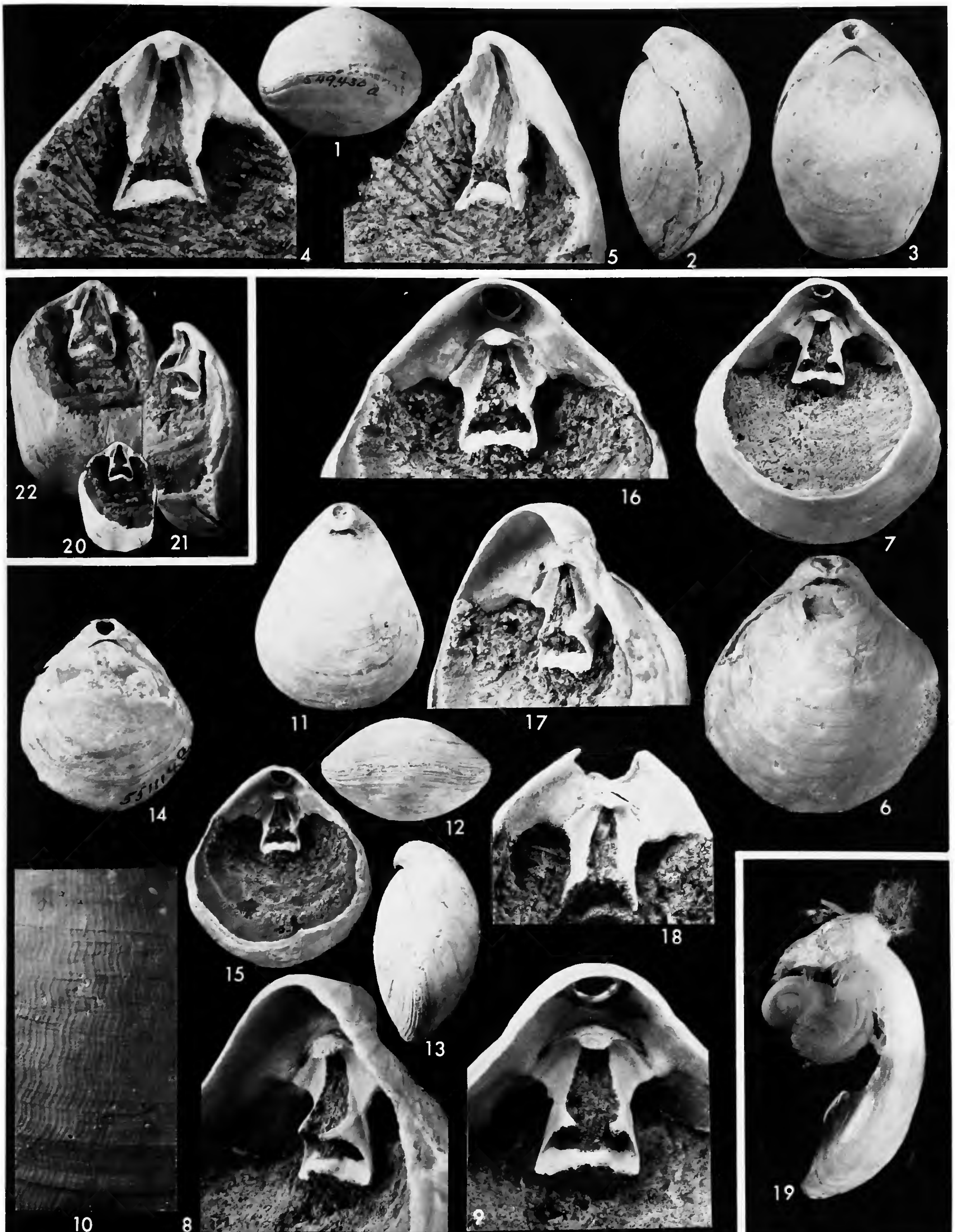

1
4
5
2
3
22
20
21
16
7
11
17
14
12
6
15
18
13
19
10
8
9

PLATE 17

FIGURES 1–3.—*Eurysoria robusta*, new species: Side, anterior, and dorsal views of complete specimen, × 1, holotype USNM 550571 (note resemblance to *Waconella*). Cretaceous (Lower), at Kent, E of Van Horn, Texas.

FIGURES 4–15.—*Eurysoria compressa*, new species: 4–6, dorsal, anterior, and side views, × 1, of holotype USNM 550567a; 7, holotype, × 2, showing large foramen; 8–10, dorsal, side, and anterior views, × 1, of paratypye USNM 550567e; 11, 12, specimen excavated to show squat form of loop, × 1, × 2, paratype 550567d. Cretaceous (Edwards Formation), 3 miles (4.8 km) NE and 1.5 (2.4 km) miles N of Oglesby, Coryell County, Texas.

13, Loop of another excavated specimen, × 1, paratype USNM 550566a; 14, 15, Ventral and side views of same specimen, × 2, showing loop in more detail. Cretaceous (Edwards Formation – *radiolites* Bed), Bluff Creek, 4 miles (6.4 km) NW of Crawford, McLennan County, Texas.

FIGURES 16–27.—*Hesperosia vespertina* (Cooper): 16–18, Anterior, dorsal, and side views, × 1, of holotype USNM 124194b; 19, dorsal view, × 2, of complete individual, showing loop, paratype USNM 124187; 20, 21, same specimen as preceding, × 1, × 3, showing natural size and loop in more detail; 22, ventral view of another dorsal interior, × 3, paratype USNM 124218; 23, interior of young specimen, × 3, paratype USNM 124196c; 24, dorsal view of specimen with pathologic loop, crural processes having fused, × 3, paratype USNM 124195a; 25, exterior, × 1, of large specimen, paratype USNM 124194c; 26, 27, side and ventral views of large specimen, × 4, showing loop, paratype USNM 124195. Cretaceous (Mural Formation), small hill, 0.2 mile (0.3 km) E of U.S. Highway 80, NW¼, SW¼, NE¼ section 36, T. 23 S., R. 25 E., opposite mouth of Glance Canyon, 3 miles (4.8 km) E of Glance and 12.7 miles (20.4 km) WNW of Douglas, Bisbee quadrangle, Cochise County, Arizona.

FIGURES 28–35.—*Aphragmus sohli*, new species: 28–30 Anterior, dorsal, and side views, × 1, of complete specimen, holotype USNM 550931a; 31–33, ventral view of loop, × 1, and ventral and side views, × 2, showing its narrow form, paratype USNM 550931d; 34, 35, ventral and side views of another specimen showing loop, × 2, paratype USNM 550931c, which has narrower anterior than preceding (See Plate 56, for further enlargements). Cretaceous (Cenomanian lower part of sand with *Catopygus obtusus* in the *Metacoceras gourdoni* Zone), Colline de la Goupillerie, Le Mans Area, France.

FIGURES 36–41.—*Hadrosia convexa*, new species: 36–38, Dorsal, side, and anterior views, × 1, of complete specimen showing strongly convex valves, holotype USNM 550930a; 39, another specimen, × 1, with exposed loop, paratype USNM 550930e; 40, 41, side and ventral views of same specimen, × 2, showing loop in detail. Cretaceous (Valanginian), Peyroules, Basse Alpes, France.

FIGURE 42.—*Nerthebrochus robertoni* (d'Archiac): Partial side view of dorsal valve interior showing loop with outer hinge plate dorsally attached to crural base, × 2, hypotype USNM 550945b. Cretaceous (Tourtia), Tournay, Belgium. (See Plate 21: figures 7–11, for other views.)

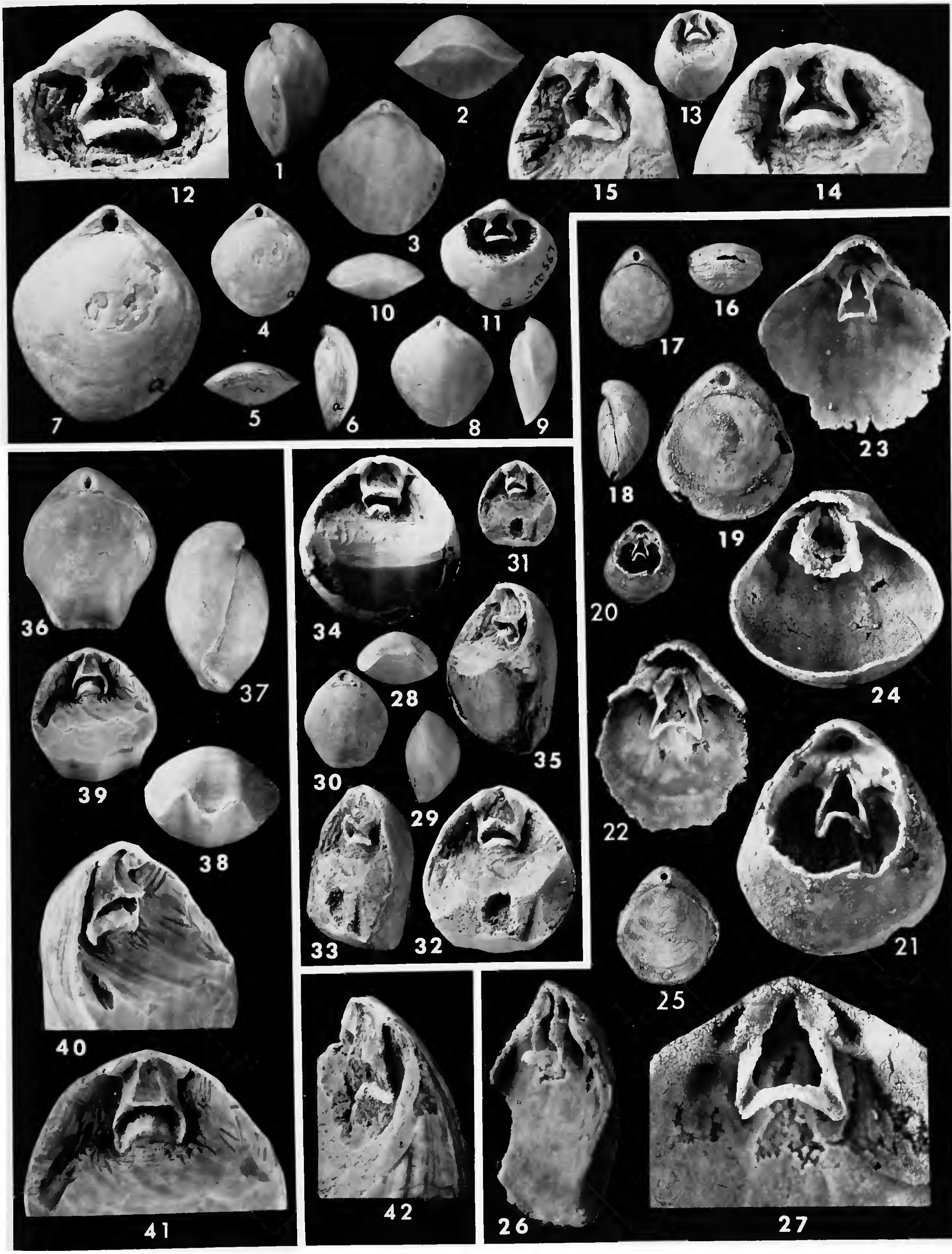


PLATE 18

FIGURES 1–12.—*Dilophosina paraplicata*, new species: 1–3, Side, anterior, and dorsal views, × 1, of complete specimen, holotype USNM 550932a; 5, loop, × 1, paratype USNM 550932d; 6, 7, ventral and side views, × 2, of preceding; 8, same, × 3, showing hinge plates in detail; 10, loop of another dorsal valve, × 1, paratype USNM 550932b; 11, 12, ventral and side views of the same, × 2. Cretaceous (Cenomanian), quarry 200 m SW of Billot, on E side of road from Billot to Notre Dame de Fresnay, 23 kms SW of Lisieux, Calvados, France.

4, Dorsal view of another complete specimen, × 1, hypotype USNM 104651a. Cretaceous (Cenomanian), Vaches Noir, Calvados, France.

9, Interior of dorsal valve showing loop, × 1, hypotype USNM 550933b. Cretaceous (Cenomanian), Villers-sur-Mer, Calvados, France. (Note external similarity to *Harmatosia*, Plate 19: figures 13–22.)

FIGURES 13–15.—Triassic Genus and Species Undetermined 1: 13, Dorsal view of exterior of specimen, × 1, with short, wide loop; 14, 15, ventral view, × 1, × 2, showing the wide loop, USNM 551163. Triassic, Cape Kekurnoi, Cold and Alinchak Bays, Alaska.

FIGURES 16–21.—*Loriolithyris valdensis* (Loriol): 16–18, Anterior, side, and dorsal views, × 1, hypotype USNM 550938a; 19, excavated loop, × 1, hypotype USNM 550938c; 20, 21, side and ventral views of preceding specimen, × 2, showing loop. Cretaceous (Valanginian), quarry on N side of road between St. Cerque and Arzier, Switzerland.

FIGURES 22–31.—*Sellithyris sella* (Sowerby): 22–24, Dorsal, side, and anterior views of typical specimen, × 1, hypotype USNM 77493. Cretaceous (Aptian), Isle of Wight, England.

25, 26, Dorsal and anterior views of large individual, × 1, hypotype USNM 550934. Cretaceous (Aptian - Hythe), Willesborough Pit, SE of Ashford, Kent, England.

27, Specimen showing excavated loop, × 1, hypotype USNM 550935; 28, 29, same specimen in ventral and partial side views, × 2. Cretaceous (Aptian - Fitton's Group IV), 200 yards (182 m) W of Whale Chine, Isle of Wight, England.

30, 31, Ventral views of another specimen with excavated loop, × 1, × 2, hypotype USNM 550936. Cretaceous (Aptian) Atherfield, Isle of Wight, England.

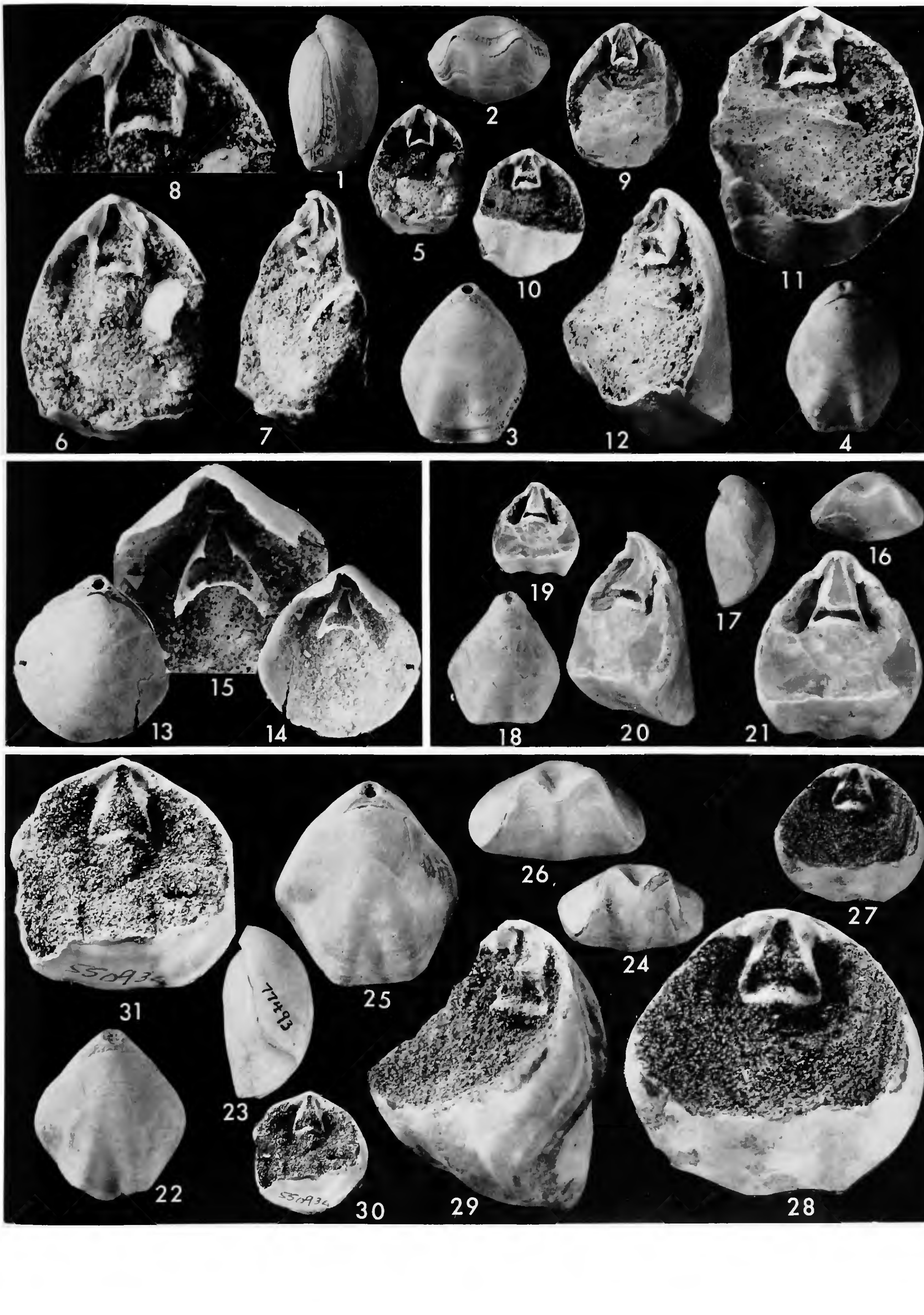

8
1
2
9
5
10
11
6
7
3
12
4
15
13
14
19
16
17
18
20
21
31
25
26
27
24
23
22
30
29
28

PLATE 19

FIGURES 1–6.—*Neoliothyrina obesa* Sahni: 1–3, Side, dorsal, and anterior views, × 1, of complete specimen, hypotype USNM 75697c; 4, 5, side and ventral views, × 2, of excavated loop showing modest development of inner hinge plates, hypotype USNM 75697b; 6, ventral view of another specimen with loop excavated, showing lesser development of inner hinge plates than preceding, × 2, hypotype USNM 75697a. Cretaceous (Senonian – *B. mucronata* Zone), Norwich, Norfolk, England.

FIGURE 7.—*Neoliothyrina? "obesa"* Sahni: Interior of dorsal valve with cardinalia excavated, × 2, showing coalesced inner hinge plates, hypotype USNM 550939b. Cretaceous (Maastrichtian), Nasitow, near Pulway, Poland.

FIGURES 8–12.—*Rhombothyris microtrema* (Walker): 8–10, Anterior, side, and dorsal views, × 1, of elongate individual, hypotype USNM 550940a; 11, 12, interior of preceding specimen, × 1, × 2, showing poorly preserved loop. Cretaceous (Aptian Lower Greensand), Upware, Cambridge, England.

FIGURES 13–22.—*Harmatosia crassa* (d'Archiac): 13–15, Side, anterior, and dorsal views, × 1, of complete specimen, hypotype USNM 550941a (compare this exterior with that of *Dilophosina* on Plate 18); 19, specimen with excavated loop, × 1, hypotype USNM 550941b; 20, 21, side and ventral views of preceding specimen, × 2, showing loop; 22, same loop, × 3, showing coalesced inner hinge plates. Cretaceous (Cenomanian), Mühlheim, Germany.

16–18, Side, anterior, and dorsal views, × 1, another complete specimen, USNM 550942. Cretaceous (Greensand), Essen, Germany.

FIGURES 23, 24.—*Cyrtothyris cyrta* (Walker): 23, Dorsal view of complete specimen, × 1, with outlines restored, hypotype USNM 551154; 24, ventral and side views of preceding specimen, × 1, with loop exposed. Cretaceous (Aptian – Lower Greensand), Upware, Cambridge, England.

FIGURES 25–29.—*Aniabrochus comptonensis* (Middlemiss): 25–27, Anterior, side, and dorsal views, × 1, of complete specimen, hypotype USNM 550944a; 28, 29, another hypotype, × 1, × 2, with loop excavated, hypotype USNM 550944b. Cretaceous (Aptian – Lower Greensand), Brickhill, Buckinghamshire, England. (Compare this loop with those of *Capillithyris* and *Capillarina* that are said to belong to *Platythyris* (= *Aniabrochus*) by Cox and Middlemiss (1978); for side view of loop and capillae of *Aniabrochus* see Plate 61: figures 14, 15.)

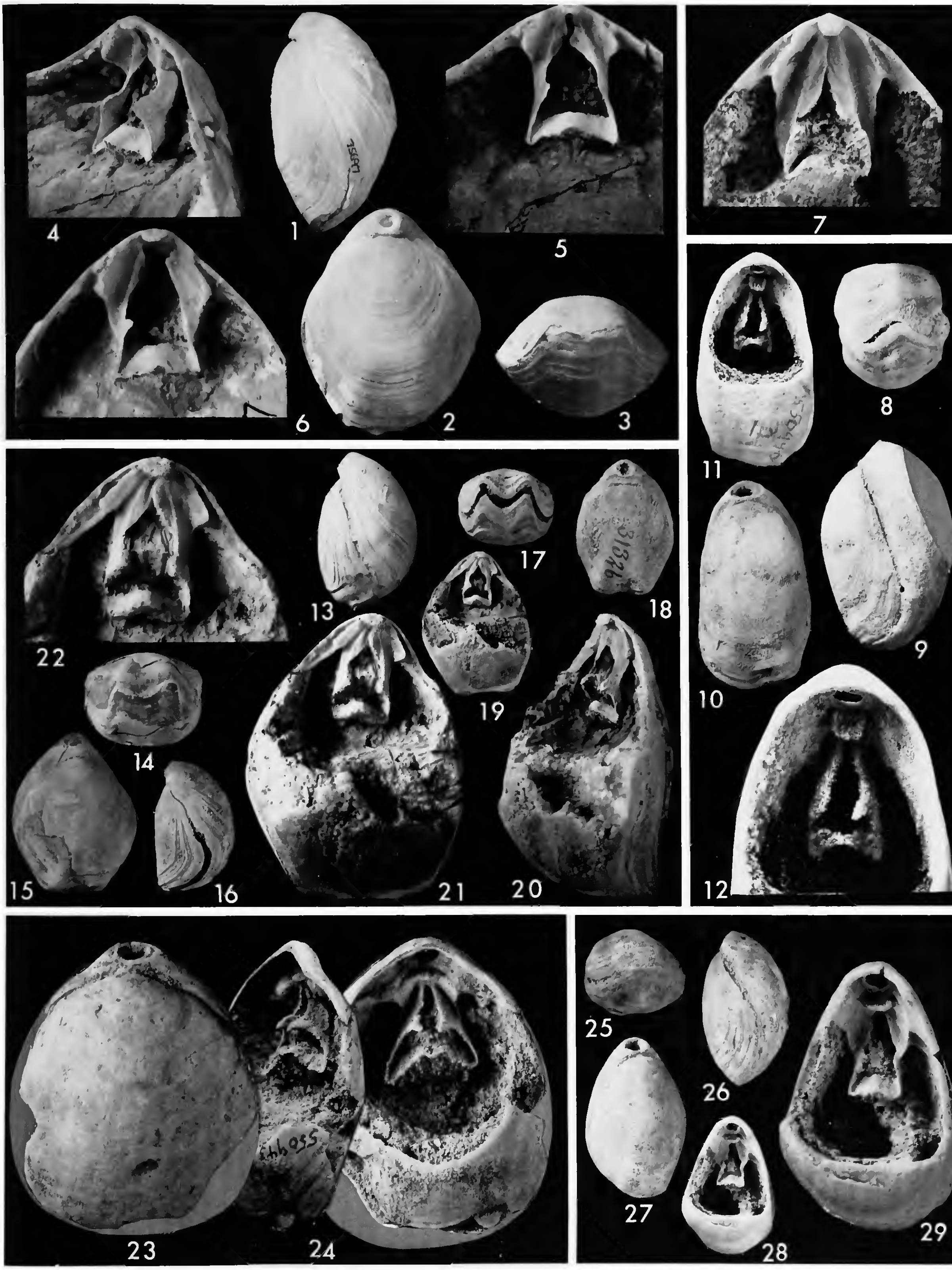

4
1
5
7
6
2
3
11
8
10
9
12
22
13
17
18
19
14
15
16
21
20
23
24
25
26
27
28
29

PLATE 20

FIGURES 1–6.—*Chatwinothyris ciplyensis* Sahni: 1–3, Side, dorsal, and anterior views, × 1, of complete specimen, hypotype USNM 104846a; 4, ventral view of another specimen excavated to show loop, × 1, hypotype USNM 104846b; 5, 6, ventral and side views of preceding, × 2, showing loop, large cardinal process, broad crural base, and crural processes. Cretaceous (Maastrichtian - Crai Phosphaté), Ciply, Belgium.

FIGURES 7–12.—*Sellithyris* aff. *S. phaseolina* (Lamarck): 7–9, Anterior, dorsal, and side views, × 1, of complete specimen, hypotype USNM 551116c; 10, specimen excavated to show loop, × 1, hypotype USNM 551116a; 11, 12, side and ventral views of preceding hypotype, × 3. Cretaceous (Turonian), 20 m NW of cemetery on NW edge of Bousse, 8 kms (airline) N of La Fleche, Sarthe, France.

FIGURES 13–20.—*Boubeithyris boubei* (d'Archiac): 13–15, Anterior, dorsal, and side views of young specimen, × 1, hypotype USNM 551097a; 16, 17, dorsal and side views of large specimen, × 1, showing symphytium, hypotype USNM 551097b; 18, interior of dorsal valve showing loop, × 1, hypotype USNM 551097c; 19, 20, side and ventral views of preceding, × 2. Cretaceous (Tourtia), Tournay, Hainaut, Belgium.

FIGURES 21–27.—*Biplicatoria hunstantonensis*, new species: 21–23, Dorsal, side, and anterior views, × 1, of holotype USNM 64628a; 24, dorsal view of another specimen, × 1, paratype USNM 64628b; 25, ventral view, × 1, of preceding excavated to show loop; 26, 27, side and ventral views, × 2, of same loop. Cretaceous (Hunstanton Red Chalk), cliffs at Hunstanton, Norfolk, England.

FIGURES 28–34.—*Rectithyris shenleyensis* (Walker): 28–30, Dorsal, side, and anterior views, × 1, of complete specimen, hypotype USNM 551087b; 31, dorsal view of another specimen excavated to show loop, × 1, hypotype USNM 551087a; 32, ventral view of preceding, × 1, × 2, showing loop; 33, lateral view of same loop, × 3; 34, ventral view, × 3, of preceding to show elevated socket ridges, and lack of inner hinge plates. Cretacous (Lower Albian - Shenley Limestone), Shenley Hill, Leighton Buzzard, Bedfordshire, England.

FIGURE 35.—*Terebratula obesa* Sowerby (= *Concinnithyris obesa* (Sowerby)): Dorsal view of type specimen, × 1, from Sowerby, 1821–1825, pl. 438: fig. 1. Introduced for comparison with specimens referred to *C. obesa* on Plate 26: figures 27, 28.

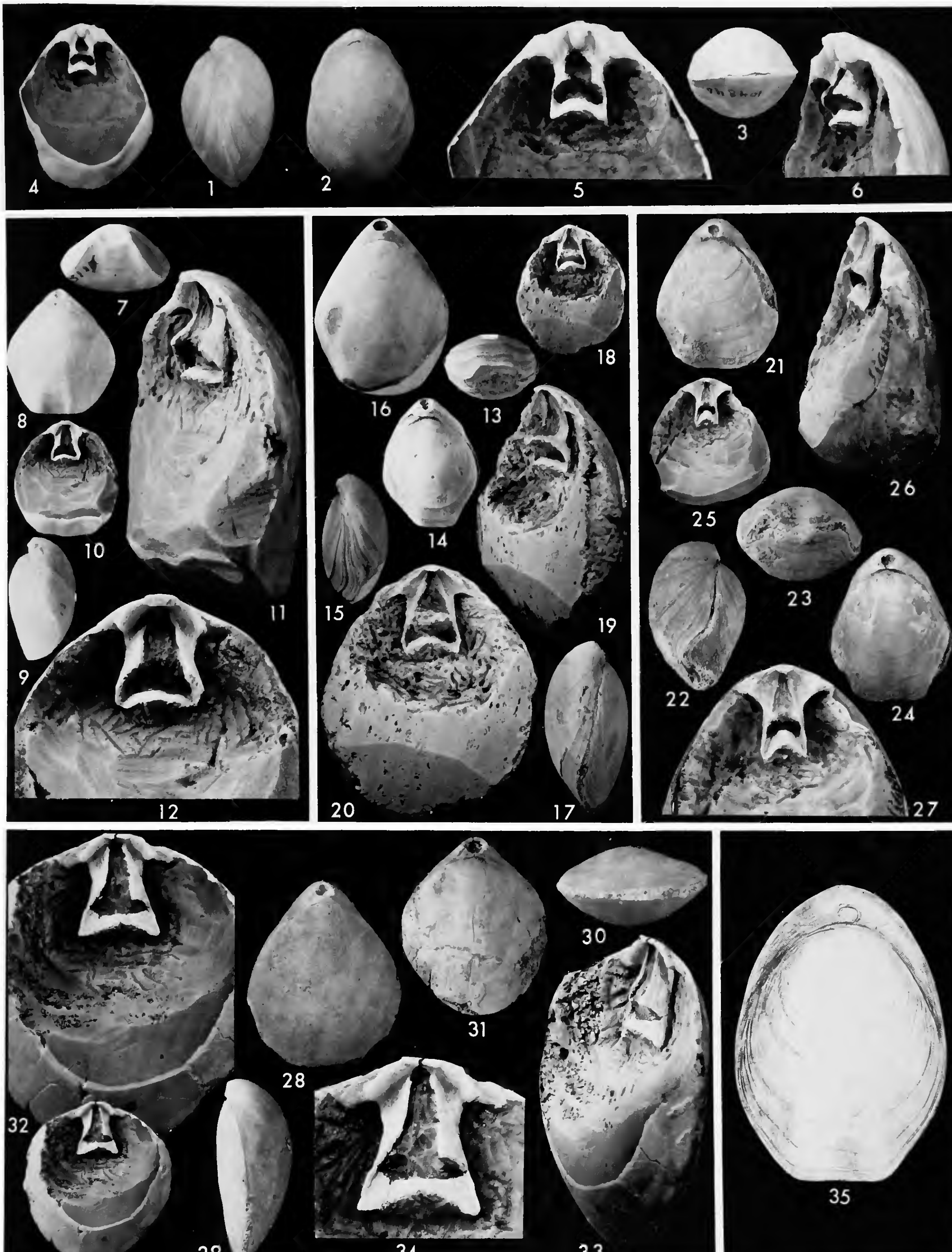

4
1
2
5
3
6
7
8
10
11
9
12
16
13
18
14
19
15
20
17
21
26
25
23
22
24
27
32
28
31
30
29
34
33
35

PLATE 21

FIGURES 1–6.—*Biplicatoria ferruginea*, new species: 1–3, Side, anterior, and dorsal views, × 1, of large, complete specimen, holotype USNM 550946; 4, dorsal view, × 1, of specimen with excavated loop, paratype USNM 550947a; 5, 6, ventral and side views of preceding, × 2, showing loop with outer hinge plates attached ventrally. Cretaceous (Upper Albian – Hunstanton Red Chalk – Bed 3), sea cliffs at Hunstanton, Norfolk, England.

FIGURES 7–11.—*Nerthebrochus robertoni* (d'Archiac): 7–9, Dorsal, anterior, and side views, × 1, of complete specimen, hypotype USNM 550945a; 10, 11, dorsal valve with excavated loop, × 1, × 2, hypotype USNM 550945b. Cretaceous (Tourtia), Tournay, Belgium. (See Plate 17: figure 42 for side view of loop.)

FIGURES 12–20.—*Rectithyris depressa* (Lamarck): 12–14, Anterior, dorsal, and side views, × 1, of complete specimen showing elongated beak and solid, conspicuous symphytium, hypotype USNM 75704a; 15, dorsal valve with loop excavated, × 1, hypotype USNM 104623a; 16, 17, same, × 2, in side and ventral views; 18, another dorsal valve with excavated loop, × 1, hypotype USNM 104623b; 19, 20, same, × 2, in side and ventral views. (Note absence of inner hinge plates in both dorsal valves and posterior extension of socket ridges.) Cretaceous (Tourtia), Tournay, Belgium.

FIGURES 21–26.—*Cyranoia vissae* (Hadding): 22–24, Dorsal, anterior, and side views, × 1, of complete specimen, × 1, hypotype USNM 73465a; 21, another specimen with cardinalia excavated, × 1, showing coalesced inner hinge plates, hypotype USNM 550948a; 25, 26, cardinalia of another dorsal valve, × 2, showing discrete inner hinge plates, and broad crural processes located at anterior junction with socket plates, hypotype USNM 112312b. Cretaceous (Senonian – *Actinocamax mammillatus* Zone), Ifö, Scania, Sweden.

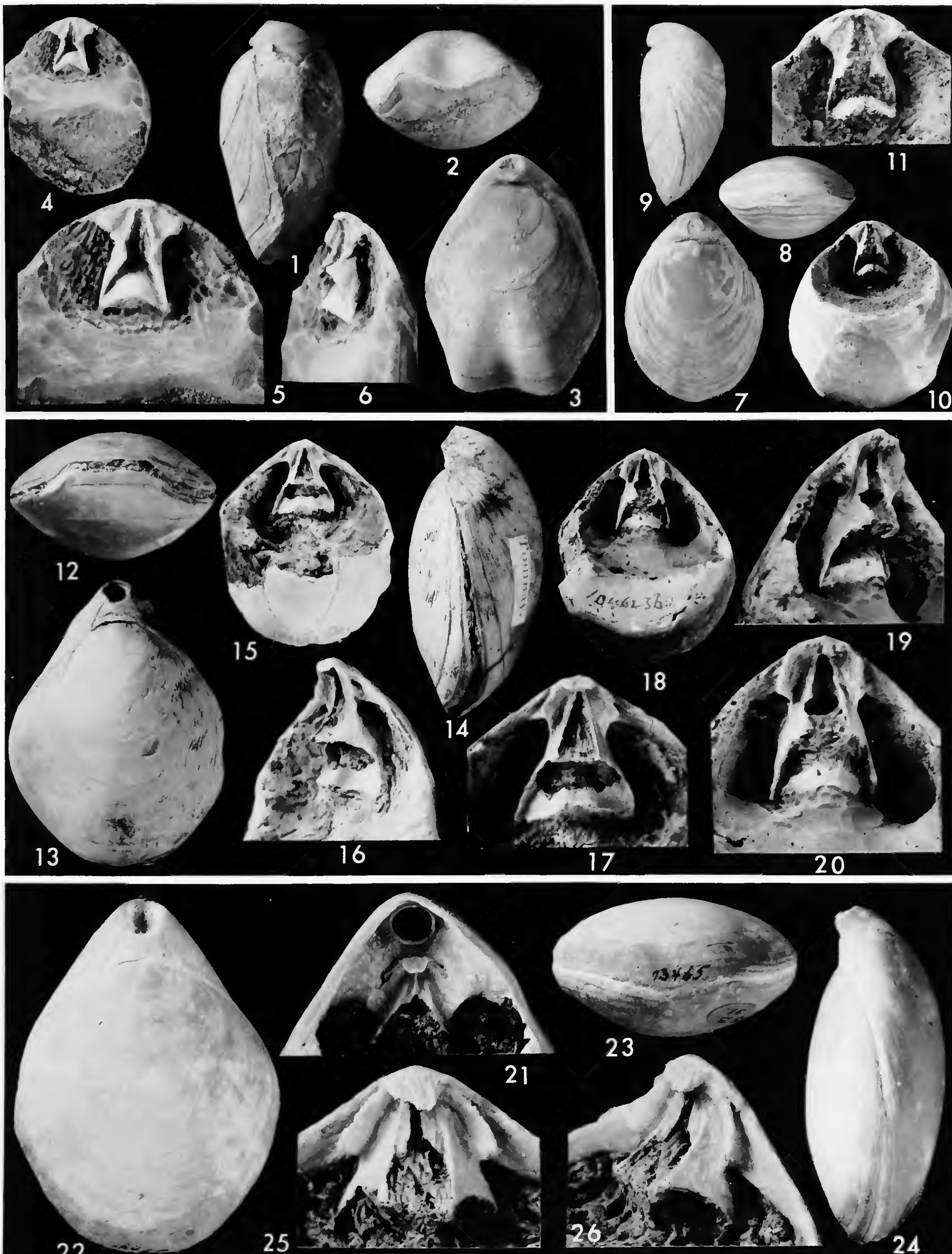

4
2
1
5
6
3
9
11
8
7
10
12
15
14
18
19
13
16
17
20
22
21
23
24
25
26

PLATE 22

FIGURES 1–4.—*Ornithothyris carinata* Sahni: 1, 2, Dorsal and side views of complete specimen, × 1, hypotype USNM 75689a; 3, 4, ventral view, × 1, × 2, of imperfect loop and large cardinal process, hypotype USNM 75689b. Cretaceous (Senonian – *Belemnitella mucronata* Zone), Whitlingham, Norwich, Norfolk, England.

FIGURES 5–7.—*Sellithyris*? species: 5, Interior of dorsal valve showing aberrant loop with terminal points, × 1, USNM 551121; 6, 7, ventral and side views of preceding specimen, × 3, showing loop in detail. Cretaceous (Cenomanian), La Donniere, Maine-et-Loire, France.

FIGURES 8–13.—*Sellithyris* species: 8–10, Dorsal, side, and anterior views of complete specimen, × 1, USNM 551104a; 11, interior of dorsal valve showing wide, rounded loop, × 1, USNM 551104b; 12, 13, side and ventral views of preceding, × 3, showing loop with rounded anterolateral extremities. Cretaceous (Cenomanian), same as above.

FIGURES 14–19.—*Boubeithyris "boubei"* (d'Archiac): 14–16, Anterior, side, and dorsal views, × 1, of complete specimen, hypotype USNM 551099a; 17, 18, cardinalia, × 1, × 3, of excavated specimen showing incipient inner hinge plates, hypotype USNM 551099b; 19, cardinalia of another dorsal valve, × 3, showing well-developed inner hinge plates, hypotype USNM 551099c. Cretaceous (Albian – Shenley Limestone), Shenley, Leighton Buzzard, Bedfordshire, England.

FIGURES 20–22.—*Rhombothyris meyeri* (Walker): 20, 21, Exterior and interior of specimen with loop, × 1, hypotype USNM 551077; 22, same loop, × 2. Cretaceous (Greensand), Upware, Cambridge, England.

FIGURE 23.—*Rhombothyris microtrema* (Walker): interior of dorsal valve, × 2, showing cardinalia with slight development of inner hinge plates, hypotype USNM 551078. Cretaceous (Lower Greensand), Upware, Cambridge, England.

FIGURES 24–27.—*Praelongithyris praelongiforma* Middlemiss: 24, 25, Exterior and interior of specimen with loop preserved, × 1, hypotype USNM 551076; 26, 27, lateral and ventral views of same loop, × 2. Cretaceous (Greensand), Upware, Cambridge, England.

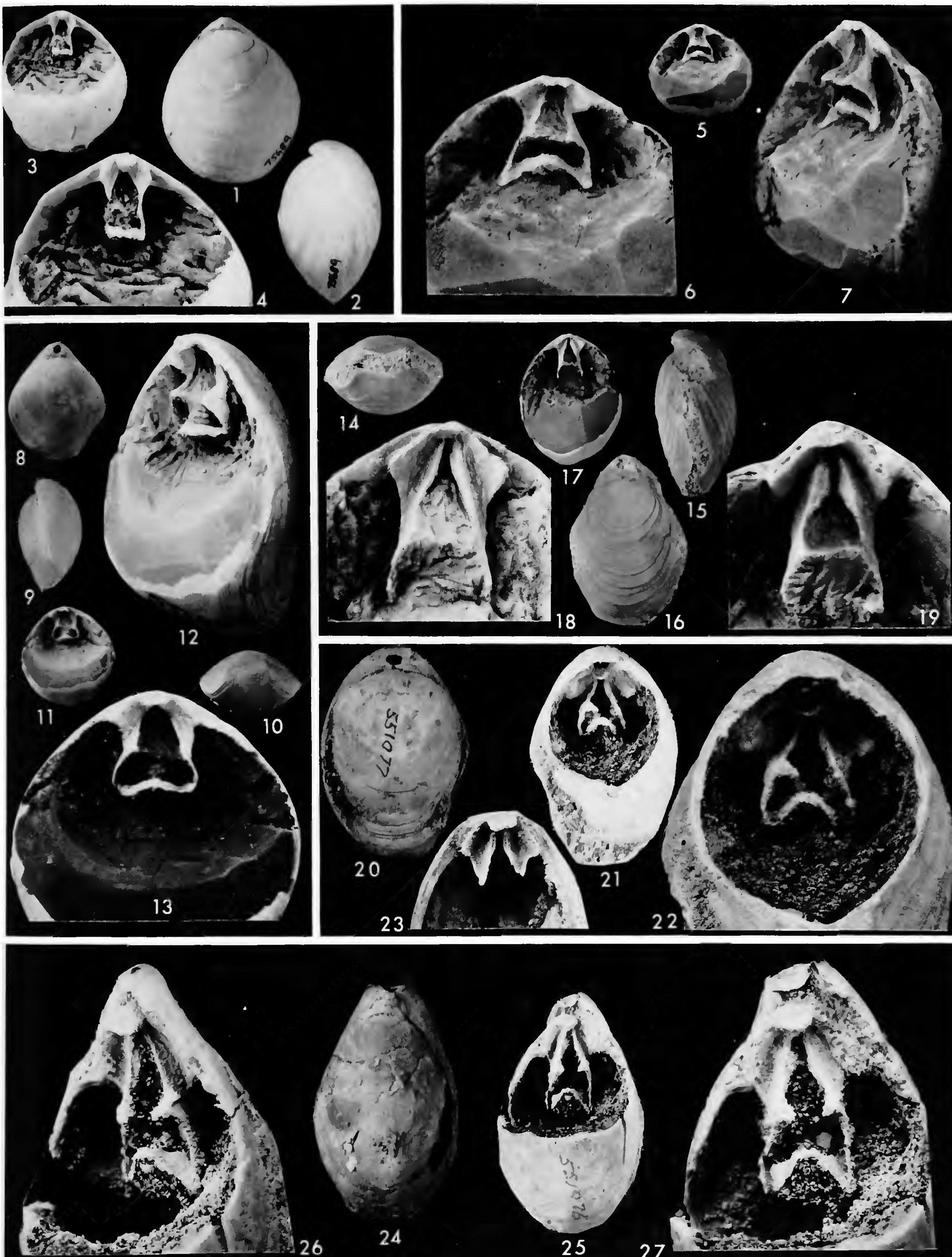

3
1
4
2
5
6
7
8
12
9
11
10
13
14
17
15
18
16
19
20
21
23
22
26
24
25
27

PLATE 23

FIGURES 1–11.—*Capillarina diversa* (Cox and Middlemiss): 1–3, Anterior, dorsal and side views, × 1, of medium-sized specimen, hypotype USNM 550952a; 5, complete specimen, × 2, showing radial capillae, hypotype USNM 550953a; 6, 7, ventral and side views, × 4, of excavated loop, hypotype USNM 550953b; 8, same at × 1; 9, specimen with excavated loop, × 1, hypotype USNM 550952b; 10, 11, ventral and side views, × 3, of preceding (note exaggerated socket ridges). Cretaceous (Lower Albian – Shenley Limestone – *regularis* Zone), Shenley Hill Pit, Leighton Buzzard, Bedfordshire, England.

4, Smaller specimen than preceding, × 1, hypotype USNM 123623a. Cretaceous (Shenley Limestone – *tardefurcata* Zone), Mundy's Hill Pit, Leighton Buzzard, Bedfordshire, England.

FIGURES 12–18.—*Capillithyris capillata* (d'Archiac): 12, Dorsal view, × 1, of cast of specimen from which loop in figures 17 and 18 was excavated, × 1, hypotype USNM 550949a; 16, excavated loop of preceding, × 1; 17, 18, side and ventral views of same, × 2, (very apex of transverse band was lost in preparation). Cretaceous (Tourtia), quarry du Cornet, Chercq, near Tournay, Belgium.

13–15, Anterior, dorsal, and side views of large specimen showing capillate surface, × 1, hypotype USNM 550956. Cretaceous (Tourtia), Montignes, Belgium.

FIGURES 19–22.—*Capillarina diversa rubicunda* (Cox and Middlemiss): 19, Dorsal view of cast of imperfect specimen from which loop was excavated, × 1, hypotype USNM 550955; 20, excavated loop, × 1; 21, 22, side and ventral views of same loop, × 2 (note unusual development of socket ridges). Cretaceous (Hunstanton Red Chalk), sea cliffs at Hunstanton, Norfolk, England.

FIGURES 23–28.—*Liramia disparilis* (d'Orbigny): 23–25, Side, anterior, and dorsal views, × 1, of typical specimen, hypotype USNM 550950a; 26, same specimen, × 3, showing longitudinal capillae; 27, 28, ventral and side views of specimen excavated to show loop, × 3, hypotype USNM 550950b. (Compare this loop and shell exterior with that of *Arcuatothyris* that occurs with *Liramia*, Plate 28.) Cretaceous (Cenomanian), La Montagne, Ste. Catherine, Rouen, France.

FIGURES 29–34.—*Sellithyris phaseolina* (Lamarck): 29–31, Anterior, dorsal, and side views, × 1, of complete specimen, hypotype USNM 550594a; 32, another specimen, × 1, with loop excavated, hypotype USNM 550954b; 33, 34, side and ventral views, × 2, of preceding loop. Cretaceous (Cenomanian), La Donniere, Maine-et-Loire, France.

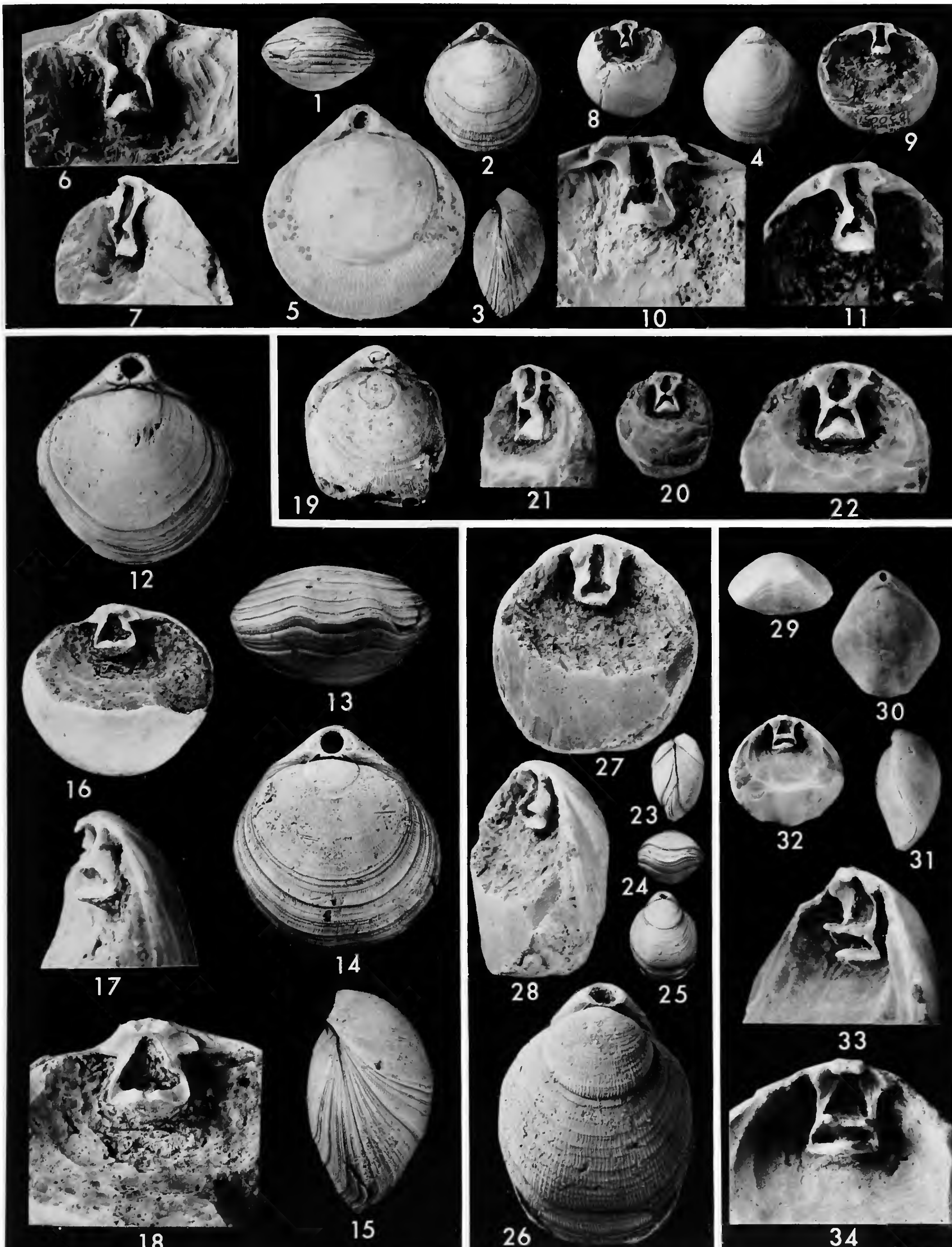

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34

PLATE 24

FIGURES 1–7.—*Atactosia* species: 1–3, Dorsal, side, and anterior views, × 1, of complete specimen, USNM 551135a; 4, 5, dorsal exterior and ventral view, × 1, of specimen excavated for loop, USNM 551110; 6, 7, lateral and ventral views, × 3, of preceding loop. Cretaceous (White Chalk), sea cliffs at Hunstanton, Norfolk, England.

FIGURES 8–14.—*Chatwinothyris curiosa* Sahni: 8–10, Anterior, side, and dorsal views, × 1, of complete specimen, hypotype USNM 75694a; 11, dorsal view of specimen excavated to show loop, × 1, hypotype USNM 75694b; 12, interior of excavated specimen, × 1; 13, 14, ventral and lateral views of preceding specimen, × 2, showing loop and large cardinal process. Cretaceous (Senonian – *Ostrea lunata* Zone), Trimingham, Norfolk, England.

FIGURES 15–17.—*Atactosia* species: 15, Interior of dorsal valve showing loop, × 1, USNM 551112; 16, 17, side and ventral views of preceding, × 3. Cretaceous (White Chalk), sea cliffs at Hunstanton, Norfolk, England.

FIGURES 18–22.—*Concinnithyris burhamensis* Sahni: 18, 19, Dorsal exterior and ventral views, × 1, showing poorly preserved loop, hypotype USNM 551098; 20, posterior of preceding, × 2, showing long pedicle collar and shelf-like cardinal process; 21, 22, partial side and ventral views, × 2, of loop of preceding. Cretaceous (Cenomanian), Bluebell Hill, Burham, Kent, England.

FIGURES 23–28.—*Magnithyris magna* Sahni: 23–25, Side, anterior, and dorsal views of young specimen, × 1, hypotype USNM 551124; 26, excavated loop of preceding specimen, × 1; 27, 28, ventral and partial side views, × 2, of preceding specimen. Cretaceous (Norwich Chalk – *Belemnitella mucronata* Zone), Thorpe, Norwich, England.

FIGURES 29, 30.—*Gibbithyris ellipsoides* Sahni: Partial side and ventral views, × 3, showing broad crural base and attachment of outer hinge plates to ventral edge of crural bases (outer hinge plates are not ventrally convex), hypotype USNM 551109. Cretaceous (Senonian – *Micraster cor-anguinum* Zone), Northfleet, Kent, England.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30

PLATE 25

FIGURES 1–6.—*Ornithothyris carinata* Sahni: 1–3, Anterior, side, and dorsal views, × 1, of complete specimen, hypotype USNM 550908a; 4, dorsal valve with excavated loop, × 1, hypotype USNM 550958b; 5, 6, ventral and side views, × 3, of same dorsal valve showing stout loop and broad crural base. Cretaceous (Senonian – Norwich Chalk – *Belemnitella mucronata* Zone), New Catton, near Norwich, Norfolk, England.

FIGURES 7–13.—*Ellipsothyris similis* Sahni: 7–9, Dorsal, side, and anterior views, × 1, of imperfect specimen, hypotype USNM 550957a; 10, dorsal valve with excavated loop, × 1, hypotype USNM 550957b; 11, 12, ventral and side views, × 2 of preceding; 13, posterior of another dorsal valve, × 2, showing cardinalia, hypotype USNM 550957c. Cretaceous (Senonian – Norwich Chalk – *Belemnitella mucronata* Zone), St. James Pit, Denmark Farm, Norwich, Norfolk, England.

FIGURES 14–19.—*Ornatothyris sulcifera* (Morris): 14–16, Side, anterior, and dorsal views, × 1, of typical lamellose specimen, hypotype USNM 550959a; 17, another specimen with loop excavated, × 1, hypotype USNM 550959b; 18, 19, ventral and side views, × 2, of preceding loop showing broad crural base. Cretaceous (Cenomanian), Fullbourne, near Cambridge, England.

FIGURES 20–22, 36.—*Carneithyris subpentagonalis* Sahni: 20–22, Side, anterior, and dorsal views, × 1, of large specimen, hypotype USNM 75700a; 36, ventral (upper view) and posterior views, × 3, of cardinalia of dorsal valve showing obese cardinal process, hypotype USNM 75700b. Cretaceous (Senonian Norwich Chalk – *Belemnitella mucronata* Zone), Mousehold, Norwich, Norfolk, England.

FIGURES 23–25.—*Carneithyris rotunda* Sahni: 23, Dorsal view with loop excavated, × 1, hypotype USNM 75698a; 24, 25, ventral and lateral views, × 2, of preceding specimen. Cretaceous (Senonian), Norwich?, Norfolk, England.

FIGURES 26, 30, 33–35.—*Carneithyris carnea* (Sowerby): 26, 30, 33, Posterior, ventral, and side views showing loop and cardinalia, hypotype USNM 550961a. Cretaceous (Senonian Norwich Chalk – *Belemnitella mucronata* Zone), Harford Bridges, Norwich, Norfolk, England.

34, 35, Ventral and side views of another loop, × 2, hypotype USNM 550962. Cretaceous (Senonian – Norwich Chalk – *Belemnitella mucronata* Zone), Norwich?, Norfolk, England.

FIGURES 27–29, 31, 32.—*Carneithyris circularis* Sahni: 27, Dorsal valve with excavated loop, × 1, hypotype USNM 550964; 29, ventral view of same loop, × 2. Cretaceous (Senonian), Sussex, England.

28, 32, Side and ventral views of specimen with excavated loop, × 1, hypotype USNM 550963; 31, preceding dorsal valve, × 2. Cretaceous (Upper Maastrichtian). Nasilow, near Pulawy, Poland.

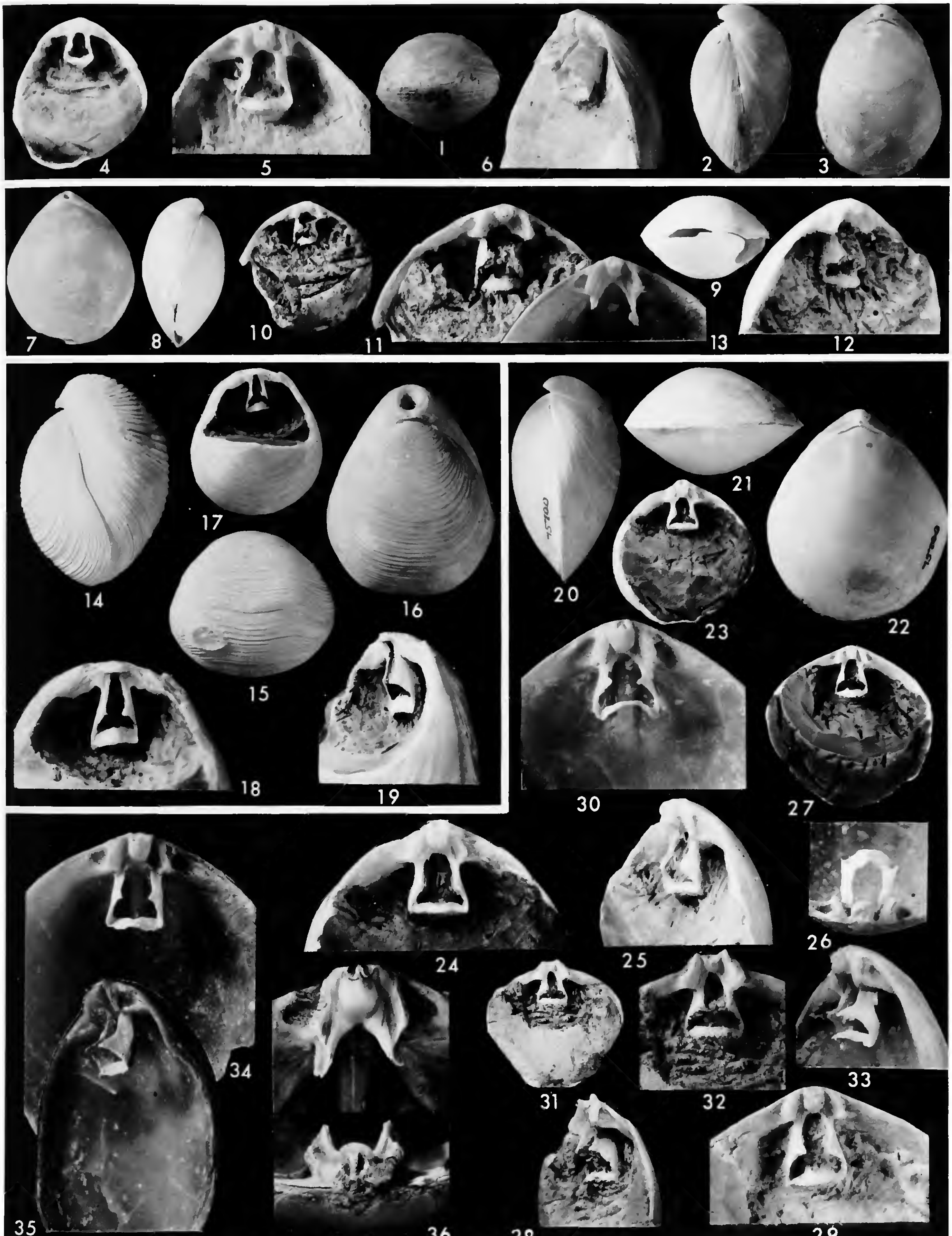

4
5
1
6
2
3
7
8
10
11
9
13
12
14
17
16
15
18
19
20
21
22
23
30
27
34
24
25
26
35
36
31
32
33
28
29

PLATE 26

FIGURES 1, 2.—*Chatwinothyris* (= *Carneithyris* species): Ventral and posterior views, × 3, of cardinalia, USNM 73942a. Cretaceous (Senonian), Stevns, Denmark.

FIGURE 3.—*Carneithyris carnea* (Sowerby): Ventral view, × 3, of cardinalia of specimen with broken loop, hypotype USNM 550960a. Cretaceous (Upper Maastrichtian), Kazimierz, middle Vistula Gorge, Poland.

FIGURES 4–6.—*Gibbithyris semiglobosa* (Sowerby): 4, Dorsal valve excavated to show loop, × 1, with damaged transverse band, hypotype USNM 123748a; 5, 6, ventral and side views, × 2, of same specimen showing broad crural base. Cretaceous (Senonian), Chateaudun, France.

FIGURES 7, 8.—*Carneithyris carnea* (Sowerby): Side and ventral views, × 2, of dorsal valve, hypotype USNM 12584a. Cretaceous (Senonian), Shilofka, Simbirsk, Russia.

FIGURES 9-15.—*Concinnithyris rouenensis,* new species: 9, 11, Ventral view of specimen with window excavated in shell to show loop, × 1, × 2; 10, exterior of preceding specimen in dorsal view, × 1, hypotype USNM 77447a; 12, exterior of young individual, × 1, hypotype 92039a; 13, another specimen excavated to show loop, × 1, hypotype USNM 92039b; 14, 15, ventral and side views of same specimen, × 2. Cretaceous (Cenomanian), Rouen, France.

FIGURES 16–18.—*Carneithyris carnea* (Sowerby): 16, Exterior, × 1, hypotype USNM 551093; 17, excavated specimen showing loop, × 1, hypotype USNM 551093a; 18, same, × 3. Cretaceous (Senonian), Rügen, Germany.

FIGURES 19–26.—*Inopinatarcula acanthodes* (Etheridge): 19, Dorsal view of exterior, × 1, hypotype 96641; 20–22, dorsal, anterior, and side views of preceding specimen, × 2; 23, specimen excavated to show loop, × 1, hypotype USNM 551119a; 24, dorsal view of ventral valve and ventral view of its dorsal valve showing symphytium, small foramen, and loop without outer hinge plates, × 4, hypotype USNM 551119a; 25, 26, side and posterior views, × 4, of preceding dorsal valve showing wide sockets and trilobed cardinal process. Cretaceous (Senonian - Gingin Chalk), Molecap, near Gingin, West Australia.

FIGURES 27–31.—*Concinnithyris obesa* (Sowerby): 27, Side view of large specimen, × 1, hypotype USNM 551136; 28, dorsal view of another large specimen, × 1, hypotype USNM 77379a; 29, 30, side and ventral views, × 1, of preceding specimen showing excavated loop; 31, enlargement, × 2, of same loop. Cretaceous, locality uncertain (see discussion under *Concinnithyris*).

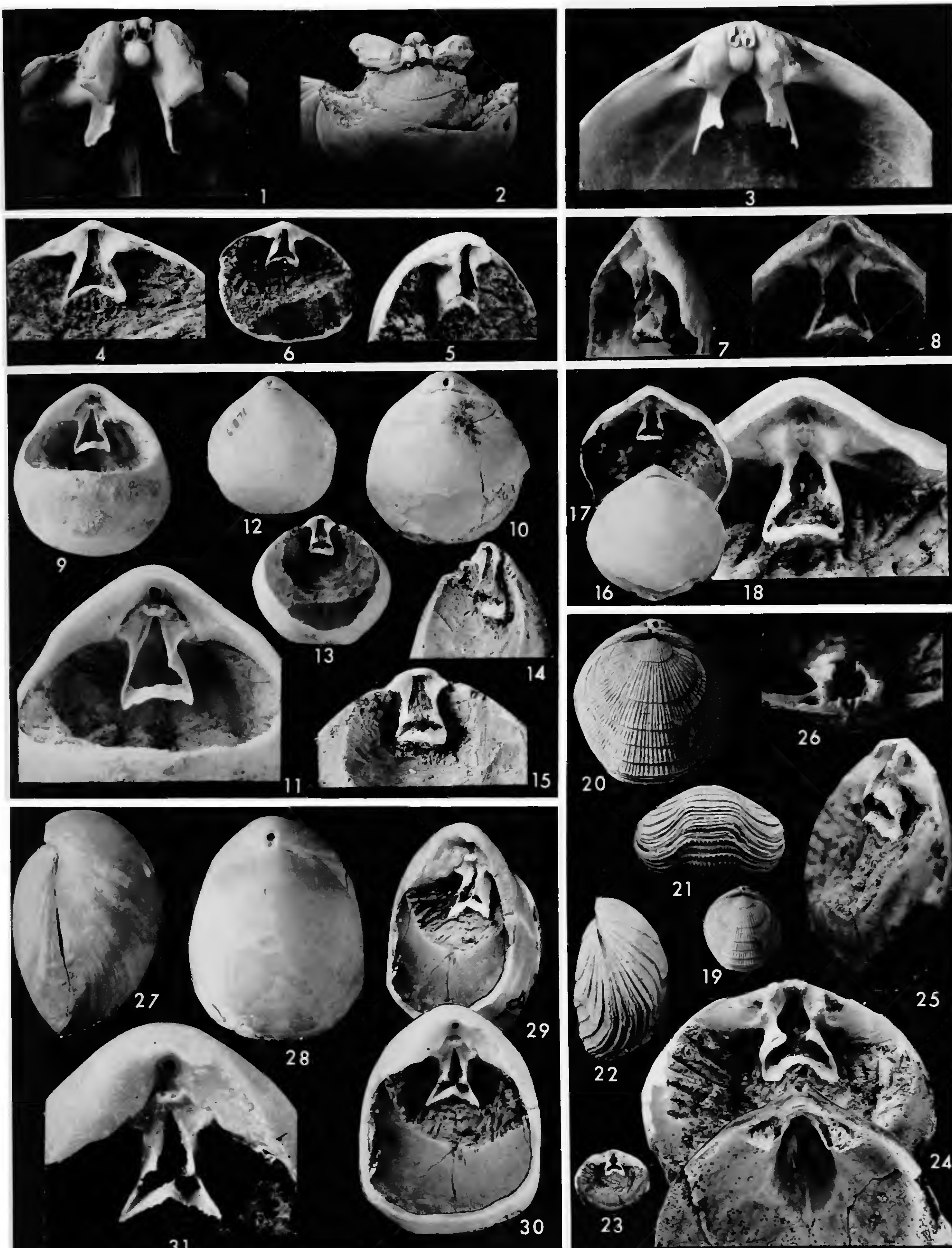

1
2
3
4
6
5
7
8
9
12
10
13
14
11
15
17
16
18
20
26
21
19
22
25
24
23
27
28
29
30
31

PLATE 27

FIGURES 1–7.—*Carneithyris* cf. *C. elongata* (J. de C. Sowerby): 1–3, Dorsal, side, and anterior views, × 1, of complete specimen, hypotype USNM 550970a; 4, dorsal valve with excavated loop, × 1, hypotype USNM 550970b; 5, 6, ventral and side views, × 2, of preceding specimen; 7, another dorsal valve, × 2, preserving cardinalia with thick cardinal process, broad crural bases, and thickened socket ridges, hypotype USNM 550970c. Cretaceous (base of Maastrichtian), Slenaken, Netherlands.

FIGURES 8–18.—*Ogmusia incisus* (von Buch): 8, 9, Anterior and dorsal views, × 1, of young specimen, hypotype USNM 91832a; 10, adult dorsal valve with excavated loop, × 1, hypotype USNM 91832b; 11–13, ventral, partial side, and posterior views, × 2, of loop and cardinalia of preceding specimen; 18, posterior view, × 2, of fragment of dorsal valve showing complicated cardinal process, hypotype USNM 73507a. Paleocene (Danian), Herfølge, Denmark.

14, Interior of dorsal valve, × 2, showing loop in detail, paratype USNM 91833. Paleocene (Danian), Fakse, Denmark.

15–17, Side, anterior, and dorsal views, × 1, of complete specimen with sulcate anterior commissure, hypotype USNM 91831a. Paleocene (Danian), Island of Saltholm, Denmark.

FIGURE 19.—*Carneithyris "subcardinalis"* Sahni: Interior, × 2, showing greatly thickened cardinalia and ventral valve, hypotype USNM 550967a. Cretaceous (Upper Maastrichtian), Nasilow near Pulawy. Poland.

FIGURES 20–31, 38, 39.—*Gibbithyris semiglobosa* (J. Sowerby): 20–22, Side, anterior, and dorsal views, of large specimen, × 1, hypotype USNM 75691a; 23, dorsal valve with excavated loop, × 1, transverse band damaged, hypotype USNM 75691b; 24, 25, ventral and side views of preceding loop, × 2, showing broad, flat crural bases and ventrally attached outer hinge plates. Cretaceous (Turonian – *H. planus* Zone), Dover, Kent, England.

26–28, Dorsal, side, and anterior views, × 1, of small specimen, hypotype USNM 550968a; 29, dorsal valve of another small specimen with loop excavated, × 1, hypotype USNM 55 0968b; 30, 31, ventral and side views of same loop, × 2. Cretaceous (Turonian), Croydon, Surrey, England.

38, 39, Side and ventral views of loop, × 2, showing broad crural bases, hypotype USNM 75693b. Cretaceous (Turonian), Dover, Kent, England.

FIGURES 32–37, 40.—*Gibbithyris* species: 32–34, Dorsal, anterior, and side views, × 1, of complete specimen, hypotype USNM 550969a; 35, 40, interior and exterior of specimen excavated to show loop, × 1, hypotype USNM 550969b; 36, 37, side and ventral views, × 2, of preceding loop showing broad crural bases. Cretaceous (Lower Chalk), Surrey, England.

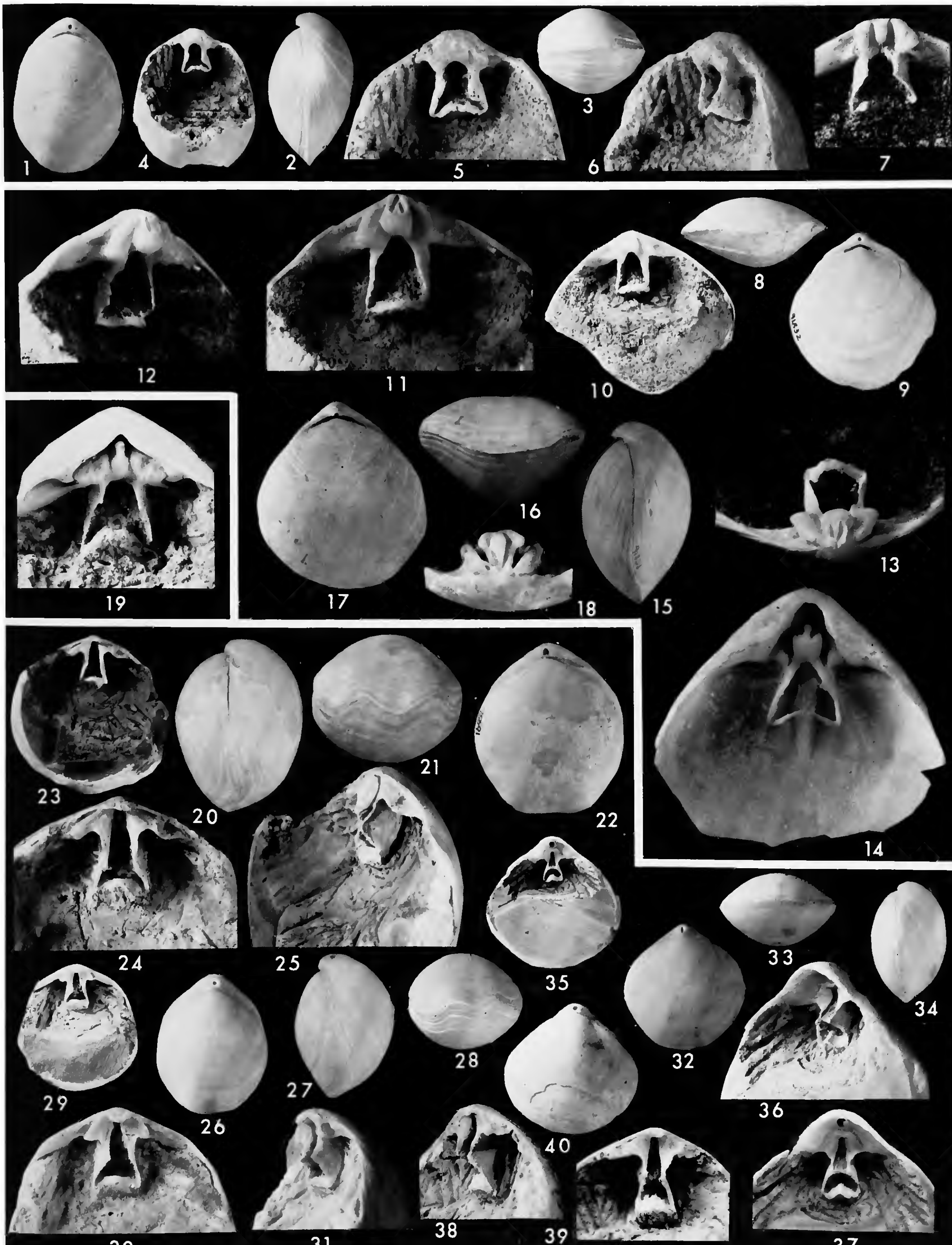

1
4
2
5
3
6
7
12
11
10
8
9
19
17
16
18
15
13
14
23
20
21
22
24
25
35
33
34
29
26
27
28
32
36
40
30
31
38
39
37

PLATE 28

FIGURES 1, 2.—*Cnismatocentrum sakhalinensis* Dall: Interior of dorsal valve, × 1, × 2, showing wide loop and lack of outer hinge plates, hypotype USNM 222598. Recent, at 60 fms (=146 m), U.S. Fish Commission (*Albatross*) Station 4286, 5.9 miles (9.5 km) S, 55° E of Tulumnit Point, Chignik Bay, Alaska. (Compare with cardinalia and loop of *Nucleatina* and *Arcuatothyris*.)

FIGURES 3–10.—*Arcuatothyris arcuata* (Roemer): 3–5, Side, anterior, and dorsal views, × 1, of typical specimen, hypotype USNM 550973a; 6, dorsal view, × 3, of same specimen showing teardrop ornament (compare with *Liramia*, Plate 23); 7, dorsal valve with cardinalia exposed, × 1, hypotype USNM 550973b; 9, 10, same dorsal valve in side and ventral views, × 3, showing lack of outer hinge plates. Cretaceous (Cenomanian - Chloritic Chalk), Côte Ste. Catherine, Rouen, Seine Maritime, France.

8, Interior of another dorsal valve, × 1, showing part of loop, hypotype USNM 19857a. Cretaceous (Cenomanian - Chloritic Chalk), La Montagne. Ste. Catherine, Rouen, France. (See Plate 61: figure 24 for additional view.)

FIGURES 11–16.—*Nucleatina toucasiana* (d'Orbigny): 11–13, Dorsal, side, and anterior views, × 1, of complete specimen, hypotype USNM 19866a; 14, 15, dorsal valve with poorly preserved loop, × 1, × 2, hypotype USNM 19866b; 16, another dorsal valve with cardinalia excavated but transverse band missing, × 2, hypotype USNM 19866c. Cretaceous (Senonian), Martigues, France.

FIGURES 17–22.—*Nucleatina nanclasi* (Cotteau): 17–19, Side, dorsal, and anterior views, × 1, of complete specimen, hypotype USNM 19874a; 20, 21, dorsal valve with complete loop excavated, × 2, hypotype USNM 19874b; 22, same, × 1. Cretaceous (Senonian), Rouen, France.

FIGURE 23.—*Arcelinithyris arcelini* (Lissajous): Side and ventral views, × 2, of loop, hypotype USNM 551038. Jurassic (Bajocian), quarry La Roche-Vineuse, Monsard, Saône-et-Loire, France.

FIGURES 24–27.—*Boubeithyris* species: 24, Dorsal exterior, × 1, USNM 551133; 25, interior of same, × 1; 26, 27, loop enlarged, × 2, showing incipient inner hinge plates. Cretaceous, Kessenberg, Germany.

FIGURES 28–30.—*Gibbithyris inflata* Sahni: 28, Excavated loop, × 1, hypotype USNM 550971b; 29, 30, side and ventral views of another specimen, × 2, hypotype USNM 550971a. Cretaceous, Greenwich, London, England.

FIGURE 31.—*Gigantothyris? omalogastyr?* Arcelin and Roché: Interior of dorsal valve, × 2, showing part of loop and flattish hinge plates, hypotype USNM 550974. Jurassic (Bajocian), quarry Roche-Vineuse, Monsard, Saône-et-Loire, France. (See Plate 61 for additional figure.)

FIGURE 32.—*Concinnithyris* species: Ventral view of loop, showing cardinal process, × 2, USNM 123631. Cretaceous (Senonian - *Belemnitella mucronata* Zone), Harford Bridges, Norwich, Norfolk, England.

PLATE 29

FIGURES 1–3.—*Concinnithyris albensis* (Leymerie): 1, Dorsal exterior, × 1, hypotype USNM 75687b; 2, 3, ventral and partial side views, × 2, of interior of preceding specimen excavated to show loop with its broad crural bases. Cretaceous (Turonian – *Terebratulina gracilis* Zone), Whyteleafe Quarry, Warlingham, Surrey, England.

FIGURES 4–7.—*Atactosia* species: 4, 5, Exterior and interior of complete specimen, × 1, excavated to show loop, USNM 551118; 6, 7, side and ventral views of loop, × 3, of preceding specimen. Cretaceous (White Chalk), sea cliffs at Hunstanton, Norfolk, England.

FIGURES 8–11.—*Harmatosia crassa* (d'Archiac): 8–10, Dorsal, side, and anterior views, × 1, of complete specimen, hypotype USNM 551086a; 11, interior of another specimen × 3, showing loop with well-formed inner hinge plates, hypotype USNM 551086b. Cretaceous (Tourtia), Tournay, Hainaut, Belgium.

FIGURES 12–14.—Cretaceous Genus and Species Undetermined: 12, Interior of dorsal valve, × 1, USNM 19459a; 13, 14, ventral and side views of same loop, × 3, showing narrow crural bases and scooplike form of loop. Cretaceous (Senonian), Meudon, France.

FIGURE 15.—*Gibbithyris semiglobosa* (Sowerby): Side view of loop, × 3, showing broad crural base, hypotype USNM 550968b. Cretaceous (Turonian), Croydon, England.

FIGURES 16–21.—*Monsardithyris? buckmani* (Davidson): 16–18, Dorsal, anterior, and side views, × 1, of complete specimen, hypotype USNM 551039; 19, excavated loop of similar specimen, × 1, hypotype USNM 551039a; 20, 21, ventral and partial side views, × 2, of preceding specimen showing loop with long terminal points. Jurassic (Bajocian Inferior Oolite), Cleave Hill, Cheltenham, Gloucestershire, England.

FIGURES 22–24.—*Carneithyris circularis* Sahni: 22, Interior of dorsal valve, × 1, showing loop, hypotype USNM 550966; 23, 24, ventral and side views of preceding specimen showing broad crural bases and cardinal process, × 3. Cretaceous (Senonian), Meudon, France.

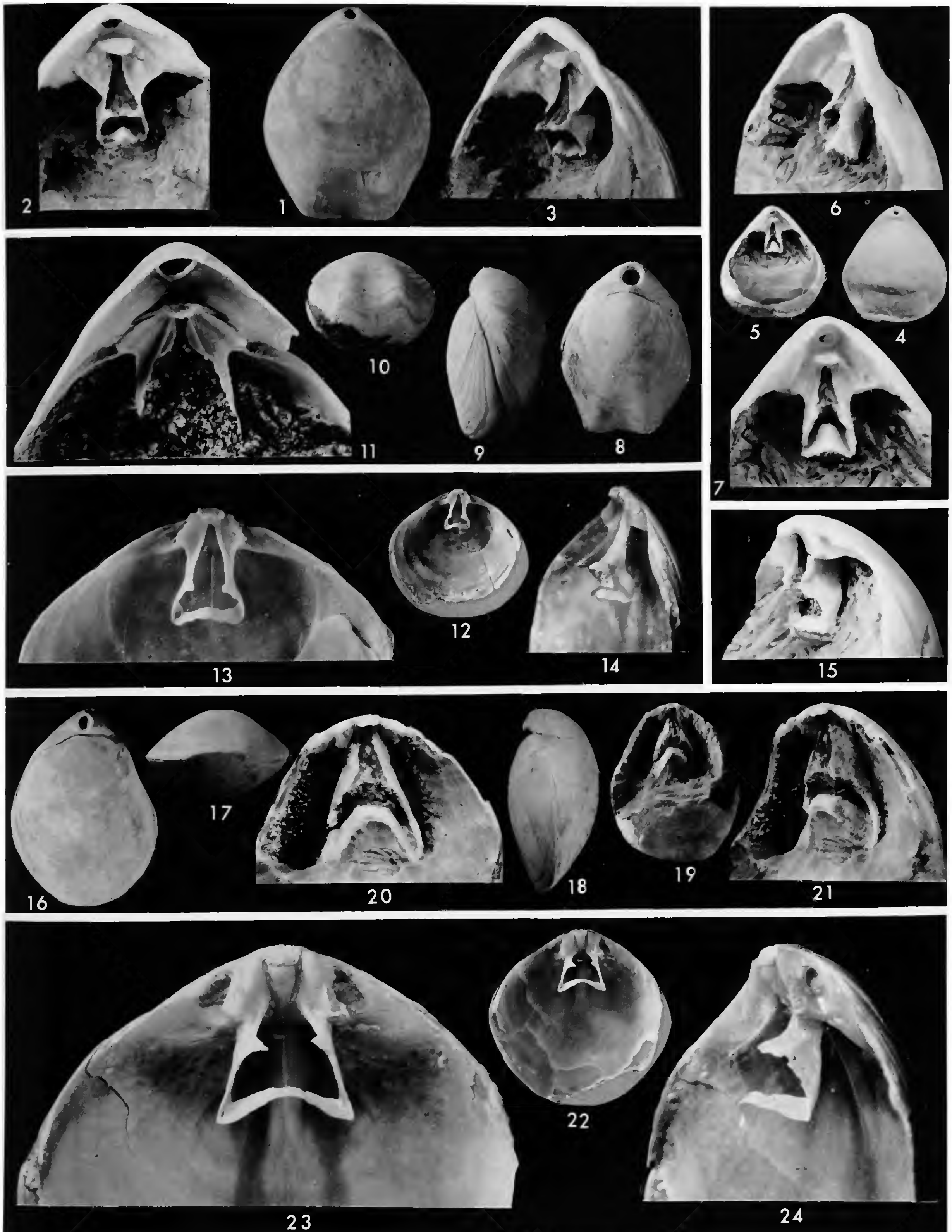

2
1
3
6
5
4
11
10
9
8
7
13
12
14
15
16
17
20
18
19
21
23
22
24

PLATE 30

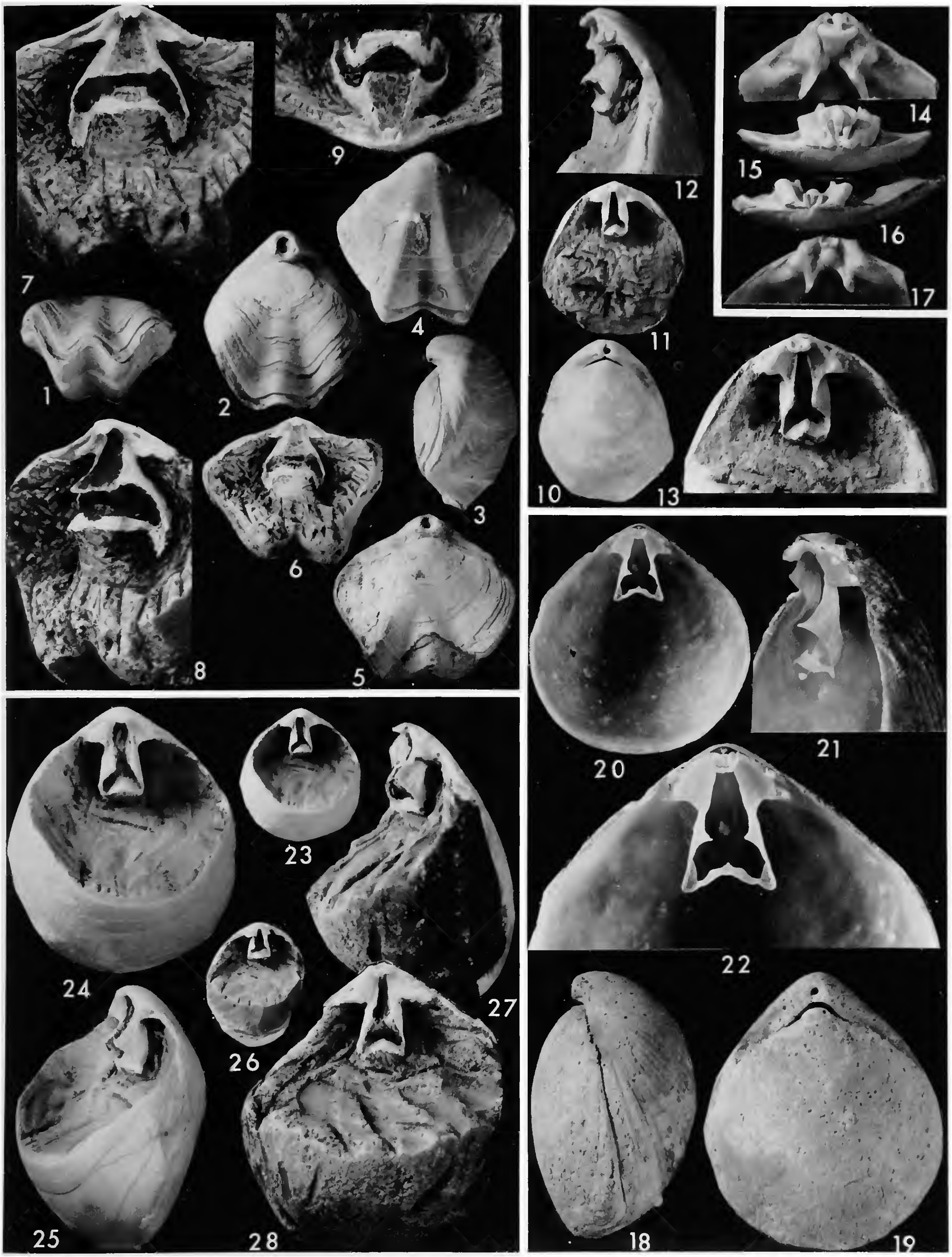
FIGURES 1–9.—*Tegulithyris bentleyi* (Morris): 1–3, Anterior, dorsal, and side views, × 1, of complete specimen, hypotype USNM 550977a; 4, 5, ventral and dorsal views, × 1, of specimen excavated to show loop, hypotype USNM 550977b; 6, loop of preceding specimen, × 1; 7–9; ventral, side, and posterior views, × 2, of loop of preceding specimen. Jurassic (Cornbrash), Peterborough, Northants, England.

FIGURES 10–13.—*Gibbithyris semiglobosa* (Sowerby): 10, Dorsal view of excavated specimen, × 1, hypotype USNM 550978; 11, excavated dorsal valve, × 1, showing loop of same specimen; 12, 13, side and ventral views of same specimen, × 2, showing narrow, thick loop with ventrad attachments of outer hinge plates. Cretaceous (Chalk), locality uncertain, England.

FIGURES 14–17.—*Ogmusia incisus* (von Buch): Ventral and dorsal views, × 2, of cardinalia of two dorsal valves, hypotypes USNM 91831a,b. Paleocene (Danian), Island of Saltholm, Denmark.

FIGURES 18–22.—*Liothyrella neozelanica* Thomson: 18, 19, Side and dorsal views, × 1, of large specimen, hypotype USNM 550976a; 20, interior of dorsal valve showing loop, × 1, hypotype USNM 550976b; 21, 22, same loop, × 2. Recent, at 402 m, 44°07′S, 179°13′W, E of New Zealand. (See Plate 60 for additional views of the loop of this species.)

FIGURES 23–28.—*Gibbithyris semiglobosa* (Sowerby): 23, Dorsal valve with excavated loop, × 1, hypotype USNM 550980b; 24, 25, ventral, side views of preceding specimen, × 2, showing stout loop with broad crural bases; 26, another dorsal valve with excavated loop, hypotype USNM 550980a; 27, 28, side and ventral views of another dorsal valve with excavated loop, hypotype USNM 550979. Cretaceous (Turonian – *Holaster planus* Zone), landslip on Beachy Head, Sussex, England. (Note ventral attachment of outer hinge plates to crural bases.)



7
9
4
2
1
3
6
8
5
12
14
15
16
11
17
10
13
20
21
22
23
24
27
26
25
28
18
19

PLATE 31

FIGURES 1–6.—*Dolichobrochus excavatus* (E. Deslongchamps): 1–3, Anterior, dorsal, and side views, × 1, of complete specimen, holotype USNM 550982a; 4, specimen with excavated loop, × 1, paratype USNM 550982b; 5, 6, ventral and side views, × 2, of loop with long crura of preceding specimen. Jurassic (Callovian), Le Chalet, at U.S. Army Depot on N side of route N761, 14 kms SE of Montreuil-Bellay, Maine-et-Loire, France.

FIGURES 7–16.—*Xestosina arguta*, new species: 7, Dorsal view, × 1, of cast of large specimen excavated to show loop, holotype USNM 92030; 8, excavated specimen, × 1, showing loop; 9, 10, side and ventral views of same specimen, × 2. Jurassic (Kimmeridgian), Mont-le-Vernois, Haute Saône, France.

11–13, Side, anterior, and dorsal views of another specimen, × 1, paratype USNM 104717a. Jurassic (Kimmeridgian), Cap de La Heve, France.

14, Dorsal valve with excavated loop, × 1, paratype USNM 550983; 15, 16, side and ventral views of preceding specimen, × 2. Jurassic (Kimmeridgian), Le Havre, Cap de le Heve, Seine Inférieure, France.

FIGURES 17–23.—*Bihenithyris* cf. *B. weiri* Muir-Wood: 17–19, Anterior, side, and dorsal views, × 1, of complete specimen, hypotype USNM 550985a; 20, specimen with excavated loop, × 1, hypotype USNM 550985b; 21–23, loop of preceding, × 2, in ventral, side, and posterior views. Jurassic (Callovian Oxfordian – Zohar Shale, near base), NW of Hamaktesh, Hagadol, southern Israel.

FIGURES 24, 25.—*Oleneothyris harlani* (Morton): Ventral and side views, × 1.5, of young specimen with low transverse band, USNM 551162b. Paleocene (Beaufort Formation), Mosleys Creek, about 3 miles (4.8 km) S of Meuse River, Ayden (15′) quadrangle, North Carolina.

FIGURES 26–32.—*Habrobrochus subsella* (Leymerie): 26–28, Dorsal, anterior, and side views, × 1, hypotype USNM 550894a; 32, another specimen with excavated loop, × 1, hypotype USNM 550984b; 29–31, side, ventral, and posterior views, × 2, of preceding specimen showing loop with narrow transverse band and short terminal points. Jurassic (Kimmeridgian), Lindenerberg, Linden, near Hanover, Germany.

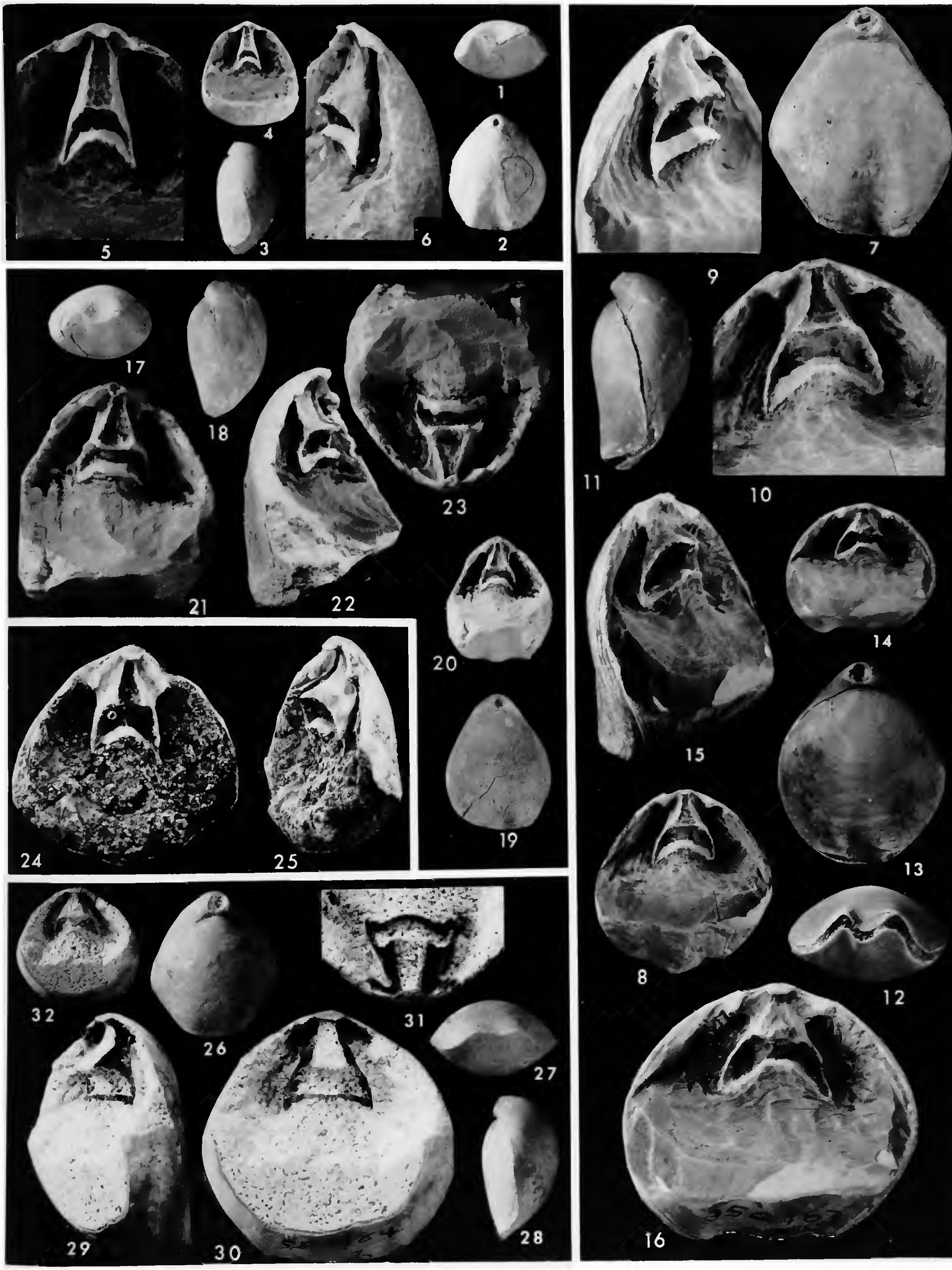

5
4
1
3
6
2
9
7
17
18
23
21
22
11
10
20
15
14
24
25
19
13
32
26
31
8
12
29
30
27
28
16

PLATE 32

FIGURES 1–6.—*Gyrosina rotunda*, new species: 1–3, Dorsal, anterior, and side views, × 1, of complete specimen, holotype USNM 550992a; 4, another specimen excavated to show loop, × 1, paratype USNM 550992b; 5, 6, ventral and side views, × 2, of same paratype showing loop. Jurassic (Callovian – *Macrocephalites macrocephalus* Zone), Nuits St. George, Côte d'Or, France.

FIGURES 7–12.—*Pseudotubithyris* species 1: 7–9, Dorsal, anterior, and side views, × 1, showing folding, USNM 550994a; 10, another specimen with excavated loop, × 1, USNM 550994b; 11, 12, side and ventral views, × 2, of preceding specimen. Jurassic (Bathonian), quarry of National French Cement Company, Langueville, Calvados, France.

FIGURES 13–17.—*Pseudowattonithyris circumdata* (Deslongchamps): 13, Dorsal view of cast of elongate specimen, × 1, excavated to show loop, hypotype USNM 550988b; 14, side view of another gibbous specimen, × 1, hypotype USNM 550988a; 15, ventral view of excavated specimen, × 1, showing loop, hypotype USNM 550988b; 16, 17, ventral and side views, × 2, of preceding hypotype. Jurassic (Bathonian), at entrance to quarry on route 814 (road to Salenelles), 1.5 kms N of Ranville, Calvados, France.

FIGURES 18–23.—*Apatecosia nutiensis* (Bague): 18–20, Dorsal, anterior, and side views, × 1, of complete specimen, hypotype USNM 550991a; 21, another specimen excavated to show loop, × 1, hypotype USNM 550991b; 22, 23, ventral and side views of same specimen, × 2. Jurassic (Callovian – *Macrocephalites macrocephalus* Zone), quarry at La Cude near Velars, on route La Cude-Corcelles, Côte d'Or, France.

FIGURES 24–27.—*Galliennithyris galliennei* (d'Orbigny): 24–26, Anterior, dorsal, and side views, × 1, of large specimen, hypotype USNM 550986a. Jurassic (Oxfordian), Bulligny, Meurthe et Moselle, France.

27, Dorsal view, × 2, showing half of loop, hypotype USNM 31335a. Jurassic (Oxfordian), Parrentruy, Old St. Remi, Launoy, Switzerland.

FIGURES 28, 29.—*Apatecosia nutiensis* (Bague): Side and ventral views, × 2, of large specimen with loop excavated, hypotype USNM 550987a. Jurassic (Callovian – *Macrocephalites macrocephalus* Zone), La Cude, near Velars, Côte d'Or, France.


5
4
1
2
3
6
7
11
10
12
8
9
16
13
15
17
14
22
23
19
18
20
21
24
25
27
26
28
29

PLATE 33

FIGURES 1–14.—*Dorsoplicathyris dorsoplicata* (Deslongchamps): 1–3, Anterior, dorsal, and side views, × 1, of slender specimen, hypotype USNM 550997a; 7, ventral view, of specimen excavated to show loop, × 1, hypotype USNM 550977b; 8, 9, ventral and side views, × 2, of same specimen; 10, another specimen excavated to show loop, × 1, hypotype USNM 550997c; 11, 12, ventral and side views of preceding specimen, × 2. Jurassic (Callovian - *koenigi* Zone), Vercra, near Marchampt, Ain, France.

4–6, Anterior, dorsal, and side views, × 1, of wide individual, hypotype USNM 550998c; 13, 14, side, and ventral views, × 2, of another specimen excavated to show loop, × 2, hypotype USNM 550998b. Jurassic (Callovian - *jasoni* Zone), Cuvergnat, Aromas, Jura, France.

FIGURES 15–22.—*Systenothyris triangulata*, new species: 15–17, Side, anterior, and dorsal views, × 1, of complete specimen, holotype USNM 550996; 18, ventral view, × 1, of specimen excavated to show loop, paratype USNM 550996a; 19, 20, side and ventral views, × 2, of preceding specimen showing loop; 21, 22, side and ventral views, of another specimen displaying loop, paratype USNM 550996b. Jurassic (Upper Bajocian Oolite Blanche), abandoned quarry, 20 m W of route D6, 2.7 km NW of Bayeux city limits, Calvados, France.

FIGURES 23–28.—*Pseudotubithyris capillata* (Arkell): 23–25, Anterior, side, and dorsal views, × 1, of complete specimen, hypotype USNM 550995a; 26, another specimen excavated to show loop, × 1, hypotype USNM 550995c; 27, 28, same specimen, × 2. Jurassic (Upper Bathonian), quarry at Ardley, route A43, between Oxford and Northhampton, England.

FIGURE 29.—*Pyraeneica*? species: Silicified dorsal valve with wide loop, × 2, USNM 551056. Jurassic (Middle Lias), field on N side of east-west road, 0.12 mile (0.2 km) NNW of Les Granges, SSE of Argenton, Indre, France.


1
2
4
5
8
9
12
6
3
7
10
11
13
14
15
16
18
17
27
28
19
21
23
26
29
24
25
22
20

PLATE 34

FIGURES 1–6.—*Mexicaria mexicana* (Ochoterena): 1–3, Anterior, dorsal, and side views, × 1, of complete specimen with three costae on fold (*Parathyridina triplicata* Ochoterena); 4, 5, anterior and dorsal views, × 1, of specimen with two costae on fold (*Parathyridina biplicata* Ochoterena); 6, silicified dorsal valve preserving loop, ca × 2 (reduced from Ochoterena, 1960, pl. 3: fig. 2a). Jurassic (Oxfordian), Rancho Pacheco, near Cuadrilla de Guadalupe, Tlaxiaco, Oaxaca, Mexico.

FIGURES 7–13.—*Charltonithyris uptoni* (S. S. Buckman): 7–9, Side, dorsal, and anterior views, × 1, of complete specimen, hypotype USNM 551000a; 10, dorsal view, × 1, of plaster cast of specimen excavated to show loop, hypotype USNM 551000b; 11, excavated specimen; × 1; 12, 13, ventral and side views, × 2, of excavated specimen. Jurassic (Bajocian – Middle Inferior Oolite – *buckmani* Grit), Withington, Andoverford, Gloucestershire, England.

FIGURES 14–19.—*Plectothyris fimbria* (Sowerby): 14–16, Anterior, dorsal, and side views, × 1, of complete young specimen with rectimarginate anterior commissure but no peripheral costae, hypotype USNM 551001a; 17, specimen excavated to show loop, hypotype USNM 551001b; 18, 19, side and ventral views of same specimen, × 2. Jurassic (Lower Bajocian Oolite Marl), Cleave Hill, Cheltenham, England.

FIGURES 20–35.—*Animonithyris dorenbergi* (Felix): 20, Dorsal view of young specimen, × 1, hypotype USNM 550999f; 21–24, side, dorsal, anterior, and ventral views, × 1, of large, strongly folded individual, hypotype USNM 550999g; 25, dorsal view, × 1, of another complete specimen, hypotype USNM 550999i; 26–28, ventral, anterior, and side views, × 1, of young adult, hypotype USNM 550999h; 29, imperfect specimen preserving loop, × 2, in ventral view, hypotype USNM 550999e; 30, 31, another dorsal valve preserving wide loop in ventral and and side views, × 2, hypotype USNM 550999b; 32, imperfect specimen with loop, hypotype USNM 550999j; 33, 34, two dorsal valves with well-preserved loops, × 2, hypotypes USNM 550999a,c; 35, large dorsal valve with loop, × 2, hypotype USNM 550999d (anterior of fragile specimen now broken away). Jurassic (Oxfordian), 5 kms W of Tlaxiaco, Oaxaca, Mexico.


6
1
2
3
4
5
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35

PLATE 35

FIGURES 1–21.—*Colosia zieteni* (Loriol): 1–3, Dorsal, side, and anterior views, × 1, of complete specimen, hypotype USNM 551002f; 4, dorsal view, × 1, of another young specimen, hypotype USNM 551002g; 5, dorsal view, × 1, of very young specimen, hypotype USNM 551002i; 6, 20, another young specimen in dorsal view, × 1, and interior of same, × 2, hypotype USNM 551002j; 7, 8, dorsal exterior and ventral views of same specimen, × 1, showing loop, hypotype USNM 551002a; 9, 13, exterior in dorsal view, × 1, and interior showing loop, × 2, of same specimen, hypotype USNM 551002b; 10, interior of young dorsal valve, × 1, hypotype USNM 551002k; 11, dorsal interior of another young specimen with loop × 1, hypotype USNM 551002-l; 12, 19, dorsal exterior of complete specimen, × 1, and interior of same, × 2, hypotype USNM 551002e; 14, interior, × 2, of full-grown dorsal valve having loop with moderately long terminal points, hypotype USNM 551002m; 15, 21, side and ventral views, × 2, of another adult dorsal valve, hypotype USNM 551002n; 16, young dorsal valve interior, × 2, hypotype USNM 551002-o; 17, loop of young dorsal valve, × 2, hypotype USNM 551002p; 18, loop of old dorsal valve, × 2, hypotype USNM 551002q. Jurassic, (Kimmeridgian – Badnerschichten) Mellikon, Switzerland.

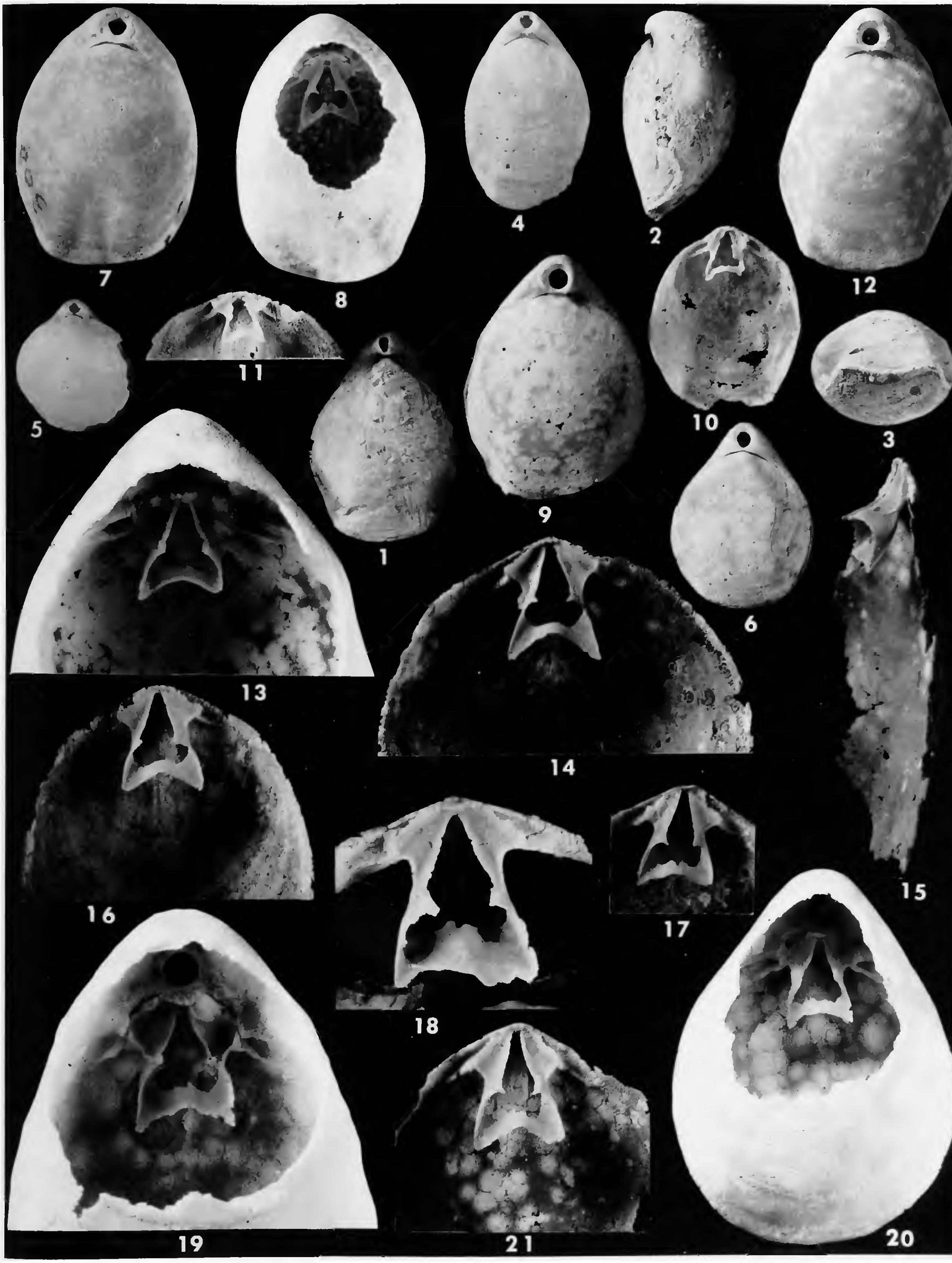

7
8
4
2
12
11
5
1
9
10
3
6
13
14
15
16
17
18
19
21
20

PLATE 36

FIGURES 1–6.—*Sphaeroidothyris?* species 2 (Sowerby): 1–3, Anterior, side, and dorsal views of rotund individual with wavy anterior commissure, × 1, USNM 551101; 4, same specimen excavated to show loop, × 1; 5, 6, ventral and side views of preceding specimen, enlarged × 2, to show loop in detail. Jurassic (Bajocian), Sully, Calvados, France. (See discussion of *Sphaeroidothyris*.)

FIGURES 7–9.—*Nucleata nucleata* (Schlotheim): Anterior, ventral, and dorsal views of silicified specimen, × 2, showing anteriorly rounded loop (specimen in figure 7 oriented with ventral valve down), hypotype British Museum (Natural History) B45093. Jurassic (Upper – White Jura), Grafenburg, Germany. (Compare with loop of *Pygites*, Plate 54: figures 12, 13.)

FIGURES 10–15.—*Pseudotubithyris globata* (J. de C. Sowerby): 10–12, Anterior, side, and dorsal views of young complete specimen, × 1, hypotype USNM 551090a; 13, dorsal valve of preceding excavated to show loop, × 1; 14, 15, same specimen in side and ventral views, × 2, showing loop in detail. Jurassic (Bathonian – Fullers Earth), Whatley, near Frome, Somerset, England.

FIGURES 16–21.—*Colosia zieteni* (Loriol): 16–18, Anterior, dorsal, and side views, × 1, of specimen with flattened dorsal valve, hypotype USNM 551111; 19, 20, exterior and interior of another specimen with flattened dorsal valve showing loop, × 1, hypotype USNM 551111a; 21, preceding enlarged × 2, to show loop in more detail. Jurassic (Kimmeridgian – Badnerschichten), Mellikon, Switzerland.

FIGURES 22–28.—*Loboidothyris perovalis* (J. de C. Sowerby): 22–24, Anterior, side, and dorsal views, × 1, of specimen excavated to show loop, hypotype USNM 551092; 27, preceding excavated specimen showing loop with modest terminal points; 25, 26, ventral and side views of same loop, × 2; 28, Sowerby's (1821–1825, pl. 436: fig. 3, lectotype) figure of this much-misidentified species. Jurassic (Bajocian – Inferior Oolite), Dundry, Somerset, England.


5
4
1
3
2
6
7
8
9
15
14
10
11
12
13
21
20
16
19
17
18
22
23
27
25
26
24
28

PLATE 37

FIGURES 1–8.—*Dictyothyris coarctata* (Parkinson): 1–3, Side, dorsal, and anterior views, × 1, of complete specimen showing folding, hypotype USNM 31338a; 4, dorsal view of another specimen, × 2, showing ornament, hypotype USNM 104663; 5, another specimen excavated to show loop, × 1, hypotype USNM 31338b; 6–8 posterior, ventral, and side views of preceding specimen, × 3, showing loop with strongly protuberant transverse band, ventrally attached outer hinge plates, and short terminal points (see Plate 61: figure 26 for exterior of this specimen showing ornament). Jurassic (Bathonian), Renville, Caen, Calvados, France.

FIGURES 9–14.—*Striithyris somaliensis* Muir-Wood: 9–11, Dorsal, side, and anterior views × 2, of small specimen showing radial capillae, hypotype USNM 551009. Jurassic (Tuwaiq Mountain Formation), 5 km NW of Ghat, on west front of Tuwaiq Mountain, Saudi Arabia.

12, Ventral view, × 1, of another specimen excavated to show loop, hypotype USNM 551008a; 13, 14, side and ventral views of same specimen, × 3, showing loop in more detail. Tuwaiq Mountain Formation (*Erymnoceras* Zone), 24°51′30″ N, 46°07′12″E. Saudi Arabia.

FIGURES 15–24.—*Pseudoglossothyris leckhamptonensis* (Rollier): 15–17, Dorsal, anterior, and side views, × 1, of complete specimen, hypotype USNM 551010a; 18–20, dorsal, side, and anterior views × 1, of another typical specimen showing sulcate anterior commissure, hypotype USNM 551010b; 21, dorsal view of plaster cast of specimen excavated, × 1, hypotype USNM 551010c; 22, ventral view of excavated specimen with loop, × 1; 23, 24, ventral and side views, × 2, of excavated specimen showing loop in more detail (see also Plate 62). Jurassic (Bajocian – Lower Inferior Oolite Oolite Marl). Leckhampton Hill, Gloucestershire, England.

FIGURES 25–27.—*Bothrothyris curiosa*, new species: Partial side, ventral, and side views, × 1, of specimen preserving loop (now broken), holotype USNM 551007. Jurassic (Callovian), 30°40′N, 32°22′E to 32°26′E, Gebel Maghara, northern Sinai. (See Plate 60 for an enlargement of loop.)

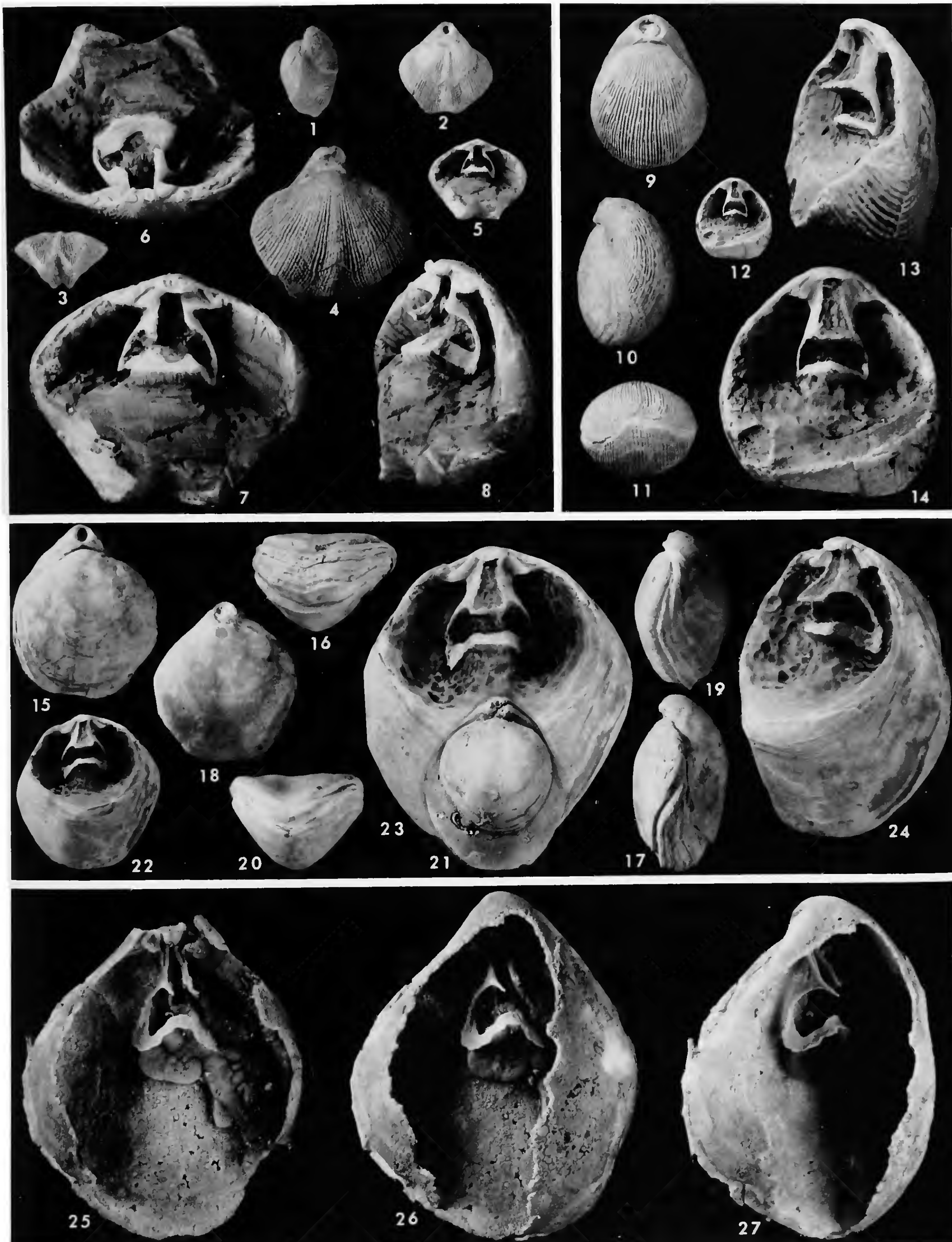

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27

PLATE 38

FIGURES 1–13.—*Morrisithyris phillipsi* (Morris): 1, Young specimen exhibiting loop, × 1, hypotype USNM 551015b; 2, 3, ventral and dorsal views, × 1, of complete specimen showing the loop, hypotype USNM 551016a; 10, 12, ventral and partial side views, × 2, of same specimen showing loop in greater detail; 4, loop of young specimen, × 2, showing truncated terminal points, hypotype USNM 551015h; 5, ventral view of loop, × 3, showing posteriorly projecting points from crest of transverse band, hypotype USNM 551015e; 6, ventral view of young specimen, × 2, showing posteriorly directed processes on transverse band, hypotype USNM 551015g; 8, dorsal view, × 1, of complete specimen showing characteristic outline, hypotype USNM 551015i; 9, another loop, × 2, with outer hinge plates greatly reduced, hypotype USNM 551016c; 11, side view, × 1, to show loop in profile, hypotype USNM 551016b; 13, interior of dorsal valve of large specimen, × 1.5, hypotype USNM 551015d. Jurassic (Bajocian), quarry, La Roche-Vineuse, Monsard, Saône-et-Loire, France.

7, Dorsal view of complete specimen, × 1, hypotype USNM 88713a. Jurassic (Bajocian – Inferior Oolite), Broad Windsor, Dorsetshire, England.

FIGURE 14.—*Monsardithyris ventricosa* (Zieten): Loop enlarged, × 3, to show details, and for comparison with loop of *Morrisithyris*, hypotype USNM 551020b. Jurassic (Bajocian), quarry, LaRoche-Vineuse, Monsard, Saône-et-Loire, France.

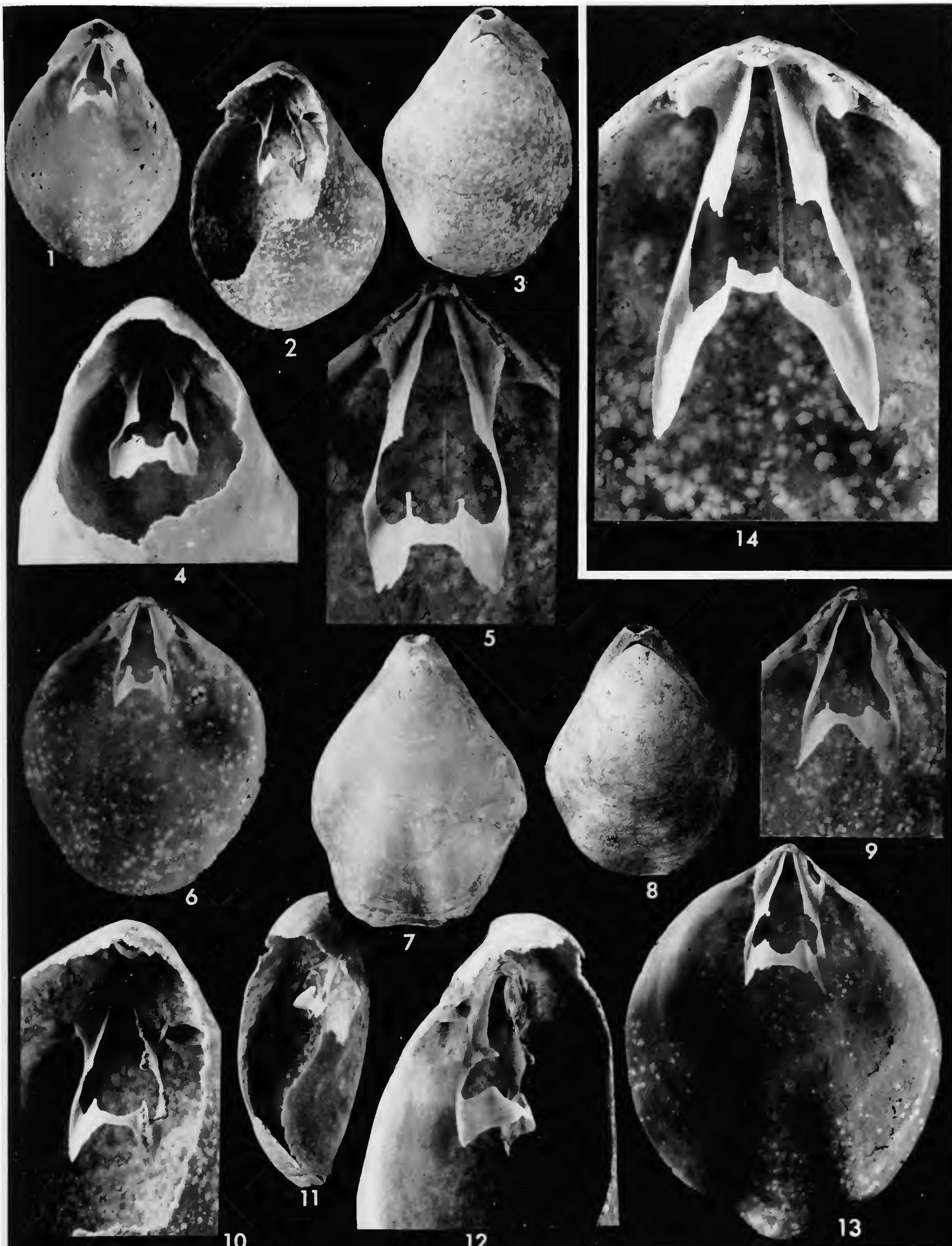

1
2
3
4
5
6
7
8
9
10
11
12
13
14

PLATE 39

FIGURES 1–6.—*Ptychtothyris baylei*, new name: 1–3, Anterior, dorsal, and side views of complete specimen, × 1, hypotype USNM 19878a; 4, ventral view, × 1, of specimen excavated to show loop, hypotype USNM 19878b; 5, 6, side and ventral views, × 2, showing same loop. Jurassic (Bajocian – Inferior Oolite), Luc, Calvados, France.

FIGURES 7–10, 13–15.—*Avonothyris bradfordensis* (Davidson): 7–9. Side, anterior, and dorsal views, × 1, hypotype USNM 551013b; 10, specimen, × 1, showing excavated loop, but minus outer hinge plates, lost in preparation, hypotype USNM 551013a; 13–15 tilted, ventral, and side views, × 2, of preceding specimen (crural processes lost). Jurassic (Bathonian – Great Oolite), Langton Herring, Dorsetshire, England.

FIGURES 11, 12.—*Avonothyris langtonensis* (Davidson): Two dorsal valves, × 2, showing well-preserved and wide hinge plates, hypotypes USNM 551014a,b. Jurassic (Bathonian – base of Forest Marble), Herbury Promontory, one mile (1.6 km) S of Langton Herring, Dorsetshire, England.

FIGURES 16–21.—*Ptychtothyris stephani* (Davidson): 16–18, Anterior, dorsal, and side views of typical specimen, hypotype USNM 551011a; 19, specimen excavated to show loop, × 1, hypotype USNM 551011b; 20, 21, ventral and side views, × 2, of loop of preceding specimen (outer hinge plates and socket ridges damaged). Jurassic (Bajocian – Upper Inferior Oolite – *schloenbachi* Zone), Broad Windsor, Dorsetshire, England. (For well-exhibited socket ridges and outer hinge plates, see Plate 45: figure 7.)

FIGURES 22–28.—*Epithyris? submaxillata* (Davidson): 22–24, Side, anterior, and dorsal views, × 1, of complete, rather narrow specimen, hypotype USNM 551012a; 25, dorsal view, × 1, of plaster cast of specimen excavated, hypotype USNM 551012b; 26, excavated specimen, × 1; 27, 28, ventral and side views of loop, × 2 (points of crural processes lost). Jurassic (Bajocian – Inferior Oolite – Gryphite Grit), Leckhampton Hill, Gloucestershire, England.

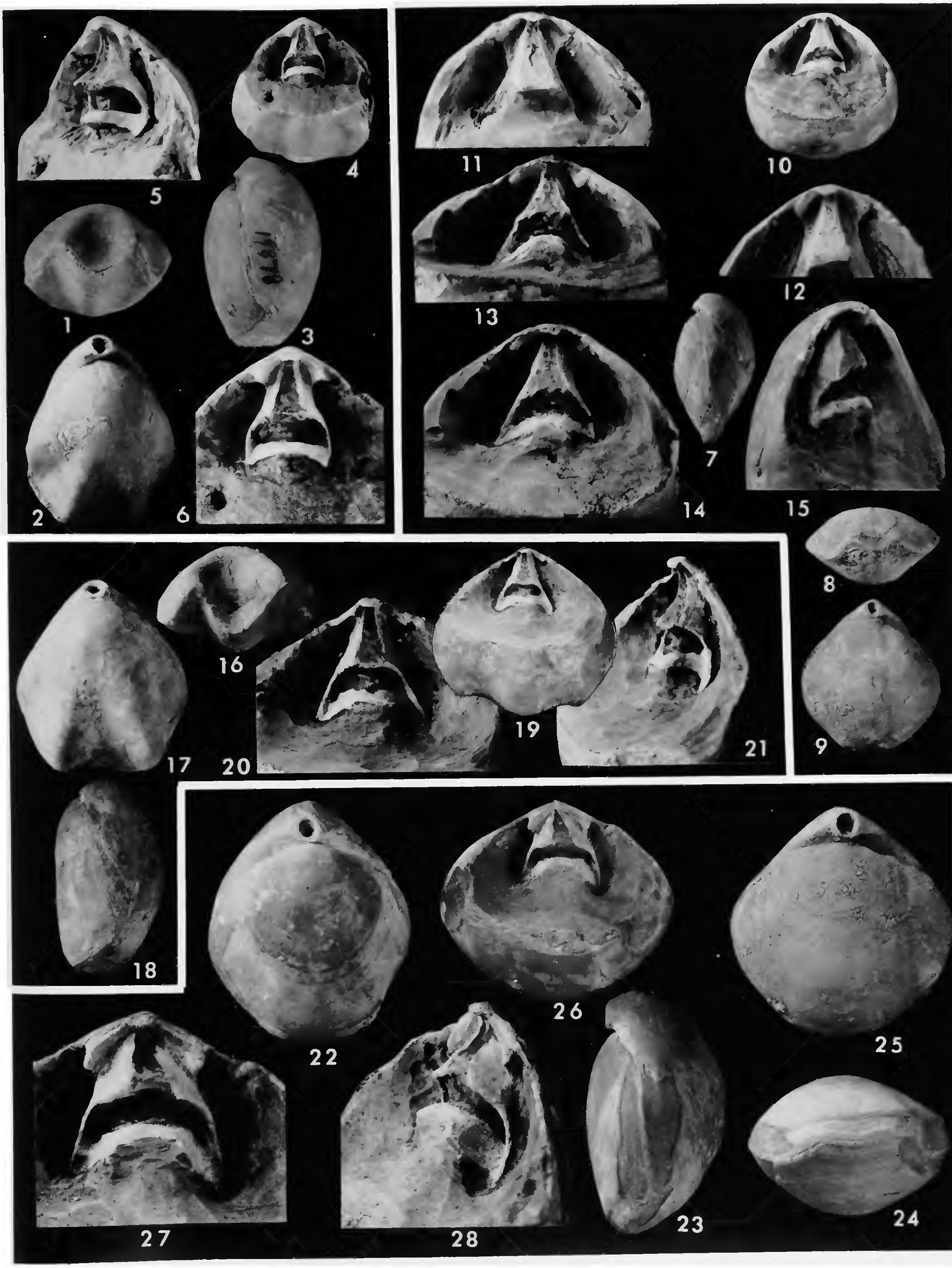

5
4
11
10
1
3
13
12
2
6
7
14
15
8
16
19
17
20
21
9
18
22
26
25
27
28
23
24

PLATE 40

FIGURES 1–6.—*Pentithyris pelagica* Rollier: 1–3, Dorsal, anterior, and side views, × 1, of complete specimen, hypotype USNM 123771a; 4, ventral view, × 1, of specimen excavated to show loop, hypotype USNM 123771b; 5, 6, side and ventral views, × 2, of preceding specimen. Jurassic (Oxfordian), Chatillon, France.

FIGURES 7–13.—*Pseudotubithyris* species 2: 7–9, Dorsal, anterior, and side views, × 1, of complete specimen, USNM 551019b; 13, ventral view of specimen excavated to show loop, × 1, USNM 551019b; 10–12, side, ventral, and posterior views × 2, of preceding specimen. Jurassic (Bathonian), NW of Bir, Gebel Maghara, Sinai.

FIGURES 14–18.—*Pseudotubithyris* aff. *P. globata* (J. deC. Sowerby): 14–16, Side, anterior, and dorsal views, × 1, of complete specimen, hypotype USNM 75068; 17, ventral view of specimen excavated to show loop, × 1, × 2, hypotype USNM 75068a; 18, same specimen, × 2 (loop partially enclosed by crystalline calcite). Jurassic (Bathonian, Bath Oolite), Marquise, Pas-de-Calais, France.

FIGURES 19–24.—*Euidothyris euides* Buckman: 19–21, Anterior, dorsal, and side views, × 1, of complete specimen, hypotype USNM 551017a; 22, specimen excavated to show loop, × 1, hypotype USNM 551017b; 23, 24, side and ventral views, × 2, of preceding specimen showing loop in detail. Jurassic (Bajocian – Pea Grit), Crickley Hill, Cheltenham, England.

FIGURES 25–28.—*Liothyrella expansa* Cooper: 25–27, Anterior, dorsal, and side views of complete specimen, holotype USNM 551153b; 28, ventral view of posterior of dorsal valve of same specimen showing typical loop, × 2. Recent, at 225–265 meters, 54°44.2′S, 037°11.2′W, off South Georgia, Antarctica.

FIGURES 29–32.—*Pseudotubithyris* species 3: 30, Plaster cast, × 1, of specimen excavated to show loop, similar but narrower than that shown in figures 17 and 18, USNM 551018; 29, ventral view of excavated loop, × 1; 31, 32, side and ventral views, × 2, of preceding specimen. Jurassic (Bradfordian), W side route 814, one km W of Amfreyville, 10.8 km NE of Caen, Calvados, France.

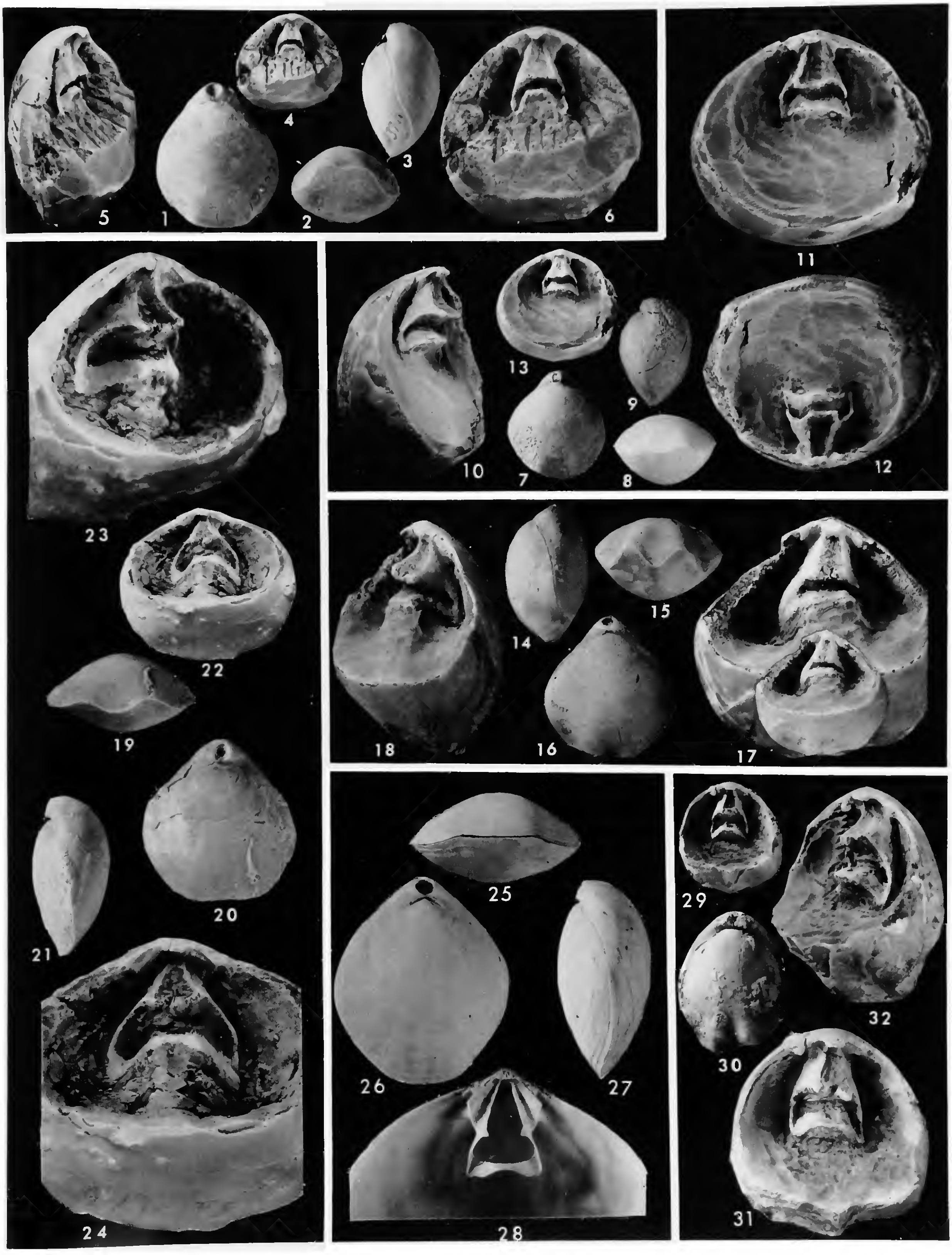

5
1
4
2
3
6
11
23
13
10
9
7
8
12
22
18
14
15
16
17
19
20
21
24
25
26
27
28
29
32
30
31

PLATE 41

FIGURES 1–7.—*Cererithyris intermedia* (J. Sowerby): 1, Dorsal view of plaster cast of specimen dissected, × 1, hypotype USNM 32137a; 5, ventral view of excavated specimen, × 1, showing wide loop; 6, 7, partial side and ventral views, × 2, of preceding specimen showing wide loop with protuberant transverse band. Jurassic (Bathonian), Boulonais, France.

2–4, Dorsal, anterior, and side views, × 1, of complete specimen, hypotype USNM 551005. Jurassic (Cornbrash), Kirtlington, England.

FIGURES 8–10.—"*Terebratula*" *suprajurensis* Thurmann: 8, Dorsal view of complete specimen, × 1, hypotype USNM 123750a; 9, 10, ventral and partial side views of excavated specimen with imperfect loop, hypotype USNM 123750b. Jurassic (Sequanian), Romagne sur Montfaucon, France.

FIGURES 11–14.—*Epithyris oxonica* (Arkell): 11, Dorsal view, × 1, of plaster cast of excavated specimen, hypotype USNM 551004a; 12, 13, side and ventral views of loop of preceding, × 2, showing great width and protuberant transverse band; 14, same specimen, × 1. Jurassic (Cornbrash), Kiddlington, Oxfordshire, England.

FIGURES 15–21.—*Heterobrochus incultus*, new species: 15–17, Anterior, dorsal, and side views of young adult, × 1, holotype USNM 30901b; 18, ventral view, × 1, of specimen excavated to show wide loop, paratype USNM 30901c; 19–21, posterior, × 2, partial side and ventral views of preceding specimen showing loop in detail, × 3, showing ventral attachment of outer hinge plates to crural bases. Jurassic (Kimmeridgian) Fritzow, near Kammin, Pomerania, Germany.

FIGURES 22–27.—*Apatecosia nutiensis* (Bague): 22–24, Anterior, side, and dorsal views, × 1, of complete specimen, hypotype USNM 551006a; 25, another specimen in dorsal view showing loop, × 1, hypotype USNM 551006c; 26, 27, side and ventral views, × 2, showing excavated loop. Jurassic (Callovian – *Macrocephalites macrocephalus* Zone), Nuits St. George, Côte d'Or, France.

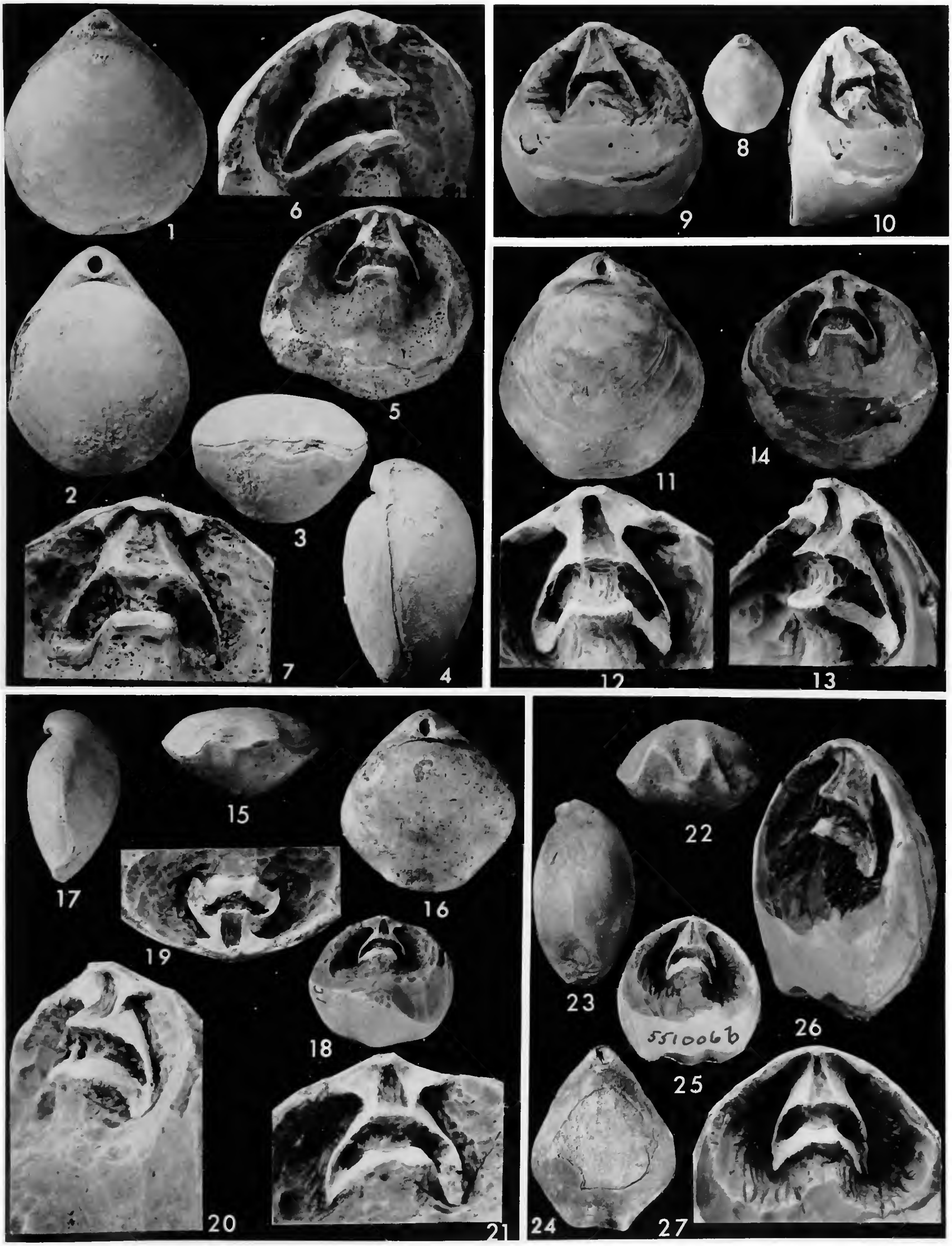

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
551006b

PLATE 42

FIGURES 1–4, 7–17.—*Epithyris oxonica* Arkell: 1–3, Side, anterior, and dorsal views of complete specimen, × 1, hypotype USNM 551023a; 13, ventral view of specimen with excavated loop, × 1, hypotype USNM 551023b; 14–16, ventral, side, and posterior views of preceding specimen, × 2. Jurassic (Upper Bathonian – White Limestone), Woodeaton Pit, Route A40 at Elsfield turnoff, Woodeaton, Oxfordshire, England.

4, Another complete specimen, × 1, hypotype USNM 551022a; 9, ventral view, × 1, of specimen excavated to show loop, hypotype USNM 551022b; 10–12, side, posterior, and ventral views, × 1.5, of preceding hypotype showing strongly protuberant transverse band. Jurassic (Bathonian – Great Oolite), Kirtlington, Oxfordshire, England.

7, 8, 17, Ventral and side views, × 2, and ventral view, × 1, of young specimen with excavated loop, showing protuberant transverse band, hypotype USNM 123738a. Jurassic (Bathonian – Great Oolite), railway cutting near Chedworth, Gloucestershire, England.

FIGURES 5, 6.—*Epithyris maxillata* (Sowerby): Ventral and side views, × 2, of specimen with excavated but partially broken loop, hypotype USNM 64419a. Jurassic (Bathonian – Bradford Clay), Bradford-on-Avon, England.


5
7
10
8
4
6
17
9
11
1
12
13
15
2
3
14
16

PLATE 43

FIGURES 1–6.—*Wattonithyris fullonica* Muir-Wood: 1–3, Anterior, side, and dorsal views, × 1, of complete specimen, hypotype USNM 75618a; 4, ventral view, × 1, of another specimen excavated to show loop, hypotype USNM 75618b; 5, 6, ventral and side views, × 2 of excavated specimen. Jurassic (Bathonian – Fullers Earth), Hawkesbury, Upton, England.

FIGURES 7–12.—*Tubithyris wrighti* (Davidson): 7–9, Dorsal, side, and anterior views, × 1, of complete specimen showing uniplicate anterior commissure, hypotype USNM 88750a; 10, ventral view of specimen excavated to show loop, × 1, hypotype USNM 551025a; 11, 12, ventral and lateral views, × 3, of preceding specimen. Jurassic (Bajocian – Middle Inferior Oolite – *Witchelia* Bed), near Cheltenham, Gloucestershire, England.

FIGURES 13–21.—*Stroudithyris pisolithica* (S. S. Buckman): 13–15, Side, anterior, and dorsal views, × 1, of complete specimen, hypotype USNM 75569b; 16, loop of same specimen, × 1; 17, 18, lateral and ventral views of preceding specimen, × 2; 19, dorsal view, × 1, of cast of another specimen, hypotype USNM 75569a; 20, 21, side and ventral views of preceding, × 2, showing cardinalia and widely bowed descending lamellae but lacking transverse band. Jurassic (Bajocian – Inferior Oolite – Pea Grit), Randwick Ash, Stroud, Gloucestershire, England.

FIGURES 22–31.—*Stiphrothyris tumida* (Davidson): 22–24, Side, anterior, and dorsal views, × 1, of typical specimen, hypotype USNM 551027a; 25, plaster cast of associated, less obese specimen, × 1, excavated to show loop, hypotype USNM 551027b; 29, excavated loop, × 1, with part of right side missing; 30, 31, ventral and side views, × 2, of preceding specimen. Jurassic (Bajocian – Inferior Oolite – Clypeus Grit), Snows Hill Mill, Gloucestershire, England.

28, Ventral view, × 1, of another specimen showing complete loop, hypotype USNM 551026b; 26, 27, side and ventral views, × 2, of same specimen. Jurassic (Bajocian – Inferior Oolite – Clypeus Grit), top of Birdlip Hill, Gloucestershire, England.


5
4
1
6
2
3
7
8
11
16
13
14
15
9
19
17
20
21
18
10
12
26
23
22
29
30
28
27
24
25
31

PLATE 44

FIGURES 1, 5–8.—*Sphaeroidothyris sphaeroidalis* (Sowerby): 1, Dorsal view, × 1, of medium-sized specimen, hypotype USNM 551032; 6, ventral view of similar specimen excavated to show loop, × 1, hypotype USNM 551032a; 7, 8, side and ventral views, × 2, of preceding specimen. Jurassic (Bajocian – Inferior Oolite), St. Vigor, near Bayeux, Calvados, France.

5, Ventral view, × 2, of another specimen showing hinge plates in detail, hypotype USNM 31337a. Jurassic (Bathonian), Montiers, France.

FIGURES 2–4, 9–11.—*Sphaeroidothyris globisphaeroidalis* S. S. Buckman: 2–4, Anterior, dorsal, and side views, × 1, of typical specimen, hypotype USNM 551031; 9, ventral view, × 1, of another specimen excavated to show loop, hypotype USNM 551031a; 10, 11, side and ventral views, × 2, of excavated specimen. Jurassic (Bajocian – Upper Inferior Oolite – *parkinsoni* Zone), Broad Windsor, Dorsetshire, England.

FIGURES 12–17.—*Lophrothyris? whitakeri* (Walker-Davidson): 12–14, Anterior, dorsal, and side views, × 1, of medium-sized specimen showing uniplicate anterior commissure, hypotype USNM 551033b; 15, ventral view of another specimen excavated to show loop, × 1, hypotype USNM 551033a; 16, 17, side and ventral views, × 2, of excavated specimen. Jurassic (Bajocian – Pea Grit), Crickley Hill, Cheltenham, Gloucestershire, England.

FIGURES 18–25.—*Plectothyris fimbria* (Sowerby): 18–20, Dorsal, anterior, and side views, × 1, of typical specimen with peripheral costation, hypotype USNM 551030b. Jurassic (Bajocian – Oolite Marl – *murchisonae* Zone), Notgrove Railroad Cut, near Cheltenham, Gloucestershire, England.

21, Ventral view, × 1, of specimen excavated to show loop, hypotype USNM 551029c; 22, 23, side and ventral views of preceding specimen, × 2; 24, 25, side and ventral views of another specimen with excavated loop, × 2, hypotype USNM 551029b. Jurassic (Bajocian – Oolite Marl), Catbrain Quarry, Painswick, Gloucestershire, England.

FIGURES 26, 27.—*Dyscolia guiscardiana* (Seguenza): Specimen, × 1, × 2, excavated to show loop with anteriorly directed transverse band, hypotype USNM 550904c. Pliocene, Messina, Sicily.


1
2
5
12
15
4
3
7
13
16
10
9
6
14
11
8
17
18
21
20
19
27
26
22
23
24
25

PLATE 45

FIGURES 1–6.—*Conarothyris opima*, new species, 1–3, Side, anterior, and dorsal views, × 1, of complete specimen, hypotype USNM 551103; 4, loop of preceding specimen, × 1; 5, 6, ventral and side views, × 2, of same specimen. Jurassic (Bajocian – Inferior Oolite), Burton Bradstock, Dorsetshire, England.

FIGURE 7.—*Ptychtothyris stephani* (Davidson): Excavated specimen showing outer hinge plates, × 3, hypotype USNM 551057a. Jurassic (Bajocian – Inferior Oolite), Broad Windsor, Dorsetshire, England. (See Plate 39 for additional views.)

FIGURES 8–15.—*Lophrothyris etheridgei* (Davidson) (= *L. lophus* S. S. Buckman): 8–10, Anterior, showing uniplicate commissure, dorsal, and side views, × 1, of narrow specimen, hypotype USNM 551100b; 11, same specimen excavated to show loop, × 1; 12, 13, ventral and partial side views, × 2, of preceding specimen; 14, 15, anterior and dorsal views, × 1, of specimen wider than preceding, showing uniplicate anterior commissure, hypotype USNM 551100a. Jurassic (Bajocian – Inferior Oolite – Pea Grit), Leckhampton, Gloucestershire, England.

FIGURES 16–18.—*Hesperithyris sinuosa minor* Dubar: 16, Exterior of nearly complete specimen, × 1, hypotype USNM 551138a; 17, 18, interior of two dorsal valves showing large, concave cardinal process and hinge plates, × 2, hypotype USNM 551138b,c. Jurassic (Pliensbachian or top of Lotharingian), Clairière de la Maison Forestiere d' Aiu-Kahla (Southwest Azrou) Causse preatlassique, Morocco.

FIGURES 19–24.—*Bihenithyris* aff. *barringtoni* Muir-Wood: 19–21, Side, anterior, and dorsal views, × 1, of narrow specimen, hypotype USNM 551117; 22, excavated dorsal valve of another specimen, × 1, showing loop, hypotype USNM 551117a; 23, 24, ventral and side views, × 2, of preceding specimen. Jurassic (Callovian – *Eligmus-Erymnoceras* Beds, 40 feet above base-subunit 23 of unit III), Maktesh, Hathira (Kurnub or Hagadol), southern Israel.

FIGURE 25.—*Arcelinithyris arcelini* (Lissajous): Complete loop, × 1. Jurassic (Bajocian), quarry La Roche-Vineuse, Monsard, Saône-et-Loire, France; from Arcelin and Roché, 1936, pl. 14: 12.

FIGURES 26–33.—*Cererithyris intermedia* (J. Sowerby): 26–28, Anterior, side, and dorsal views, × 1, of large, complete specimen, hypotype USNM 551096c; 31, excavated loop of another large specimen, × 1, hypotype USNM 551096a; 32, 33, ventral and side views, × 2, of preceding specimen showing protuberant transverse band and acute crural processes; 29, interior of another excavated specimen, × 1, lacking transverse band, hypotype USNM 551096b; 30, lateral view of preceding specimen, × 2, showing tapering attachment of outer hinge plate to dorsal edge of crural base and sharp crural processes. Jurassic (Bathonian – Cornbrash), excavation for petrol tanks at Islip Railway Station, near Oxford, England. (Compare with *Epithyris*, Plate 42.)


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33

PLATE 46

FIGURES 1–3, 7, 8.—*Aromasithyris balinensis* (Szajnocha): 1–3, Side, anterior, and dorsal views, × 1, of complete specimen, hypotype USNM 75952a; 7, 8, ventral and side views, × 2, specimen excavated to show loop (imperfect), hypotype USNM 75952b. Jurassic (Dogger), Balin, near Cracow, Poland.

FIGURES 4–6, 9–10.—*Aromasithyris almerasi* Boullier: 4–6, Side, anterior, and dorsal views, × 1, of complete specimen, hypotype USNM 551042a; 9, 10, ventral and side views, specimen excavated to show loop, × 2, hypotype USNM 551042b. Jurassic (Callovian – *koenigi* Zone), Vercra, near Marchampt, Ain, France.

FIGURE 11.—*Gigantothyris gigantea* Seifert: Ventral view of specimen exhibiting loop, × 1, paratype, Geological Institute Tübingen Brachiopoda 1020/8. Jurassic (Dogger – Braun Jura – delta – *humphriesianum* Oolite), Stuifen, Germany. From Seifert, 1963, fig. 9e.

FIGURES 12–15.—*Arcelinithyris arcelini* (Lissajous): 12–14, Side, dorsal, and anterior views, × 1, of complete specimen, hypotype USNM 551037; 15, side view, × 2, of specimen preserving long loop, hypotype USNM 551038a. Jurassic (Bajocian), quarry La Roche-Vineuse, Monsard, Saône-et-Loire, France.

FIGURES 16–22.—*Lissajousithyris matisconensis* (Lissajous): 16, 17, Side and anterior views, × 1, of complete specimen, hypotype USNM 551036a; 18, dorsal view, × 1, of another specimen, × 1, hypotype USNM 551036b; 19, interior of dorsal valve, × 1, hypotype USNM 551036c; 20, 21, ventral and side views, × 2, same specimen; 22, interior, × 2, of another dorsal valve with long loop, hypotype USNM 551036d. Jurassic (Bajocian), quarry La Roche-Vineuse, Monsard, Saône-et-Loire, France.

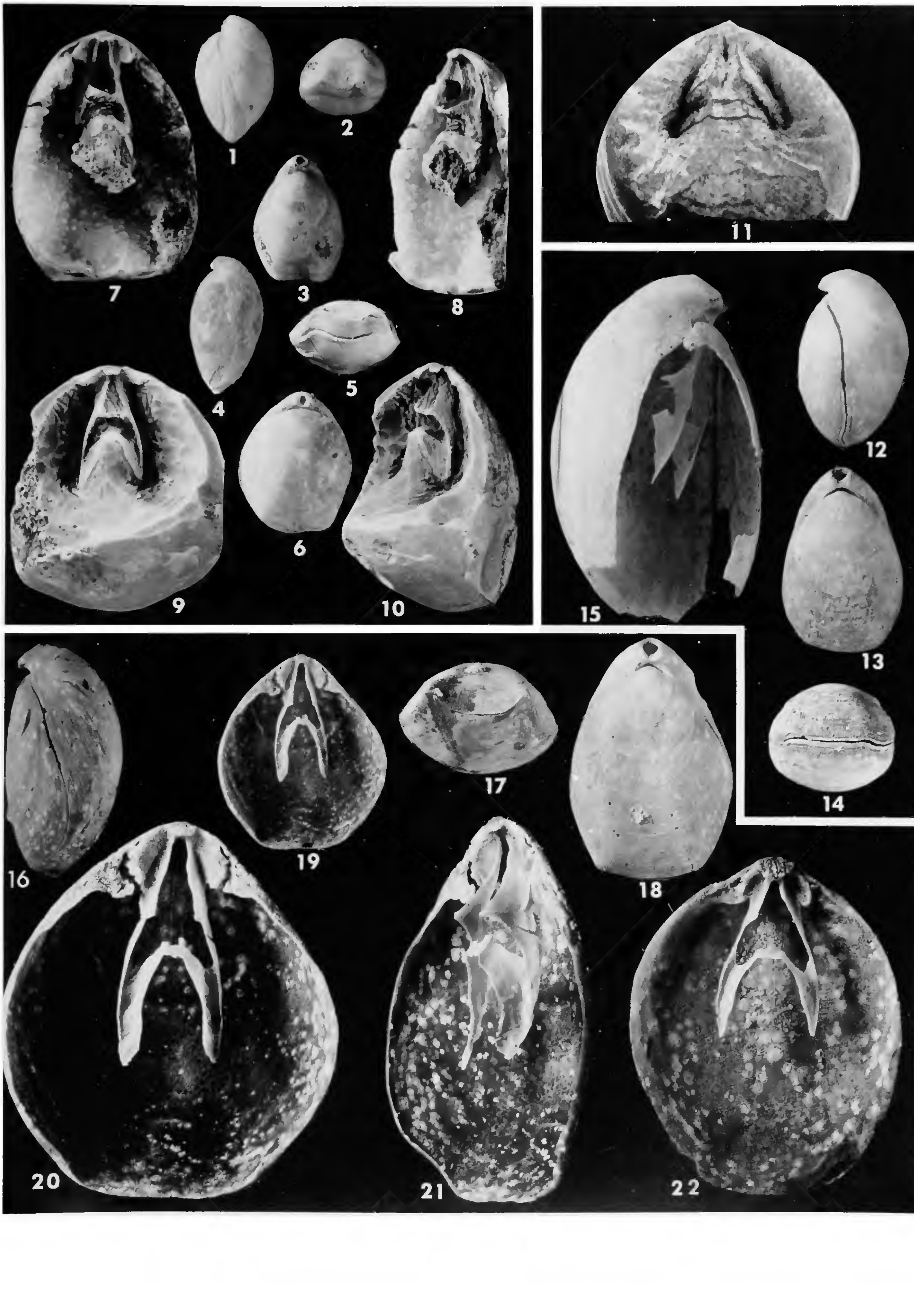

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

PLATE 47

Figures 1–4.—*Monsardithyris? buckmaniana* (Walker): 1, Dorsal view, × 1, of complete but imperfect specimen, hypotype USNM 551035; 2, ventral view, specimen excavated to show loop, × 1, hypotype USNM 551035a; 3, 4, ventral and side views, × 2, preceding specimen. Jurassic (Bajocian – Inferior Oolite – Pea Grit), Crickley Hill, Cheltenham, Gloucestershire, England.

Figures 5–15.—*Monsardithyris ventricosa* (Zieten): 5, 6, 13, Exterior and interior of silicified specimen, × 1, interior × 1.5, hypotype USNM 551020c; preceding specimen, × 1.5; 7, 8, another smaller specimen in exterior and interior views, × 1, showing loop with long terminal points, hypotype USNM 551020d; 14, interior of same specimen, × 1.5; 9, interior of young dorsal valve, × 1.5, hypotype USNM 551034a; 10, ventral view, × 1, larger specimen with narrow bridge of transverse band, hypotype USNM 551034g; 11, 12, ventral and side views of loop, × 2, hypotype USNM 551020i; 15, interior of dorsal valve, × 2, showing long terminal points, short outer hinge plates, and posterior projections from bridge of loop, hypotype USNM 551020a. Jurassic (Bajocian), quarry La Roche-Vineuse, Monsard, Saône-et-Loire, France.

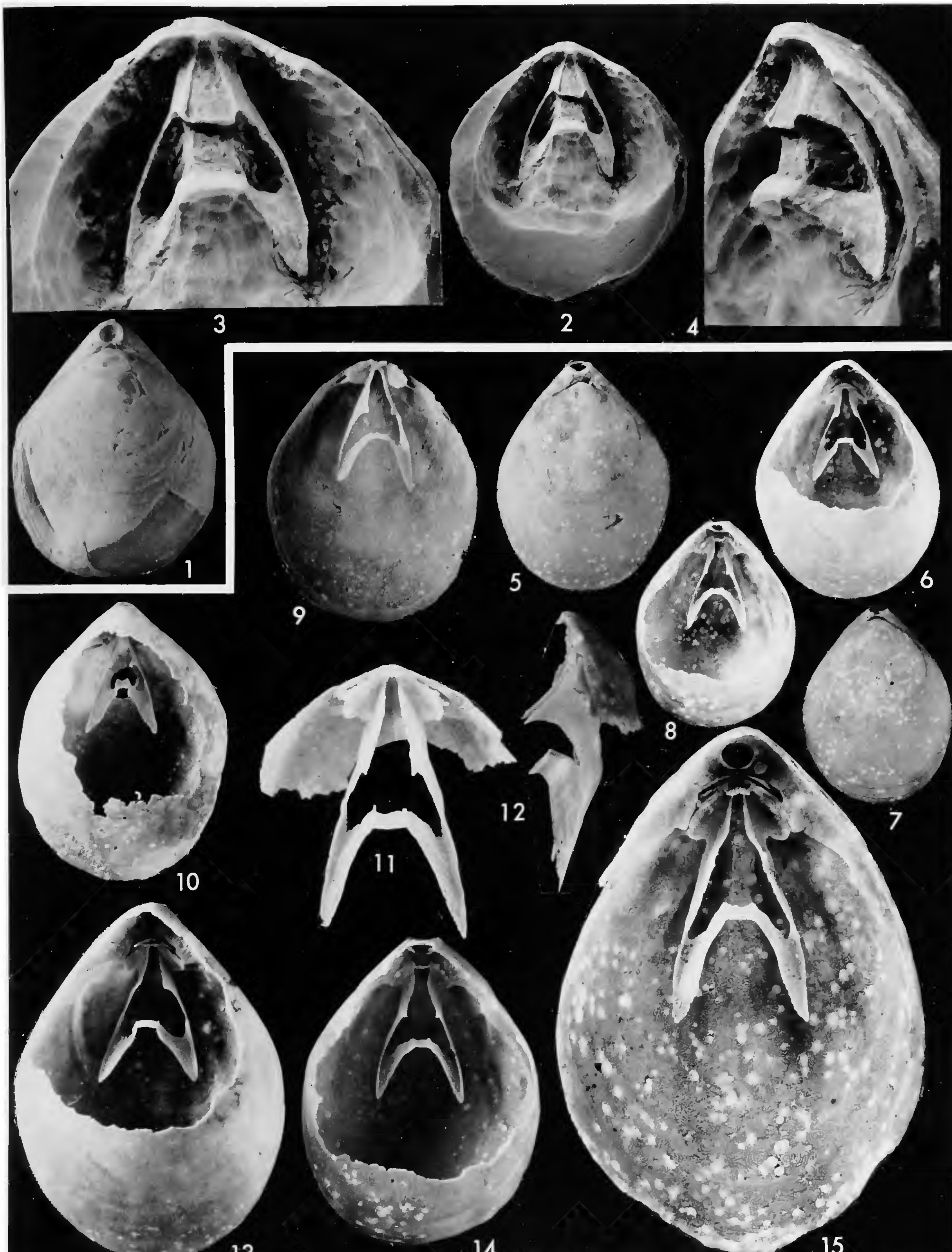

3
2
4
1
9
5
6
8
10
12
11
7
13
14
15

PLATE 48

FIGURES 1–10.—*Avonothyris plicatina* S. S. Buckman: 1–3, Dorsal, side, and anterior views, × 1, of cast of Buckman's type specimen, Great Britain Geological Survey 51326. Jurassic (Bradfordian), Bradford-on-Avon, Wiltshire, England.

4–6, Anterior, dorsal, and side views, × 1, of complete specimen, hypotype USNM 551115; 7, ventral view of preceding specimen excavated to show loop, × 1; 8–10, ventral, posterior, and side views, × 2, showing unusually long, slender crural processes and transverse band. Jurassic (Bradfordian), same as above.

FIGURES 11–14.—*Pseudodielasma pingue* Cooper and Grant: 11–13, Dorsal, anterior, and side views, × 2, of complete specimen, paratype USNM 153366r. Permian (Word Formation – Willis Ranch Member), arroyo 0.55 mile (0.9 km) N, 15° W of hill 5611, 4.13 miles (6.6 km) N, 34° E of Hess Ranch, Hess Canyon (15′) quadrangle, Texas.

14, Loop, × 10, showing no outer hinge plates, paratype USNM 154321. Permian (Word Formation – Willis Ranch Member), N slope of hill 5611, 1.85 miles (3 km) S, 82° W of Old Word Ranch, 3.78 miles (6.1 km) N, 40° E of Hess Ranch, Hess Canyon (15′) quadrangle, Texas. (See Plate 49 for another loop.)

FIGURES 15–20.—*Oligorhytisia magnifica*, new name: 15–17, Anterior, dorsal, and side views, × 1, of large individual on which peripheral costae have not yet formed, hypotype USNM 88729a; 18, same specimen excavated to show loop, × 1; 19, 20, ventral and side views of loop, × 2, of same specimen. Jurassic (Bajocian – Inferior Oolite – Pea Grit), Birdlip, Gloucestershire, England.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

PLATE 49

FIGURES 1–5.—*Juralina bauhini* (Etallon): 1, 2, Ventral and side views, × 1, of complete specimen showing beak elongated like that of *Rectithyris* of Lower Cretaceous, hypotype USNM 551048b; 3, ventral view, × 1, of specimen excavated to show imperfect loop, hypotype USNM 551048a; 4, 5, ventral and side views, × 2, of preceding specimen. Jurassic (Upper Rauracian), Bois du Treuil, Sayhières, Switzerland.

FIGURES 6–8.—*Juralina insignis cervicula* (Quenstedt) (=*Juralina feldstettensis* (Rollier)): 6, 7, Dorsal exterior, ventral views, × 1, of specimen preserving imperfect loop, external homeomorph of *Rectithyris*, hypotype USNM 551047; 8, posterior of same, × 1.5. Jurassic (White Jura - Zeta), Schnaitheim, Germany.

FIGURES 9–17.—*Notosia chiliensis*, new species: 9–11, Anterior, dorsal, and side views, × 1, of complete specimen showing anterior uniplication, holotype USNM 551049a; 12, 13, interior of dorsal valve, × 1, × 4, showing loop and outer hinge plates, paratype USNM 551049b; 14, same in side view, × 2; 15–17, interior of three dorsal valves, × 2, paratypes USNM 551049d,c,e. Jurassic (Lias), 4 miles (6.5 km) ENE of Smithsonian Montezuma Observatory, Calama, Chile.

FIGURES 18–23.—*Sphaeroidothyris?* species 1 (Sowerby): 18–20, Anterior, dorsal, and side views, × 1, of specimen excavated, USNM 92910; 21, ventral view of dissected dorsal valve, × 1; 22, 23, side and ventral views of preceding showing well-developed hinge plates, socket ridges, and incomplete loop with long terminal points, × 2. Jurassic (Inferior Oolite), Calvados, France. (See Plates 36 and 44 for loops of other specimens of *Sphaeroidothyris*.)

FIGURE 24.—*Pseudodielasma ovatum* Cooper and Grant: Ventral view of cardinalia and loop, × 10, showing lack of outer hinge plates, paratype USNM 154318f. Permian (Word Formation - Willis Ranch Member), arroyo 0.55 mile (0.9 km) N, 15° W of hill 5611, 4.13 miles (6.6 kms) N, 34°E of Hess Ranch, Hess Canyon (15′) quadrangle, Texas.

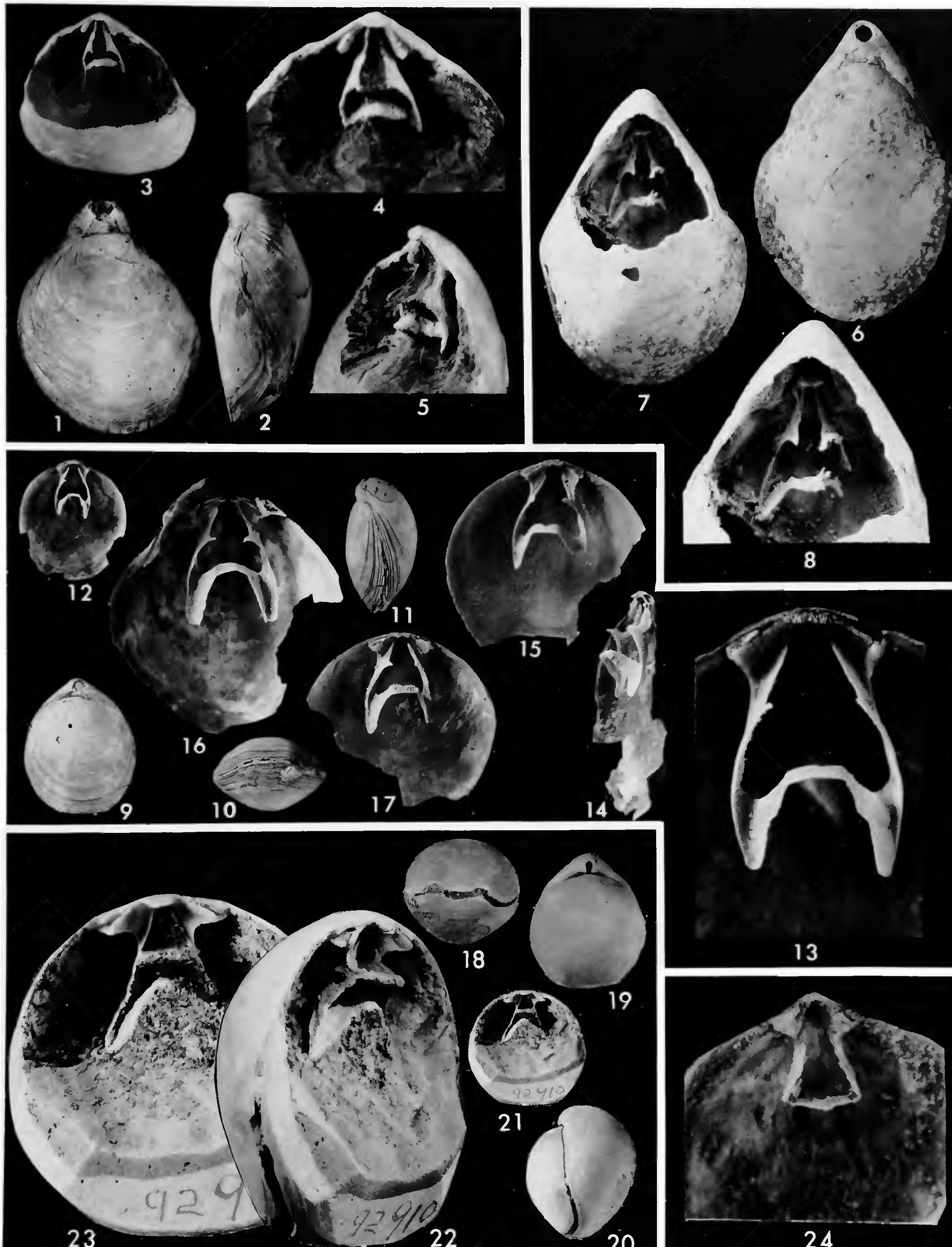


PLATE 50

FIGURES 1–6.—*Stenogmus pentagonalis*, new species: 1–3, Dorsal, anterior, and side views, × 1, of complete specimen, paratype USNM 551095. Jurassic (Callovian - Variansschichten), Bölchenstrasse, oberhalb Kamberberg to Hägendorf near point 936, Switzerland.

4, Ventral view of specimen excavated to show loop, × 1, paratype USNM 551094; 5, 6, ventral and side views, × 2, of preceding specimen showing strongly protuberant transverse band. Jurassic (Callovian - Variansschichten), Kilchberg, Switzerland. (See Plate 61 for additional views.)

FIGURES 7–12.—*Conarothyris opima*, new species: 7–9, Side, anterior, and dorsal views, × 1, of complete obese specimen, USNM 551127; 10, ventral view of another specimen excavated to show loop, × 1, USNM 551127a; 11, 12, side and ventral views, × 3, of preceding specimen. Jurassic (Bajocian - Inferior Oolite), Dundry, Somerset, England.

FIGURES 13–18.—*Saucrobrochus whaddonensis* (S. S. Buckman): 13–15, Anterior, side, and dorsal views, × 1, of complete specimen, hypotype USNM 551089a; 16, loop of preceding specimen, × 1; 17, 18, partial side and ventral views, of preceding, × 2, showing dorsal attachment of short outer hinge plate to crural base. Jurassic (Bajocian Inferior Oolite), Stoke Knapp, Whaddon Hill, near Broadwindsor, Dorset, England.

FIGURES 19–24.—*Stiphrothyris?* species: 19–21, Dorsal, side, and anterior views, × 1, of complete specimen, USNM 64436; 22, ventral view of another specimen excavated to show loop, × 1, USNM 64436a; 23, 24, side and ventral views of preceding, × 2, (loop deformed on left side). Jurassic (Bajocian - Inferior Oolite), Stroud, Gloucestershire, England.

FIGURES 25–33.—*Strongylobrochus omalogastyr* (Zieten): 25–27, Anterior, dorsal, and side views, × 1, of complete specimen showing nearly flat dorsal valve, hypotype USNM 75808; 31, same specimen excavated to show loop, × 1; 32, loop in side view, × 2, (points of crural processes lost in excavation); 33, loop in ventral view, × 3; 28–30, anterior, side, and dorsal views, × 1, of large specimen. Jurassic (Dogger - *humphriesianum* Zone), Auerbach, Oberfalz, Bavaria, Germany.


5
4
1
2
3
6
11
7
8
10
9
12
13
14
17
15
16
18
19
22
20
21
23
24
25
28
31
26
27
33
32
29
30

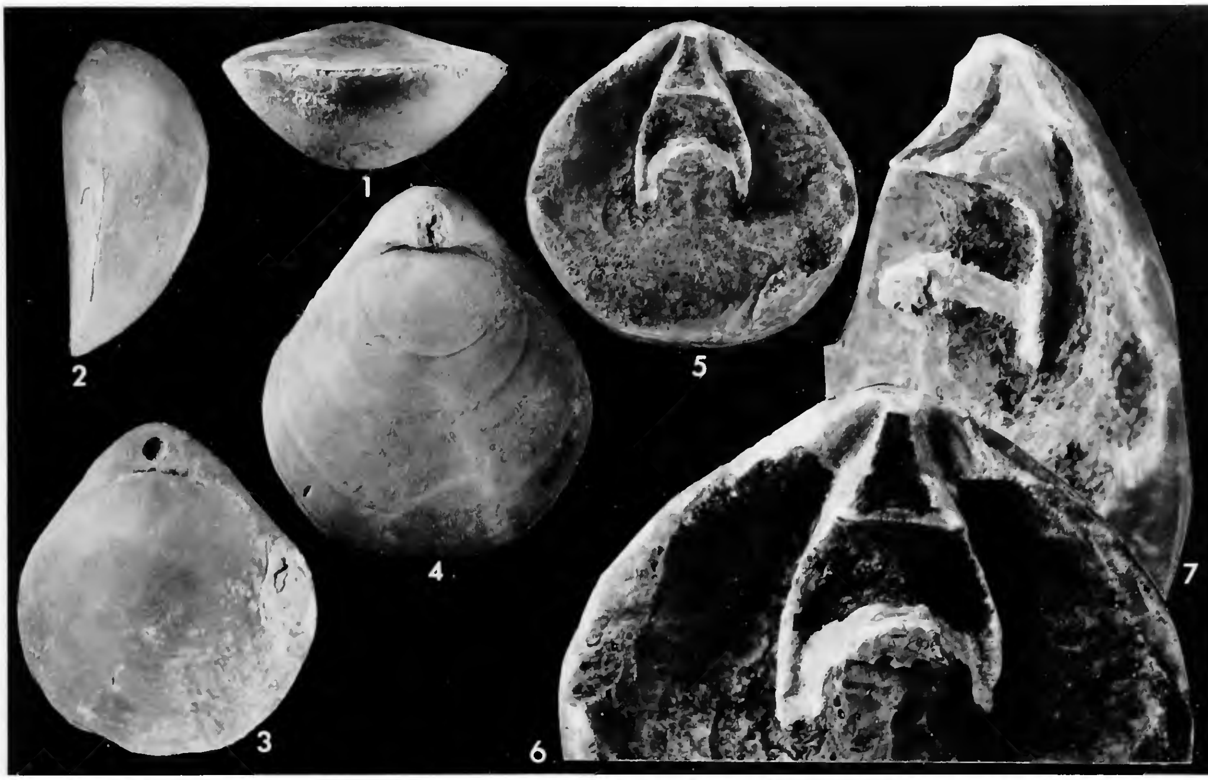
PLATE 51

FIGURES 1–7.—*Petalothyris simplex* (J. Buckman): 1–3, Anterior, side, and dorsal views, × 1, of complete specimen showing flat to anteriorly faintly concave dorsal valve, hypotype USNM 551044. Jurassic (Bajocian – Inferior Oolite – Pea Grit), Leckhampton Quarry, Cheltenham, Gloucestershire, England.

4, Dorsal view of plaster cast of specimen excavated to show loop, × 1, hypotype USNM 88735; 5, ventral view of excavated specimen, × 1, showing long, wide loop, hypotype USNM 88735; 6, 7, ventral and side views, × 2, of preceding specimen. Jurassic (Bajocian – Inferior Oolite), Gloucestershire, England.

FIGURES 8–15.—*Plectoidothyris polyplecta* (S. S. Buckman): 8, dorsal view of plaster cast, × 1, of specimen excavated to show loop, hypotype USNM 551043a, 9–11, dorsal, anterior, and side views, × 1, of complete specimen showing peripheral costae, hypotype USNM 551043; 12, ventral view, × 1, of excavated specimen showing loop; 13, 14, side and ventral views, × 2, of excavated specimen (compare figure 14 with figure 15). Jurassic (Bajocian – Inferior Oolite – Oolite Marl), near Notgrove, Gloucestershire, England.

15, Reconstruction of interior, reduced from Muir-Wood (1934, pl. 63: fig. 35), about × 1.75.


1
2
3
4
5
6
7

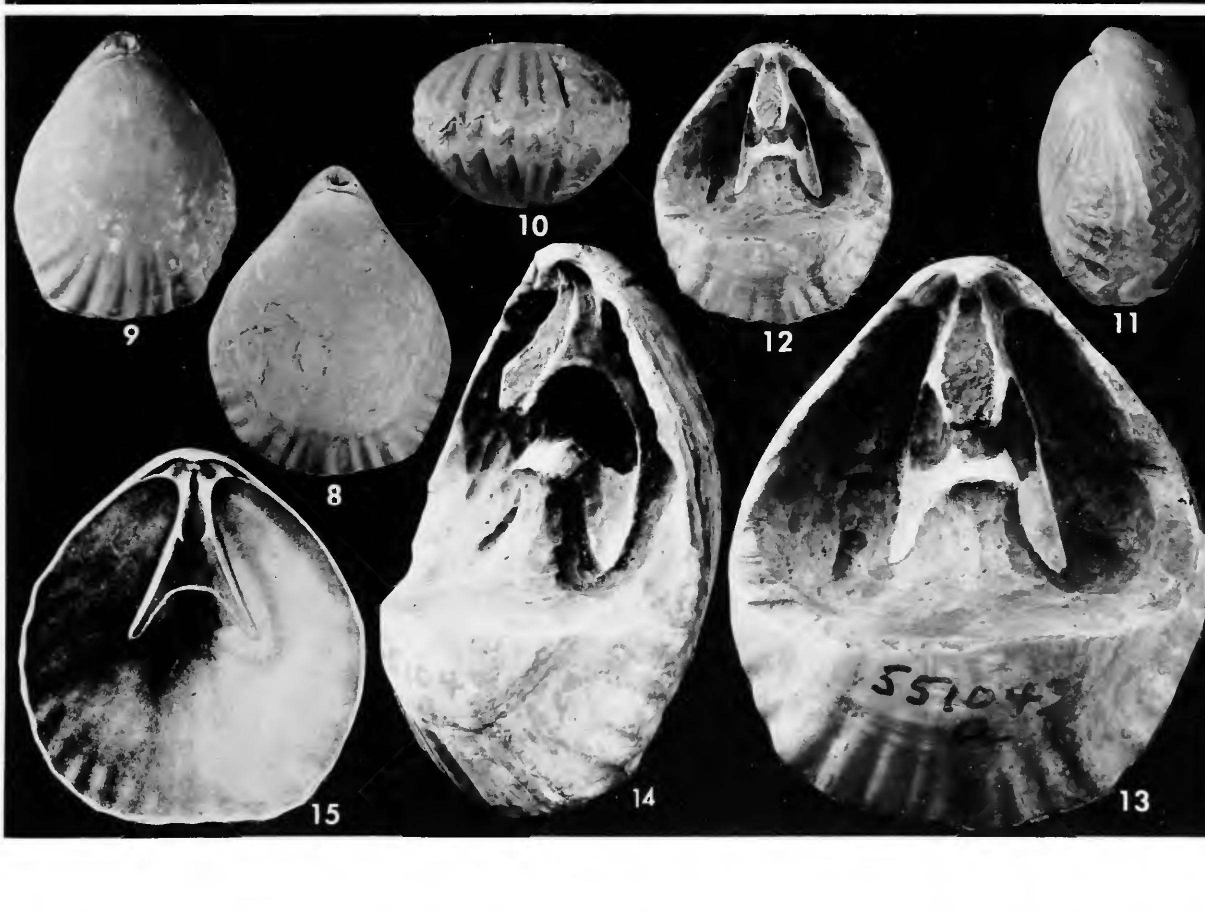

8
9
10
11
12
13
14
15

PLATE 52

FIGURES 1–6.—*Inaequalis* species: 1–3, Anterior, dorsal, and side views, × 1, of complete specimen showing rectimarginate anterior commissure, USNM 551041; 4, ventral view of similar specimen excavated to show loop, × 1, USNM 551041a; 5, 6, partial side, and ventral views, × 2, of preceding specimen showing long terminal points and taper of outer hinge plates to dorsal edge of crural bases (narrow bridge of transverse band lost in preparation). Jurassic (Middle Lias), near Cheltenham, Gloucestershire, England.

FIGURE 7.—*Lobothyris punctata* (Sowerby): Reconstruction from serial sections of loop and cardinalia, from Muir-Wood (1934, pl. 63: fig. 37, reduced), about × 1.5.

FIGURES 8–14.—*Pirotothyris?* species: 8, 9, Anterior and dorsal views, × 1, of well-rounded specimen, × 1, USNM 551040a; 10, ventral view of preceding, × 1.5 showing loop with long terminal points; 11, interior of young dorsal valve, × 2, showing immature loop, USNM 551040f; 12, loop of specimen seen from dorsal side, × 1.5, USNM 551040c; 13, 14, ventral and side views, × 2, of specimen with exceptionally long terminal points, USNM 551040b. Jurassic (Middle Lias), field on NW side of east-west road, 0.12 mile (0.2 km) NNW of Les Granges, SSE of Argenton, Indre, France.

FIGURE 15.—*Lobothyris punctata pentagonalis* Dubar (= *Pyraeneica* Sučić-Protić): Interior of dorsal valve, × 1, showing loop, from Dubar (1925, pl. 6: fig. 18). Jurassic (Middle Lias), Jean-Germa, near Foix, French Pyrenees.

FIGURE 16.—*Lobothyris subpunctata pentagonalis* Dubar (= *Inaequalis dubari* Sučić-Protić): Interior of dorsal valve showing loop, × 1, from Dubar (1925, pl. 6: fig. 20). Jurassic (Middle Lias), S of Pech St. Sauveur, French Pyrenees.

FIGURE 17.—*Lobothyris subpunctata* Dubar (not Davidson) (= *Pirotothyris ampla* Sučić-Protić): Dorsal interior, × 1, from Dubar (1925, pl. 6: fig. 22). Jurassic (Middle Lias), N of Cos, French Pyrenees.

FIGURES 18–23.—*Glyphysaria uniplicata*, new species: 18–20, Side, anterior, and dorsal views, × 1, of strongly uniplicate specimen, holotype USNM 551085; 21, same specimen excavated to show loop, × 1, with short terminal points; 22, 23, ventral and partial side views, × 2, of preceding specimen showing notched outer hinge plates. Jurassic (Sequanian), Bourges, Cher, France.


11
12
16
13
8
17
7
15
9
4
1
5
2
10
14
3
6

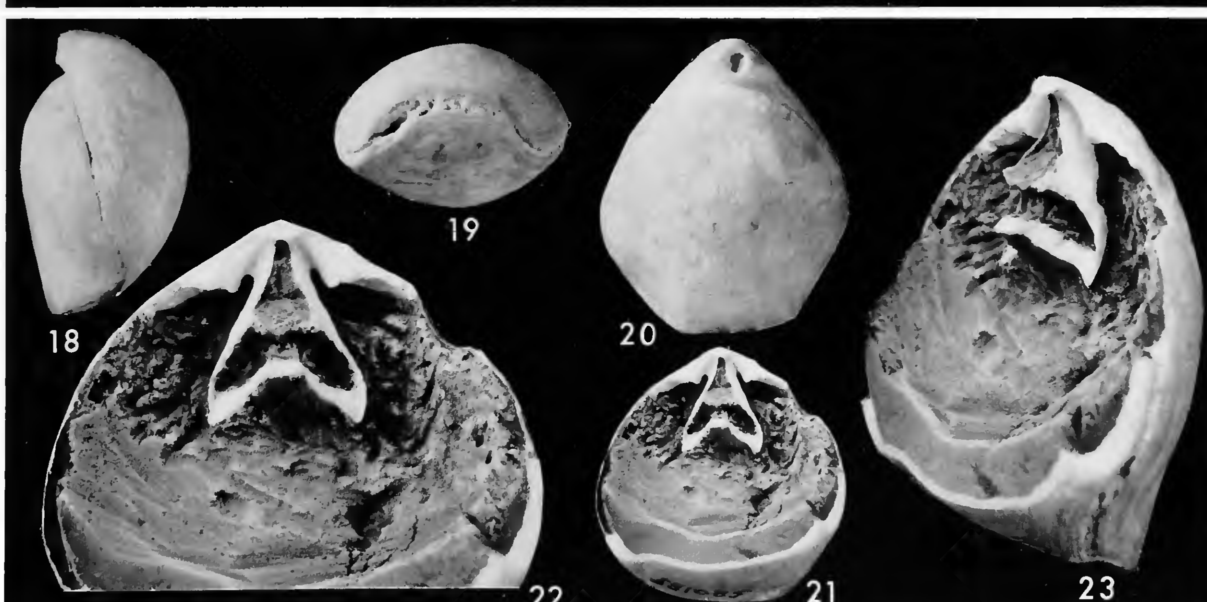

19
18
20
22
21
23

PLATE 53

FIGURES 1–7.—*Rhytisoria alabamensis*, new species: 1–4, Dorsal, ventral, side, and anterior views, × 1, of holotype USNM 549392a; 5, interior of dorsal valve, showing loop, × 1, paratype USNM 549392b; 6, 7, side and ventral views of preceding, × 2. Paleocene (Midway – Clayton Formation), well near the depot at Brundidge, Pike County, Alabama.

FIGURES 8–10, 14–17.—*Rhombaria minor* (Nilsson): 8–10, Side, dorsal, and anterior views of complete specimen, × 1, hypotype USNM 551059. Cretaceous (Senonian – *Actinocamax mammillatus* Zone), Klagstorp, Skåne, Sweden.

14, 15, Partial side and ventral views of dorsal valve showing outer hinge plates, × 2, hypotype USNM 73469b; 16, 17, partial side and ventral views of another dorsal valve, × 2, showing hinge plates, crura, and crural processes, hypotype USNM 73469a. Cretaceous (Senonian – *A. mammillatus* Zone), Ifö, Sweden.

FIGURES 11–13, 18–21.—*Rhombaria rhomboidalis* (Nilsson): 11–13, Anterior, side, and dorsal views, × 1, of imperfect specimen, hypotype USNM 551060; 18, preceding specimen excavated to show loop, × 1; 19–21, partial side, posterior, and ventral views, × 2, of preceding hypotype showing wide loop with protuberant transverse band. Cretaceous (Senonian – *A. mammillatus* Zone), Klagstorp, Skåne, Sweden.

FIGURES 22–25.—*Striithyris "somaliensis"* Muir-Wood: 22, Interior of young dorsal valve excavated to show loop, × 1, hypotype USNM 551054b; 23, 24, same specimen, × 2; 25, side view, × 1, of specimen showing ornament, hypotype USNM 551054a. Jurassic (Callovian – *grossuvria* Beds), Maktesh, Kurnub, Israel.

FIGURES 26–31.—*Bihenithyris* species: 26–28, Side, anterior, and dorsal views, × 1, of complete specimen, USNM 551058a; 29, dorsal valve, × 1, excavated to show loop, USNM 551058b; 30, 31, same dorsal valve in ventral and side views, × 2. Jurassic (Callovian – *Eligmus-Erymnoceras* Zone), Maktesh, Hathira, Kurnub, Israel.

FIGURES 32–34.—*Carneithyris? lens* (Nilsson): 32, 33, Ventral and partial side views, × 1.5, showing ponderous cardinal process with median ridge, swollen hinge plates, and broad crural base; 34, dorsal view, × 1, of same specimen, USNM 550975a. Danian, Limnhamn Quarry, Limnhamn, Sweden.

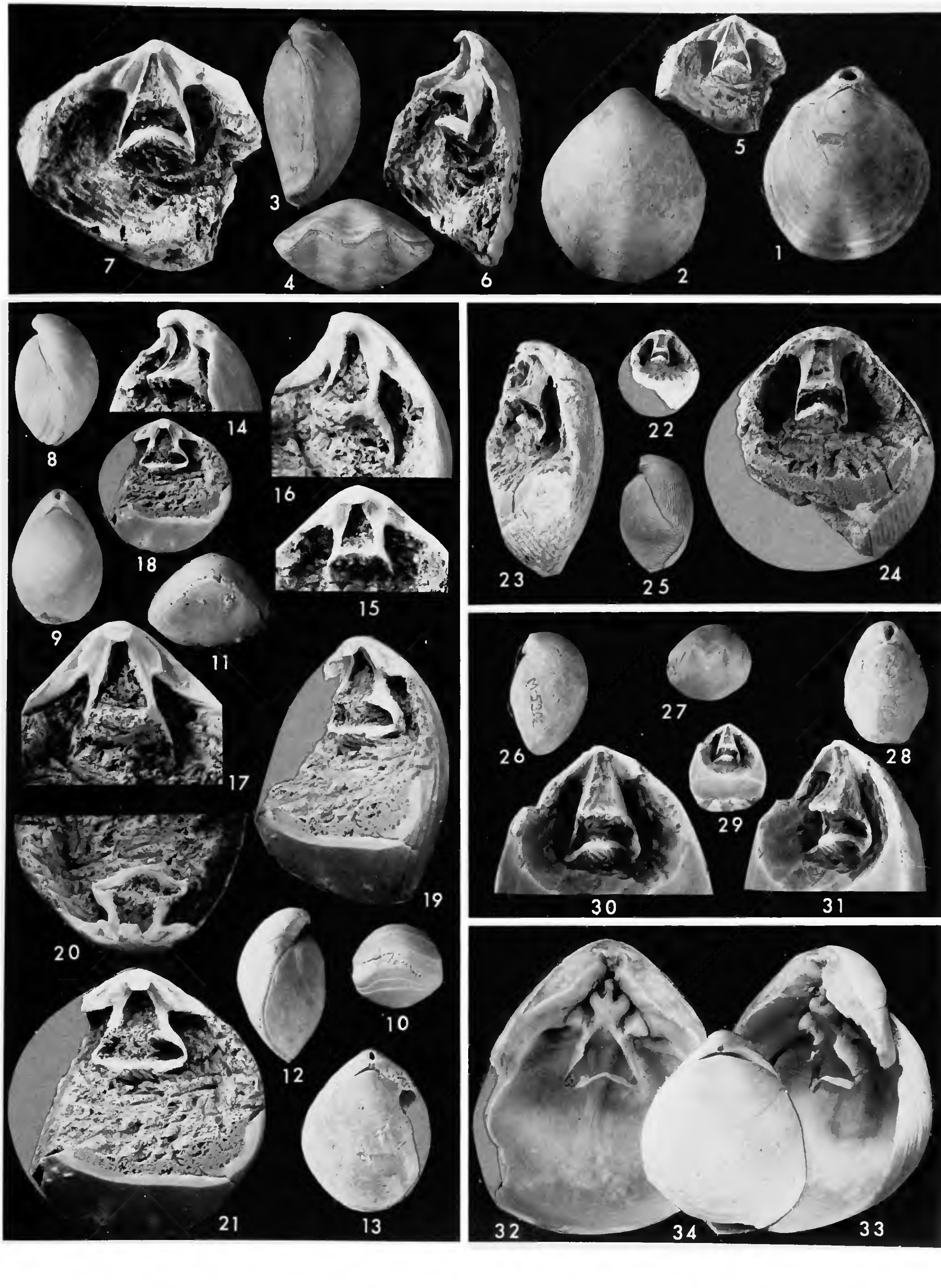

7
3
4
6
2
5
1
8
14
16
18
9
11
15
17
19
20
12
10
21
13
23
22
25
24
26
27
28
29
30
31
32
34
33

PLATE 54

FIGURES 1–8.—*Eurysoria texana*, new species: 1–3, Anterior, dorsal, and side views, × 1, of holotype, USNM 550572a; 4, 5, dorsal exterior, × 1, and posterior of same specimen, × 3, showing nature of symphytium, beak ridges, and interarea, paratype USNM 550572b. Cretaceous (Main Street Formation), road cut N of Glen Garden Country Club swimming pool, Fort Worth, Texas.

6, Interior of dorsal valve excavated to show loop, × 1, paratype USNM 551051b; 7, 8, ventral and partial side views, × 3, of same specimen. Cretaceous (Main Street Formation), half mile (0.8 km) N of Meadow Brook Country Club on Wallace Road, E side of Fort Worth, Texas.

FIGURES 9–11.—*Liothyrella uva* Broderip: Side, dorsal, and anterior views, × 1.5, holotype BMNH ZB1352, introduced for comparison with all *L.* "*uva*" from southern South America and Antarctica. Gulf of Tehuantepec, Mexico. (By permission of British Museum (Natural History); for additional views of *Liothyrella* see Plates 4, 8, 40, 54, 55, 58.)

FIGURE 12.—*Nucleata veronica* Nekvasilova: Posterior of dorsal valve showing short loop, × 3.5, Cretaceous, Kopřivnice Formation, locality S20, Lower Blücher Quarry and Kotouč Quarry, Stramberk, NE Moravia, Czechoslovakia. From Nekvasilova, 1980, pl. 5; fig. 1.

FIGURE 13.—*Pygites diphyoides* (d'Orbigny): Posterior of dorsal valve, × 2.6, showing short loop. Cretaceous (Kopřivnice Formation), Locality S-25, Koutouč Quarry, Stramberk, NE Moravia, Czechoslovakia. From Nekvasilova 1980, pl. 5: fig. 1, reduced one half.

FIGURES 14, 15.—*Merophricus semiarata* Dubar: 14, Peripherally plicated terebratulid, × 1, showing dorsal interior; 15, exterior of dorsal valve of same specimen, × 3, showing broad outer hinge plates and wide loop. (See Plate 66, figure 13, for drawing of loop.) Jurassic (Lower Lias), Ari-bou-Larfa, S of Timhadit, Middle Atlas, Morocco. From Dubar 1942, pl. 3: fig. 26 (part). See Plate 55 for additional views of *Merophricus*.

FIGURES 16–21.—*Liothyrella delsolari* Cooper: 16–18, Anterior, dorsal, and side views, × 1, of holotype, USNM 551061; 19, interior, × 1, of dorsal valve of holotype; 20, 21, ventral and side views, × 2, of dorsal valve interior of holotype. Recent, 4°S, 80°30′W, between Mancora and Chicama, Peru.

FIGURES 22–24.—*Hesperithyris sinuosa* Dubar: 22, 23, Side and dorsal views of interior fillings of two complete specimens showing strong plication, × 1, hypotypes USNM 551062a,b. Jurassic (lower Domerian), Piste de Talialit au Col du Tarhzeft, edge of Middle Atlas, Morocco.

24, Interior of silicified dorsal valve, × 2, showing large cardinal process and hinge plates, hypotype USNM 551063a. Jurassic (Domerian), Plateau du jebel Hebbri, 4–5 km W of Grand Route Midelt to Maknes, near Azrou, Preatlas, Morocco (see Plate 45).

FIGURES 25–26.—*Cyranoia viassae* (Hadding): 25, Dorsal view, × 1, showing long beak; 26, posterior of interior of same specimen showing large cardinal process, inner hinge plates, pedicle collar, and long crural processes, × 2, hypotype USNM 112312. Cretaceous (Senonian), Blaksudden, Skäne, Ifö, Sweden.

FIGURE 27.—*Arcelinithyris arcelini* (Lissajous): Interior of silicified dorsal valve showing extremely long loop and narrow hinge plates, × 2, hypotype USNM 551038b. Jurassic (Bajocian), quarry, La Roche-Vineuse, Mondsard, Saône-et-Loir, France.

FIGURES 28, 29.—*Praelongithyris praelonga* (Sowerby): Excavated dorsal valve, × 1, in ventral view and partial side view, × 2, showing deeply concave outer hinge plate attached on dorsal edge of crural base just dorsad of crural process, hypotype USNM 550929b. Cretaceous (Albian Lower Greensand), Wicken, near Cambridge, England.

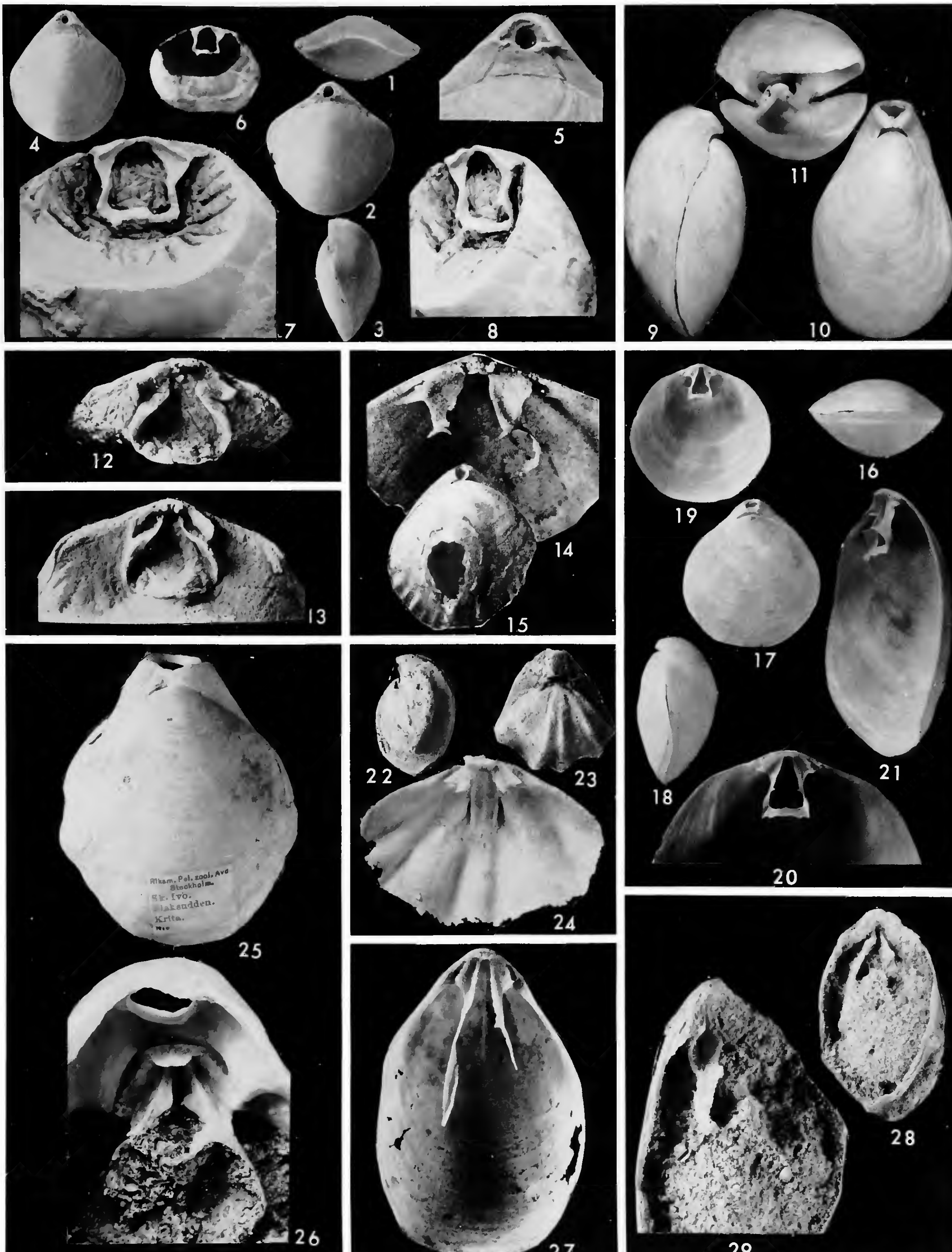


PLATE 55

FIGURES 1-5.—*Merophricus moreti* (Dubar): 1-3, Side, anterior, and dorsal views, × 1, of complete specimen, hypotype USNM 551064; 4, 5, side and ventral views of silicified specimen without anterior part of loop, × 2, showing broad hinge plates, hypotype USNM 550164a. Jurassic (Upper Lotharingian), valley of Ounila, near Irheris, High Atlas of Marrakech, Morocco.

FIGURE 6.—*Gryphus vitreus* (Born): Side and ventral views of loop, × 3, showing narrow crus, scooplike anterior of loop, and flattish hinge plates, hypotype USNM 550824c. Recent, at 150 m, off Calvi, Corsica, Mediterranean.

FIGURE 7.—*Rectithyris* species: Ventral view, showing distorted loop, × 1, USNM 551066a. Cretaceous (Aptian - Fitton's Group XIII), Shanklin, Isle of Wight, England.

FIGURES 8-12.—*Nerthebrochus* species: 8-10, Dorsal, side, and anterior views of complete specimen, × 1, USNM 551067; 11, 12, side and ventral views of loop, × 2, showing broad crural process, USNM 551068. Cretaceous (Albian Red Chalk), cliffs at Hunstanton, Norfolk, England.

FIGURE 13.—*Cyranoia longirostris* (Wahlenburg): Posterior view of interior of dorsal valve interior, × 2, showing coalesced inner hinge plates, hypotype USNM 88682a. Cretaceous (Senonian - *Actinocamax mammillatus* Zone), Barnakälla, Sweden.

FIGURE 14.—*Galliennithyris galliennei* (d'Orbigny): Posterior of specimen showing hinge plates and crural processes, × 2, hypotype USNM 31335b. Jurassic (oxfordian), Old St. Remi, Launoy, Switzerland.

FIGURE 15.—*Abyssothyris elongata* (Cooper): Ventral view of loop, × 3, showing rounded anterolateral extremities, paratype USNM 550398X. Recent, at 3777-3792 m, 32°05'N, 120°29.4'W to 32°03'N, 120°30'W, abyssal plain SW of Los Angeles, California. (See Plate 2, figure 12.)

FIGURE 16.—*Liothyrella "uva"* (Broderip): Ventral and side views, × 2, of specimen showing short subrectangular loop without crura and with narrow transverse band, hypotype USNM 551069. Recent, at 104-115 m, 53°54'S, 64°36'W to 53°55'S, 64°52'W, ESE of Rio Grande, Argentina.

FIGURES 17-21.—*Liothyrella fosteri* Cooper: 17-19, Anterior, side, and dorsal views, × 1, holotype USNM 551070; 20, 21, ventral and side views of loop, × 2, of preceding specimen. Recent, at 220-240 m, 61°18'S, 56°09'W to 61°20'S, 56°10'W, Antarctica.

FIGURES 22-24.—Tertiary Genus and Species Undetermined: 22, ventral view of dorsal valve showing loop, × 1, USNM 551071; 23, 24, ventral and side views of same specimen, × 2, showing small inner hinge plates. Miocene (Sahelian), Oran, Algeria.

FIGURE 25.—*Ogmusia incisus* (von Buch): Ventral and side views of specimen showing loop with broad crural processes and thick cardinal process, × 1, hypotype USNM 551053a. Paleocene (Danian), old portion of quarry directly below town, Fakse, Denmark.

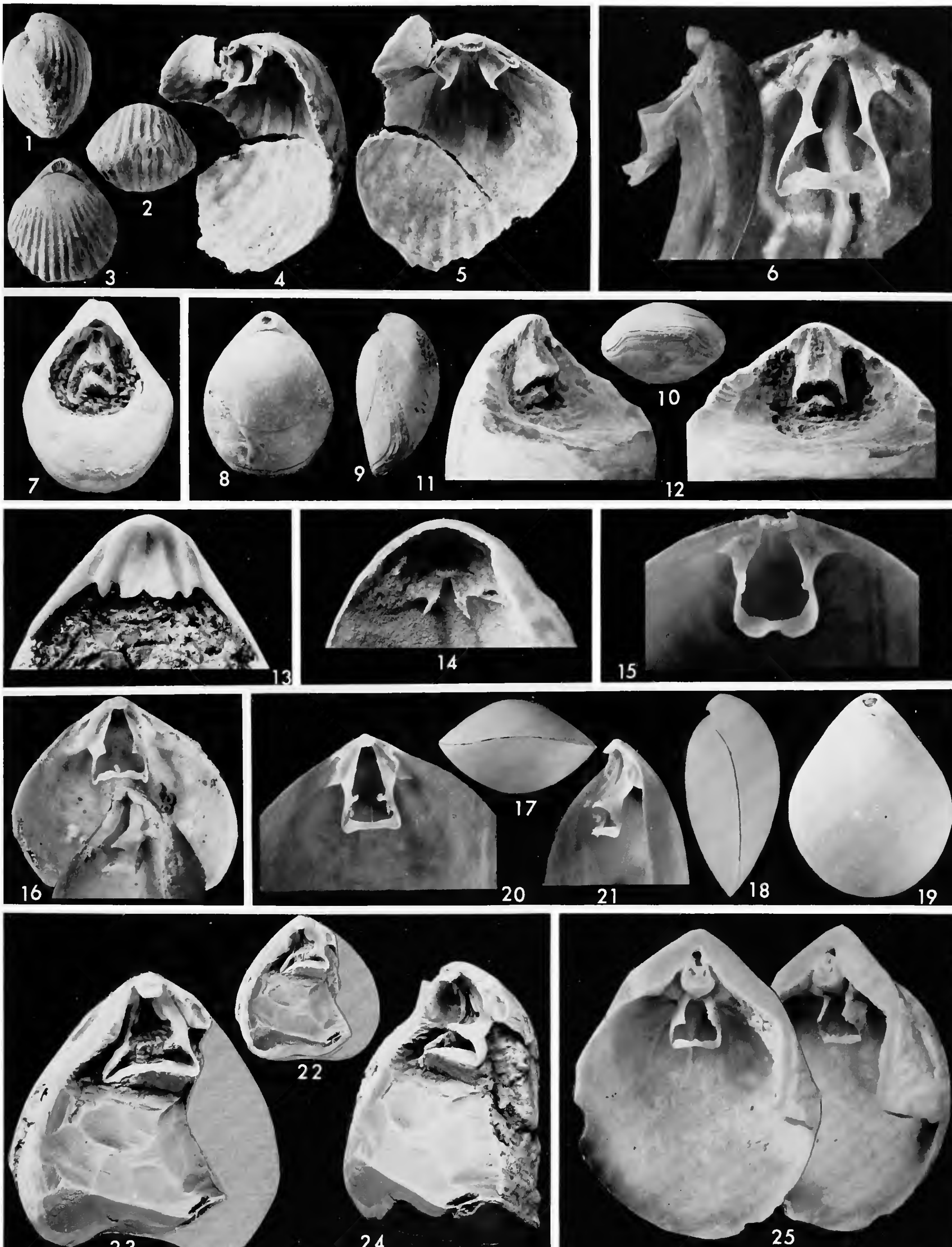

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

PLATE 56

FIGURES 1–4.—*Nerthebrochus robertoni* (d'Archiac): 1, Dorsal exterior of complete specimen, × 1, hypotype USNM 551079; 2, same specimen excavated to show loop, × 1; 3, 4, ventral and side views, × 2, of preceding specimen. Cretaceous (Tourtia), Tournay, Hainaut, Belgium.

FIGURES 5–8A.—*Postepithyris cincta* (Cotteau): 5–7, side, anterior, and dorsal views, × 1, of complete specimen, hypotype USNM 551075a; 8, ventral view of excavated dorsal valve of same specimen, × 1, showing loop with long terminal points; 8A, same specimen in ventral and side views, × 2. Jurassic (Sequanian), Bourges, Cher, France.

FIGURES 9–14.—*Caryona saemani* (Oppel): 9–11, Side, anterior, and dorsal views, of a complete specimen, × 1, hypotype USNM 551083a; 14, ventral view, × 1, of excavated dorsal valve of another specimen, hypotype USNM 75092a; 12, 13, ventral and side views of preceding specimen, × 3. Jurassic (Callovian - Kelloway Rock), Pizieux, Sarthe, France.

FIGURES 15–19.—*Aphragmus sohli*, new species: 15, 16, Partial side and ventral views, × 3, of specimen with narrow loop, paratype USNM 550931c; 17, 18, partial side and ventral views of another, somewhat wider specimen, × 3, paratype USNM 550931d; 19, ventral view of cardinalia of third specimen showing lack of elevated crural bases on inside margin of outer hinge plates, × 3, paratype 550931b. Cretaceous (Upper Cenomanian), colline de la Goupillerie, Le Mans area, France. (See also Plate 17.)

FIGURES 20–25.—*Concinnithyris rouenensis*, new species: 20–22, Anterior, side, and dorsal views, × 1, of large, rotund specimen, holotype USNM 551072a; 23, ventral view of excavated dorsal valve of holotype, × 1; 24, 25, ventral and side views of preceding specimen, × 2, showing broad crural base. Cretaceous (Cenomanian), Ste. Catherine, Rouen, France.

FIGURE 26.—*Concinnithyris rouenensis*, new species: Partial side view of fairly large specimen, × 2, showing loop with broad crural base, hypotype USNM 77447a. Cretaceous (Cenomanian), Rouen, France. (For other views see Plate 26.)


2
1
3
4
5
6
8
7
8A
9
10
14
11
12
13
15
19
17
16
18
20
21
23
24
25
22
26

PLATE 57

FIGURES 1–7.—*Eristenosia circularis*, new species: 1–3, Dorsal, anterior, and side views, × 1, of complete specimen with slightly skewed dorsal valve, holotype USNM 30902; 4, excavated loop of another dorsal valve, × 1, paratype USNM 30902a; 5, 6, ventral and partial side views, × 2, of preceding paratype; 7, same loop, × 3. Jurassic (Kimmeridgian), Tonnere, Yonne, France.

FIGURES 8–12.—Jurassic Genus and Species Undetermined: 8, 9, Anterior and dorsal views of uniplicate specimen, USNM 551024; 10, preceding specimen excavated to show loop, × 1; 11, 12, partial side and ventral views, × 2, of same loop. Jurassic (Bathonian), Amfreville, Calvados, France.

FIGURES 13–18.—"*Terebratula*" *suprajurensis* Thurman: 13–15, Side, anterior, and dorsal views, × 1, of complete specimen, hypotype USNM 123754; 16, another specimen excavated to show loop, × 1, hypotype USNM 123754a; 17, 18, ventral and side views, × 3, of preceding specimen. Jurassic (Sequanian), Romagne, Mont Faucon, France. (For other views see Plate 41.)

FIGURES 19–29.—*Conarothyris opima*, new species: 19–21, Anterior, side, and dorsal views, × 1, of complete specimen, hypotype USNM 551126a; 22, ventral view, × 1, of another specimen excavated to show loop, hypotype USNM 551125a; 23, 24; ventral and side views of preceding specimen, × 2; 25, ventral view of cardinalia of another specimen, × 2, hypotype USNM 129170a. Jurassic (Bajocian – Inferior Oolite *concavum* Zone), Dundry, Somerset, England.

26, Ventral view, × 1, of specimen excavated to show loop, hypotype USNM 551129a; 27, 28, ventral and side views of same specimen, × 2; 29, ventral view of preceding specimen, × 3. Jurassic (Bajocian – Inferior Oolite – *concavum* Zone), Corton, Denham, Sherborne, Dorset, England.

FIGURES 30–38.—"*Terebratula*" *movelierensis* Mühlberg: 30–32, Anterior, dorsal, and side views, × 1, of complete specimen, hypotype USNM 123747b; 33–35, anterior, side, and dorsal views of another complete specimen, × 1, hypotype USNM 123747a; 36, dorsal view of preceding specimen excavated to show loop, × 1; 37, 38, ventral and side views, × 2, of preceding specimen. Jurassic (Bathonian), Chenove, Côte d'Or, France.

FIGURES 39–44.—*Pionothyris eudesiana* (Buckman): 39–41, Side, dorsal, and anterior views, × 1, of complete specimen with bilobed anterior margin, hypotype USNM 551102; 42, ventral view, × 1, of preceding excavated to show loop; 43, 44, ventral and side views of preceding specimen, × 3. Jurassic (Bajocian – Inferior Oolite), Dundry, Somerset, England.


1
5
6
4
3
7
2
8
11
10
9
12
17
16
13
14
15
18
19
25
20
21
29
30
33
34
32
31
36
37
35
38
23
22
24
39
40
41
42
43
44
27
26
28

PLATE 58

FIGURES 1–8.—*Arctosia arctica* (Friele): 1–3, Side, dorsal, and anterior views, × 1, of adult hypotype USNM 551146a; 4, dorsal view of preceding specimen, × 2; 5, dorsal view of another complete specimen, × 1; hypotype USNM 551146b; 6, interior of dorsal valve, × 3, showing loop, hypotype USNM 551146c; 7, 8, ventral and side views of loop of preceding, × 5. Recent at 500 m, 73°27.1′N, 016°02′W, off Greenland.

FIGURES 9–22.—*Atactosia obtusa* (Sowerby): 9–11, Dorsal, anterior, and side views, × 1, of somewhat worn specimen, hypotype USNM 551134a; 12–14, dorsal, anterior, and side views, × 1, of narrow specimen, hypotype USNM 551134b; 15, dorsal view, × 1, of more strongly concentrically marked specimen, hypotype USNM 551134c; 16, dorsal view of young specimen, × 1, hypotype USNM 551134d; 17–19, loop of preceding in ventral and side views, × 1, × 2; 20, ventral view of another specimen with excavated loop, × 1, hypotype USNM 551134e; 21, 22, side and ventral views, × 2, of preceding hypotype. Cretaceous (Upper Greensand), Cambridge, England.

FIGURES 23–35.—*Acrobrochus hendleri* (Cooper): 23–25, Dorsal, side, and anterior views, × 1, of complete specimen, holotype USNM 551141a; 26, interior of dorsal valve showing loop, × 1, paratype USNM 551141h; 27, 28, ventral and side views of preceding, × 3; 29, interior of another dorsal valve having loop with short terminal points, × 1, paratype USNM 551141g; 30, same loop, × 2; 31, side view of another loop, × 2, paratype USNM 551141e; 32, same in ventral view, × 3; 33, ventral view, × 3, of loop with angular anterolateral extremities, paratype USNM 551141c; 34, ventral view, × 3, of loop with smooth edges and rounded anterolateral extremities, paratype USNM 551141i; 35, side view of loop, × 3, showing tapered outer hinge plate, paratype USNM 551141f. Recent, at 415–612 m, 57°39.4′S, 26°26.7′W, off South Sandwich Islands, Antarctica.

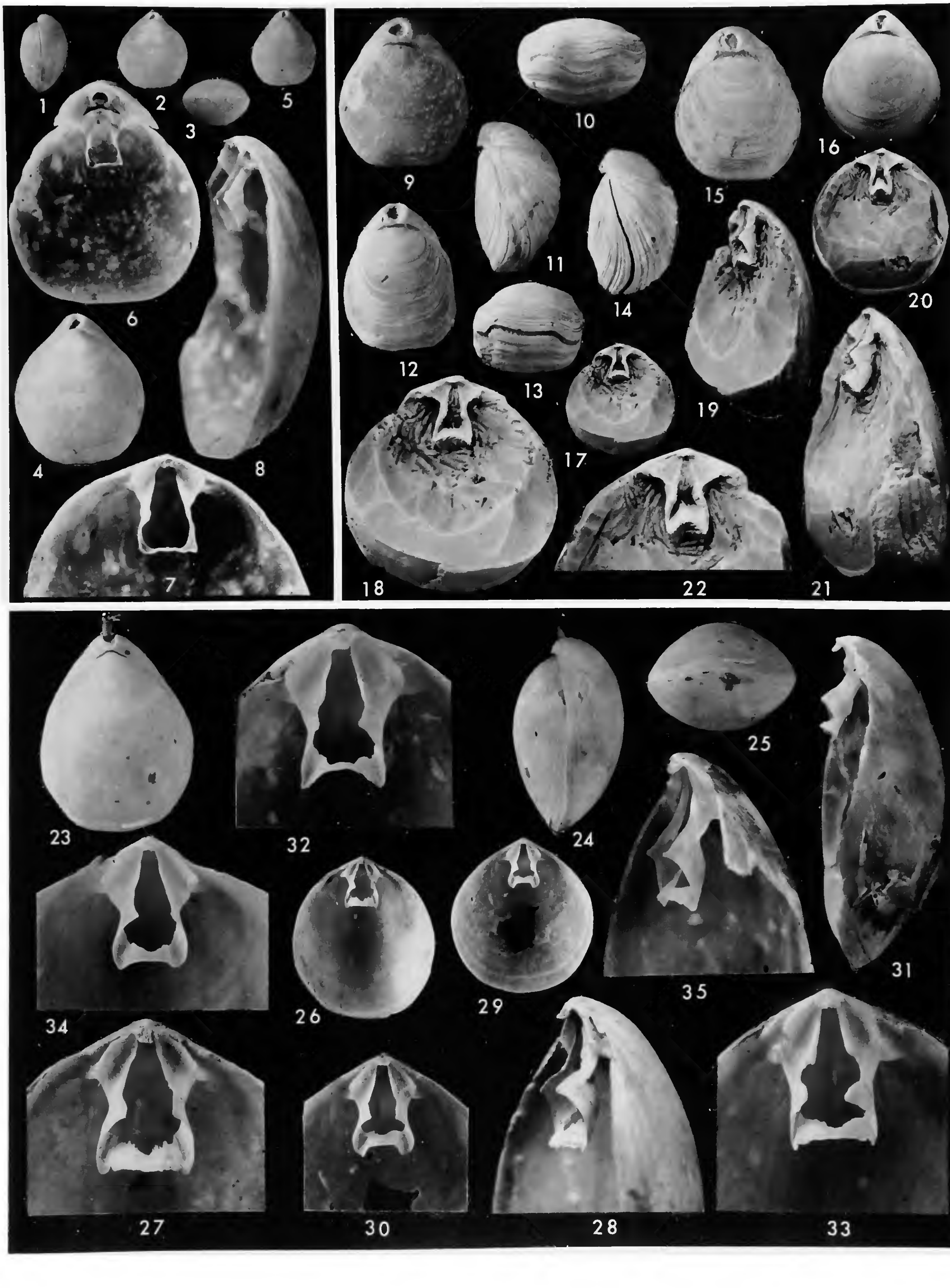


PLATE 59

FIGURES 1–10.—*Embolosia sphenoidea*, new species: 1–5, Posterior, dorsal, side, anterior, and ventral views, × 1, of paratype USNM 138055b; 6, 7, dorsal and side views, × 1, of holotype USNM 138055a; 8, ventral view of loop of holotype, × 1; 9, interior of ventral valve of holotype, cap removed to show loop, × 1; 10, loop of holotype, × 2, showing long, thickened outer hinge plates. Eocene (Castle Hayne Formation), quarry near National Cemetery, Wilmington, North Carolina.

FIGURES 11–14.—*Plectoconcha aequiplicata* (Gabb): 11, 12, Dorsal and side views, × 1, of well-preserved specimen, hypotype USNM 106249a. Triassic (Luning Formation), Shoeshone Range, 2000 feet (610 m) ENE of Richmond Mine, one mile (1.6 km) from mouth of Union Canyon, E side, Nye County, Nevada.

13, 14, side and dorsal views, × 3, of imperfect loop, USNM 242083. Upper Triassic, north wall of Keyhole Canyon, elevation 6200 feet (1887 m) section 21, T. 28 N., R. 39, E., Sonoma Range (1°) quadrangle, Pershing County, Nevada.

FIGURES 15–21.—*Mimorina magna* (Hamilton): 15–18, Posterior, anterior, dorsal, and side views, × 1, of well-preserved specimen, hypotype USNM 551151a; 19, 20, ventral and side views of cardinalia, × 1, hypotype USNM 551151c; 21, exterior of small specimen, × 3, showing zigzag capillae like those of *Mimorina gravida* and *Dyscolia* (Plate 16), hypotype USNM 551151b. Lower Oligocene (Lower Kongahu Formation), on coast one mile (1.6 km) S of little Wanganui River, South Island, New Zealand.

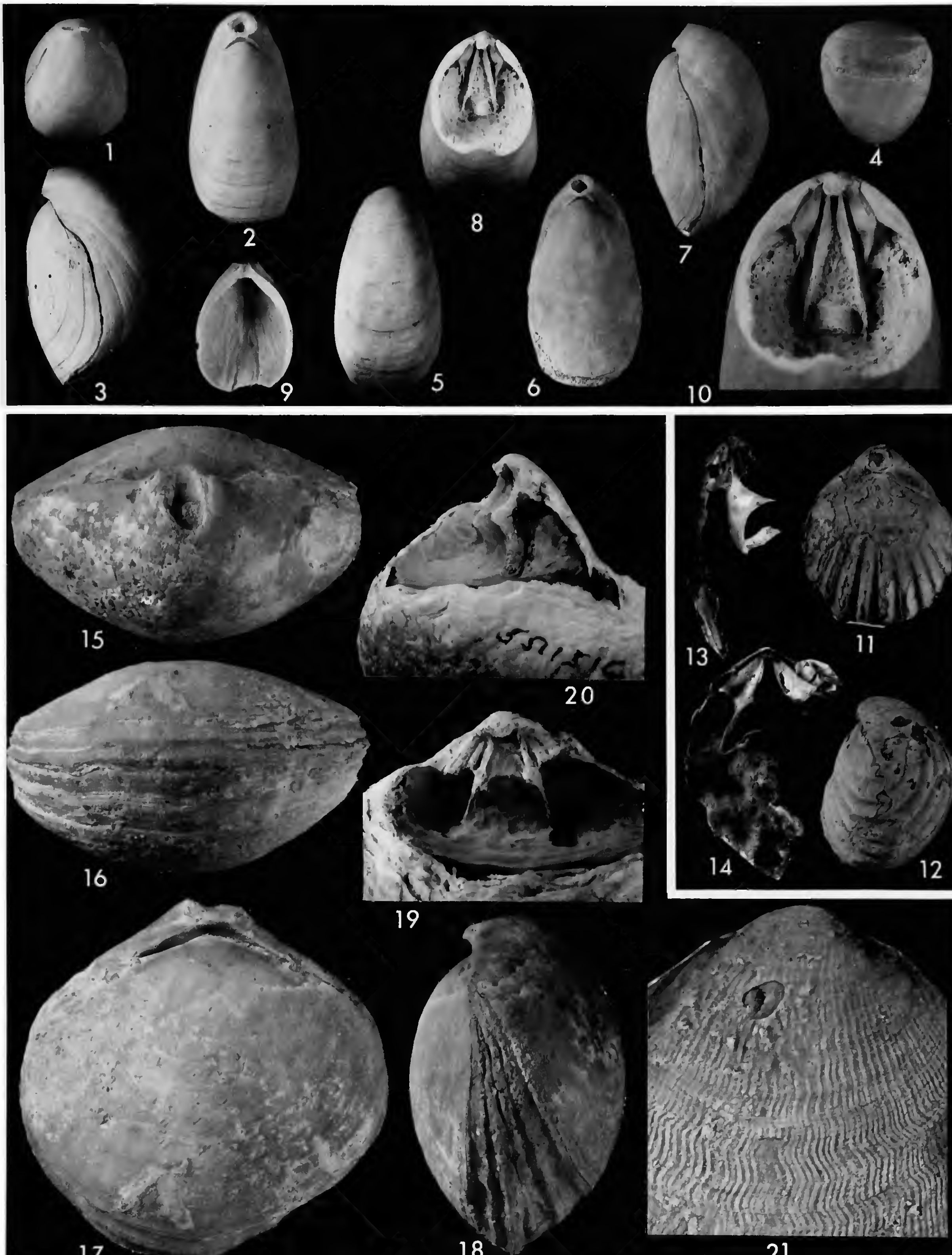

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21

PLATE 60

FIGURE 1.—*Bothrothyris curiosa*, new species: Ventral view of loop showing narrowed combination of trough-like crural bases and outer hinge plates, × 2, holotype USNM 551007. Jurassic (Callovian), 30°40′N, 32°22′E to 32°26′E, Gebel Maghara, Sinai Pennisula.

FIGURES 2–8.—*Acrobelesia cooperi* (d'Hondt): 2, Dorsal view of exterior, × 1, hypotype USNM 551147a; 3–5, same in side, anterior, and dorsal views, × 2; 6, preceding specimen, × 3, showing lamellose surface and faint capillae; 7, cardinalia and imperfect loop of dorsal valve, × 5, hypotype USNM 551147b. Recent, at 570–615 m, 44°07′N, 04°43.8′W, Gulf of Gascogne, France.

8, Ventral view of another dorsal valve, × 5, showing complete loop with pointed and anteriorly directed transverse band, NMNH-BRA-78-11. Recent, at 580–545 m, 44°06.5′N, 04°45.2′W to 44°06.5′N, 04°45.0′W, Gulf of Gascogne, France.

FIGURE 9.—*Arctosia arctica* (Friele): Loop enlarged, × 5, to show squarish anterior, hypotype USNM 551144. Recent, at 240 m, 74°30.5′N, 014°20′W, off E coast of Greenland.

FIGURES 10–18.—*Liothyrella neozelanica* Thomson: 10, loop of large specimen, × 3, showing broad outer hinge plates, hypotype USNM 550976f. Recent at 200 m, 44°07′S, 179°13′W, W of Chatham Island, E of South Island, New Zealand.

11, 14, 16, 17, Loop × 3, showing variation, hypotypes respectively, USNM 551149a,c,d,g. Recent, at 6 m, 46°04.8′S, 166°37.6′E, off South Island, New Zealand.

12, 13, 15, 18, Variation of adult loops, × 3, hypotypes respectively, USNM 551148a,b,d,e. Recent at 3–30 m, Dusky Sound, Wet Jacket Arm, west side of South Island, New Zealand.

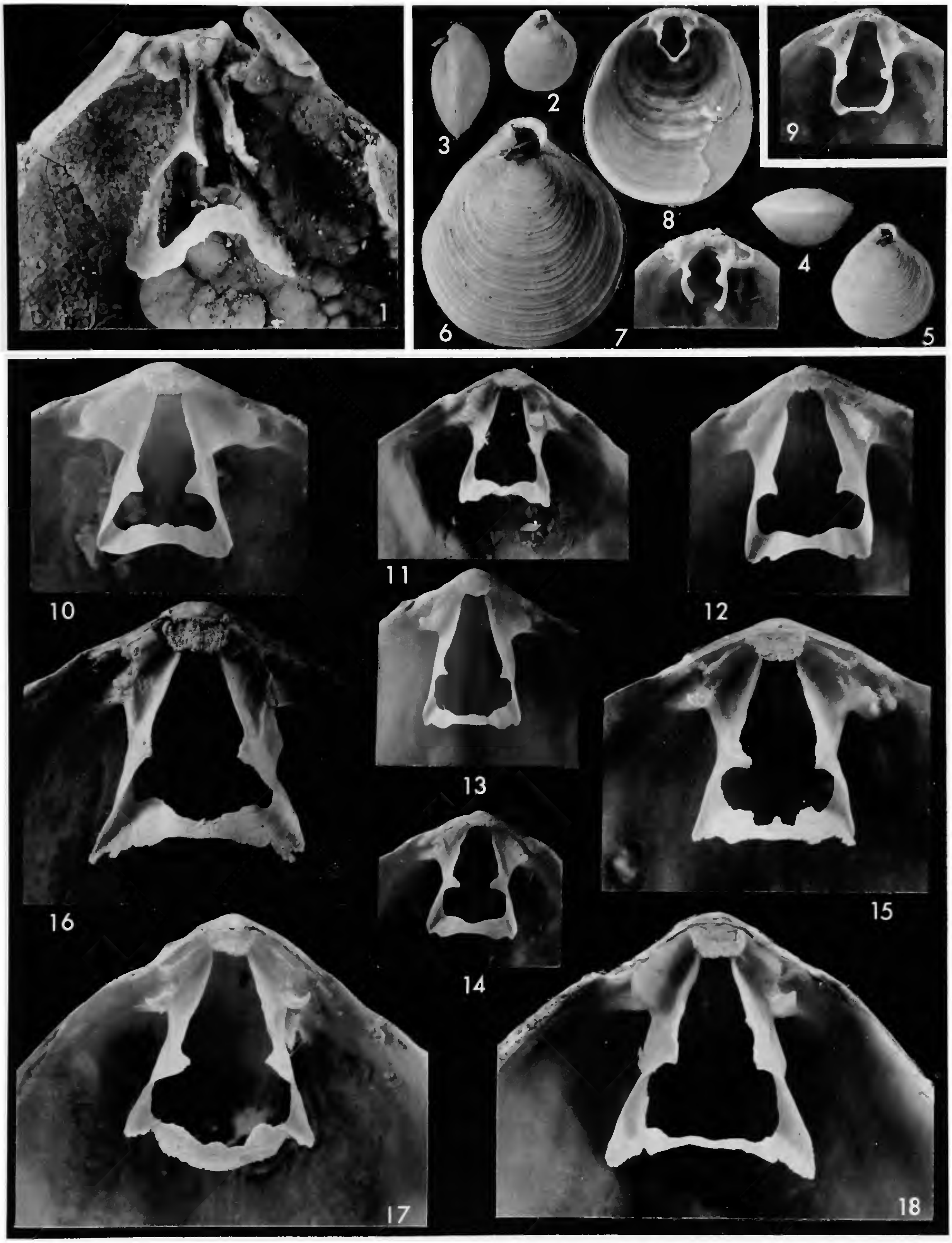

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

PLATE 61

FIGURES 1–5.—*Dienope trigeri* (E. Deslongchamps): 1, 2, Dorsal and anterior views, × 1, of large specimen showing parasulcate folding, hypotype USNM 95094. Jurassic (Kelloway Rock), Montbizet, Sarthe, France.

3, 4, Ventral view of smaller specimen, × 1, and side view of same specimen excavated to show long loop, × 2, hypotype USNM 551152. Jurassic (Callovian), Deux, Deux-Sevres, France.

5, Interior of dorsal valve showing loop, × 1. (Reduced ½ from original of E. Deslongchamps 1862–1884, pl. 20: fig. 2, somewhat idealized but showing webs uniting descending and ascending branches.)

FIGURES 6–9.—Triassic Genus and Species Undetermined 2: 6, 7, Dorsal view of exterior, × 1, × 2, of silicified specimen; 8, interior of dorsal valve showing cardinalia, × 2,; 9, fragment of dorsal valve preserving loop, × 2, USNM 551160a-c. Upper Triassic, Table Mountain, 10.35 miles (17 km) E of Luning, Hawthorne quadrangle, Nevada.

FIGURES 10–13.—*Dyscritothyris cubensis* Cooper: Dorsal, side, anterior, and ventral views, × 2, holotype USNM 550460a. Upper Cretaceous, 7.3 (?) kms ESE of Madruga, 2.4 kms S of Grua Esperanza, Habana Province, Cuba.

FIGURES 14–15.—*Aniabrochus comptonensis* Middlemiss: 14, Part of ventral valve, × 5, showing fine capillae, hypotype USNM 550944c; 15, partial side view, × 2, showing loop with broad transverse band and broad outer hinge plates, hypotype USNM 550944b. (See Plate 19: figures 28, 29, for additional views.) Cretaceous (Aptian - Lower Greensand), Brickhill, Buckinghamshire, England.

FIGURES 16–20.—*Vex semisimplex* (White): 16–18, Anterior, dorsal, and side views, × 2, hypotype USNM 242077; showing semicostate exterior; 19, 20, ventral and side views of dorsal valve interior showing cardinalia and descending branch of long loop, × 3, hypotype USNM 242069. Triassic (Upper - Thaynes Formation - Portneuf Member), SW¼ SW¼ section 2, T. 3 S., R. 37 E., Higham Peak (7½′) quadrangle, Idaho.

FIGURE 21.—*Terebratulina kiiensis* Dall and Pillsbry: Partial dorsal view of lophophore showing median coil, × 1.5, hypotype USNM 208868a. Recent, at 240 fms (= 439 m), off Santa Cruz Island, California.

FIGURE 22.—*Terebratulina latifrons* Dall: Ventral view of posterior of dorsal valve showing loop with ring, × 6, hypotype USNM 550519. Recent, at 284–247 m, 21°13′N, 86°25′W, Yucatan Channel, NE of Porto de Morelos, Mexico.

FIGURE 23.—*Terebratulina silicea* (Quenstedt): Ventral view of dorsal valve showing loop with suture of coalescence of crural processes, × 3, hypotype USNM 77407. Jurassic (White Jura - epsilon), Württemberg, Germany.

FIGURE 24.—*Arcuatothyris arcuata* (Roemer): Partial side view, × 3, of cardinalia showing fulcral plates and crural bases, hypotype USNM 551074a. Cretaceous (Chloritic Chalk), Rouen, France. (Compare with cardinalia of *Terebratulina*.)

FIGURE 25.—*Pseudokingena deslongchampsi* (Davidson): Ventral view of dorsal valve showing loop, × 4 (from Deslongchamps, 1862–1885, pl. 33: fig. 9). (Compare with cardinalia of *Terebratulina* and *Arcuatothyris*.)

FIGURE 26.—*Dictyothyris coarctata* (Parkinson): Dorsal view of dorsal valve with excavated loop. (See Plate 37: figures 6–8) showing ornament. Jurassic (Bathonian), Renville, Caen, France.

FIGURES 27–31.—*Stenogmus pentagonalis*, new species: 27–30, Dorsal, ventral, anterior, and side views, × 1, of hypotype USNM 551155c. Jurassic (Callovian - Variansschichten), Hägendorf-Homberg, Switzerland.

31, Posterior view, × 2, showing loop with strongly protuberant bridge of transverse band, paratype USNM 551094. Jurassic (Callovian Variansschichten), Kilchberg, Switzerland. (For additional views of loop see Plate 50.)

FIGURES 32, 33.—*Terebratulina unguicula* Carpenter: Ventral and partial side views, × 3, of lophophore, showing median coil and lateral branches, hypotype USNM 110897a. Recent, at 155 fms (206 m), off Santa Cruz, California.

FIGURE 34.—*Stenosarina angustata* Cooper: Loop, × 6, showing anterior serration and posteriorly projecting extension, USNM 550594. Recent, at 205 fms (= 375 m), R/V *Oregon II*, Station 11163, 24°18′N, 87°50′W, on Campeche Shelf, N of Yucatan Peninsula, Mexico.

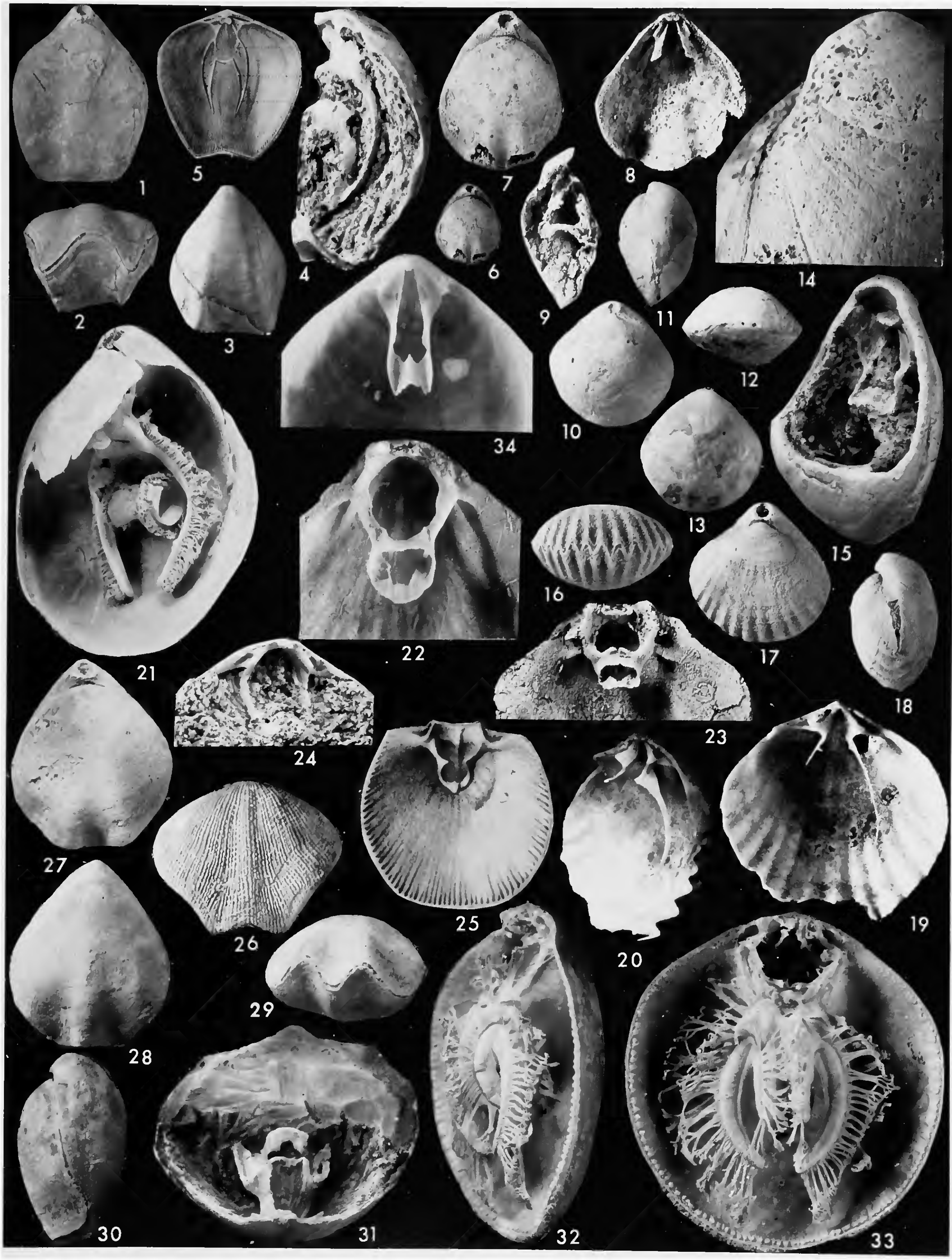

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34

PLATE 62

FIGURES 1, 2.—*Lobothyris punctata* (Sowerby) (=*Pirotothyris*? species): 1, Ventral view of dorsal valve, about × 1, showing loop; 2, loop enlarged, about × 3, from Deslongchamps, 1862–1885, pl. 109: figs. 1, 2. Jurassic (Lias), France.

FIGURES 3–8.—*Faksethyris nielsoni* Asgaard: 3–5, Anterior, side, and ventral views, × 12.5, of imperfect specimen showing loop, syntype MMH 11032; 6, 7, ventral and side views of anteriorly tapering loops, × 15, of preceding specimen; 8, dorsal view of posterior showing large foramen and narrow deltidium, × 15. From Asgaard, 1971, pl. 1: figs. 1–6 (all figures reduced ½ from original). Danian, Fakse Quarry, Denmark.

FIGURES 9–11.—*Pseudoglossothyris curvifrons* (Oppel): 9, Ventral view of imperfect dorsal valve showing loop, × 1; 10, 11, isolated brachidium, × 3. From Roché 1939, pl. 10: figs. 12, 15, 16. Jurassic, Chaintré, France.

FIGURE 12.—*Spasskothyris rjasanensis* Smirnova: Reconstruction of dorsal valve with loop having exceptionally long terminal points and inner hinge plates, about × 0.75. From Smirnova, 1975a:77, fig. 5 (reduced ½ from original). Early Cretaceous, Russian Platform.

FIGURE 13.—*Okathyris chevkinensis* Smirnova: Ventral view of reconstructed dorsal valve showing loop, about × 1, from Smirnova, 1975a:71, fig. 2 (reduced ½ from original). Lower Cretaceous, Russian Platform.

FIGURE 14.—*Atelithyris crestensis* Smirnova: Ventral view of reconstructed dorsal valve showing loop, about × 1, from Smirnova, 1975a:79, fig. 7 (reduced ½ from the original). Lower Cretaceous, Russian Platform.

FIGURE 15.—*Placothyris rollieri* (Haas): Partial side view of loop of silicified specimen, × 3, from Westphal, 1970, pl. 1: fig. 1. Jurassic (Kimmeridgian), Germany.

FIGURE 16.—*Pseudotubithyris globata* (Sowerby): Interior of dorsal valve, × 2, showing loop, from Deslongchamps, 1862–1885:376, pl. 109: fig. 3. Jurassic (Fullers Earth), Saône-et-Loire, France.

FIGURE 17.—*Conarothyris eudesi* (Oppel): Interior of silicified specimen showing loop, × 1, from Deslongchamps, 1862–1885:375, pl. 109: fig. 6. Jurassic (Lower Jurassic Oolite), Saône-et-Loire, France.

FIGURE 18.—*Lenothyris perflexus* Dagis: Reconstruction of dorsal valve showing loop with long terminal points, about × 1, from Dagis, 1968:103, fig. 61 (reduced ½ from original). Jurassic, northern Siberia.

FIGURE 19.—*Gigantothyris ochoticus* Dagis: Reconstruction of dorsal valve showing strong loop, about × 1, from Dagis, 1968:107, fig. 64 (reduced ½ from original). Jurassic, northern Siberia.

FIGURE 20.—*Pinaxiothyris campestris* Dagis: Reconstruction of dorsal valve showing wide loop, about × ½, from Dagis, 1968:88, fig. 53 (reduced ½ from original). Jurassic (Lower Volgian), northern Urals.

FIGURE 21.—*Gigantothyris* species: Dorsal interior of specimen identified by Quenstedt as *Terebratula intermedia* and showing loop, and dorsal view of specimen called *T. omalogastyr* (=*Gigantothyris luculenta* Seifert). Both from Jurassic (*humphriesianum* Zone), Stuifen, Germany; loop resembles that figured by Seifert (1963:163, fig. 9e).

FIGURE 22.—*Juralina insignis* (Schübler): Ventral view of specimen opened to show loop, × 1, from Quenstedt, 1868–1871, Atlas, pl. 48: fig. 14. Jurassic, Nattheim, Germany.

FIGURE 23.—*Acrobrochus* species: Dorsal valve interior, × 2, showing short narrow loop, USNM 549693. Recent, at 127 fms (= 231 m), 25°44′S, 85°25′W, off Peru.

FIGURE 24.—*Giantothyris*? *"omalogastyr"* Arcelin and Roché (not Zieten): Ventral view of flat dorsal valve showing loop, × 1, from Arcelin and Roché, 1936, pl. 12: fig. 6. Jurassic (Bajocian), quarry La Roche-Vineuse, Monsard, Saône-et-Loire, France.

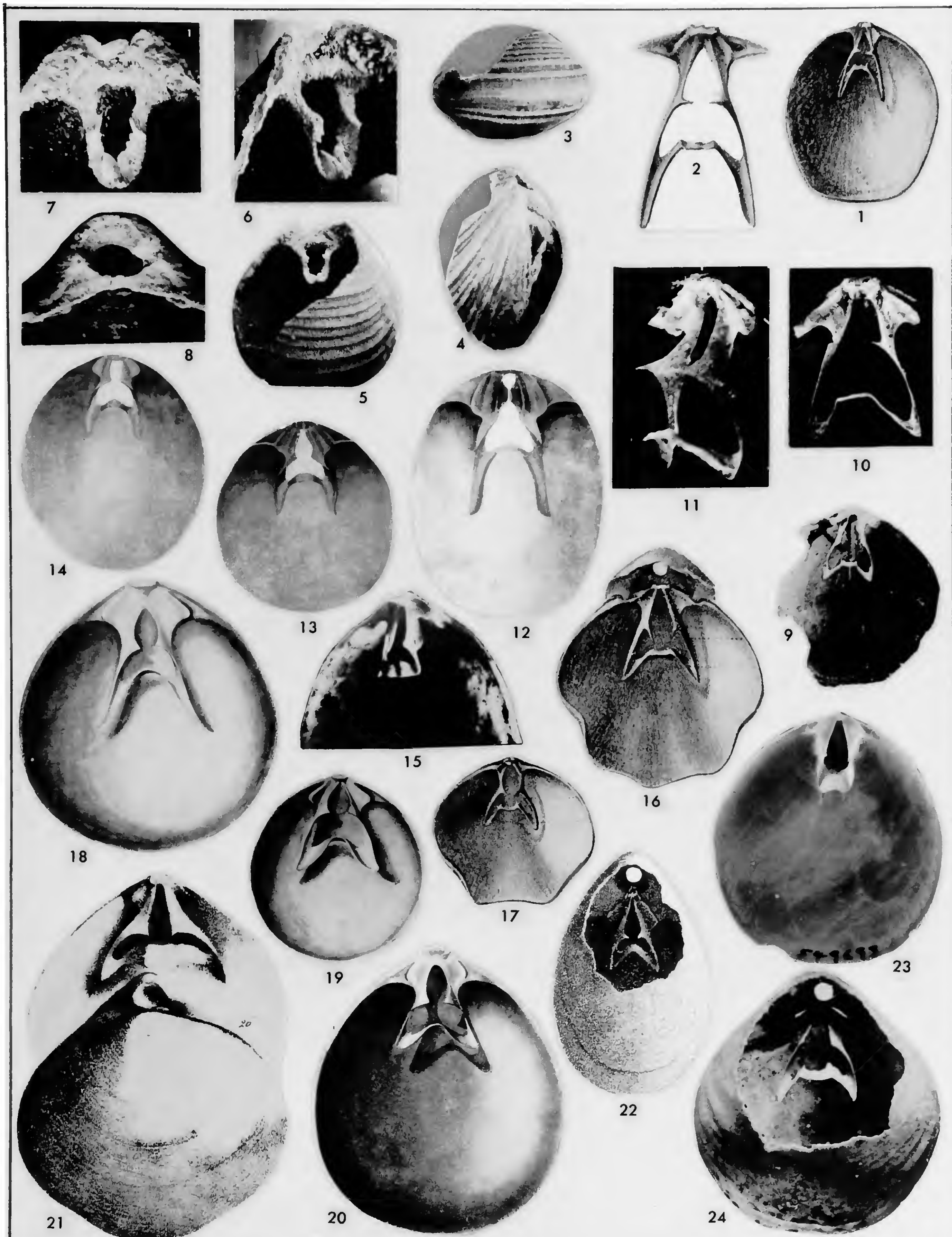


PLATE 63

Loops Reconstructed from Serial Sections

FIGURES 1, 2.—*Dictyothryis gzheliensis* (Gerassimov): 1, 2, From Makridin, 1964:262, fig. 90. Compare loop with those of type-species of *Dictyothyris* and *Dienope*, Plates 37 and 61.

FIGURE 3.—*Kutchithyris acutiplicata* Kitchin: From Ovcharenko, 1969, fig. 3.

FIGURE 4.—*Nalivkinella nalivkini* Popov: From Makridin, 1964:216, fig. 73, as *Loboidothyris retrocarinata* (Nalivkin).

FIGURE 5.—*Cheirothyropsis pseudotrigonella* (Trautschold): From Makridin, 1964:268, fig. 94.

FIGURE 6.—*Epithyris oxonica* (Arkell): From Rollet, 1969, fig. 2. Compare loop with excavated specimen on Plate 42: figures 12, 14.

FIGURE 7.—*Uralella gigantea* Makridin: From Makridin, 1964:257, fig. 86. Compare with loop figured on Plate 46: figure 11.

FIGURE 8.—*Arceythyris diptycha* (Oppel): From Contini and Rollet, 1970:40, fig. 3.

FIGURES 9, 10.—*Arcuatothyris arcuata* (Roemer): Ventral and side views, from Katz, in Krymholz, 1974:243, fig. 54–57, 8.

FIGURE 11.—*Weberithyris moisseevi* (Weber): From Smirnova, 1969:146, fig. 2.

FIGURE 12.—*Nucleatina nanclasi* (Coquand): From Katz, 1962:138, fig. 6.

FIGURE 13.—*Moeschia alata* (Rollet): From Boullier, 1976:344, fig. 186 (reduced ½ from original).

FIGURE 14.—*Argovithyris birmansdorfensis* (Moesch): From Rollet, 1972:106, fig. 8.

FIGURE 15.—*Viligothyris orientalis* Dagis, 1968:91, fig. 55. Note inner hinge plates, rare in Jurassic brachiopod.

FIGURE 16.—*Karadagella moisseievi* Babanova: From Babanova, 1965:96, fig. 3.

FIGURE 17.—*Argovithyris birmansdorfensis* (Moesch): From Boullier, 1976:316, fig. 170b. Compare with figure 14 above. Reduced ½ from original.

FIGURE 18.—*Postepithyris cincta* (Cotteau): From Boullier, 1976:369, fig. 196.

FIGURE 19.—*P. cincta* (Cotteau): From Makridin, 1964:227, fig. 77.

FIGURE 20.—*P. cincta* (Cotteau): From Barczyk, 1969:21, fig. 12a.

FIGURE 21.—*Tchegemithyris tchegemensis* (Moisseev): From Prosorovskaya, 1968:77, fig. 52 (reduced).

FIGURE 22.—*Terebratula movelierensis* Mühlberg: From Contini and Rollet, 1970:33, fig. 2. Compare with Plate 57: figures 36, 37.

FIGURE 23.—*Juralina bauhini* (Etallon): From Boullier, 1976:368, fig. 195. Compare with Plate 49: figure 4.

FIGURE 24.—*Placothyris welshi* Boullier: From Boullier, 1976:312, fig. 168. Reduced ½ from original.

FIGURE 25.—*Galliennithyris galliennei* (d'Orbigny): From Boullier, 1976:112, fig. 53.

FIGURE 26.—*Rouillieria michalkowi* (Fahrenkohl): From Makridin, 1964:251, fig. 84.

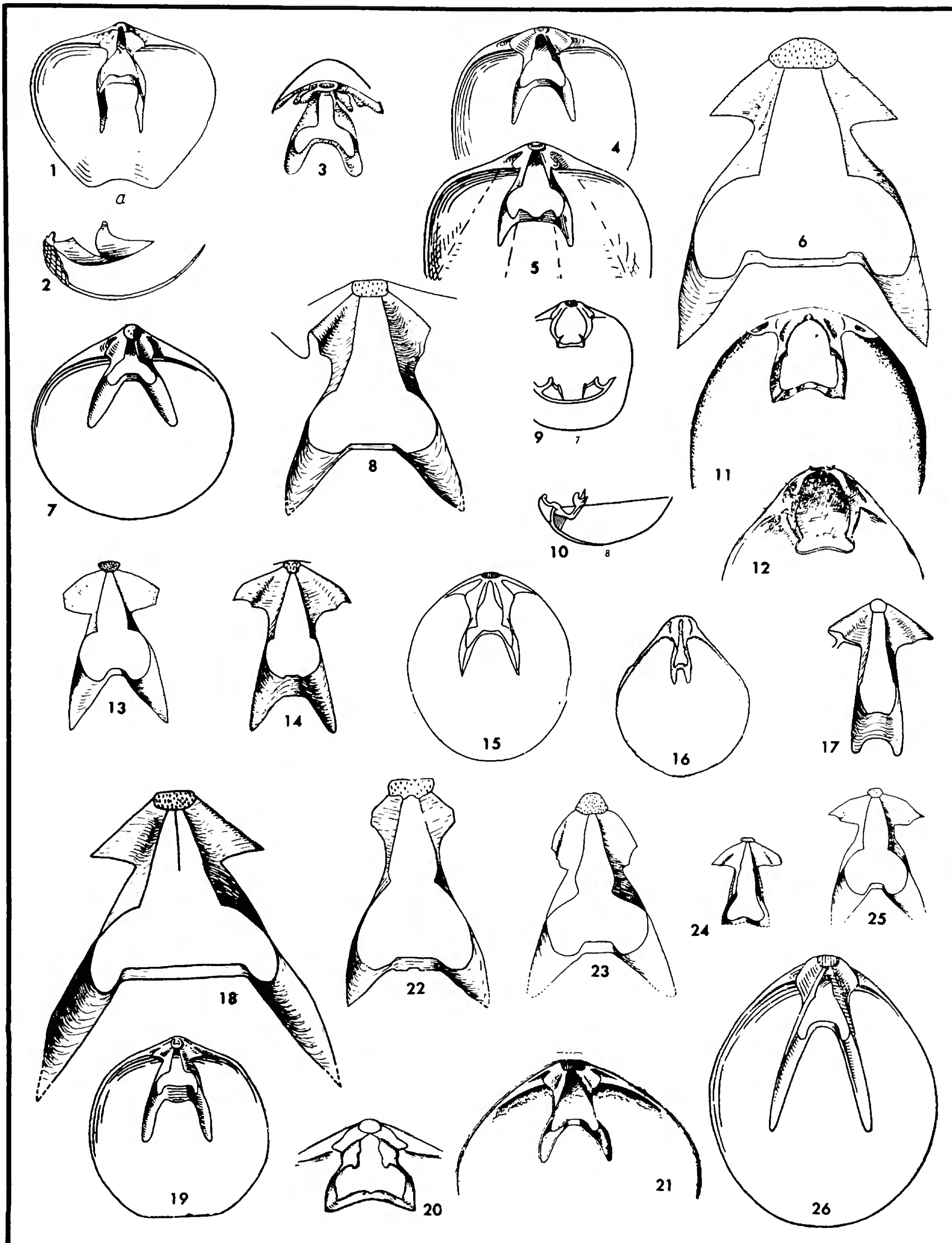

1
a
2
3
4
5
6
7
8
9
7
10
8
11
12
13
14
15
16
17
18
22
23
24
25
19
20
21
26

PLATE 64

Loop Drawings

FIGURES 1, 2.—*Abyssothyris*, × 5, Plate 2: figure 4.

FIGURES 3, 4.—*Liothyrella notorcadensis*, × 2, Plate 8: figures 19–21.

FIGURES 5, 6.—*Terebratula*, × 2, Plate 4: figures 11–13.

FIGURES 7, 8.—*Maltaia*, × 2, Plate 6: figures 24–28.

FIGURES 9, 10.—*Liothyrella neozelanica*, × 2, Plate 30: figures 20–22.

FIGURES 11, 12.—*Pycnobrochus*, × 2, Plate 12: figures 9, 10.

FIGURES 13, 14.—*Rhytisoria*, × 3, Plate 53: figures 5–7.

FIGURES 15, 16.—*Mimorina*, × 2.5, Plate 16: figures 7–9.

FIGURES 17, 18.—*Pliothyrina*, × 1, Plate 5: figures 2–4.

FIGURES 19, 20.—*Apletosia*, × 0.5, Plate 5: figures 10, 11.

FIGURES 21, 22.—*Sellithyris*, × 2, Plate 18: figures 27–29.

FIGURES 23, 24.—*Loriolithyris*, × 2, Plate 18: figures 19–21.

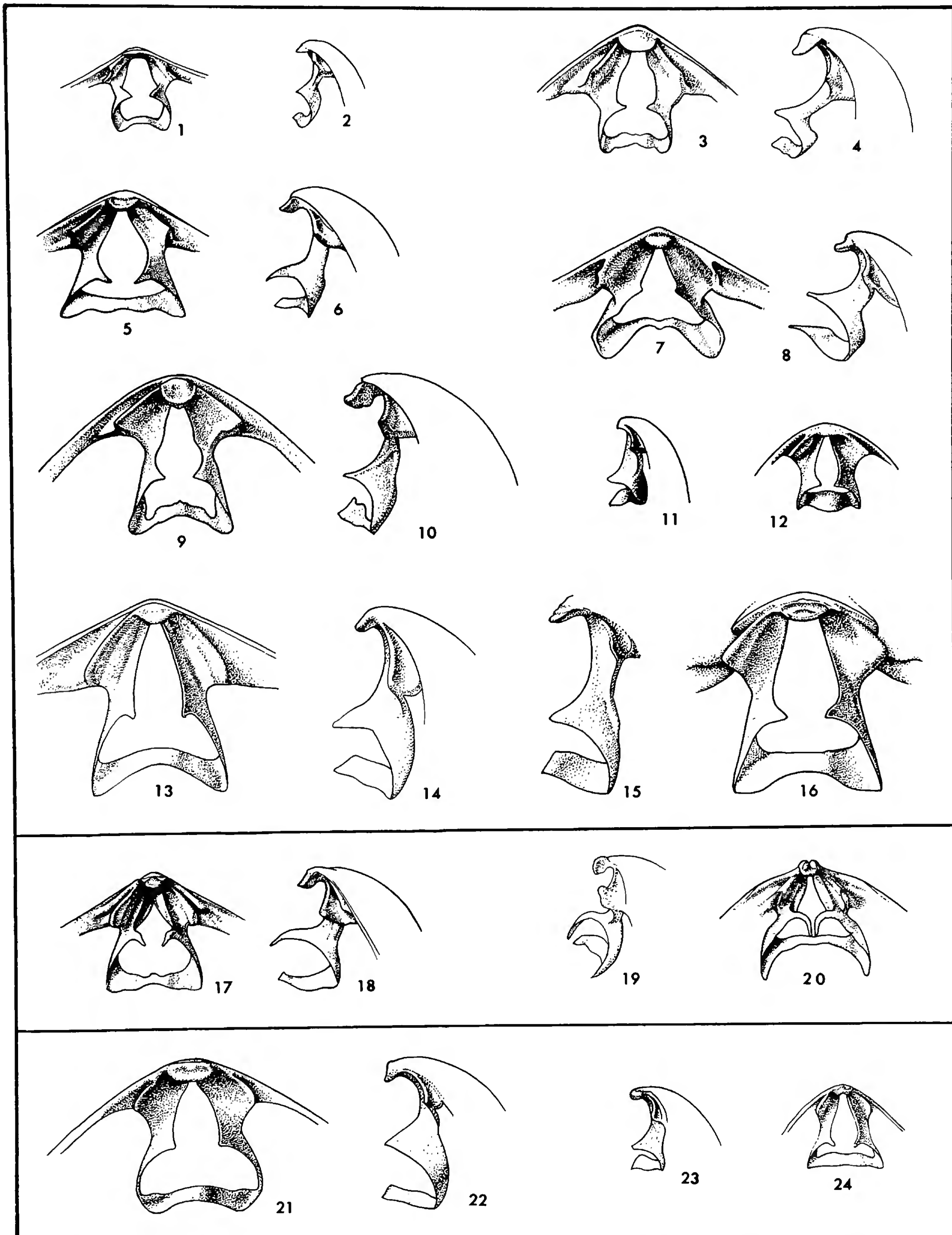

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

PLATE 65

Loop Drawings

FIGURES 1, 2.—*Erymnia muralifera*, × 2, Plate 15: figures 27–30.

FIGURES 3, 4.—*E. angustata*, × 2, Plate 15: figures 24–26.

FIGURES 5, 6.—*Eurysina plicata*, × 2, Plate 9: figures 10, 11.

FIGURES 7, 8.—*Arctosia*, × 7.5, Plate 60: figure 9.

FIGURES 9, 10.—*Eurysina obesa*, × 3, Plate 13: figures 38, 39.

FIGURES 11, 12.—*Tichosina floridensis*, × 2, Plate 13: figures 33, 34.

FIGURES 13, 14.—*Zygonaria*, × 3, Plate 3: figures 24, 25.

FIGURES 15, 16.—*Eurysina? bartletti*, × 2, Plate 9: figures 21, 22.

FIGURES 17, 18.—*Tichosina? abrupta*, × 6, Plate 3: figures 31, 32.

FIGURES 19, 20.—*Stenosarina*, × 4, Plate 15: figure 6.

FIGURES 21, 22.—*Epacrosina*, × 2, Plate 14: figures 23, 24.

FIGURES 23, 24.—*Dysedrosia*, × 2.5, Plate 10: figures 24–27.

FIGURES 25, 26.—*Stenobrochus*, × 2.5, Plate 14: figures 4, 5.

FIGURES 27, 28.—*Gryphus*, × 2, Plate 10: figures 6, 7.

FIGURES 29, 30.—*Dallithyris*, × 2, Plate 10: figures 16–19.

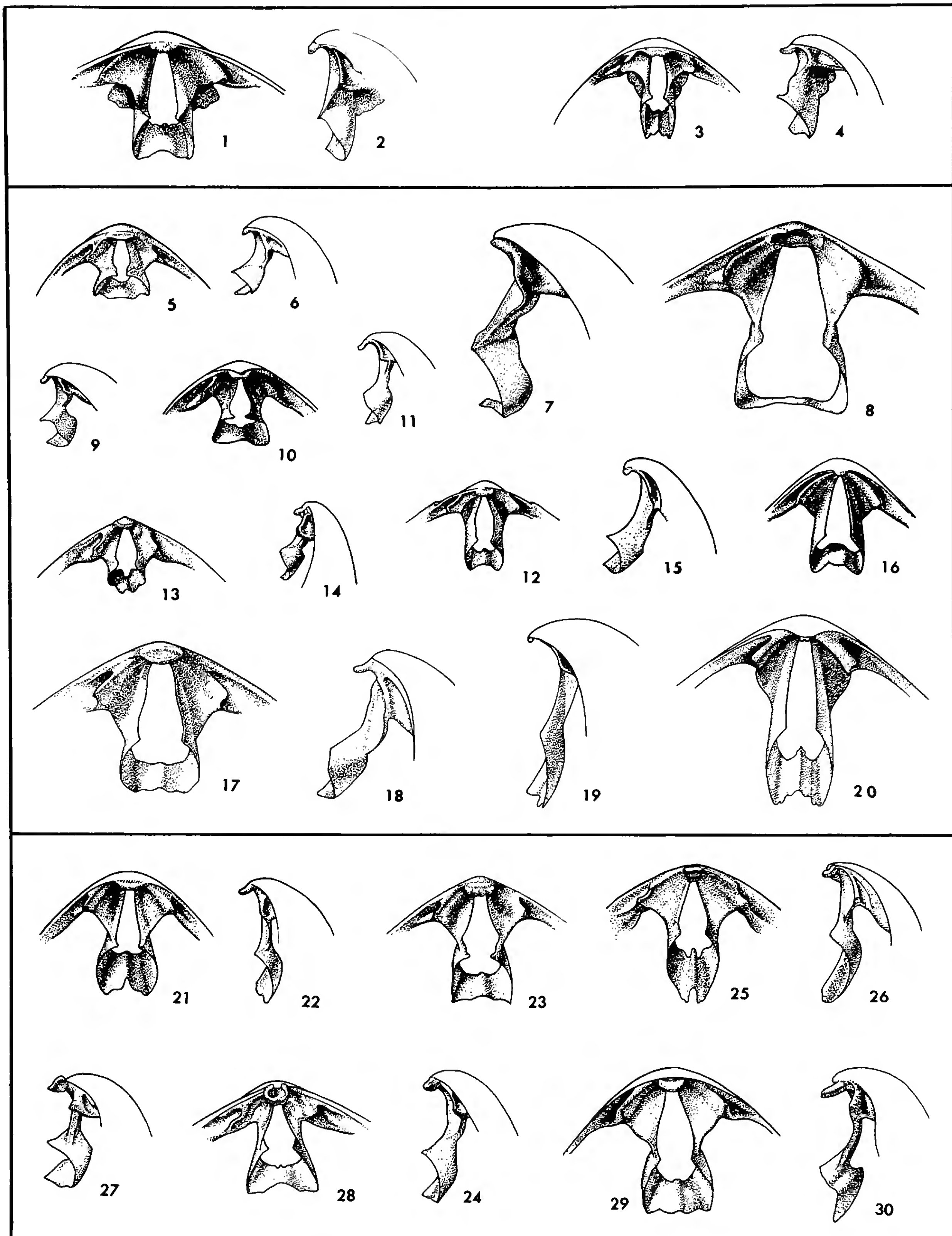

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
25
26
27
28
24
29
30

PLATE 66

Loop Drawings

FIGURE 1.—*Aniabrochus*, × 2, Plate 19: figures 28, 29.

FIGURE 2.—*Cyranoia*, × 1, Plate 21: figure 21.

FIGURES 3, 4.—*Rectithyris*, × 2, Plate 21: figures 15–17.

FIGURES 5, 6.—*Dolichosina*, × 2, Plate 7: figures 2–5.

FIGURES 7, 8.—*Plicatoria*, × 2, Plate 7: figure 12.

FIGURES 9, 10.—*Dolichozygus*, × 2, Plate 12: figures 18–20.

FIGURES 11, 12.—*Triadithyris*, × ?, Pearson 1977:47, fig. 16.

FIGURE 13.—*Merophricus dubari*, × 3, from Dubar, 1942, pl. 3: fig. 26.

FIGURES 14, 15.—*Plectoconcha*, × 3, Plate 59: figures 13, 14.

FIGURES 16, 17.—*Capillithyris*, × 2, Plate 23: figures 16–18.

FIGURES 18, 19.—*Capillarina*, × 3, Plate 23: figures 9–11.

FIGURES 20, 21.—*Dyscolia*, × 2, Plate 1: figures 30–32.

FIGURES 22, 23.—*Goniobrochus*, × 3, Plate 2: figures 36–38.

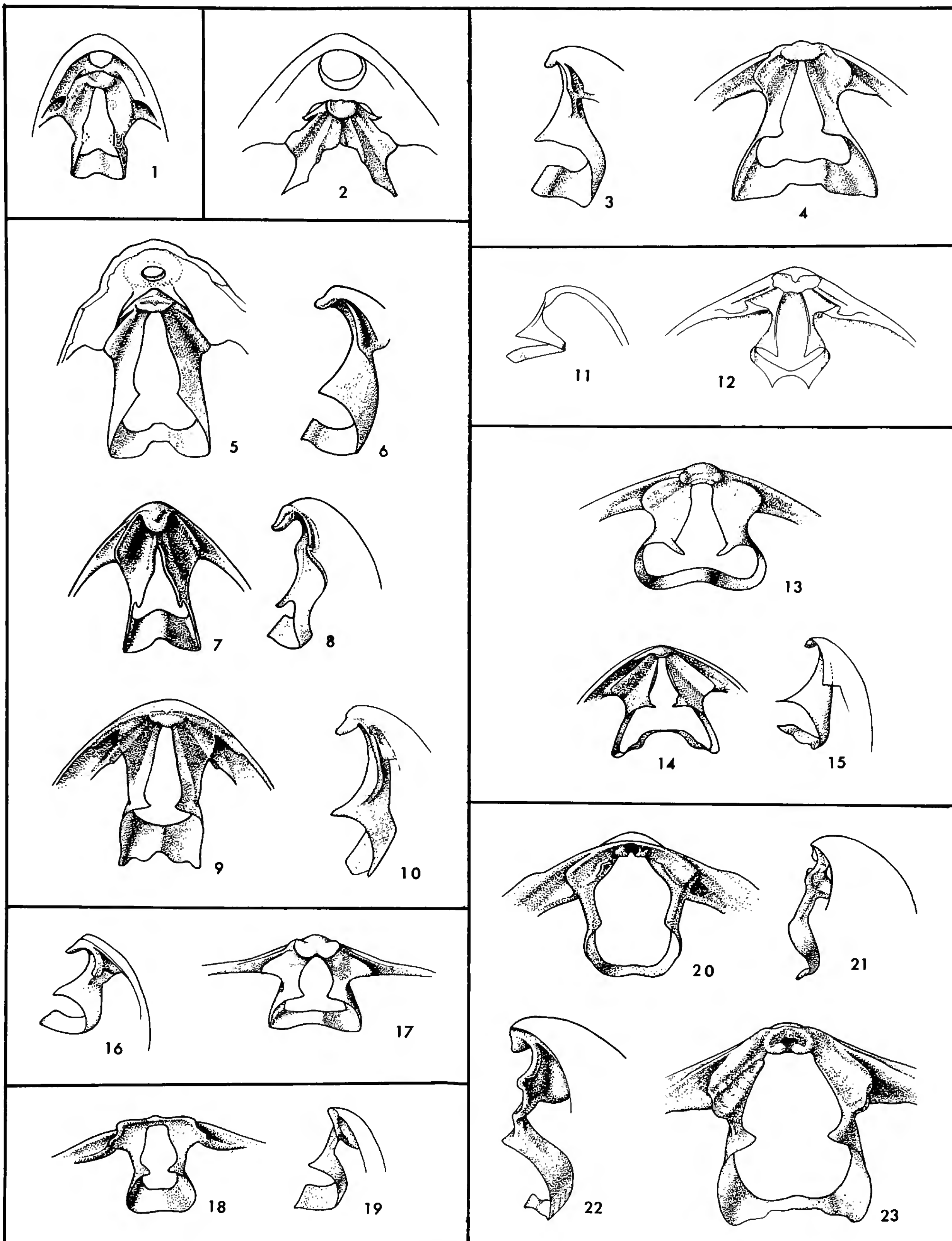

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

PLATE 67

Loop Drawings

FIGURES 1, 2.—*Hesperosia*, × 3, Plate 17: figures 20, 21.

FIGURES 3, 4.—*Najdinothyris*, × 3, Plate 15: figures 13–15.

FIGURE 5.—*Harmatosia*, × 3, Plate 29: figure 11.

FIGURES 6, 7.—*Liramia*, × 3, Plate 23: figures 27, 28.

FIGURES 8, 9.—*Hadrosia*, × 2, Plate 17: figures 39–41.

FIGURES 10, 11.—*Harmatosia*, × 2, Plate 19: figures 19–22.

FIGURES 12, 13.—*Biplicatoria*, × 2, Plate 21: figures 4–6.

FIGURES 14, 15.—*Nerthebrochus*, × 2, Plate 21: figures 10, 11; Plate 17: figure 42.

FIGURES 16–18.—*Neoliothyrina*, × 2, Plate 19: figures 4–6.

FIGURES 19, 20.—*Boubeithyris*, × 4, Plate 20: figures 18–20.

FIGURES 21, 22.—*Dilophosina*, × 3, Plate 18: figures 5–8.

FIGURES 23, 24.—*Biplicatoria*, × 5, Plate 20: figures 25–27.

FIGURES 25, 26.—*Nerthebrochus*, × 3, Plate 56: figures 2–4.

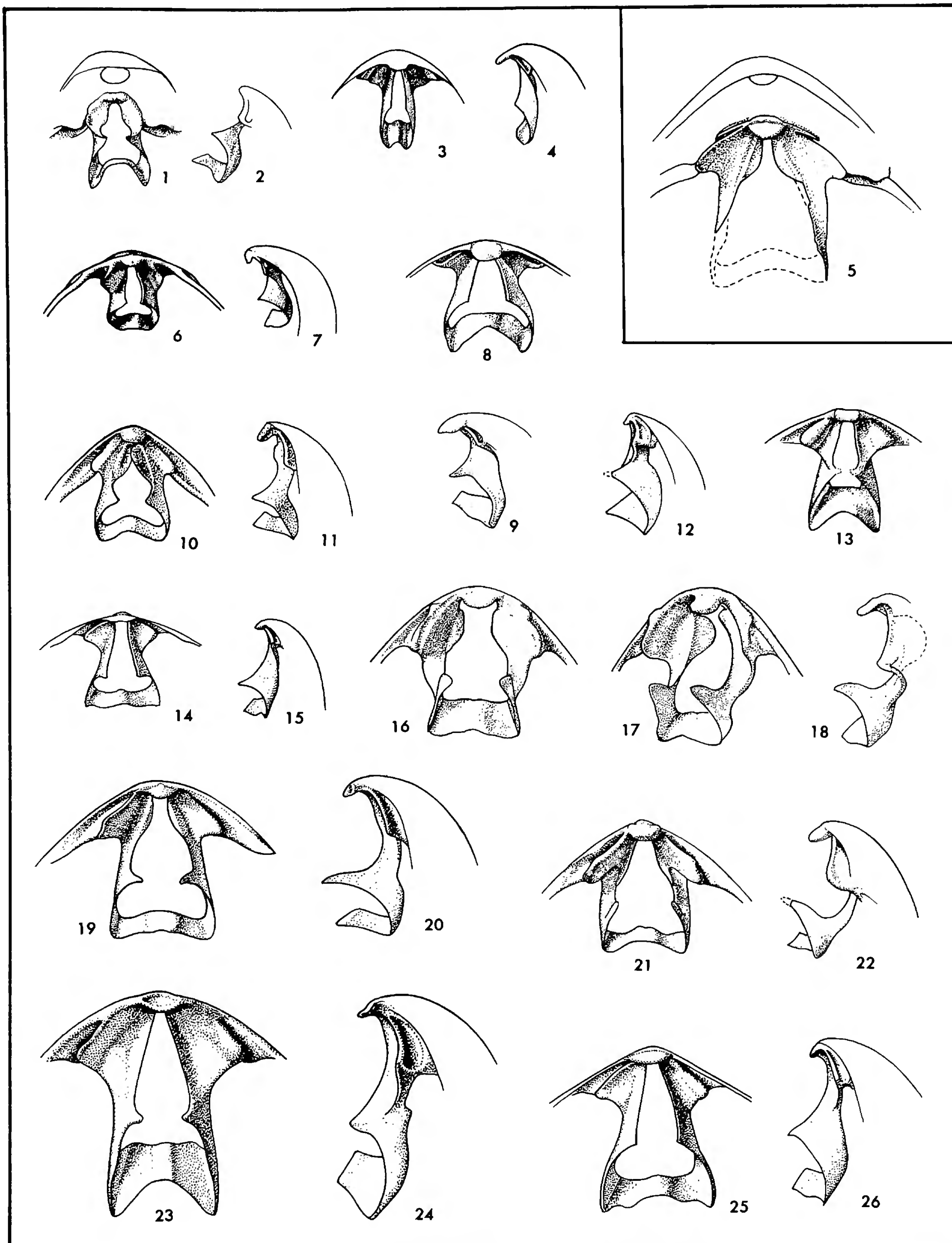

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26

PLATE 68

Loop Drawings

FIGURES 1, 2.—*Aphragmus*, × 3, Plate 56: figures 15–18.

FIGURES 3, 4.—*Eurysoria*, × 3, Plate 54: figures 6–8.

FIGURES 5, 6.—*Rhombaria*, × 4, Plate 53: figures 18–20.

FIGURES 7, 8.—*Gibbithyris*, × 2, Plate 30: figures 23–25.

FIGURES 9, 10.—*Ornatothyris*, × 2, Plate 25: figures 17–19.

FIGURES 11, 12.—*Concinnithyris rouenensis*, × 2, Plate 26: figures 9, 11.

FIGURES 13, 14.—*Magnithyris*, × 3, Plate 24: figures 26–28.

FIGURES 15, 16.—*Atactosia*, × 3.5, Plate 29: figures 5–7.

FIGURES 17, 18.—*Atactosia*, × 3.5, Plate 58: figures 20–22.

FIGURES 19, 20.—*Concinnithyris rouenensis*, × 3, Plate 56: figures 23–25.

FIGURES 21, 22.—*Concinnithyris obesa*, × 2, Plate 26: figures 29–31.

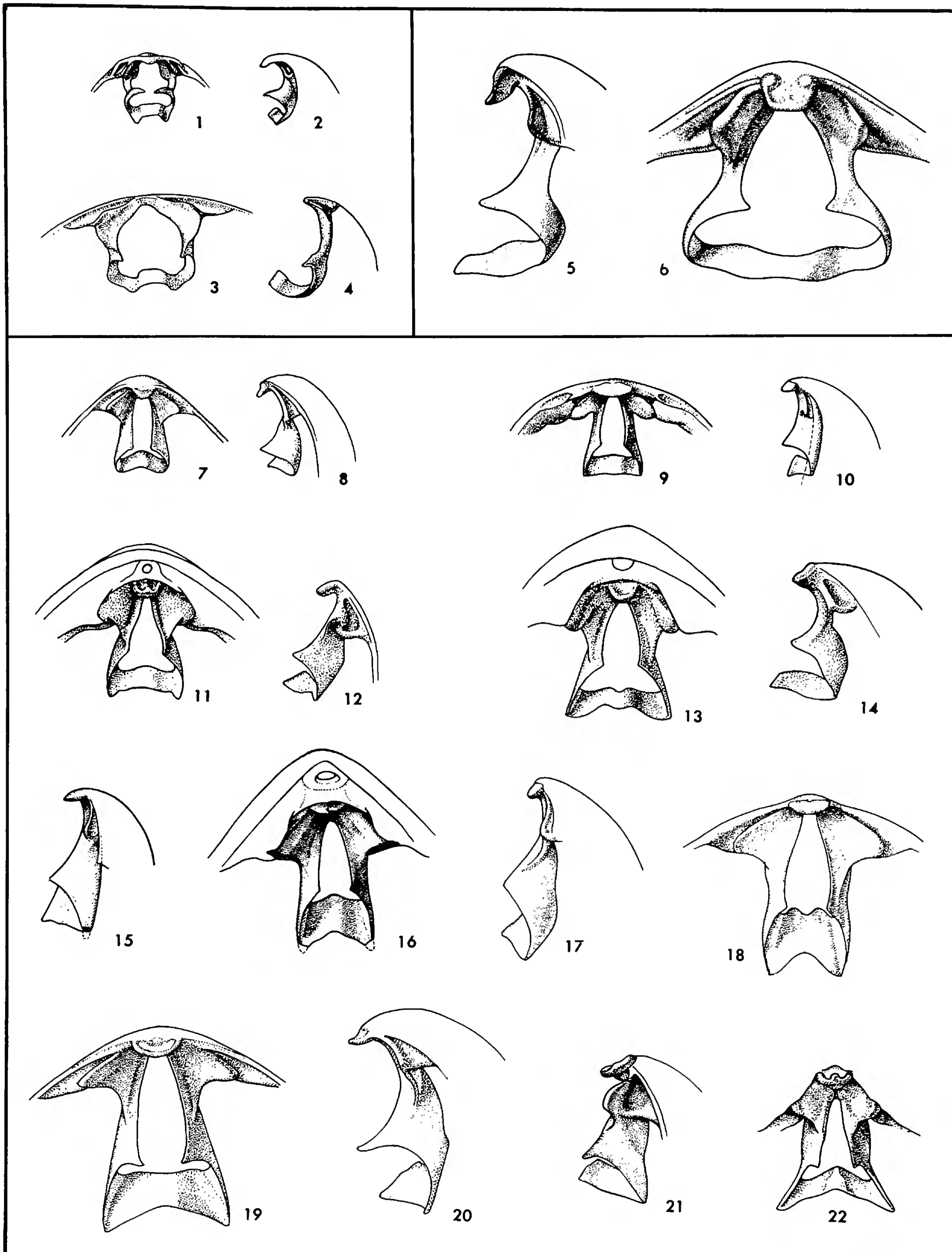

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

PLATE 69

Loop Drawings

FIGURES 1, 2.—*Aenigmathyris*, × 3, Plate 1: figures 4–9.

FIGURES 3, 4.—*Abyssothyris elongata* Cooper, × 3, Plate 2: figures 12–15.

FIGURES 5, 6.—*Xenobrochus*, × 12, Plate 2: figure 23.

FIGURES 7, 8.—*Ceramisia*, × 5, Plate 1: figures 20, 21.

FIGURE 9.—*Acrobelesia*, × 12, from d'Hondt, 1976:7, fig. 2b.

FIGURES 10, 11.—*Tegulithyris*, × 2, Plate 30: figures 6–9.

FIGURES 12, 13.—*Heterobrochus*, × 2, Plate 41: figures 18–21.

FIGURES 14, 15.—*Bothrothyris*, × 1, Plate 37: figures 25–27.

FIGURES 16, 17.—*Dictyothyris*, × 3, Plate 37: figures 5–8.

FIGURES 18, 19.—*Chatwinothyris cipleyensis*, × 4, Plate 20: figures 4–6.

FIGURES 20, 21.—*Ornithothyris*, × 4, Plate 25: figures 4–6.

FIGURES 22, 23.—*Carneithyris*, × 4, Plate 25: figures 30, 33.

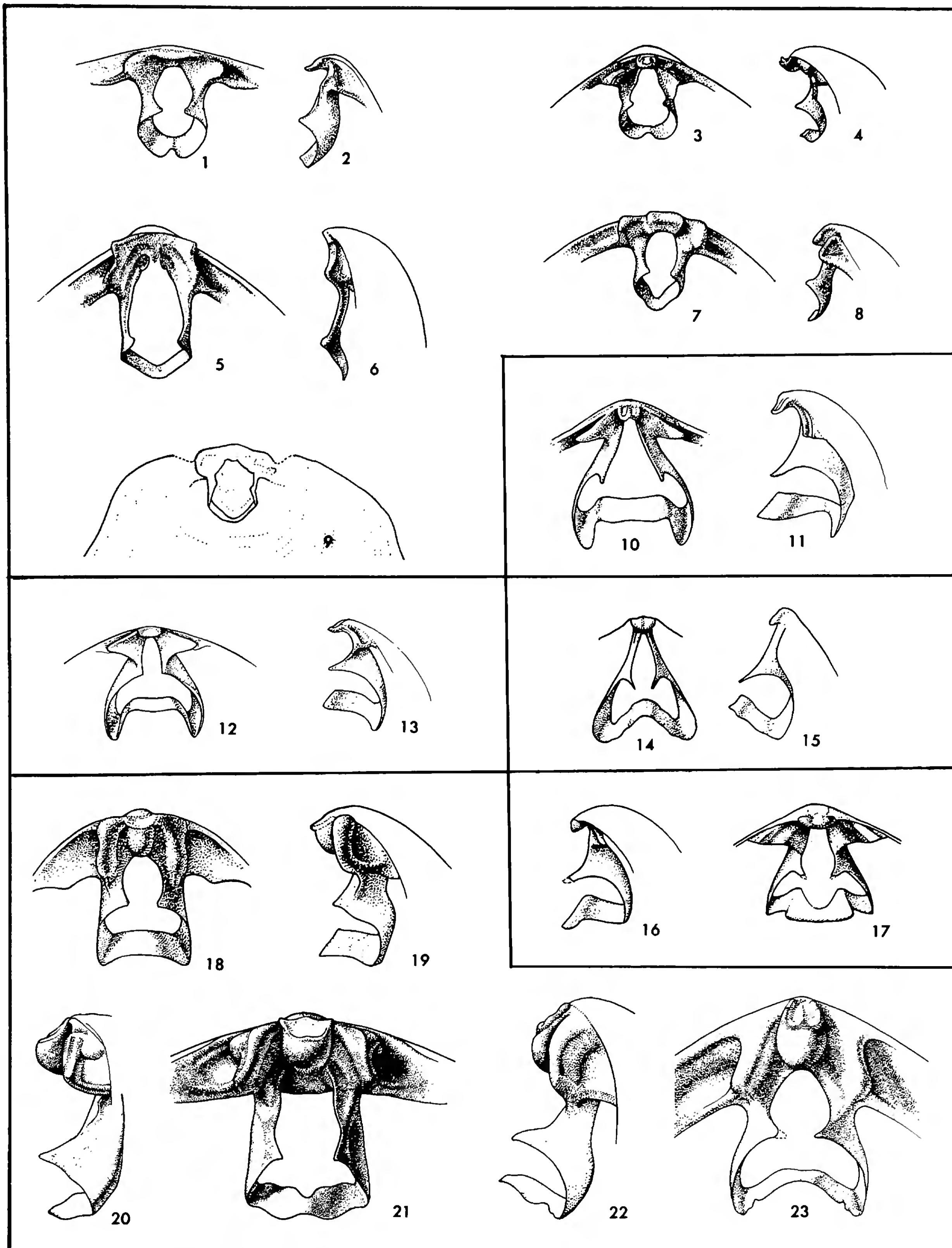

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

PLATE 70

Loop Drawings

FIGURES 1, 2.—*Wattonithyris*, × 2, Plate 43: figures 4–6.

FIGURES 3, 4.—*Pionothyris*, × 5, Plate 57: figures 42–44.

FIGURES 5, 6.—*Pseudoglossothyris*, × 2, Plate 37: figures 22–24.

FIGURES 7, 8.—*Sphaeroidothyris globisphaeroidalis*, × 2, Plate 44: figures 9–11.

FIGURES 9, 10.—*Cererithyris*, × 2, Plate 41: figures 5–7.

FIGURES 11, 12.—*Colosia*, × 4.5, Plate 35: figures 15, 21.

FIGURES 13, 14.—*Striithyris*, × 3, Plate 37: figures 12–14.

FIGURES 15, 16.—*Animonithyris*, × 2, Plate 34: figure 35.

FIGURES 17, 18.—*Loboidothyris perovalis*, × 2.5, Plate 36: figures 25–27.

FIGURES 19, 20.—*Habrobrochus*, × 2, Plate 31: figures 29–32.

FIGURES 21, 22.—"*Terebratula*" *movelierensis*, × 4, Plate 57: figures 36–38.

FIGURES 23, 24.—*Cererithyris*, × 2.5, Plate 45: figures 30–32.

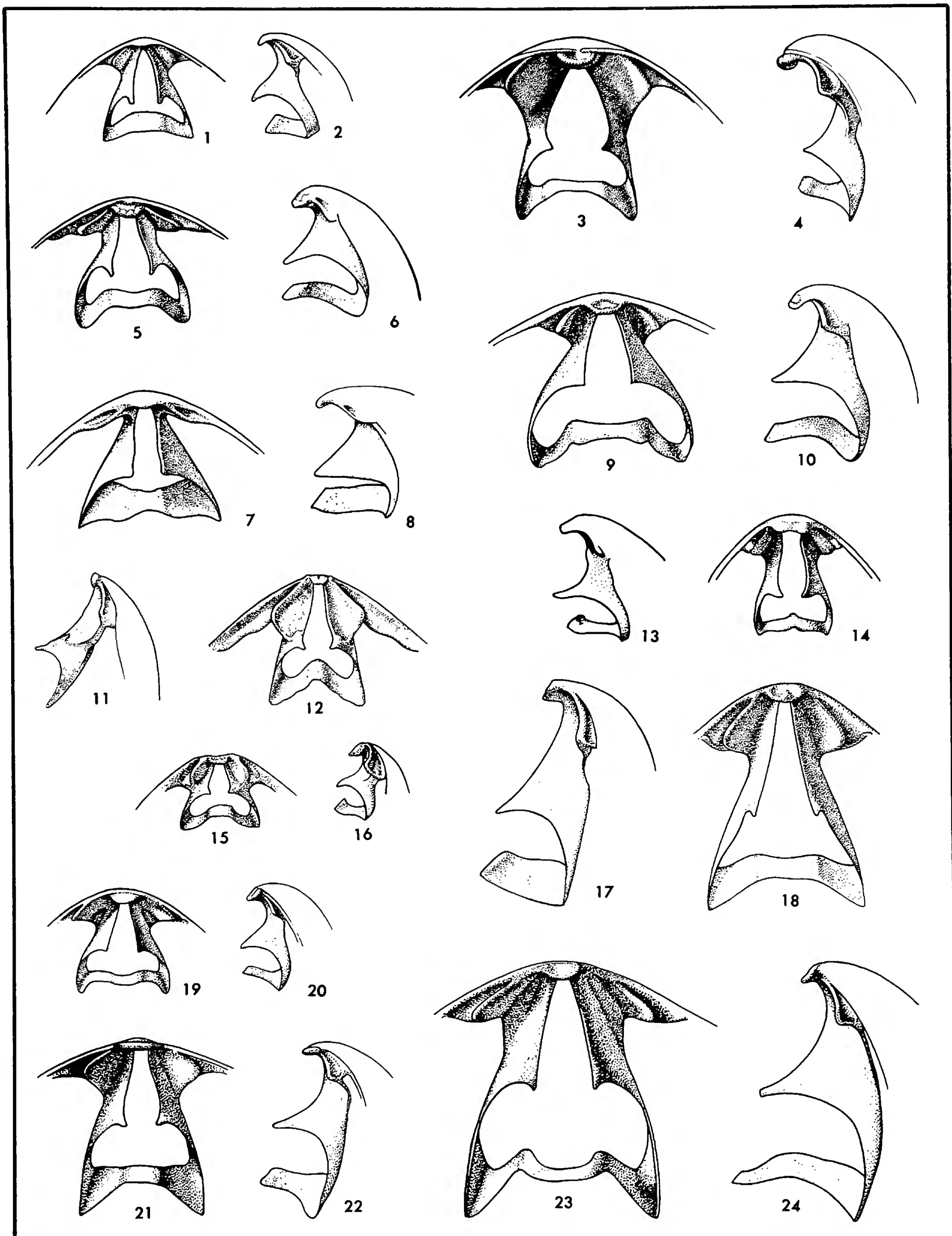

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

PLATE 71

Loop Drawings

FIGURES 1, 2.—*Apatecosia*, × 2, Plate 32: figures 21–23.

FIGURES 3, 4.—*Monsardithyris? buckmani*, × 2, Plate 29: figures 19–21.

FIGURES 5, 6.—*Inaequalis?*, × 2, Plate 52: figures 4–6.

FIGURES 7, 8.—*Saucrobrochus*, × 3, Plate 50: figures 16–18.

FIGURES 9, 10.—*Notosia*, × 2, Plate 49: figures 12–14.

FIGURES 11, 12.—*Monsardithyris*, × 1, USNM 551020j, not figured on plates.

FIGURES 13, 14.—*Stroudithyris*, × 3, Plate 43: figures 16–18.

FIGURES 15, 16.—*Aromasithyris almerasia*, × 2, Plate 46: figures 9, 10.

FIGURES 17, 18.—*Arcelinithyris*, × 3, Plate 28: figure 23.

FIGURES 19, 20.—*Lissajousithyris*, × 2, Plate 46: figures 19–21.

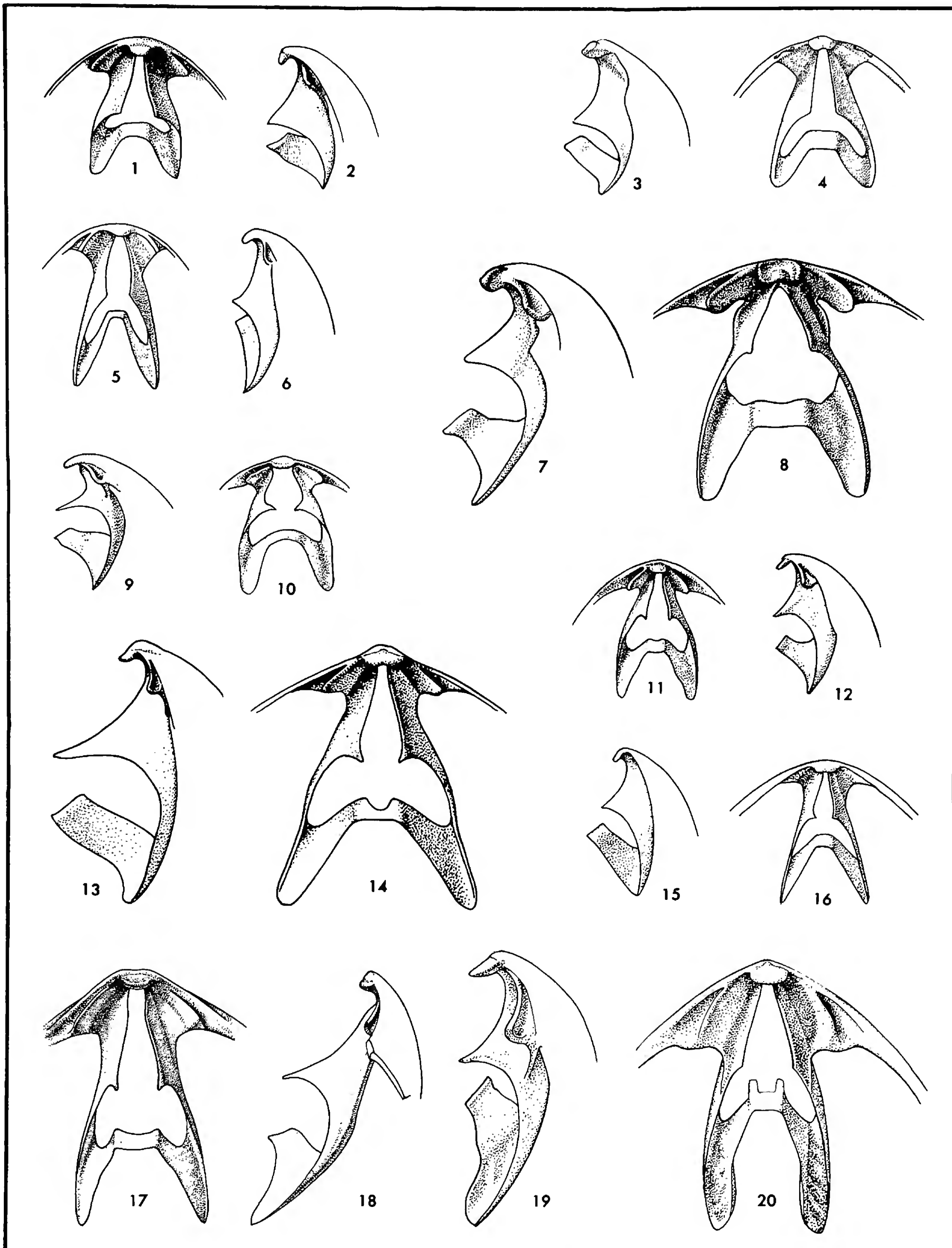

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

PLATE 72

Loop Drawings

FIGURES 1, 2.—*Dorsoplicathyris*, × 2, Plate 33: figures 7–9.

FIGURES 3, 4.—*Conarothyris*, × 4.5, Plate 50: figures 10–12.

FIGURES 5, 6.—*Plectoidothyris*, × 1.5, Plate 51: figures 12–14.

FIGURES 7, 8.—*Conarothyris*, × 4, Plate 45: figures 4–6.

FIGURES 9, 10.—*Postepithyris*, × 2.5, Plate 56: figure 8, 8A.

FIGURES 11, 12.—*Systenothyris*, × 2, Plate 33: figures 18–20.

FIGURES 13, 14.—*Conarothyris*, × 3, Plate 57: figures 26–28.

FIGURES 15, 16.—*"Sphaeroidothyris,"* × 3, Plate 36: figures 4–6.

FIGURES 17, 18.—*"Sphaeroidothyris,"* × 4.5, Plate 49: figures 21–23.

FIGURES 19, 20.—*Eristenosia*, × 4, Plate 57: figures 4–7.

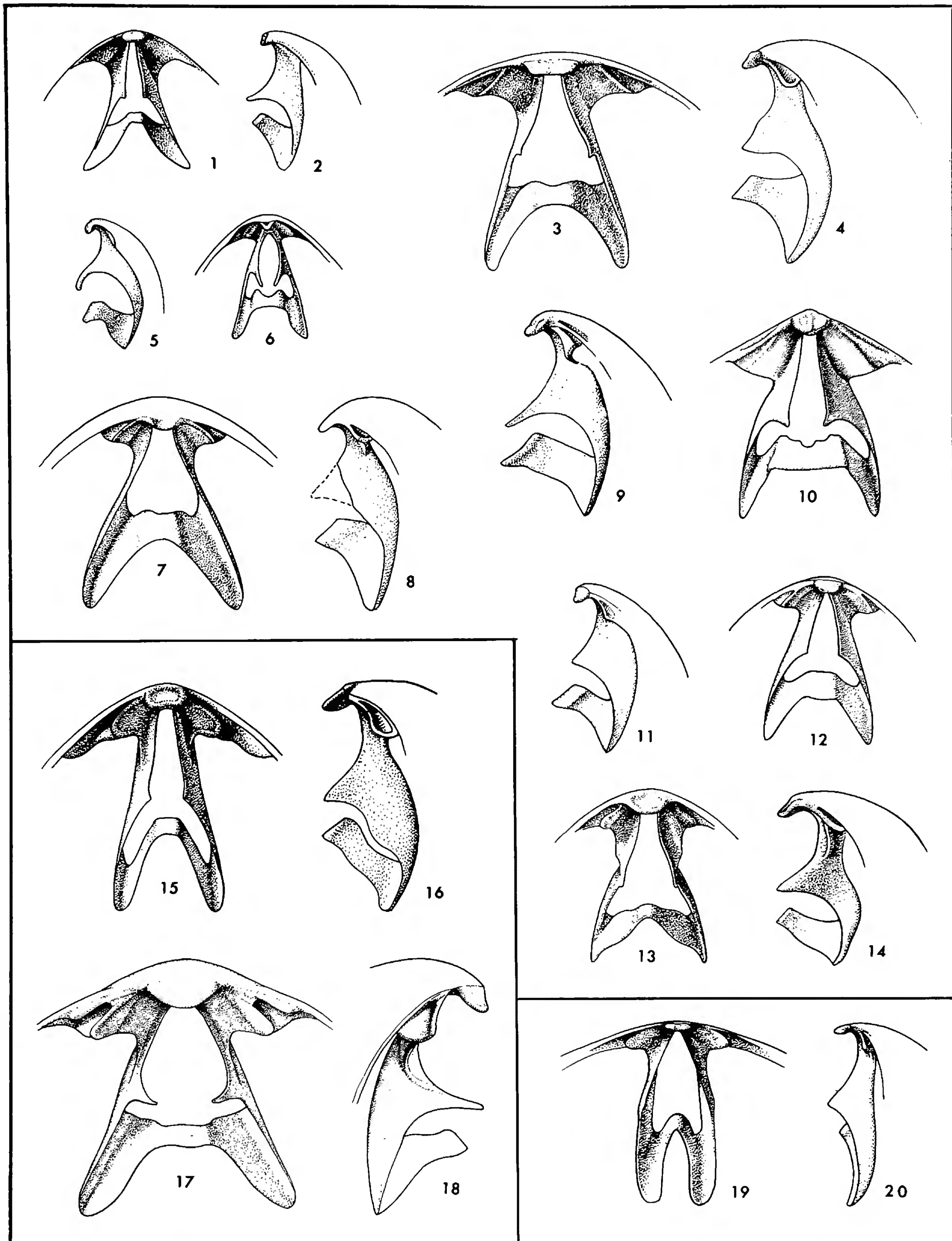

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

PLATE 73

Loop Drawings

FIGURES 1, 2.—*Oleneothyris*, × 1, Plate 6: figures 7–9.

FIGURES 3, 4.—Jurassic Genus and Species Undetermined: × 4, Plate 57: figures 10–12.

FIGURES 5, 6.—*Epithyris*, × 1, Plate 42: figures 13–16.

FIGURES 7, 8.—*Plectothyris*, × 2, Plate 44: figures 24, 25.

FIGURES 9, 10.—*Pseudowattonithyris*, × 2, Plate 32: figures 15–17.

FIGURES 11, 12.—*Euidothyris*, × 2, Plate 40: figures 22–24.

FIGURES 13, 14.—*Juralina*, × 1.5, Plate 49: figures 7, 8.

FIGURES 15, 16.—*Oligorhytisia*, × 2, Plate 48: figures 18–20.

FIGURES 17, 18.—*Xestosina*, × 2, Plate 31: figures 8–10.

FIGURES 19, 20.—*Bihenithyris*, × 3, Plate 45: figures 22–24.

FIGURES 21, 22.—*Epithyris? submaxillata*, × 2, Plate 39: figures 26–28.

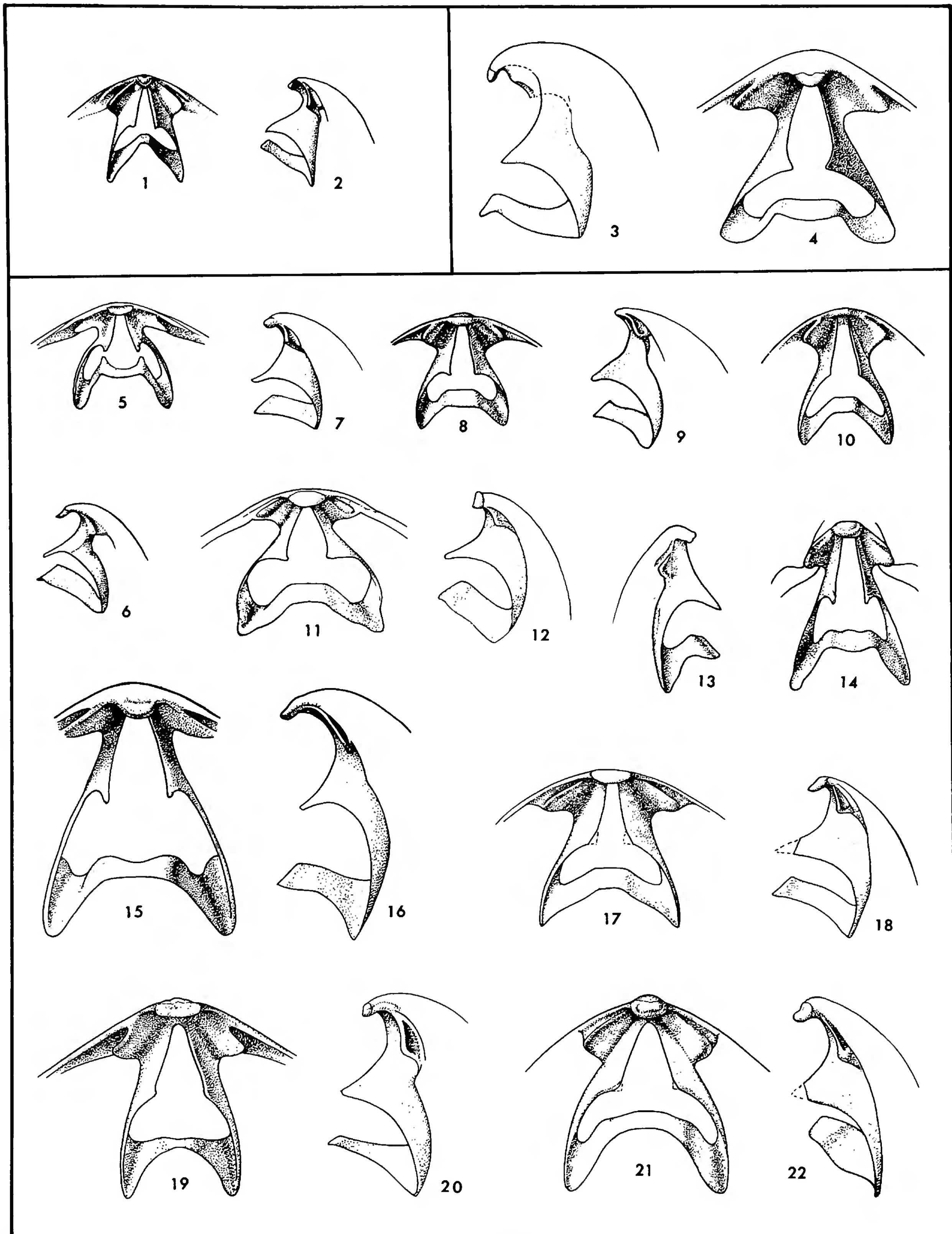

1
2
3
4
5
7
8
9
10
6
11
12
13
14
15
16
17
18
19
20
21
22

PLATE 74

Loop Drawings

FIGURES 1, 2.—*Lophrothyris?*, × 2, Plate 44: figures 15–17.

FIGURES 3, 4.—*Gyrosina*, × 2, Plate 32: figures 4–6.

FIGURES 5, 6.—*Pentithyris*, × 2, Plate 40: figures 4–6.

FIGURES 7, 8.—*Tubithyris*, × 3, Plate 43: figures 10–12.

FIGURES 9, 10.—*Caryona*, × 4, Plate 56: figures 12–14.

FIGURES 11, 12.—*Stiphrothyris*, × 2, Plate 43: figures 29–31.

FIGURES 13, 14.—*Avonothyris*, × 2.5, Plate 48: figures 7–10.

FIGURES 15, 16.—*Glyphisaria*, × 3, Plate 52: figures 21–23.

FIGURES 17, 18.—*Stiphrothyris?*, × 3, Plate 50: figures 22–24.

FIGURES 19, 20.—*Pseudotubithyris globata*, × 3, Plate 36: figures 13–15.

FIGURES 21, 22.—*Stiphrothyris*, × 2, Plate 43: figures 26–28.

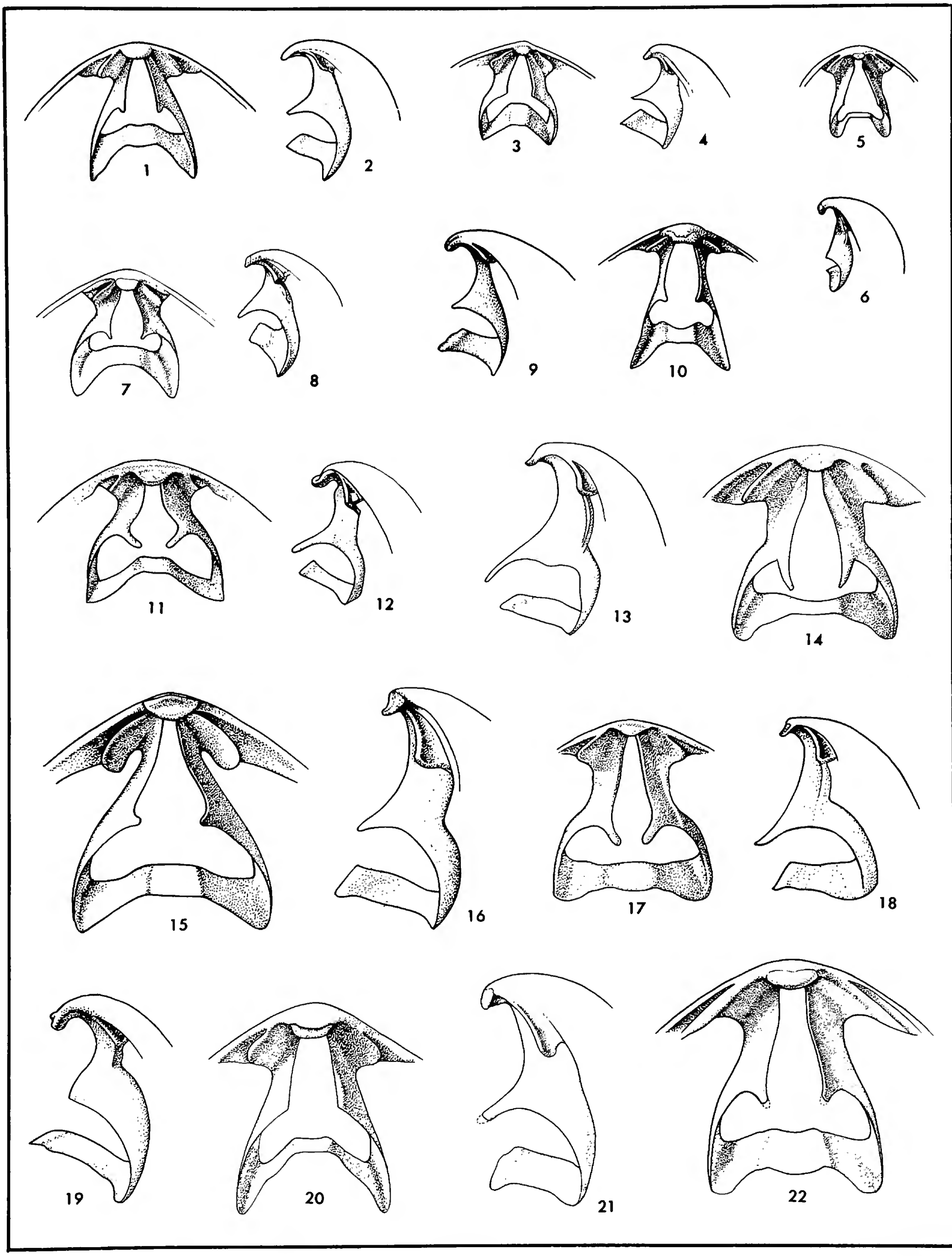

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

PLATE 75

Loop Drawings

FIGURES 1, 2.—*Pseudotubithyris*, × 2, Plate 32: figures 10–12.

FIGURES 3, 4.—*Dolichobrochus*, × 2, Plate 31: figures 4–6.

FIGURES 5, 6.—*Ptychtothyris*, × 2 (composite), Plate 39: figures 19–21; Plate 45: figure 7.

FIGURES 7, 8.—*Lophrothyris*, × 3, Plate 45: figures 11–13.

FIGURES 9, 10.—*Stenogmus*, × 2.5, Plate 50: figures 4–6.

FIGURES 11, 12.—*Morrisithyris*, × 1.5, Plate 38: figure 5.

FIGURES 13, 14.—*Charltonithyris*, × 2, Plate 34: figures 11–13.

FIGURES 15, 16.—*Petalothyris*, × 1, Plate 51: figures 5–7.

FIGURES 17, 18.—*Strongylobrochus*, × 2, Plate 50: figures 31–33.

FIGURES 19, 20.—*Nucleatina*, × 2, Plate 28: figures 20, 21.

FIGURES 21, 22.—*Inopinatarcula*, × 6, Plate 26: figures 23–26.

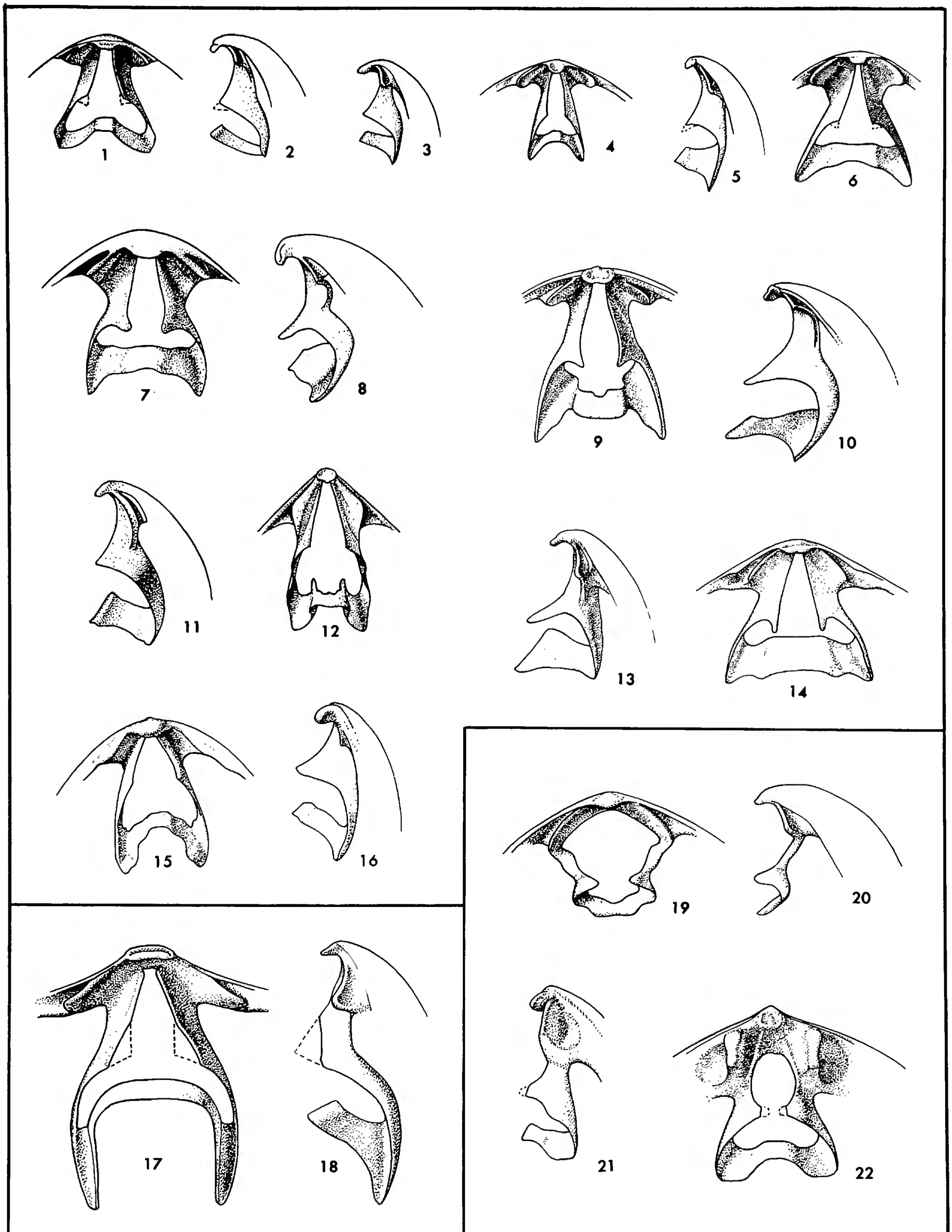

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

PLATE 76

Loop Drawings

FIGURE 1.—*Iberithyris*, ca × 3, showing loop and supporting plates, from Kvakhadze, 1972:77, fig. 2a.

FIGURE 2.—*Cererithyris intermedia*, ca × 3, reconstruction of loop by Tchoumatchenko, 1976/1977:219, fig. 15A. Compare with figure of *Cererithyris* on Plate 45: figures 30–32.

FIGURE 3.—*Wattonithyris wattonensis*, ca × 4, reconstruction of loop by Tchoumatchenko, 1976/1977:209, fig. 9A. Compare with *W. fullonica* loop, Plate 43: figures 4–6.

FIGURE 4.—*Postepithyris bauchini* (sic), ca × 4, reconstruction by Makridin, 1964:236, fig. 79. Compare with Plate 49: figures 3–5.

FIGURE 5.—*Lunpolaia*, × 3, from Ye and Yang, 1979:67, pl. 1: fig. 45.

FIGURES 6, 7.—*Cyrtothyris*, × 1, Plate 19: figure 24.

FIGURE 8.—*Rhombothyris*, × 3, Plate 22: figures 21, 22.

FIGURES 9, 10.—*Rhombothyris*, × 3, Plate 19: figures 11, 12.

FIGURES 11, 12.—*Praelongithyris*, × 2.5, Plate 22: figures 25–27.

FIGURES 13, 14.—Cretaceous Genus and Species Undetermined, × 4, Plate 29: figures 12–14.

FIGURE 15.—"Diagram showing hinge plates and inner socket ridges in transverse sections." (After Muir-Wood, 1965:H818, fig. 697, by permission of the Geological Society of America.)

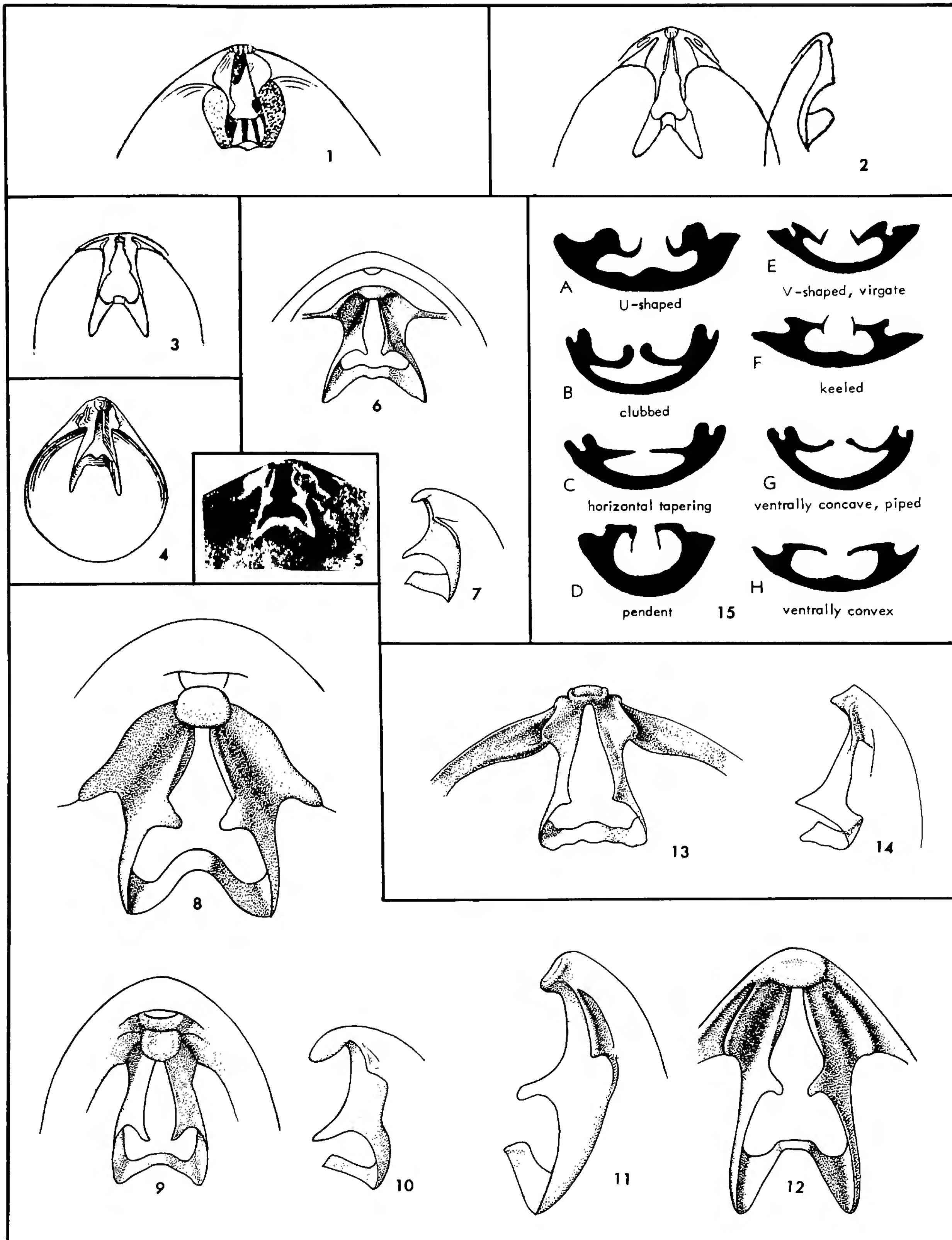

1
2
3
6
4
5
7
A U-shaped
E V-shaped, virgate
B clubbed
F keeled
C horizontal tapering
G ventrally concave, piped
D pendent
15
H ventrally convex
8
13
14
9
10
11
12

PLATE 77

Loop Drawings

(all figure reconstructions by Sučić-Protić 1971, × 2)

FIGURE 1.—*Lobothyris punctata* (Sowerby), pl. 37: fig. 3.

FIGURE 2.—*Squamiplana piroidea*, pl. 37: fig. 4.

FIGURE 3.—*Inaequalis dubari*, pl. 37: fig. 7.

FIGURE 4.—*Senokosica matura*, pl. 39: fig. 3.

FIGURE 5.—*Pirotothyris fortis*, pl. 40: fig. 1.

FIGURE 6.—*Serbiothyris medioliasica,* pl. 39: fig. 4.

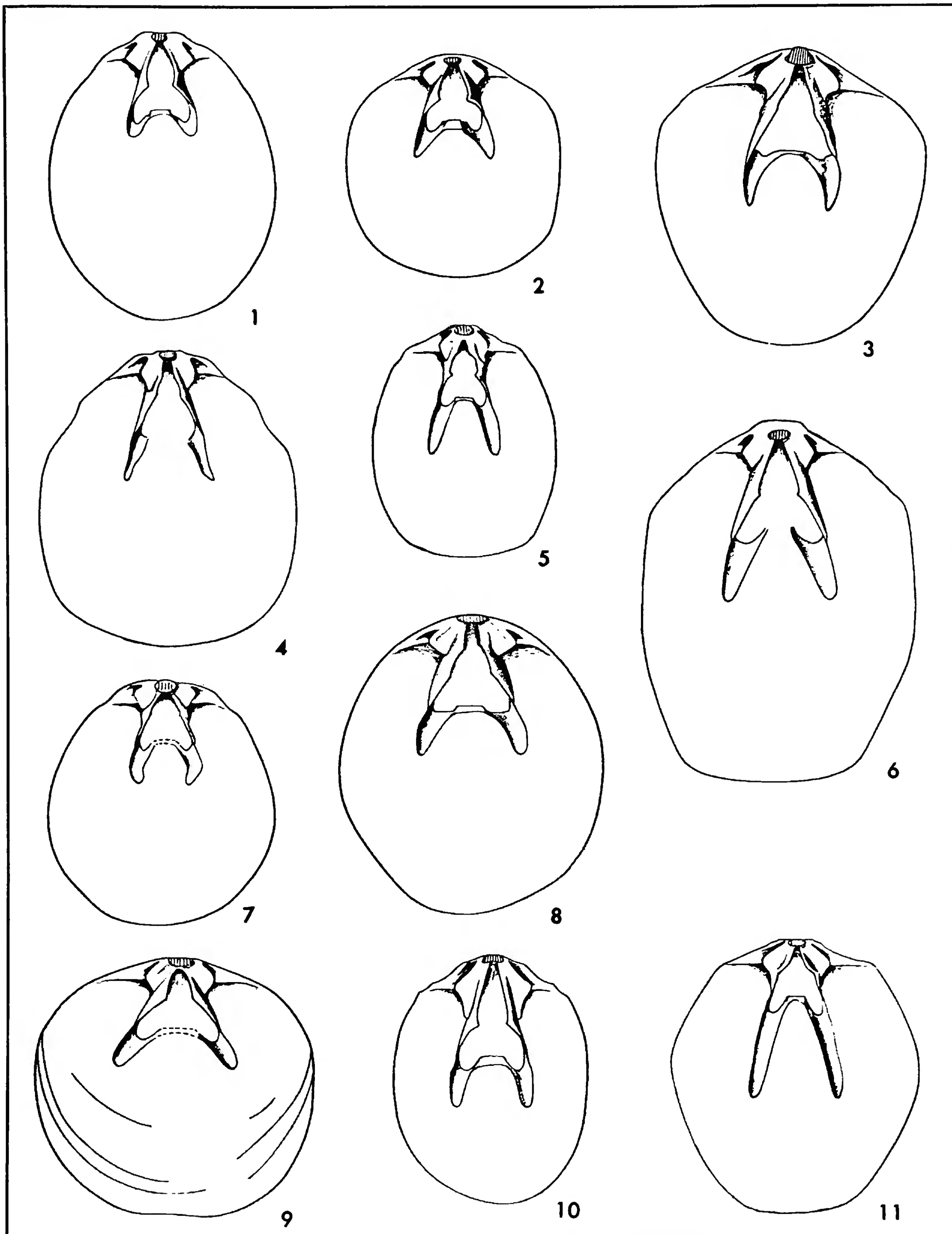
FIGURE 7.—*Loboidothyropsis (Loboidothyropsis) tipica*, pl. 38: fig. 1.

FIGURE 8.—*L. (Bullothyris) crassa*, pl. 38: fig. 5.

FIGURE 9.—*Pyraeneica numerosa*, pl. 38: fig. 9.

FIGURE 10.—*Mirisquamea clevelandensis* (Ager), pl. 40: fig. 7.

FIGURE 11.—*Exceptothyris expressa*, pl. 40: fig. 6.


1
2
3
4
5
6
7
8
9
10
11

REQUIREMENTS FOR SMITHSONIAN SERIES PUBLICATION

Manuscripts intended for series publication receive substantive review within their originating Smithsonian museums or offices and are submitted to the Smithsonian Institution Press with Form SI-36, which must show the approval of the appropriate authority designated by the sponsoring organizational unit. Requests for special treatment—use of color, foldouts, case-bound covers, etc.—require, on the same form, the added approval of the sponsoring authority.

Review of manuscripts and art by the Press for requirements of series format and style, completeness and clarity of copy, and arrangement of all material, as outlined below, will govern, within the judgment of the Press, acceptance or rejection of manuscripts and art.

Copy must be prepared on typewriter or word processor, double-spaced, on one side of standard white bond paper (not erasable), with 1¼" margins, submitted as ribbon copy (not carbon or xerox), in loose sheets (not stapled or bound), and accompanied by original art. Minimum acceptable length is 30 pages.

Front matter (preceding the text) should include: **title page** with only title and author and no other information; **abstract** page with author, title, series, etc., following the established format; table of **contents** with indents reflecting the hierarchy of heads in the paper; also, **foreword** and/or **preface**, if appropriate.

First page of text should carry the title and author at the top of the page; **second page** should have only the author's name and professional mailing address, to be used as an unnumbered footnote on the first page of printed text.

Center heads of whatever level should be typed with initial caps of major words, with extra space above and below the head, but with no other preparation (such as all caps or underline, except for the underline necessary for generic and specific epithets). Run-in paragraph heads should use period/dashes or colons as necessary.

Tabulations within text (lists of data, often in parallel columns) can be typed on the text page where they occur, but they should not contain rules or numbered table captions.

Formal tables (numbered, with captions, boxheads, stubs, rules) should be submitted as carefully typed, double-spaced copy separate from the text; they will be typeset unless otherwise requested. If camera-copy use is anticipated, do not draw rules on manuscript copy.

Taxonomic keys in natural history papers should use the aligned-couplet form for zoology and may use the multi-level indent form for botany. If cross referencing is required between key and text, do not include page references within the key, but number the keyed-out taxa, using the same numbers with their corresponding heads in the text.

Synonymy in zoology must use the short form (taxon, author, year:page), with full reference at the end of the paper under "Literature Cited." For botany, the long form (taxon, author, abbreviated journal or book title, volume, page, year, with no reference in "Literature Cited") is optional.

Text-reference system (author, year:page used within the text, with full citation in "Literature Cited" at the end of the text) must be used in place of bibliographic footnotes in all Contributions Series and is strongly recommended in the Studies Series: "(Jones, 1910:122)" or ". . . Jones (1910:122)." If bibliographic footnotes are required, use the short form (author, brief title, page) with the full citation in the bibliography.

Footnotes, when few in number, whether annotative or bibliographic, should be typed on separate sheets and inserted immediately after the text pages on which the references occur. Extensive notes must be gathered together and placed at the end of the text in a notes section.

Bibliography, depending upon use, is termed "Literature Cited," "References," or "Bibliography." Spell out titles of books, articles, journals, and monographic series. For book and article titles use sentence-style capitalization according to the rules of the language employed (exception: capitalize all major words in English). For journal and series titles, capitalize the initial word and all subsequent words except articles, conjunctions, and prepositions. Transliterate languages that use a non-Roman alphabet according to the Library of Congress system. Underline (for italics) titles of journals and series and titles of books that are not part of a series. Use the parentheses/colon system for volume(number):pagination: "10(2):5–9." For alignment and arrangement of elements, follow the format of recent publications in the series for which the manuscript is intended. Guidelines for preparing bibliography may be secured from Series Section, SI Press.

Legends for illustrations must be submitted at the end of the manuscript, with as many legends typed, double-spaced, to a page as convenient.

Illustrations must be submitted as original art (not copies) accompanying, but separate from, the manuscript. Guidelines for preparing art may be secured from Series Section, SI Press. All types of illustrations (photographs, line drawings, maps, etc.) may be intermixed throughout the printed text. They should be termed **Figures** and should be numbered consecutively as they will appear in the monograph. If several illustrations are treated as components of a single composite figure, they should be designated by lowercase italic letters on the illustration; also, in the legend and in text references the italic letters (underlined in copy) should be used: "Figure 9b." Illustrations that are intended to follow the printed text may be termed **Plates**, and any components should be similarly lettered and referenced: "Plate 9b." Keys to any symbols within an illustration should appear on the art rather than in the legend.

Some points of style: Do not use periods after such abbreviations as "mm, ft, USNM, NNE." Spell out numbers "one" through "nine" in expository text, but use digits in all other cases if possible. Use of the metric system of measurement is preferable; where use of the English system is unavoidable, supply metric equivalents in parentheses. Use the decimal system for precise measurements and relationships, common fractions for approximations. Use day/month/year sequence for dates: "9 April 1976." For months in tabular listings or data sections, use three-letter abbreviations with no periods: "Jan, Mar, Jun," etc. Omit space between initials of a personal name: "J.B. Jones."

Arrange and paginate sequentially every sheet of manuscript in the following order: (1) title page, (2) abstract, (3) contents, (4) foreword and/or preface, (5) text, (6) appendixes, (7) notes section, (8) glossary, (9) bibliography, (10) legends, (11) tables. Index copy may be submitted at page proof stage, but plans for an index should be indicated when manuscript is submitted.