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Charles D. and Mary Vaux Walcott
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(With 3 Plates)

By
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and
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U. S. Geological Survey
Denver, Colorado, and Washington, D. C.

(Publication 4654)

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SILICIFIED ORDOVICIAN BRACHIOPODS FROM EAST-CENTRAL ALASKA[1]

By

REUBEN JAMES ROSS, JR. and J. THOMAS DUTRO, JR.

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ABSTRACT

Silicified brachiopods from the Tatonduk River area, central eastern Alaska along the Canadian border, are possibly of late Middle or early Late Ordovician age. The assemblage closely resembles one described by Schuchert and Cooper (1930) and Cooper and Kindle (1936) from Percé, Quebec, Canada. Many elements are also present in the classical Caradoc section of Girvan, Scotland.

Species of *Dicoelosia, Ptychopleurella, Cyclospira, Ptychoglyptus, Diambonia,* and *Christiania* are very like those from Quebec. Except for *Dicoelosia,* which has not been reported previously below the Ashgill in Europe, all the above genera plus *Catazyga* and the species *Anoptambonites* cf. *A. grayae* and *Xenambonites* cf. *X. revelatus* suggest correlation with rocks of Caradoc age at Girvan.

The collection is from a thin-bedded shelly limestone unit in the sequence of Paleozoic strata on the north end of Jones Ridge, Charley River (A-1) quadrangle. The locality has special significance because essentially correlative Ordovician strata exposed along the Tatonduk River 7 miles to the southwest are black graptolitic shales.

INTRODUCTION

A small collection of silicified Ordovician brachiopods from central eastern Alaska calls attention to a promising area of paleontologic investigation along the Alaskan-Canadian boundary. Although too small in number of specimens to be the basis for definitive conclusions,

[1] Publication authorized by the Director, U.S. Geological Survey.

the collection has paleogeographic significance and raises important questions concerning intercontinental correlations.

During the summer of 1962, R. J. Ross, Jr., and L. R. Mayo collected Cambrian, Ordovician, and Devonian fossils from the north end of Jones Ridge along the valley of Hard Luck Creek, Alaska. This work was done in support of a mapping program conducted by Earl E. Brabb of the U.S. Geological Survey in the Charley River quadrangle. The general area is north of the Tatonduk River, a tributary of the Yukon, in sec. 9, 15, 16, T. 3 N., R. 33 E., Charley River (A-1) quadrangle (fig. 1). This area was originally mapped

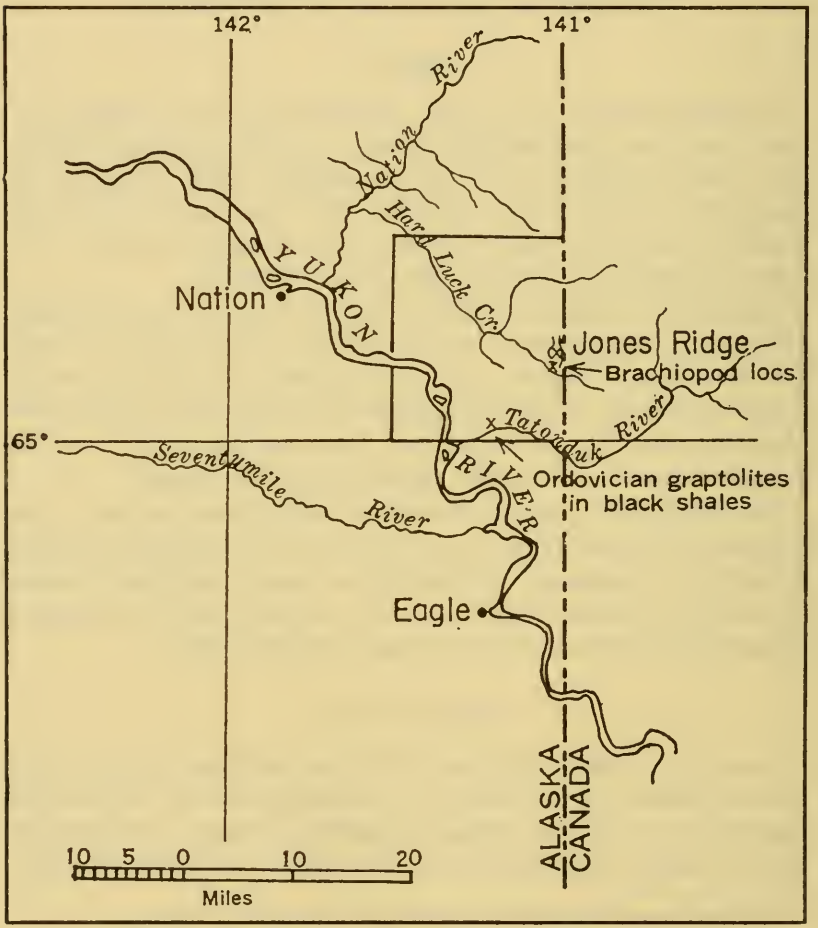

FIG. 1.—Index map, showing relative positions of brachiopod-bearing carbonate rocks and graptolite-rich shales of Ordovician age. Charley River (A-1) quadrangle outlined.

by J. B. Mertie, Jr. (1932, pp. 401-415), who collected fossils from about the same places.

The brachiopods here described are included in USGS collection D1072-CO: altitude approximately 2,000 feet, located 2,000 feet east and 2,000 feet north of SW cor., sec. 9, T. 3 N., R. 33 E., Charley River (A-1) quadrangle, Alaska; from a thin cherty bed approximately 250 feet above the base of Ordovician limestone, south end of Jones Ridge.

Paleozoic strata in Jones Ridge are nearly vertical, dipping southeastward. Thin- to thick-bedded limestones along Hard Luck Creek range in age from Cambrian on the northwest to Devonian on the southeast. Overlying the limestones are highly contorted Devonian black argillites and cherts which form much of the valley between Jones Ridge on the north and Squaw Mountain 3 miles to the south. Structural complications in this broad area remain to be worked out as a part of Brabb's mapping program.

The Jones Ridge locality is significant because essentially correlative Ordovician strata along the Tatonduk River, 7 miles to the southwest (sec. 10, T. 2 N., R. 32 E.), are black graptolitic shales, an entirely different facies. The Tatonduk River region seems to straddle the boundary between miogeosynclinal and eugeosynclinal deposition during the early Paleozoic (Ross, 1961, p. 335).

This collection of Ordovician silicified brachiopods and corals closely resembles an assemblage from Percé at the eastern end of the Gaspé Peninsula in eastern Canada (Schuchert and Cooper, 1930; Cooper and Kindle, 1936). The assemblage also includes genera and species found previously in the Caradoc of the Girvan District of Scotland (Williams, 1962). Strangely, the nearby Ordovician rocks of Anticosti Island in the Gulf of St. Lawrence, supposedly of the same age, have little in common with those from Percé.

The fossil assemblage is limited because of logistic problems involved in getting large samples out of the area by helicopter. Several species are represented only by immature specimens and others by single specimens. At least 9 species cannot be identified because of inadequate material and 6 of these cannot be assigned to genera with certainty.

CORRELATION

Correlation of this small assemblage is difficult and must be considered preliminary. It shares a problem common to the Ordovician in many parts of western North America. The assemblage includes, from a limited stratigraphic interval, genera and species which are

commonly considered guides to either the Late Ordovician or the Middle Ordovician, but not both, as well as other species known to be common to both. Dating such a mixture of species becomes a highly subjective matter because different criteria are invoked by different paleontologists in interpreting the mixture.

The association of *Ptychopleurella, Dicoelosia, Diambonia, Ptychoglyptus, Christiania,* and *Cyclospira* suggests close equivalence with the fauna from Percé, Quebec, summarized and dated by Charles Schuchert and described by G. A. Cooper (Schuchert and Cooper, 1930). Revisions and additions to the descriptions were made later by Cooper and Kindle (1936). A review of the original paper by Schuchert and Cooper shows that the Late Ordovician age was based primarily on the occurrence of *Dicoelosia.*

With the exception of that genus, all the other Percé forms, plus *Xenambonites* and *Anoptambonites,* are reported from the Caradoc of Girvan, Scotland, by Williams (1962). It is Williams' conclusion (pp. 57-62) that the Girvan Caradoc can be closely correlated with the Middle Ordovician of eastern North America, equal to the Porterfield, Wilderness, and Trenton Stages of Cooper (1956).

Within the Alaskan assemblage, the following correlations are suggested by genus or species:

Richmond or younger	—*Dicoelosia*
Cincinnatian or Trenton	—*Catazyga*
	Leptaenid (Undet. genus B)
Trenton or upper Wilderness	—*Anoptambonites* cf. *A. grayae*
Wilderness or Porterfield	—*Ptychopleurella* cf. *P. lapworthi*
	Diambonia cf. *D. anatoli*
	Xenambonites cf. *X. revelatus*

Cyclospira and *Christiania* are typical Middle Ordovician genera, which range, however, into the Late Ordovician. The Late Ordovician occurrence of *Ptychoglyptus* may be questioned, but it is well known in Middle Ordovician strata. Although the age of this fauna is open to review, it is clearly either late Middle or Late Ordovician.

The total aspect of the assemblage is undeniably Caradocian. Perhaps future collections will provide evidence either to extend the ranges of additional Middle Ordovician forms into the Upper Ordovician or to document the occurrence of *Dicoelosia* in older beds. *Dicoelosia* may join *Austinella* and *Catazyga* as genera now known to have their beginnings in the Middle Ordovician.

The only coral in the collection was identified by W. A. Oliver, Jr.

(oral communication, 1963) as an immature *Grewingkia*. In the opinion of Ross it indicates a late Middle or Late Ordovician age.

TAXONOMIC DESCRIPTIONS

Superfamily ORTHACEA Walcott and Schuchert, 1908

Genus PTYCHOPLEURELLA Schuchert and Cooper, 1931

Ptychopleurella cf. *P. lapworthi* (Davidson)

Plate 1, figures 2, 4, 6, 8

Orthis lapworthi Davidson. Davidson, 1883, Monograph British fossil Brachiopoda, vol. 5, pt. 2, Silurian Supplement, p. 176, pl. 13, figs. 9, 10, Paleontographical Society (London).

Glyptorthis sublamellosa Cooper. Schuchert and Cooper, 1930, Am. Jour. Sci., ser. 5, vol. 20, pp. 265-268, pl. 1, figs. 21-22.

Description.—Shell biconvex, subrectangular, slightly wider than long; greatest width just anterior of hinge line; anterior commissure gently sulcate; costate with about 12-14 costae on each valve, strong concentric growth lines provide lamellose appearance. Pedicle valve evenly convex with low median fold bearing one strong costa, two lateral costae are intercalated about one-third distance from pedicle beak to anterior margin; lateral slopes with 4-6 costae; low apsaclinal area has small open delthyrium; dental plates reduced. Brachial valve with rather shallow median sulcus bearing two costae; cardinalia typical for genus with rather short, slightly curved brachiophores and thin cardinal process.

Discussion.—The Alaskan specimens agree closely with those illustrated by Davidson. They are also to a considerable degree like *Ptychopleurella sublamellosa* (Cooper) from the Gaspé. The latter species is slightly smaller and may have a deeper sulcus in the brachial valve. However, size of costae and spacing of lamellae is highly variable within our small sample and we consider *P. sublamellosa* a possible synonym of *P. lapworthi*. Although it is difficult to establish the range of variation within this group of shells because of the small number of specimens—there are only eight specimens in the Alaskan collection—there is enough variation to include not only the Gaspé form but also *P. uniplicata* (Cooper) from the Porterfield. All these specimens could represent a single species. More detailed studies of variation, especially of the Virginia specimens, are needed before this can be demonstrated.

Figured specimens.—USNM 145324, 145325, 145326.

Superfamily DALMANELLACEA Schuchert and LeVene, 1929

Genus DICOELOSIA King, 1850

Dicoelosia jonesridgensis Ross and Dutro n. sp.

Plate 3, figures 1-5

Description.—Shell concavo-convex, deeply emarginate giving exterior the general shape of a maple seed (double samara); length approximately equal to width which is greatest near antero-lateral tips of the extended wings; hingeline short, about half width of shell; area triangular and apsaclinal; valves weakly costellate, about 3 costellae in 0.5 mm, with a single rib more prominent on each wing; commissure crenulated along sides of shell as well as in anterior emargination. Pedicle valve strongly convex, sulcate, crudely pentagonal in outline; delthyrium open, apparently unmodified. Brachial valve deeply concave; anterior crenulation separated from visceral cavity by flanges; cardinal process arises from floor of simple notothyrial cavity and has small expanded knob-like myophore; brachiophores are slender rods lying along edges of visceral cavity and are seemingly attached to shell for most of length with only the tips free.

Discussion.—This species is represented by eight silicified specimens, one of which shows the cardinalia quite well. *Dicoelosia indentus* (Cooper) from the Gaspé is the only other known Ordovician species in North America. The ornamentation of *D. indentus* is coarser than that of the Alaskan form. *D. alticavatus* (Whittard and Barker) as an emarginate anterior like the Alaskan species, but the indentation is far narrower. In addition, the sides of the Silurian shell are more nearly parallel and it is not as strongly concavo-convex in lateral profile. *D. jonesridgensis* is more deeply emarginate than either the Silurian species *D. biloba* (Linné) and *D. oklahomensis* Amsden or the Devonian *D. varica* (Conrad). Illustrations in Hall and Clark (1892, pl. 10, fig. 18) show the brachiophores as flat blades in the last species, dissimilar to those of *D. jonesridgensis*. However, the cardinalia seem almost identical to those of *D. oklahomensis* as illustrated by Amsden (1951, pl. 15, fig. 6). Brachiophores of *Dicoelosia lata* Wright from the Portrane limestone of Ireland (Wright, 1964, p. 226, pl. 9, figs. 9, 17) are wider and shorter than those in the Alaskan species; anterior emargination of the Irish species is less pronounced.

Holotype.—USNM 145347.

Figured paratype.—USNM 145348.

Superfamily SYNTROPHIACEA Schuchert and Cooper, 1931

Genus CAMERELLA Billings, 1859

Camerella? sp.

Plate 1, figures 11-14, 16

Description.—Unequally biconvex with pedicle valve rostrate and brachial valve less convex; outline suboval with beak angle about 80°; surface nearly smooth with about 6 broad costae developed in anterior half of shell; faint, shallow median sulcus in brachial valve. Pedicle interior with small spondylium; because of silicified secondary material, presence or absence of supporting septum not ascertainable. No brachial interiors obtained.

Discussion.—The two specimens in our collection have had much of the original surface of the shells removed in some unknown manner. The anterior commissure is distinctly toothed, indicating 6 costae on the brachial valve, all in the median half of the shell. The faint sulcus in the brachial valve is a feature suggesting pentamerid rather than camerellid relationships. Until more and better preserved specimens can be obtained, the correct taxonomic position of this species must be considered indefinite.

Figured specimens.—USNM 145332, 145333.

Superfamily RHYNCHONELLACEA Schuchert, 1896

Genus RHYNCHOTREMA Hall, 1860

Rhynchotrema? sp.

Plate 1, figures 1, 3, 5

Description.—Rhynchonelliform, strongly biconvex, subpentagonal in outline; anterior commissure uniplicate; brachial valve with 10 strong angular costae, 4 low costae of equal height on fold and three on each flank; pedicle sulcus with 3 costae; imbricate ornamentation suggested, although most of exterior has been removed during silicification process. Pedicle interior with strong dental plates, indicated by molds in interior filling. Brachial interior with strong median septum, divided hinge plate; no cardinal process seen, although absence may be due to poor preservation.

Discussion.—Unfortunately, the presence or absence of a cardinal process cannot be demonstrated. Although its apparent absence would suggest assigning this shell to *Rostricellula,* the ornamentation and lack of supporting plates argue more strongly for tentative assignment

to *Rhynchotrema.* More material than the single specimen available is needed, especially well-preserved brachial interiors, before proper identification can be made.

Figured specimen.—USNM 145323.

Superfamily SPIRIFERACEA Waagen, 1883

Genus CYCLOSPIRA Hall and Clarke, 1893

Cyclospira cf. *C. glansfagea* Cooper and Kindle

Plate 2, figures 2, 4, 6

Cyclospira glansfagea Cooper and Kindle. Cooper and Kindle, 1936, Jour. Paleontology, vol. 10, No. 5, p. 359, pl. 52, figs. 1, 4, 7.

Description.—Shell biconvex, subpentagonal in outline; brachial valve with single median costa constituting low fold; narrow sulcus bounded by two low costae on pedicle valve; no other ornamentation. Portion of spire shown in one broken specimen with spire extending well over halfway to anterior margin.

Discussion.—All of the specimens at hand are very small as compared with both *C. bisulcata* (Emmons) and *C. glansfagea.* In shape of profile and depth of sulcus they compare favorably with the latter and may represent immature specimens of that species. Larger collections than the present very limited ones will be necessary to indicate their true nature.

Figured specimens.—USNM 145337, 145338.

Cyclospira? sp.

Plate 2, figures 8, 11, 13

Discussion.—A small, smooth biconvex specimen is perhaps assignable to this genus. It has the shape characteristics of an immature individual. Although it is about the same size as the specimens referred to *C.* cf. *C. glansfagea,* it does not show the characteristic pentagonal shape or sulcus in the pedicle valve. If more material were available, this might prove to be a distinct species of *Cyclospira.*

Figured specimen.—USNM 145339.

Genus CATAZYGA Hall and Clarke, 1893

Catazyga homeospiroides Ross and Dutro n. sp.

Plate 1, figures 7, 9, 10, 15, 17-20

Description.—Shell equally biconvex, longer than wide, subovate in outline; costellate ornamentation, with 6 costellae in space of 5 mm

at anterior margin of specimen that is 13 mm long; shell impunctate. Pedicle valve apparently with open delthyrium; remnants of small deltidial plates in a few specimens; small hinge teeth unsupported by dental plates; umbo extended, not incurved. Brachial valve with faint sulcus; interior with divided hinge plate; no evidence of cardinal process; strong median septum extends three-quarters the length of valve; spire with descending lamella in plane of commissure.

Measurements in mm:

	Length	Width	Thickness
USNM 145331	12	11	4
USNM 145329	9	10	3+ (broken)
USNM 145327 (holotype)	13	12	8.5
USNM 145330	10	9	—
USNM 145328	6	3.5	2

Discussion.—This species is similar to *C. cartieri* Cooper and Kindle in the spacing of radial ornamentation but has only about half as many costellae. The outline of *C. cartieri* is more nearly circular and its pedicle umbo is smaller. *C. homeospiroides* possesses a faint sulcus on the brachial valve, not on the pedicle valve as in *C. cartieri.*

This species is similar to *C. arcana* Williams from Girvan in size and general shape. However, the brachial valve is not as broadly or deeply sulcate and costellation is a little coarser; in *C. arcana* there are about 8 costellae in 5 mm at a distance of 13 mm from the pedicle umbo. In addition, the pedicle valve of the Scottish species is more convex than the brachial, whereas the Alaskan shells are equally biconvex. *Catazyga headi* is more finely ribbed and more rotund, with a widely V-shaped brachial sulcus.

Williams (1962, p. 247) states that adult shells tend to be longer relative to width than juveniles in *C. arcana,* but the opposite seems to be true in the present form, as shown in plate 1, figure 15.

Although the ribbing is coarser than is customary in *Catazyga,* and the brachial valve lacks a pronounced sulcus, this species is placed in that genus. Future investigation may show that several impunctate species now classified within *Homeospira* should be grouped with *Catazyga homeospiroides* as a distinct genus.

Approximately ten silicified specimens and two calcareous specimens of *C. homeospiroides* are the basis for the above description.

Holotype.—USNM 145327.

Figured paratypes.—USNM 145328, 145329, 145330, 145331.

Genus WHITFIELDELLA Hall and Clarke, 1893

Whitfieldella? sp.

Plate 2, figures 14, 17, 19

Plate 3, figures 6-10, 14, 17, 20

Discussion.—A large broken specimen and possibly a dozen clearly immature ones may be referable to *Whitfieldella.* All are characterized by a smooth exterior, oval outline, and biconvex profile. The single large specimen is a broken brachial valve in which there is a very strong median septum originating beneath a divided hinge plate with stout crural bases. There is no cardinal process. What appears to be a subcircular visceral area is actually related to growth of the shell as shown by comparison with the exterior of the valve. More than one species, perhaps more than one genus, is represented by the small specimens. Some are elongate oval while others are almost pentagonal and as wide as long. Some may be young individuals of the species here referred to as *Camerella?.*

Additional complete mature valves are needed to determine the correct taxonomic position of these specimens.

Figured specimens.—USNM 145343, 145349, 145350, 145351.

Superfamily PLECTAMBONITACEA Cooper and Williams, 1952

Genus ANOPTAMBONITES Williams, 1962

In the collections from Hard Luck Creek are several specimens that are obviously closely related to *Leptella? grayae,* a species originally illustrated by Davidson (1883, p. 171) partly under two names, *Leptaena grayae* and *Leptaena llandeiloensis.* As pointed out by Reed (1917, pp. 873-874) Davidson included the interior of *L. grayae* (1883, pl. 12, figs. 27a, b) as *L. llandeiloensis.* Jones (1928, p. 489) showed that one of the specimens illustrated by Reed (1917, pl. 13, fig. 14) should be excluded from *L. grayae.*

Jones included *L. grayae* in his genus *Leptelloidea* (1928, pp. 385-389, 399-400) although it differs from all other species in the genus in lack of convexity and "undifferentiated surface ornamentation."

Öpik (1930, pp. 132-133; 1933, pp. 30-32) revised the genus *Leptelloidea* using the characters of the diaphragm in the brachial valve as the most important features. This resulted in a somewhat different grouping of species than that proposed by Jones. Öpik tended to agree with Reed that *L. grayae* probably belonged in *Leptella* Hall and Clarke, although at the time that genus was too imperfectly known for anyone to be sure how it should be classified relative to *Leptelloidea.*

Ulrich and Cooper (1938, pp. 187-191) erected the genus *Leptellina* and presented the first modern description of *Leptella,* with illustrations of *Leptella sordida* (Billings), the type species of *Leptella.* These illustrations show what seem to be two lobes of a bilobed cardinal process in one specimen. Ulrich and Cooper (1938, pl. 39H, figs. 29, 32, p. 188) interpret these to be chilidial plates. They make no comment on the assignments of any European species to *Leptella* other than to question their correctness.

In 1957 Spjeldnaes reclassified many strophomenid genera emphasizing the importance of the pallial markings. Unfortunately, the vascular arrangements of most North American genera and species are undescribed, unillustrated, or unknown. Spjeldnaes's efforts are commendable but have thrown many of our traditional concepts into disarray. His criteria cannot be applied without considerable revision. In this reclassification Spjeldnaes (1957, p. 66) did nothing with *Leptella,* but he placed *Leptellina* in synonymy with *Sampo* Öpik (1957, p. 67-72). However, *Sampo* possesses a denticulate hinge line by original definition (Öpik, 1933, pp. 35-36, pl. 6, fig. 4).

Spjeldnaes (1957, p. 70) also assigned the species *S. indentata* to *Sampo,* noting that it lacked a denticulate hinge and implying that this important feature is of no consequence (1957, pp. 20-22). We do not have the necessary material at hand to effect the revision of American and European forms that Spjeldnaes' work indicates may be needed.

Externally these Alaskan shells cannot be classified with *Leptellina, Sampo, Leptelloidea,* or *Leptella* because the costellation is of more uniform size and even spacing. They lack the prominent cardinal process of *Leptelloidea* and *Sampo* Öpik (not Spjeldnaes). They possess a rectangular platform in the notothyrium much like that in *Leptella sordida,* with only a faint median groove in the posterior surface of the platform. A chilidium covers the greater part of this platform. The brachiophores are similar to those of *Leptellina,* not to those of *Leptella.* The median septum and circumvisceral flange (brachial lamellae of Öpik) are high, narrow, and nearly perpendicular to the plane of the brachial valve, lacking the ragged lamellose appearance found in the other genera above.

The genus *Anoptambonites* was described by Williams (1962) covering this very interesting group of shells, and the Alaskan specimens fit his descriptions closely. The present occurrence is the first record of the genus in North America.

Roomusoks (1963, pp. 233-235, pl. 1, figs. 1-4) has included in

this genus the species *A. pirguensis,* which lacks the exaggerated elevation of the border of the brachial diaphragm (or lophophore platform) and possesses a somewhat different aspect of the median septum at its confluence with the cardinal process as compared with the type species, *A. grayae* (Davidson). He has also included *Rafinesquina carinata* Holtedahl (1916, p. 25, pl. 2, figs. 4-5), the interior of which has never been described or illustrated. Williams (written communication, Jan. 13, 1964) has accepted the generic assignment of *A. pirguensis,* which we question here, but he joins in questioning that of *R. carinata.*

Anoptambonites cf. *A. grayae* (Davidson)

Plate 2, figures 1, 3, 5, 7, 9

Leptaena grayae Davidson. Davidson, 1883, Mon. Brit. Fossil Brachiopoda, vol. 5, pt. 2, Silurian Supplement, p. 171, pl. 12, figs. 23-25.

Leptaena llandeiloensis Davidson. Davidson, 1883, Mon. Brit. Fossil Brachiopoda, vol. 5, pt. 2, Silurian Supplement, pp. 171-172, pl. 12, fig. 27.

Leptella grayae (Davidson). Reed, 1917, Trans. Roy. Soc. Edinburgh, vol. 51, pt. 4, No. 26, p. 873, pl. 13, figs. 10-13, 15-17.

Leptelloidea grayae (Davidson). Jones, 1928, Mem. Geol. Survey Great Britain, Paleontology, vol. 1, pt. 5, pp. 489-490.

Anoptambonites grayae (Davidson). Williams, A., 1962, Geol. Soc. London Mem. No. 3, p. 171, p. 16, figs. 11, 12, 13, 14, 17.

Description.—Valves very gently concavo-convex with finely costellate exteriors; costellae increase by implantation and are of a uniform size; interspaces are narrower than costellae, which number 10 in 5 mm at the front edge of a shell 13 mm long; greatest concavity of the brachial valve is along the midline, producing a sulcate appearance; the posterolateral flanks are flat or very slightly convex; pedicle valve obtusely carinate along the midline and gently convex on the flanks. Pedicle interior with small muscle field as in *Leptellina;* delthyrial cavity with tiny plate close to the apex; pallial trunks originate near the front of each diductor muscle scar, one pair runs forward parallel to the midline of the valve, bifurcating in about 2 mm, the other runs anterolaterally for about the same distance before bifurcation. Brachial interior with strong median septum terminating against the strongly developed, nearly vertical edge of the visceral disk; cardinal process, located on a raised quadrate platform between the brachiophores, consists of a pair of exceedingly small linear ridges, chilidial plate covers posterior end; brachiophores slender rods as in typical *Leptellina;* pallial markings strongly incised; two pairs

of prominent vascular trunks originate close to the brachiophores; one pair runs close on either side of the median septum, crosses the circumvisceral ridge, and branches dichotomously twice; the other main pair nearly bisects the visceral area and crosses the boundary ridge before branching. Interior surfaces of both valves covered with fine papillae, probably representing inner ends of pseudopunctae.

Discussion.—Additional collections from the area of Hard Luck Creek will undoubtedly produce more specimens of this species. Until we have a larger sample on which to base a new species it seems best to refer these forms tentatively to *Anoptambonites grayae* (Davidson).

Figured specimens.—USNM 145334, 145335, 145336.

Genus DIAMBONIA Cooper and Kindle, 1936

This genus is probably represented in the Alaskan collection by three species. No brachial interiors have been found so that these specimens cannot be distinguished from *Bilobia*. However, associations in the Percé fauna suggest that *Diambonia* is more likely to be present and all three species are assigned tentatively until brachial valves are found.

The three species differ markedly in shell ornamentation. Two specimens possess a single radial costella (*Diambonia* sp. 2); 5 specimens have 5 radial costellae spaced about 1 mm apart (*D.* cf. *D. anatoli*), and one specimen has 3 radial costellae spaced over 2 mm apart (*D.* sp. 1). Although all three may be variants of a single species, the total sample studied is too small to permit a reasonable appraisal of variability until more extensive collecting has been done. Among these specimens a tendency for the smaller ones to possess a larger median septum than the large specimens suggests that septa in the larger specimens may have been resorbed.

Although *Diambonia* is typically a Middle Ordovician genus, *D. discuneata* (Lamont) is reported from Lower Ashgill rocks (Lamont, 1935, p. 316), and *D. septata* (Cooper) is reported from Percé from strata reputedly of Late Ordovician age.

Diambonia cf. *D. anatoli* Spjeldnaes

Plate 2, figures 10, 12

Diambonia anatoli Spjeldnaes. Spjeldnaes, 1957, vol. 37, No. 1, p. 80, pl. 2, figs. 6-8, text fig. 11R.

Description.—Pedicle valve strongly convex, wider than long with acute cardinal extremities; ornamented with 5 costellae which, at a

distance of 3 mm from the beak, are approximately 1 mm apart; cardinal angle varies from 55° to 60°; faint and narrow median sulcus barely discernible and occupied by the median costella. Pedicle interior with median septum shaped like a strong rod resting upon a thin blade; there is a suggestion that the supporting blade is subject to resorption. No brachial valves obtained.

Measurements in mm:

	Length	Hinge width	Thickness	Cardinal angle
USNM 145340	4	7.5	2.4	±55°
USNM 145340a	4.2	6.4	2.4	60°
USNM 145340b	4	7	—	—
USNM 145340c	4	7	2.4	+55°
USNM 145340d	3	4	1.6	50°

Discussion.—This species closely resembles *D. anatoli* Spjeldnaes in size and proportions. Although ornamentation of the Scandinavian species is not illustrated, Spjeldnaes (1957, pp. 80-81, pl. 2, figs. 6-8, text fig. 11R) states that it possesses 5-7 radial costellae. It is not clear whether the number is related to the size of the specimen. If there is no relation it may be impossible to distinguish specimens of *D. anatoli* with 5 costellae from the Alaskan specimens described here. *D. anatoli* is found in Stage 4b alpha of the Norwegian sequence, correlative with the Middle Ordovician Porterfield or Wilderness Stages of North America (Berry, 1960, table 1) and with the lower Caradoc of Great Britain (Dean, 1960, pp. 83-87).

The Alaskan specimens compare closely in size with *Diambonia gibbosa* (Winchell and Schuchert) (Cooper and Kindle, 1936, pl. 51, figs. 9, 10). However, the Minnesota species is more nasute in anterior outline, has strong ridges defining the pedicle muscle area, and possesses 6-7 radial costellae (Winchell and Schuchert, 1895, pp. 416-417, pl. 32, figs. 13-17).

Diambonia septata (Cooper) (Schuchert and Cooper, 1930, pl. 1, figs. 9-13) is a relatively longer species, although it also has 5 similarly spaced radial costellae. *D. discuneata* (Lamont) is a larger and wider species than the Alaskan form, with main costellae spaced 0.5 mm apart. A form identified by Williams (1962, p. 173, pl. 16, figs. 25-28) as *D.* cf. *D. discuneata* from the upper Caradocian has costellae about 1.0 mm apart at a distance of 3 mm from the beak. Its proportions seem closer to those of *D. septata* than to those of Lamont's description of *D. discuneata.*

Figured specimen.—USNM 145340.

Diambonia sp. 1

Plate 2, figures 15, 16

Description.—A single damaged pedicle valve has an outline more transverse than that of other two species, being less than half as long as wide; specimen about 15 mm wide and 6.5 mm long; cardinal angle approximately 50°; convexity of pedicle valve moderate; surface ornamented with 3 radial costellae which, at a distance of 3 mm from the beak, are spaced about 2 mm apart. Pedicle interior with median septum smaller than in other species.

Discussion.—This specimen probably represents a species distinct from the other two described here. The spacing of the radial costellae is wider than in any previously described species. Only *D. discuneata* (Lamont), among described species, has as wide an outline. The convexity of the valve in lateral profile is remarkably low for the genus.

Figured specimen.—USNM 145341.

Diambonia sp. 2

Plate 2, figures 18, 20

Description.—Shell strongly concavo-convex; cardinal angles acute, forming an angle with the hinge line of a little over 60°. Brachial valve bearing a very low, narrow fold, about 0.5 mm wide at anterior margin. Pedicle valve possessing a correspondingly narrow sulcus, in which a single costella is faintly developed; otherwise surface is smooth.

Measurements in mm:

	Hinge width	Length pedicle	Length brachial	Cardinal angle
USNM 145342	6.2	3.3	2.8	60°
USNM 145342a	5.6	3.8	—	65°

Discussion.—These are the only known specimens of *Diambonia* with a surface almost completely devoid of ornamentation. Although they may prove to be variants of one of the other species, they are here conservatively separated until larger collections can be secured and studied. One specimen of *D. anatoli* as described by Williams (1962, pl. 16, fig. 24) resembles these Alaskan specimens to a remarkable degree.

Figured specimen.—USNM 145342.

Genus XENAMBONITES Cooper, 1956

Xenambonites cf. *X. revelatus* Williams

Plate 2, figures 21-26

Xenambonites revelatus Williams. Williams, 1962, Geol. Soc. London Mem. No. 3, p. 191, pl. 18, figs. 21-23, 25.

Description.—Shell small, concavo-convex, wider than long, wide-hinged with acute cardinal extremities; anterior margin apparently intraplicate in young stages; valves finely costellate with concentric wrinkles; sharp geniculation near anterior. Pedical valve with fold that has median sulcus in early growth stages; pedicle interior not observed. Brachial valve with shallow sulcus, divided by narrow median fold in posterior part, poorly defined anteriorly; pair of elongate pits occupies sulcus near hinge line; interior with tentlike structure described by Cooper (1956, p. 814), apparently formed by fusing of brachiophores and cardinal process; pallial trunks originate beneath notothyrial structure and run nearly straight forward beneath the margins of sulcus. Largest shell about 9 mm wide (estimated) and 3.7 mm long; geniculation crosses midline at about 3.2 mm.

Discussion.—This species is tentatively assigned because only three specimens are available. The complete young shell is supplemented by two broken brachial valves, no separate pedicle valve having been recovered. There is little question of the generic assignment, however.

The Alaskan shells lack the relatively coarse radial costellation of *X. undosus* Cooper, but they possess a much finer radial ornamentation interrupted by irregularly spaced concentric wrinkles. Such wrinkles are not present in *X. revelatus* Williams which has a brachial sulcus divided similarly by a narrow median fold. Two elongate pits are located close to the hinge line in the sulcus in both the Scottish and Alaskan specimens. The manner of anterolateral geniculation is also similar. Where geniculation crosses the midline in *X. revelatus* it produces a narrowly angular pinching of the shell (Williams, 1962, pl. 18, figs. 21, 22). In the largest Alaskan specimen, the geniculation crosses the middle of the shell in a wider curve, but apparently the individual is immature; a more angular form and greater sinuosity probably would be produced by further growth.

Figured specimens.—USNM 145344, 145345, 145346.

Genus PTYCHOGLYPTUS Willard, 1928

Ptychoglyptus? cf. *P? pauciradiatus* Reed

Plate 3, figures 18, 19

Ptychoglyptus pauciradiatus Reed. Reed, F. R. C., 1932, Skrift Norske Videnskap-Akad. Oslo I. Mat.-Nat. Klasse, No. 4, pp. 122-123, pl. 18, figs. 1, 2.

Description.—Shell thin, concavo-convex, roughly semicircular, wider than long with greatest width at hinge line; surface with seven primary costellae between which are many finer capillae; regular concentric wrinkles interrupt the capillae but do not cross the primary costellae; wrinkles are uniform except in the sectors on the ears. No internal structures available for study.

Discussion.—A single well-preserved complete specimen is tentatively referred to this species. The Alaskan specimen possesses 7 principal costellae, rather than the 5 of *P. bellarugosus* Cooper from the Gaspé. At a distance of 5 mm from the umbo there are about 20 secondary capillae between the larger costellae. Concentric wrinkles are closely spaced, simple, and aligned transversely from one sector to the next, a characteristic which distinguishes the specimen from many species of the genus as well as from *P. bellarugosus.*

Although one can hardly discuss a species on the basis of a single specimen, it can be noted that this shell resembles *P. virginiensis* in number of primary costellae but that concentric wrinkles are far more regularly and closely spaced. *P. ambiguus* Reed possesses twice as many large radial costellae. In *P. ulrichi* Endo many of the radial costellae are intercalated and closely spaced and concentric wrinkles are very irregular. Costellae are also more closely spaced in *P. shanensis* Reed, in which transverse wrinkles are chevron-shaped within each sector. Larger costellae of *P. valdari* Spjeldnaes are far more numerous than in the Alaskan specimen and the concentric wrinkles are irregularly spaced from one sector to the next.

The specimen from Alaska is very similar to *P. pauciradiatus* Reed both in radial and concentric ornamentation. Reed's species is from the Upper Ordovician Hovin Sandstone of the Trondheim area, Norway. On the other hand, the Alaskan specimen is also similar in ornamentation to an immature (?) shell of comparable size from low in the Caradoc, referred by Williams (1962, p. 160, pl. 14, fig. 34) to *Glyptambonites* aff. *G. glyptus* Cooper.

Figured specimen.—USNM 145354.

Genus undetermined A

Plate 3, figures 13, 15, 16

Discussion.—An interesting small, very wide shell is unique in the collection from Hard Luck Creek. In outline and configuration of anterior commissure it resembles the small shells that can be identified as *Xenambonites* (pl. 2, figs. 21, 23, 25). However, it is much wider at the hingeline and is costellate, unlike the *Xenambonites* species described. Its affinities must remain uncertain until adult shells with this ornamentation are secured.

Figured specimen.—USNM 145353.

Superfamily STROPHOMENACEA Schuchert, 1896

Genus CHRISTIANIA Hall and Clarke, 1892

Christiania sp.

Plate 3, figure 21

Discussion.—A single broken brachial valve assignable to *Christiania* is present in the silicified material from Hard Luck Creek. The exterior is encrusted with siliceous foreign material, but the interior shows two pairs of strong bladelike, divergent plates characteristic of the genus.

Figured specimen.—USNM 145355.

Genus undetermined B

Plate 3, figures 11, 12

Discussion.—A single fragment of a brachial valve exhibits the hinge line, general shape, and brachial apparatus of a leptaenid. Although no other specimens are available, this fragment is illustrated to indicate a potentially important element of the brachiopod assemblage. It is hoped that more specimens will be present in the future collections from eastern Alaska.

Figured specimen.—USNM 145352.

LITERATURE CITED

Amsden, T. W.
1951. Brachiopods of the Henryhouse formation (Silurian) of Oklahoma. Jour. Paleontol., vol. 25, pp. 69-96, pls. 15-20.

Berry, W. B. N.
1960. Correlation of Ordovician graptolite-bearing sequences. XXI Internat. Geol. Cong., Norden 1960, rept., pt. 7, Ordovician and Silurian Stratigraphy and Correlation, pp. 97-108.

Cooper, G. A.
1956. Chazyan and related brachiopods. Smithsonian Misc. Coll., vol. 127, pts. 1 and 2, 1024 pp., 269 pls.

Cooper, G. A., and Kindle, C. H.
1936. New brachiopods and trilobites from the Upper Ordovician of Percé, Quebec. Jour. Paleontol., vol. 10, no. 5, pp. 348-372, pls. 51-53.

Davidson, T.
1883. Monograph of British fossil brachiopoda, vol. 5, pt. 2, Silurian Supplement, pp. 135-242, pls. 8-17. Palaeontographical Society (London). Also published as the fourth article in vol. 37, Palaeontographical Society.

Dean, W. T.
1960. The use of shelly faunas in a comparison of the Caradoc series in England, Wales, and parts of Scandinavia. XXI Internat. Geol. Cong., Norden 1960, rept., pt. 7, Ordovician and Silurian Stratigraphy and Correlation, pp. 82-87.

Hall, J., and Clarke, J. M.
1892. An introduction to the study of the genera of Paleozoic Brachiopoda. New York Geol. Survey, vol. 8, pt. 1, 367 pp., pls. 1-20.

Holtedahl, O.
1916. The Strophomenidae of the Kristiania Region. Videnskap. Kristiania Skrifter for 1915, Mat.-Naturv. Klasse, no. 12, pp. 1-117, pls. 1-16.

Jones, O. T.
1928. Plectambonites and some allied genera. Great Britain Geol. Survey Mem., Paleontology, vol. 1, pt. 5, pp. 367-527, pls. 21-25.

Lamont, A.
1935. The Drummuck Group, Girvan; a stratigraphical revision, with descriptions of new fossils from the lower part of the group. Geol. Soc. Glasgow Trans., vol. 19, pt. 2, pp. 288-330, pls. 7-9.

Mertie, J. B., Jr.
1932. The Tatonduk-Nation district, Alaska. U.S. Geol. Survey Bull. 836, pp. 347-443.

Öpik, A.
1930. Brachiopoda Protremata der estlandischen ordovizichen Kukruske-Stufe. Univ. Tartu, Acta et Commentationes, A, vol. 17, 261 pp., 22 pls.

1933. Uber Plectamboniten. Univ. Tartu, Acta et Commentationes, A, vol. 24, No. 7, pp. 1-79, 12 pls.

Reed, F. R. C.
1917. The Ordovician and Silurian brachiopoda of the Girvan district. Royal Soc. Edinburgh Trans., vol. 51, pt. 4, no. 26, pp. 795-998, pls. 1-24.
1932. Report on the brachiopods from the Trondheim area [Norway]. Skrift. Norske Vidensk-Akad. Oslo. I. Mat.-Nat. Klasse, no. 4, pp. 115-146, pls. 18-22.

Roomusoks, A.
1963. Ordovician and Silurian Strophomenidae from Estonia-II. New genera and species from the Harju Series. Izvest. Akad. Nauk Estonian SSR, Biological Ser., no. 3, pp. 231-240, pls. 1-2.

Ross, R. J., Jr.
1961. Distribution of Ordovician graptolites in eugeosynclinal facies in western North America and its paleogeographic implications. Am. Assoc. Petroleum Geologists Bull., vol. 45, no. 3, pp. 330-341.

Schuchert, A., and Cooper, G. A.
1930. Upper Ordovician and lower Devonian stratigraphy and paleontology of Percé, Quebec. Am. Jour. Sci., 5th ser., vol. 20, pp. 161-176, 265-288, 365-392.

Spjeldnaes, Nils.
1957. The Middle Ordovician of the Oslo region, Norway: 8. Brachiopods of the suborder Strophomenida. Norsk. Geol. Tidssk., vol. 37, no. 1, pp. 1-214, 14 pls.

Twenhofel, W. H.
1927. Geology of Anticosti Island. Canada Geol. Survey Mem. 154, 481 pp., 60 pls.

Ulrich, E. O., and Cooper, G. A.
1938. Ozarkian and Canadian Brachiopoda. Geol. Soc. America Spec. Paper no. 13, 323 pp., 57 pls.

Whittard, W. F., and Barker, G. H.
1950. The upper Valentian brachiopod fauna of Shropshire. Annals and Mag. Nat. History, 12 ser., vol. 3, pp. 553-590, pls. 1-8.

Williams, A.
1962. The Barr and lower Ardmillan Series (Caradoc) of the Girvan district, southwest Ayrshire, with descriptions of the Brachiopoda. Geol. Soc. London Mem. no. 3, 267 pp., 25 pls.

Winchell, N. H., and Schuchert, C.,
1895. The geology of Minnesota: Chapter 5, Brachiopoda. Minnesota Geol. and Nat. History Survey, Final Rept., vol. 3, pt. 1, pp. 333-474, pls. 29-34.

Wright, A. D.
1964. The fauna of the Portrane limestone, II. British Mus. (Nat. Hist.) Geol. Bull., vol. 9, no. 6, pp. 159-256, pls. 1-11.

EXPLANATION OF PLATES

Plate 1

(All specimens from USGS coll. D1072 CO)

Figs. 1, 3, 5. *Rhynchotrema*? sp. Brachial, pedicle, and right lateral views, × 2, the only specimen obtained, USNM 145323.

Figs. 2, 4, 6, 8. *Ptychopleurella* cf. *P. lapworthi* (Davidson) × 5. 2, 4. Pedicle and brachial views of a complete specimen, USNM 145324; 6, pedicle interior, USNM 145325; 8, brachial interior, USNM 145326.

Figs. 7, 9, 10, 15, 17-20. *Catazyga homeospiroides* Ross and Dutro, n. sp. 7, 9, 10. Brachial, pedicle, and left lateral views, × 2, holotype, USNM 145327; 15, brachial view, × 4, immature specimen, USNM 145328; 17, brachial interior view, × 2, showing base of loop, divided hinge plate, and absence of cardinal process, USNM 145329; 18, view through break in pedicle valve, × 2, showing part of loop, USNM 145330; 19, 20, exterior and interior views, × 2, of a pedicle valve, USNM 145331.

Figs. 11-14, 16. *Camerella*? sp. × 2. 11, 12, 16. Pedicle, brachial, and right lateral views of a complete specimen, USNM 145332; 13, 14, interior and exterior views of pedicle valve, the only specimen which shows the spondylium, USNM 145333.

Plate 2

(All specimens from USGS colln. D1072 CO)

Figs. 1, 3, 5, 7, 9. *Anoptambonites* cf. *A. grayae* (Davidson), × 2. 1, 3. Interior and exterior views of a damaged brachial vavle, USNM 145334; 5, interior showing only the visceral disc ("lophophore platform" of Williams, 1962) of a broken immature brachial valve, USNM 145335; 7, 9, interior and exterior of a pedicle valve, USNM 145336.

Figs. 2, 4, 6. *Cyclospira* cf. *C. glansfagea* Cooper and Kindle, × 5. 2. Left lateral view of a broken specimen showing part of the spire inside, USNM 145337; 4, 6, brachial and pedicle views of a complete specimen, USNM 145338.

Figs. 8, 11, 13. *Cyclospira*? sp. Brachial, pedicle, and left lateral views, × 5, USNM 145339.

Figs. 10, 12. *Diambonia* cf. *D. anatoli* Spjeldnaes. Exterior and interior views of a small pedicle valve, × 4, showing well developed septum and ornamentation of 5 ribs, USNM 145340.

Figs. 15, 16. *Diambonia* sp. 1. Exterior and interior views of a pedicle valve, × 2, showing relatively short median septum and only 3 ribs, USNM 145341.

Figs. 18, 20. *Diambonia* sp. 2. Brachial and pedicle views of a complete specimen, × 4, lacking any ribs, USNM 145342.

Figs. 14, 17, 19. *Whitfieldella*?. sp. Pedicle, brachial, and left lateral views, × 4, USNM 145343.

Figs. 21-26. *Xenambonites* cf. *X. revelatus* Williams. 21, 23, 25. Brachial, pedicle, and anterior views, × 5, complete but immature specimen, USNM 145344; 22, fragmentary specimen, × 5, showing peculiar distinctive cardinalia, USNM 145345; 24, 26, exterior and interior of brachial valve, × 4, USNM 145346.

Plate 3

(All specimens from USGS colln. D1072 CO)

Figs. 1-5. *Dicoelosia jonesridgensis* Ross and Dutro, n. sp. 1, 2, 3, 5. Brachial, left lateral, pedicle, and anterior views of complete specimen, × 5, holotype, USNM 145347; 4, brachial interior, × 5, paratype, USNM 145348.

Figs. 6-10, 14, 17, 20. *Whitfieldella?* sp. 6, 8, 10. Brachial, pedicle, and left lateral views, × 5, of a specimen possibly referable to *Glassia*, USNM 145349; 7, 9, interior and exterior views, × 2, damaged brachial valve, USNM 145350; 14, 17, 20, brachial, pedicle, and left lateral views, × 4, USNM 145351.

Figs. 11, 12. Genus undetermined B. Exterior and interior views, × 2, fragmentary brachial valve, USNM 145352.

Figs. 13, 15, 16. Genus undetermined A. Anterior, brachial, and pedicle views, × 5, USNM 145353.

Figs. 18, 19. *Ptychoglyptus?* cf. *P?. pauciradiatus* Reed. Brachial and pedicle views, × 2, of the only specimen obtained, USNM 145354.

Fig. 21. *Christiania* sp. Brachial interior, × 2, fragmentary specimen, USNM 145355.

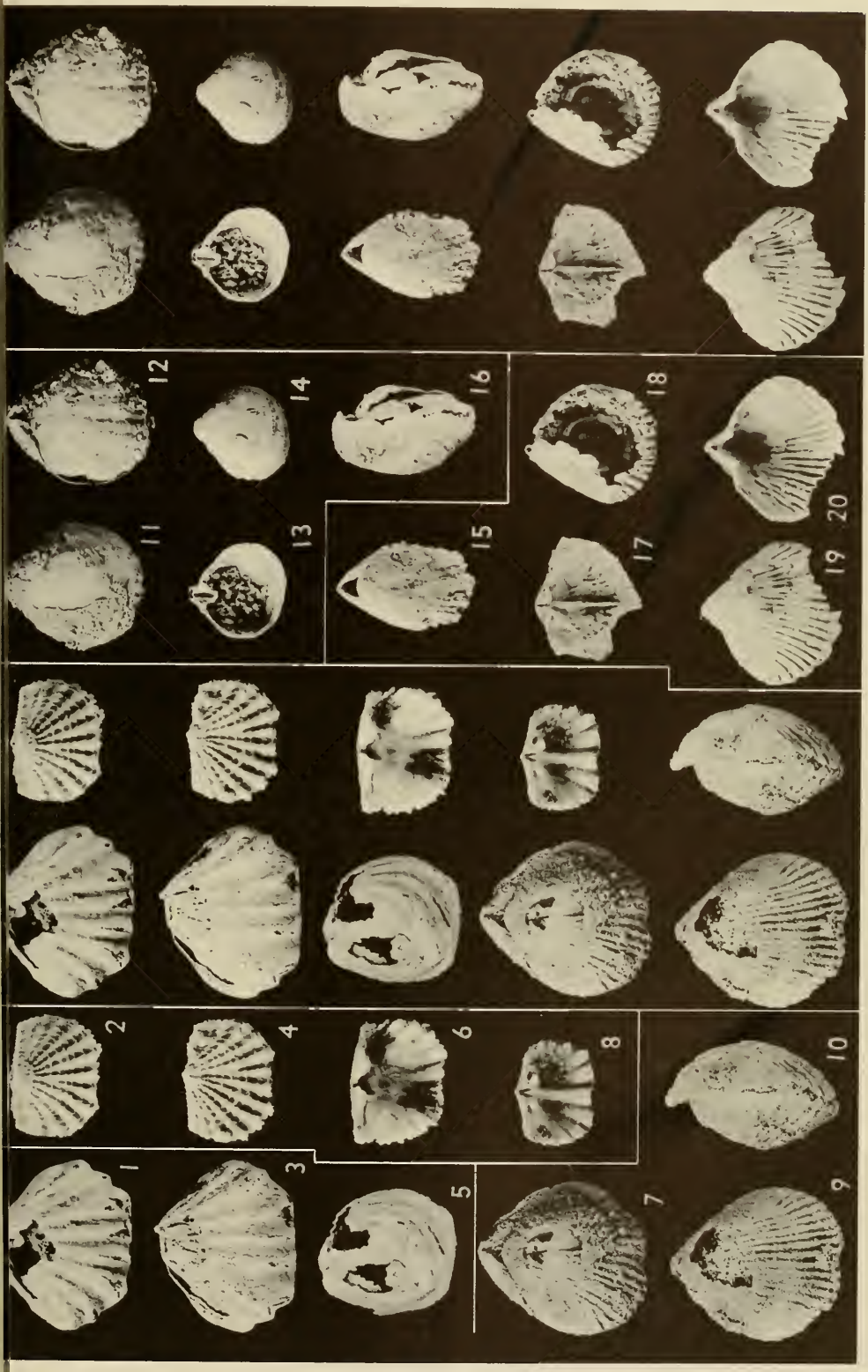

PLATE 1

(See explanation of Plate at end of text.)

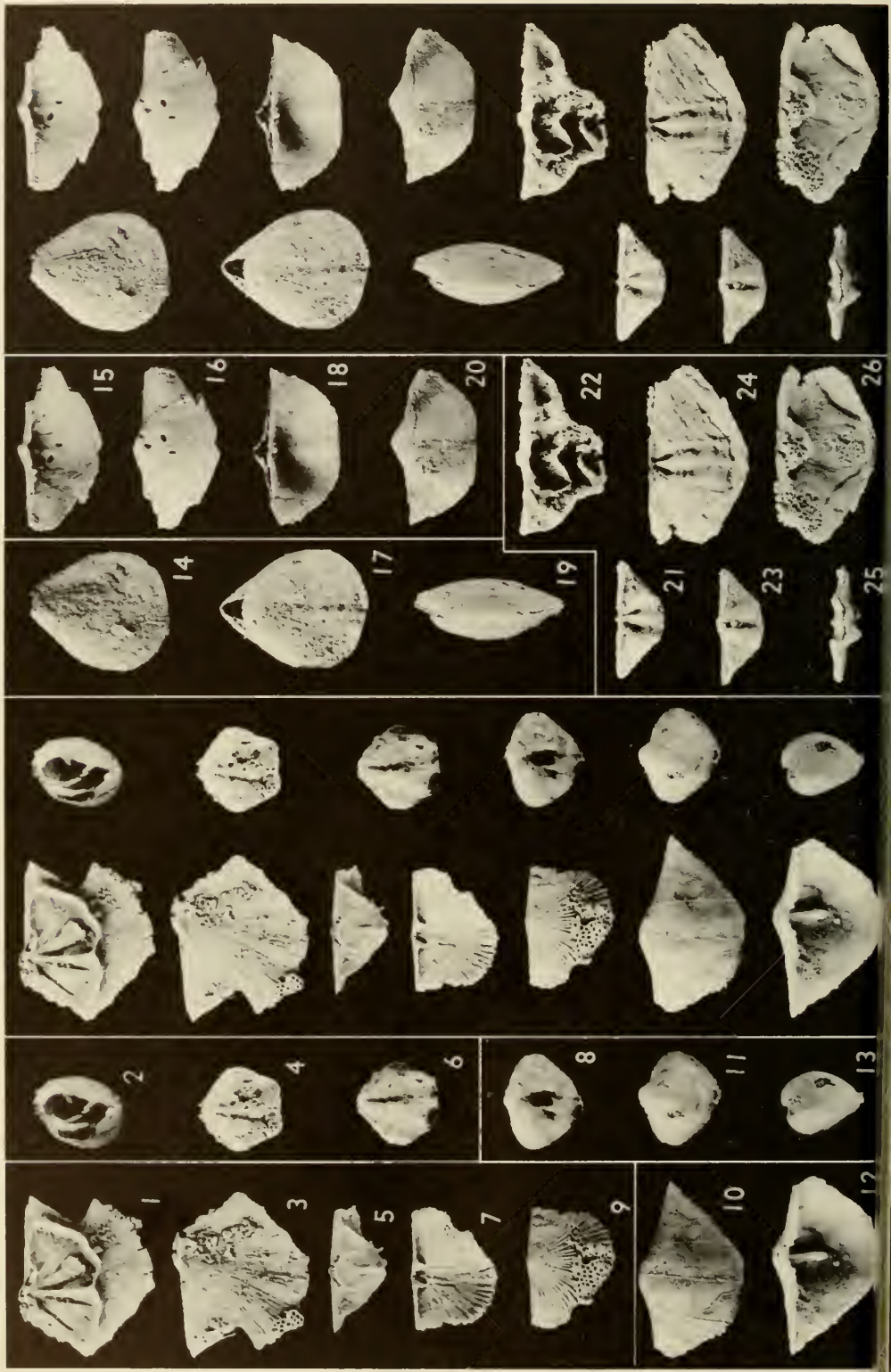

PLATE 2

(See explanation of Plate at end of text.)

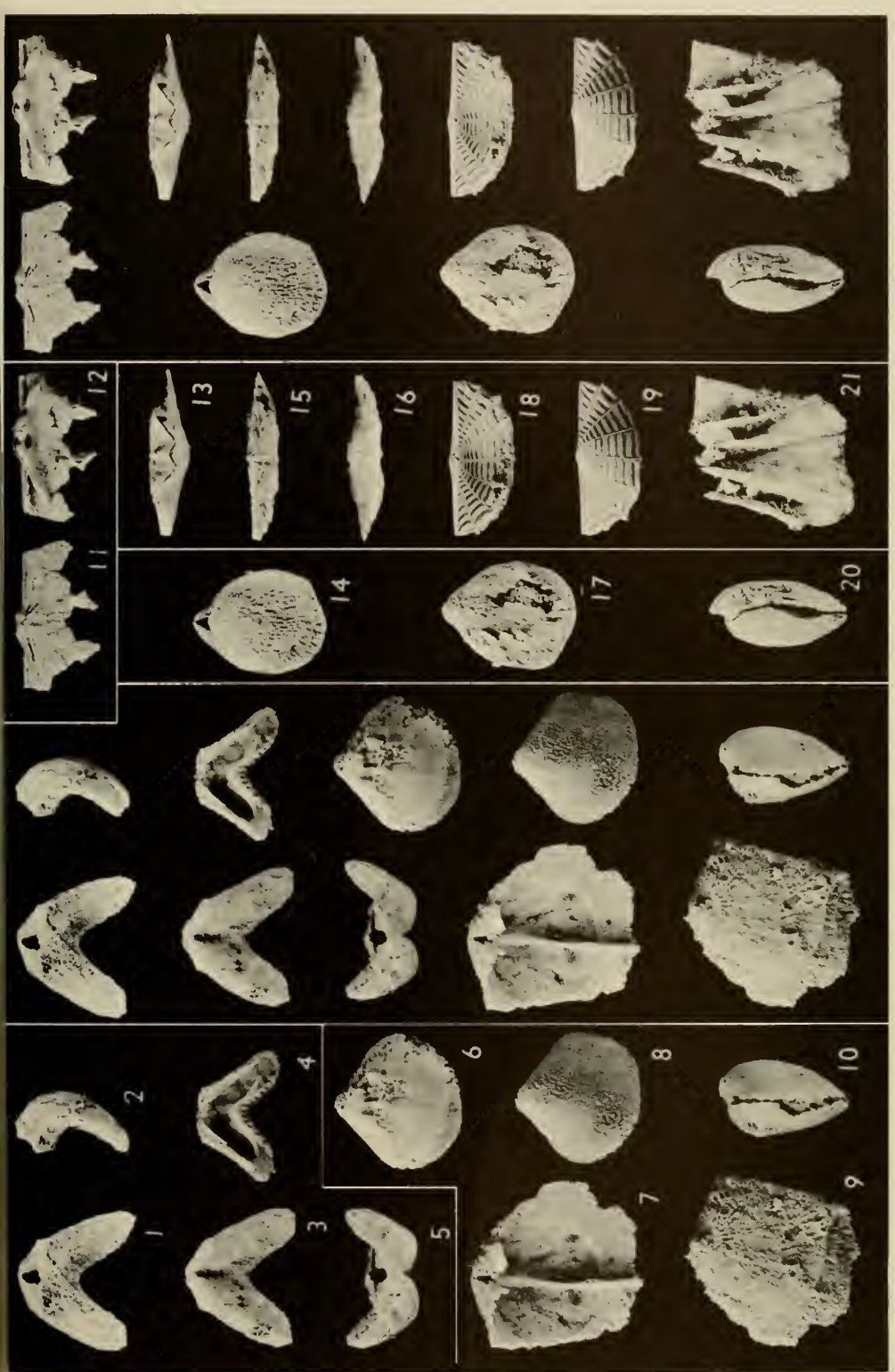

PLATE 3

(See explanation of Plate at end of text.)