Introduction

(by R.K. Olsson, W.A. Berggren, and Ch. Hemleben)

The Paleogene Planktonic Foraminifera Working Group of the International Subcommission on Paleogene Stratigraphy, International Union of Geological Sciences, was formed in 1987 following a meeting (organized by W.A. Berggren) at the British Petroleum Research Centre in Sunbury on Thames, U.K., of researchers interested in improving the understanding of Paleogene planktonic foraminiferal taxonomy and lineage phylogenies. The consensus of the meeting was that a concerted effort among workers was needed to unravel conflicting taxonomic usages of Paleogene taxa due to misunderstanding and lack of access to type collections, particularly in the former Soviet Union. The origins of many of the important biostratigraphic lineages was obscure so that the radiation of Paleogene planktonic foraminifera was poorly understood, and, in fact, some long-held concepts proved to be erroneous. Some of the important questions included the origin of the basal Cenozoic radiation, the taxa involved and how to distinguish them, the origin of the genus Acarinina, and the phylogeny of the morozovellids. In the following years, important breakthroughs in research led to the evolution of the working group’s understanding of the taxonomy and phylogeny of Paleogene planktonic foraminifera.

The first official meeting of the Paleogene Planktonic Foraminifera Working Group was held at the Institute of Geology and Paleontology at the University of Tübingen, Tübingen, Germany. In order to achieve a meaningful reconstruction of the taxonomy and phylogeny of Paleogene planktonic foraminifera the working group decided to focus on unraveling the origins and evolution of the earliest Paleocene (Danian) taxa so as to identify lineages of species that could be traced into the later Paleocene and ultimately through the Paleogene.

An important step in the understanding of Danian taxonomy came about with the visit by W.A. Berggren and F. Rögl to study type collections of V.G. Morozova housed in Moscow and with the study of Russian species in the collections of W.A. Berggren and H.P. Luterbacher. The work of Ch. Hemleben provided a preliminary understanding of a classification of living species, which was based on whether or not spines were used in their biological behavior, a division that Parker (1962) clearly showed could be applied to living planktonic foraminifera based on the presence or absence of spines. His work focused on the identification in fossilized specimens of the spinose condition, because spines are used only when the individual is alive and are shed during gametogenesis. The presence of spine holes and spine bases in and on the chamber walls of fossil specimens indicated a spinose condition. The importance of wall structure was emphasized by Steineck and Fleisher (1978) in their seminal paper on a phylogenetically based classification of planktonic foraminifera. An important breakthrough in using wall texture and structure in the taxonomic classification of Paleocene planktonic foraminifera was announced at the 1989 meeting of the working group in Tübingen. This was the discovery by Ch. Hemleben and R.K. Olsson of spinose wall texture in specimens of Eoglobigerina eobulloides (Morozova) from Zone P0 in the Danian section at
Millers Ferry, Alabama. This discovery showed that the spinose condition had developed in planktonic foraminifera following the terminal Cretaceous mass extinction. It was an innovation not present in Cretaceous planktonic foraminifera, and it meant that a phylogenetic classification based on wall texture might be applied to Danian planktonic foraminifera. In addition to E. eubulloides, Parasubbotina pseudobulloides (Plummer) was subsequently shown to have a spinose wall texture. This discovery abruptly uprooted long-held notions about Paleocene planktonic foraminiferal phylogenies (Bolli, 1957a; Blow, 1979) in which P. pseudobulloides was considered the ancestor of the nonspinose post-Danian muricate morozovellid radiation. The study by F.T. Banner (1989) of the planktonic foraminiferal genus Globanomalina clarified the taxonomy of the smooth-walled group of Paleocene planktonic foraminifera and showed that wall texture was highly important in tracing phylogeny and in identifying lineages. His work identified the earliest Danian species, Globanomalina archeocompressa (Blow), as the first species of a smooth-walled nonspinose lineage. By the next meeting in 1990 in Tübingen the first Danian cancellate nonspinose species, Praemurica taurica (Morozova), was identified. It was now clear that Danian planktonic foraminifera consisted of four groups based on wall texture. These four groups had the same kind of wall texture as did the four groups of living planktonic foraminifera (Hemleben et al., 1991). The wall textures are microperforate, normal perforate smooth-walled nonspinose, normal perforate cancellate nonspinose, and normal perforate cancellate spinose. Using this classification (Olsson et al., 1992), the new genera Parasubbotina and Praemurica were erected to represent two distinct Danian lineages.

During the 1991 and 1992 meetings in Tübingen and the 1993 meeting of the working group at the Cushman Laboratory, National Museum of Natural History (NMNH), Smithsonian Institution, Washington, D.C., details of the Danian phylogeny had been worked out (Pearson, 1993), and the origin of the smooth-walled, cancellate nonspinose, and cancellate spinose groups from Hedbergella was demonstrated (Liu and Olsson, 1994); however, two opposing interpretations of the origin of the morozovellids remain unresolved as this atlas goes to press. At issue is the derivation of this group from either Praemurica, the traditional view, or from Globanomalina, which is a newly developed view. The traditional view, based on the original hypothesis of Bolli (1957a), is emphasized in the recent work of Norris (1996) and Kelly et al. (1996). The alternate view, which is based on the studies of Olsson and Hemleben (1996), emphasizes the development of the characteristic heavy pustulose wall texture of these groups from a smooth-walled Globanomalina ancestor. These views and their alternate phylogenetic interpretations are presented in “Wall Texture, Classification, and Phylogeny,” below.

During the first meeting of the working group it was recognized that the microperforate wall texture separated a distinct group of planktonic foraminifera that dominate the lowest Danian assemblages. This group was viewed as opportunistic following the terminal Cretaceous mass extinction of planktonic foraminifera. It included Chiloguembelina, Globoconusa, Guembelitria, Parvulagaroglobigerina, and Woodringina. Confusion over the difference between the normal perforate and microperforate species had led Brinkhuis and Zachariasse (1988) and Keller (1988) to erroneously identify microperforate specimens from the lower Danian at El Kef as normal perforate species (cancellate spinose and cancellate nonspinose). Thus, clarification and phylogeny of the microperforate group became an objective of our working group. By 1992 the phylogeny of the microperforates from the Cretaceous survivor species Guembelitria cretacea (Cushman) had been constructed (D'Hondt, 1991; Liu and Olsson, 1992). Confusion with regard to the possible Cretaceous origin of Chiloguembelina, however, prompted a careful morphologic comparison of Danian Chiloguembelina with the species Chiloguembelina waiparaensis Jenkins, which, although described from the Danian of New Zealand, occurs in the uppermost Cretaceous at Ocean Drilling Program (ODP) Site 758 in the Southern Ocean. At the 1993 meeting in Washington, D.C., it was shown that waiparaensis has a distinctive morphology separating it from Chiloguembelina and that it is properly placed in the genus Zeauvigerina, which has a Cretaceous to Paleocene range. Zeauvigerina, which is restricted to the southern latitudes, is tentatively placed in the Heterohelicidae as it does not have a phylogenetic relationship with the Guembelitridae (Huber and Boersma, 1994).

Work on the origin and phylogeny of Acarinina by W.A. Berggren and R.D. Norris led to an important revision of Paleocene Zone P4. They showed that the consecutive appearances of A. subsphaerica Subbotina and A. soldadoensis (Bronnimann) allow Zone P4 to be divided into three subzones. This plus other refinements has resulted in an updated version of the Berggren and Miller (1988) zonation of the Paleocene (Berggren and Norris, 1993; Berggren et al., 1995), which is summarized in this volume (Figure 1).

An important development in the clarification of Russian species appears on Plates 8–12, where many holotypes are illustrated by SEM for the first time. F. Rögl was able to borrow the type material described by Morozova in the collections of the Geological Institute, Academy of Sciences (GAN) in Moscow and the type material described by Subbotina in the collections of VNIGRI in St. Petersburg and was able to obtain low KV SEM images of these species. One big surprise is that the widely used but poorly understood species, Globigerina fringa Subbotina, has a coarsely cancellate wall and thus is not closely related to any of the earliest Danian taxa. In fact, this species appears to be described from an upper Danian stratigraphic level and has affinities with Subbotina cancellata. This illustrates the pitfalls for workers who use poorly illustrated drawings of Russian species in identifying taxa for biostratigraphic studies. These SEM images of Russian types and the personal observations of Russian taxa by W.A.
<table>
<thead>
<tr>
<th>Epoch</th>
<th>Paleocene Biozone</th>
<th>Datum Marker and Chronologic Age (Ma)</th>
<th>Other Bioevents and Chronologic Age (Ma)</th>
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<tbody>
<tr>
<td>Eocene</td>
<td>Zone P6</td>
<td>LA: <em>M. velascoensis</em> (54.7)</td>
<td>LA: <em>M. acuta</em> (54.7)</td>
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<td>Eocene</td>
<td>Zone P5</td>
<td>LA: <em>G. pseudomenardii</em> (55.9)</td>
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<td>FO: <em>G. australiformis</em> (55.5)</td>
<td>FO: <em>M. subbotinae</em> (55.9)</td>
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<td>Eocene</td>
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<td>LA: <em>A. nitida &amp; mckannai</em> (56.3)</td>
<td>FO: <em>M. aequa &amp; A. coalingensis</em> (56.5)</td>
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<td>LA: <em>A. subsphaerica</em> (57.1)</td>
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<td>FO: <em>I. albeari</em> (60.0)</td>
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<td>FO: <em>A. nitida &amp; subsphaerica</em> (59.2)</td>
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<td>FO: <em>Pr. uncinata</em> (61.2)</td>
<td>LA: <em>Ps. varianta &amp; variospira</em> (59.2)</td>
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<td>FO: <em>Ps. triloculinoides</em> (64.5)</td>
<td>FO: <em>G. imitata</em> (61.3)</td>
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<tr>
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<td>FO: <em>Ps. varianta</em> (63.0)</td>
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<td>LA: <em>Par. extensa</em> (64.9)</td>
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<td>FO: <em>G. daubjergensis &amp; W. claytonensis</em> (64.97)</td>
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<td>FO: <em>G. imitata</em> (61.3)</td>
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<td>FO: <em>Ps. varianta</em> (63.0)</td>
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<td>LA: <em>Par. extensa</em> (64.9)</td>
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<td>FO: <em>G. daubjergensis &amp; W. claytonensis</em> (64.97)</td>
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<td>FO: <em>G. archeocompressa &amp; Par. extensa</em></td>
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<td>LA: <em>hedbergellids</em></td>
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**Figure 1.**—Paleocene biostratigraphic zonation showing the first occurrence (FO) and last appearance (LA) of zonal species and other important bioevents.

Berggren and F. Rögl have greatly improved the understanding of these species, their taxonomy, and their synonymy. In addition to the SEM images of Russian types (Plates 8-12), low KV SEM images taken by B.T. Huber of types in the Cushman collections are also shown (Plates 13-17). The atlas also includes SEM images of toptypes of *Globanomalina australiformis* (Jenkins), *Hedbergella holmdelensis* Olsson, *Hedbergella monmouthensis* (Olsson), *Morozovella acutispira* (Bolli and Cita), *Woodringina hornerstownensis* Olsson, and specimens of *Parvularugoglobinerina eugubina* (Luterbacher and Premoli Silva) from the type level at Gubbio, Italy.

The atlas includes a section on the newly revised zonation for the Paleocene (Figure 1), with range charts showing the maximum known range of each species organized according to generic classification, which, in turn, is organized by wall-texture groups (Figure 2). Other range charts show the order of the first appearances of taxa (Figure 3) and the last appearances of taxa (Figure 4). The section on wall texture and classification describes the basis for the classification used in this atlas and illustrates in Plates 1-6 the comparison of the types of wall texture in living species and Paleocene species of planktonic foraminifera. The section on taxonomy includes the species considered valid by the working group and includes a synonymy of species considered to be junior synonyms by personal observation of working group members. Most of the species are illustrated by a plate of figures in order to illustrate
the range of morphologic variability of the species. Species that are obscure or are poorly known are not included because their validity is unproven. These species names are mentioned in the taxonomic discussion under the species considered to be the probable senior synonym. Paleobiogeographic maps showing the known distribution of nominate species representative of each genus is included under that species. Reconstruction of paleobiogeographic maps was generated using the PGIS/Mac™ software package. Land-sea distributions are modified from Barron (1987). Occurrences are plotted only for well-documented identifications either by SEM showing unequivocal images, by unequivocal drawings, or by personal observation of a working group member. Lists of identified species without illustrations were not used. Interested workers can update these maps through their own research. A database for each figure on the plates is archived at the Cushman Laboratory, at Rutgers University, and at the University of Tübingen.

The working group was saddened by the sudden death of Graham Jenkins in August 1995. He played an active role at the meetings of the working group in his capacity as secretary of the International Subcommission on Paleogene Stratigraphy and was valued for his expert knowledge of Paleocene Southern Ocean planktonic foraminifera.

ACKNOWLEDGMENTS

The Paleogene Planktonic Foraminiferal Working Group (PPFWG) is indebted to Hans Bolli (Zurich), Walter Blow (deceased), and Nina Subbotina (deceased) whose pioneering contributions to the study of Paleogene planktonic foraminifera spanned nearly a half-century from the mid-1930s to the mid-1980s and laid the groundwork and provided the inspiration for the taxonomic revision presented in this Atlas. The Paleogene Planktonic Foraminifera Working Group was organized in 1987 at a meeting at the British Petroleum (BP) Research Centre in Sunbury on Thames, U.K. We thank J. Athersuch of BP for hosting this important first meeting. The next five meetings of the working group were held at the Institute und Museum für Geologie und Paläontologie, Universität Tübingen, Tübingen, Germany, where Ch. Hemleben graciously hosted those meetings. The invaluable logistical assistance of J. Breitinger and D. Mühlen at those meetings is deeply appreciated. We thank H. Hüttemann for his assistance in examining specimens using a scanning electron microscope and H.P. Luterbacher, Universität Tübingen, for access to his collections of Russian species and samples from the type level of the “Globigerina” eugubina Zone. Brian T. Huber hosted the seventh meeting of the working group at the National Museum of Natural History, Smithsonian Institution, Washington, D.C., and R.K. Olsson hosted the final meeting at Rutgers University, Piscataway, New Jersey.

Discussions with Nina Subbotina (St. Petersburg, deceased), Valery Krasheninnikov (Moscow), and Khalil Aliyula (Baku, deceased) were helpful in elucidating problems of taxonomy among species housed in the collections of VNIGRI (St. Petersburg), AN (GI) (Moscow), and AN (GI) (Baku), respectively, during various visits (1958-1988) by W.A. Berggren. We appreciate the assistance of S.P. Jakovleva, VNIGRI, St. Petersburg, and N. Muzylovy, Geological Institute, Russian Academy of Sciences, Moscow, to F. Rögl in obtaining a loan of Russian type material. These specimens are shown on Plates 8–12 of the atlas. Scanning electron micrographs (SEM) of primary types at the National Museum of Natural History (collections of the former United States National Museum (USNM)) shown on Plates 13–17 were taken and mounted by B.T. Huber. Scanning electron microscopy by S. D’Hondt at the University of Rhode Island was assisted by P. Johnson.

Material used in preparing scanning electron micrographs of Paleocene species were supplied by members of the working group. Specimens were selected from personal collections and from Deep Sea Drilling Project (DSDP) and ODP sites. These are illustrated on Plates 17–71. Micrographs for wall texture and preservation illustrated on Plates 1–7 are from the collections of Ch. Hemleben. We deeply appreciate the indefatigable work of H. Hüttemann, Universität Tübingen, in taking of the thousands of micrographs needed for composing the plates for the atlas. These plates were prepared in the laboratory of Ch. Hemleben. We thank J. Breitinger, D. Mühlen, and B. Rödiger for their assistance. We acknowledge the opportunity to investigate specimens collected by W. Weiss.

The following research support is acknowledged: W.A. Berggren (Marine Geology and Geophysics Branch, Ocean Sciences Division of NSF), Ch. Hemleben (Deutsche Forschungsgemeinschaft (DFG) He 697/15), S. D’Hondt (supported in part by the Earth Sciences Division of NSF), and R.D. Norris (Earth Sciences Division of NSF). We thank the Ocean Drilling Program for supplying samples used in this study.

FIGURE 2.—Stratigraphic ranges of Paleocene planktonic foraminiferal species by genus. (* dashed line represents range extension at southern high latitude sites.)
Hedbergella holmdelensis
Guembelitria cretacea
Rectoquembelina cretacea
Zeauvigerina waiparensis
Hedbergella momouathensis
Parvularugoglobigerina alabamensis
Parvularugoglobigerina extensa
Globanomalina archeco pressa
Eoglobigerina eobulloides
Praemurica taurica
Parasubbotina aff. pseudobulloides
Parvularugoglobigerina eugubina
Globoconusa daubjergensis
Woodringina claytonensis
Woodringina horners townensis
Chiloguembelina morsei
Subbotina trivalis
Eoglobigerina edita
Globanomalina planocompressa
Praemurica pseudoinconstans
Parasubbotina pseudobulloides
Chiloguembelina midwayensis
Subbotina triloculinoa
"Zeauvigerina" virgata
Globanomalina compressa
Praemurica inconstans
Parasubbotina varianta
Chiloguembelina subtriangularis
Zeauvigerina teuria
Globanomalina imitata
Subbotina cancellata
Eoglobigerina spiralis
Praemurica unc nata
Morozovella praegululata
Globanomalina ehrenbergi
Subbotina triangularis
Parasubbotina variospira
Morozovella angulata
Igorina pusilla
Morozovella conicotruncata
Acarinina strabocella
Igorina albeari
Morozovella apanthesma
Subbotina velascoensis
Igorina tadikistanensis
Morozovella velascoensis
Globanomalina chapmani
Morozovella passionensis
Morozovella acutispira
Morozovella occlusa
Globanomalina pseudomenardii
Acarinina subspaira* 
Acarinina nitida
Chiloguembelina crinita
Acarinina mckannai
Morozovella acuta
Zeauvigerina aegyptiaca
Chiloguembelina wilcoxensis
Globanomalina ovals
Acarinina coalingensis
Acarinina soldadoensis
Morozovella aqua
Globanomalina planoconica
Morozovella subbotinae
Chiloguembelina trinitatensis
Globanomalina australiformis
Morozovella gracilis

**FIGURE 3.**—Stratigraphic ranges of Paleocene planktonic foraminiferal species by first occurrence. (• dashed line represents range extension at southern high latitude sites.)
<table>
<thead>
<tr>
<th>Cretaceous</th>
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<th>late Paleocene</th>
<th>Taxon</th>
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**FIGURE 4.**—Stratigraphic ranges of Paleocene planktonic foraminiferal species by last occurrence. (* dashed line represents range extension at southern high latitude sites.)
of Science and Technology, London, U.K.; S. Spezzaferri, University of Milano, Milan, Italy; and S. Sturrock, British Petroleum Ltd., Sunbury, U.K. We thank J.V. Browning, Rutgers University, for his assistance in the preparation of figures.

**ABBREVIATIONS.**—Index of abbreviations used in the atlas for foraminifer collections and collection examiners is as follows.

**Foraminifer Collections:**

- **BP** British Petroleum, London, England
- **CC** Cushman Collection Catalog (USNM)
- **CPC** Commonwealth Paleontological Collection, Canberra, Australia
- **GAN** Geological Institute, Academy of Sciences, Moscow, Russia
- **P** Protozoa Catalog (USNM)
- **UC** Collections of the University of Chicago Walker Museum in the Field Museum, Chicago, Illinois
- **USNM** Collections of the former United States National Museum now in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.
- **UWA** University of Western Australia, Perth, Australia
- **VNIGNI** Vsesoyuznogo Neftyanogo Nauchno-Issledovatel'skogo Geologo Instituta (All Union Petroleum Scientific Research Geological Institute), St. Petersburg, Russia
- **VNIGRI** Vsesoyuznogo Neftyanogo Nauchno-Issledovatel'skogo Geologo-Razvedochnogo Instituta (All Union Petroleum Scientific Research Geological Prospecting Institute), St. Petersburg, Russia

**Examiners:**

- **BTH** Brian T. Huber
- **CL** Chengjie Liu
- **FR** Fred Rögl
- **GJ** Graham Jenkins
- **RDN** Richard D. Norris
- **RKO** Richard K. Olsson
- **SD** Steven D'Hondt
- **WAB** William A. Berggren

**BIOSTRATIGRAPHY**

*(by W.A. Berggren and R.D. Norris)*

The use of planktonic foraminifera in biostratigraphy may be said to be an essentially post-World War II phenomenon (although there were several pre-war contributions of less than lasting value) that resulted from the recognition of their usefulness in local and regional biostratigraphic zonation and correlation. These studies were often, but not exclusively, connected with the exploration for petroleum, particularly in the North Caucasus, Crimea, Tadzhik Depression, and other southwestern portions of the former Soviet Union (Subbotina, 1947, 1953; Morozova, 1959, 1961; Leonov and Alimarina, 1960; Alimarina, 1962, 1963), in the Caribbean region (Brönniman, 1952; Bolli, 1957a, 1957b), and in the Gulf of Mexico and Atlantic Coastal Plain regions (Loeblich and Tappan, 1957a). Various biostratigraphic zonal schemes were developed by the authors cited above and by others, and these have been rapidly enounced in the classic biostratigraphic hagiography of the past half century. Since the advent of the DSDP (1968) and its successor program the ODP (1985–present) the various zonal schemes have found widespread application in regional and global biostratigraphic studies. In the following section we present a brief review of the major Paleocene biostratigraphic zonal schemes developed over the past 50 years. It should be remembered that some of these schemes were developed as part of a larger zonal scheme—the Paleogene or the Cenozoic—so that reference to the larger framework is unavoidable in certain instances.

A detailed zonal biostratigraphy of the Danian and Montian stages (as recognized) in the Crimea, North Caucasus, and “Boreal” areas (Russian Platform and Precaspian Basin) was developed by Morozova (1959, 1960). In these and subsequent studies (Morozova, 1961), she recognized several taxa that have become important in lower Paleocene (lower Danian Stage) biostratigraphy, such as *Eoglobigerina eobulloides* and *Globigerina taurica*.

Coarsely muricate acarininids have figured prominently in middle to late Paleocene zonal biostratigraphies, particularly that of the “official” Paleogene zonation of the former Soviet Union (Permanent Interdepartmental Stratigraphic Commission for the Paleogene of the USSR, 1963). This is because of the general paucity of keeled *morozovellids* (*M. acuta, M. velascoensis*) and of *globanomalinds* (*G. pseudomenardii*) in the formation(s) above the strata bearing *Morozovella angulata–M. conicotruncata* in the northern foothills of the Caucasus Mountains (Subbotina, 1953; Alimarina, 1963) and in southwestern Crimea (Morozova, 1959, 1960). This latter scheme would appear to have drawn heavily upon the detailed studies by the authors cited above as well as those of Shutskaya (1956, Precaucasus; 1962, Crimea, Precaucasus, and Transcaspian Region; 1965, Turkmenistan). (The taxonomic treatment of taxa is not up-to-date, and the identification of some taxa shouldn’t be attempted when preservation is so poor.) Shutskaya subsequently presented a detailed synthesis of her decade-long studies in the southwestern Soviet Union, including a detailed zonal scheme for the Paleocene to lower Eocene in her doctoral thesis (1965) and then concluded with an exhaustive historical overview of the Paleogene (bio)stratigraphic succession and zonal characteristics of the Crimea, northern Precaucasus, and western part of Central Asia (1970a). In the latter work she included 40 plates containing detailed illustrations of the faunal content (planktonic and...
PLATE 1

Spinose and Nonspinose Wall Texture

FIGURE 1.—**Globorotalia hirsuta** (d’Orbigny), nonspinose smooth wall surface with scattered pustules, notice the size gradient of pustule distribution from the ultimate to the antiprepenultimate chambers (bar = 200 µm). Recent, plankton net catch, off Bermuda.

FIGURE 2.—**Globorotalia menardii** (Parker, Jones, and Brady), cross section of bilamellar wall, primary organic membrane (POM) spans across the pore cross section; during life the pore is closed by this organic layer in addition to organic pore fillings (bar = 10 µm). Recent, plankton net catch, Indian Ocean.

FIGURE 3.—**Globigerinoides ruber** (d’Orbigny), overall view of early adult stage showing spines implanted in test wall (bar = 100 µm). Recent, plankton net catch off Barbados, Caribbean Sea.

FIGURE 4.—**Globigerinoides sacculifer** (Brady), cross section showing POM and remanents of pore plate, organic pore lining, and terraced pore structure with plate-like crystals. Rather fine-grained crystals form the wall (bar = 2 µm). Recent, plankton net catch, Indian Ocean.

FIGURE 5.—**Globorotalia menardii** (Parker, Jones, and Brady), keel with small and medium-sized pustules growing on a very smooth surface (bar = 20 µm). Recent, Eltanin cruise 15 sample.

FIGURE 6.—**Globigerinoides truncatulinoides** (d’Orbigny), tangential view and cross section of pustules showing layering indicating that pustules grow as part of the test wall (bar = 5 µm). Recent, DSDP Site 1/1/1: 1-4 cm.

FIGURE 7.—**Globigerinoides ruber** (d’Orbigny), cross section of wall showing broken spine that is separated from the wall. POM with part of the pore plate, inner organic lining (IOL), and organic pore lining (bar = 5 µm). Recent, plankton net catch, South Pacific Ocean.

FIGURE 8.—**Globorina praebulloides** Blow, cross section of spine hole containing mold of a spine (bar = 2 µm). Upper Eocene, DSDP Hole 362A/7/5: 24-26 cm; Walvis Ridge, eastern South Atlantic Ocean.

FIGURE 9.—**Globigerinoides sacculifer** (Brady), overall view of surface of test showing regular cancellate structure with spines and spine holes (bar = 100 µm). Recent, plankton net catch off Barbados, Caribbean Sea.

FIGURE 10.—**Subbotina linaperta** (Finlay), overall view of surface of test showing same cancellate surface texture as above with spine holes (bar = 100 µm). Upper Eocene, DSDP Hole 362A/7/5: 24-26 cm; Walvis Ridge, eastern South Atlantic Ocean.

FIGURE 11.—**Globigerinoides ruber** (d’Orbigny), showing a less regular cancellate surface texture than G. sacculifer or S. linaperta. Note spine holes (bar = 100 µm). Recent, plankton net catch off Barbados, Caribbean Sea.

FIGURE 12.—**Globigerina bulloides** d’Orbigny, showing a more pitted surface due to rather isolated spine bases. Note spine holes in spine bases (bar = 100 µm). Recent, sediment trap off Bermuda, North Atlantic.

FIGURE 13.—**Globigerina praebulloides** Blow, same as Figure 8, above, but showing a rather thick wall (bar = 100 µm). Upper Eocene, DSDP Hole 362A/7/5: 24-26 cm; Walvis Ridge, eastern South Atlantic Ocean.

FIGURE 14.—**Globigerinoides sacculifer** (Brady), enlarged view of test wall showing spine holes left by the resorption of spines during gametogenesis (bar = 10 µm). Recent, plankton net catch off Barbados, Caribbean Sea.

FIGURE 15.—**Globigerinoides ruber** (d’Orbigny), enlarged view of test wall showing spine holes and some gametogenic calcification (bar = 10 µm). Recent, plankton net catch off Barbados, Caribbean Sea.

FIGURE 16.—**Globigerina bulloides** d’Orbigny, enlarged view of test wall showing spine holes (bar = 40 µm). Recent, plankton net catch, middle North Atlantic Ocean.

FIGURE 17.—**Globigerinoides sacculifer** (Brady), juvenile specimen showing a globorotaliid test with a smooth wall and a few spines (bar = 20 µm). Live specimen, Barbados.

FIGURE 18.—**Globigerinoides sacculifer** (Brady), showing crystal growth in surface view (bar = 20 µm). Live specimen, Barbados.

FIGURE 19.—**Globigerinoides sacculifer** (Brady), enlargement of Figure 18 showing the pore resorption (bar = 5 µm).

FIGURE 20.—**Globigerinoides sacculifer** (Brady), detail of cancellate structure of the pore funnel with plate-like crystal growth and spines (bar = 10 µm). Recent, Eltanin cruise 15 sample.
Gametogenetic Calcification (Spinose Wall Texture)

Figure 1.—Globigerinoides ruber (d'Orbigny), view of test wall showing a cancellate structure with spines on the interpore ridges (bar = 10 μm). Recent, plankton net catch, off Bermuda.

Figure 2.—Globigerinoides sacculifer (Brady), view of test wall showing gametogenic calcification covering the spine holes (bar = 10 μm). Live specimen, off Bermuda.

Figure 3.—Subbotina linaperta (Finlay), view of test wall showing spine holes and incipient gametogenic calcification (bar = 20 μm). Upper Eocene, DSDP Hole 362A/7/5: 24–26 cm; Walvis Ridge, eastern South Atlantic Ocean.

Figure 4.—Subbotina linaperta (Finlay), view of test wall showing different stages of gametogenetic calcification (bar = 20 μm). Upper Eocene, DSDP Hole 362A/7/5: 24–26 cm; Walvis Ridge, eastern South Atlantic Ocean.

Figure 5.—Subbotina linaperta (Finlay), enlarged view of test wall showing partial gametogenetic overgrowth of a spine hole (bar = 4 μm). Upper Eocene, DSDP Hole 362A/7/5: 24–26 cm; Walvis Ridge, eastern South Atlantic Ocean.

Figure 6.—Subbotina cancellata Blow, view of test wall showing gametogenic calcification covering the spine holes (bar = 10 μm). Paleocene, Zone P4, DSDP Site 549/20/5: 20–22 cm; Goban Spur, eastern North Atlantic.

Figures 7–9.—Parasubbotina pseudobulloides (Plummer): 7, view of test wall showing a cancellate surface texture with spine holes and rather heavy corrosion; 8, spine holes and gametogenic calcification; 9, well-preserved specimen showing typical gametogenic calcification (bar = 10 μm). Paleocene, Zone P2, Midway Group, Texas, sample 8030.

Figure 10.—Globigerinoides ruber (d'Orbigny), view of test wall showing a less well-developed cancellate surface texture with gametogenic calcification (bar = 10 μm). Recent, plankton net catch, off Bermuda.

Figures 11–13.—Eoglobigerina eobulloides Morozova: 11, view of test wall showing cancellate wall texture, spine holes, and gametogenic calcification; 12, corroded surface (lower left) and gametogenic calcification; 13, well-preserved specimen showing rather thick gametogenic calcification (bar = 10 μm). Paleocene, Zone Pa, Core 226, samples 8, 21, 84, respectively, Millers Ferry, Alabama.

Figure 14.—Globigerina praebulloides Blow, view of test wall showing spine holes and spine bases (bar = 10 μm). Upper Eocene, DSDP Hole 362A/7/5: 24–26 cm; Walvis Ridge, eastern South Atlantic Ocean.

Figures 15, 16.—Subbotina triangularis (White), views of test wall showing spine holes, spine bases, and gametogenic calcification. Compare to Figure 11 (bar = 10 μm). Paleocene, Zone P4, Glendola Well, New Jersey, sample 286–287 feet.
PLATE 3

Nonspinose (Globorotaliid) Wall Texture

FIGURE 1.—Globorotalia scitula (Brady), overall view of a thin-walled test showing smooth surface and scattered pustules in umbilical area (bar = 100 μm). Recent, sediment trap, off Barbados.

FIGURE 2.—Globorotalia truncatulinoides (d’Orbigny), overall view of a medium thick-walled test showing heavier pustule growth on the older chambers (bar = 200 μm). Recent, sediment trap, off Bermuda.

FIGURE 3.—Globorotalia inflata (d’Orbigny), overall view of a medium thick-walled test showing pustules of various ages on all chambers (bar = 100 μm). Recent, plankton net catch, western South Atlantic Ocean.

FIGURE 4.—Globorotalia inflata (d’Orbigny), overall view of test showing a final layer of thick pustule growth (bar = 100 μm). Recent, plankton net catch, off Bermuda.

FIGURE 5.—Globorotalia truncatulinoides (d’Orbigny), enlarged view of chamber surface with young small pustules (bar = 10 μm). Recent, North Atlantic Ocean.

FIGURE 6.—Globorotalia inflata (d’Orbigny), enlarged view of tangential section of a thin-layered wall covering a previously formed wall, indicating superposition of various calcification events (bar = 4 μm). Recent, plankton net catch, off Bermuda.

FIGURE 7.—Globorotalia inflata (d’Orbigny), enlarged view of tangential section of test wall showing consecutive pustule growth that leads to a bumpy layered wall (bar = 20 μm). Recent, plankton net catch, Chain 35, Station 89.

FIGURE 8.—Globorotalia scitula (Brady), enlarged view of 3rd and 4th chambers of Figure 1 showing distribution of pustules and covering of pores by growth of pustules (bar = 20 μm). Recent, sediment trap, off Barbados.

FIGURE 9.—Globorotalia truncatulinoides (d’Orbigny), enlarged view of test wall showing several generations of pustule growth and an increase in wall thickness by pustule growth (bar = 40 μm). Recent, plankton net catch, South Atlantic Ocean.

FIGURES 10, 11.—Globorotalia inflata (d’Orbigny): 10, enlarged view of test wall showing outermost pustules and the beginning of calcite crust growth (bar = 20 μm); 11, additional calcification on top of pustules (bar = 4 μm). Recent, plankton net catch, off Bermuda.

FIGURE 12.—Globorotalia truncatulinoides (d’Orbigny), cross section of test wall showing the normal wall and a layered pustule (bar = 20 μm). Recent, DSDP Site 2/4/2: 149-151 cm; Gulf of Mexico.

FIGURE 13.—Globorotalia truncatulinoides (d’Orbigny), branching pustules (bar = 40 μm). Recent, DSDP Site 2/4/2: 149-151 cm; Gulf of Mexico.

FIGURES 14-16.—Globorotalia menardii (Parker, Jones, and Brady): 14, cross section of test wall showing the normal wall and the beginning of the calcite crust (elongated crystals); 15, early stage of keel development showing the doubling of the wall; at this stage the keel contains a few pores that do not function (bar = 10 μm). Recent, DSDP Site 2/4/2: 149-151 cm; Gulf of Mexico. 16, medium stage of keel development showing the layering of the keel (bar = 10 μm). Recent, DSDP Site 1/1/1: 1-4 cm; Gulf of Mexico.
PLATE 4

Non-spinose (Globorotaliid) Wall Texture, Cretaceous and Paleocene

FIGURES 1-3.—*Hedbergella holmdelensis* Olsson: 1, overall view of test showing a smooth wall with pustule distribution resembling *Globorotalia scitula* (Brady) (bar = 50 μm); 2, enlarged view of 3rd chamber showing overgrowth of pores by pustules (bar = 5 μm); 3, pustule growth covering wall surface on 5th chamber (bar = 5 μm). Topotype, upper Maastrichtian, Navesink Formation, New Jersey.

FIGURES 4, 5.—*Globanomalina archeocompressa* (Blow): 4, overall view of test showing a smooth surface with a pustule distribution similar to *G. scitula* (Brady) and *H. holmdelensis* Olsson (bar = 20 μm); 5, enlarged view of wall showing a smooth surface and some small pustules in front of the aperture (bar = 10 μm). Paleocene, Zone P1a, DSDP Site 356/29/1: 70-72 cm; São Paulo Plateau, South Atlantic Ocean.

FIGURES 6, 7.—*Globanomalina planocompressa* (Shutskaya): 6, overall view of test showing a very smooth surface and no pustules (bar = 50 μm); 7, closeup view of 3rd chamber (bar = 10 μm). Paleocene, Zone P1c, Mexia Clay, Texas.

FIGURE 8.—*Globanomalina chapmani* (Parr), enlarged view of test wall showing smooth surface and some pores in the imperforate peripheral band (bar = 10 μm). Paleocene, Zone P4, Glendola Well, New Jersey, sample 286-287 feet.

FIGURES 9, 10.—*Globanomalina pseudomenardii* (Bolli): 9, cross section of test wall showing the layered wall and the trace of the POM (primary organic membrane) and pustule exhibiting the same morphology as in globorotaliid species (bar = 2 μm), Paleocene, Zone P4, Whitesville Well, New Jersey, sample 210-215 feet. 10, view of surface layer on top of keel and of pustules of various generations (bar = 10 μm), Paleocene, Zone P4, Glendola Well, New Jersey, sample 286-287 feet.

FIGURES 11-13, 16.—*Globanomalina imitata* (Subbotina): 11, enlarged view of test wall showing typical globorotaliid pustules (bar = 10 μm); 12, chambers of the inner whorl showing conical inner chambers with rounded and sharp-tipped pustules (bar = 20 μm); 13, enlarged view of inner chamber of Figure 12 showing pustules (bar = 10 μm); Paleocene, Zone P4, Whitesville Well, New Jersey, sample 210-215 feet. 16, enlarged view of inner chamber showing same pustule development as in Figure 12 (bar = 10 μm), Paleocene, Zone P4, DSDP Site 384/7/CC; southeast Newfoundland Ridge, North Atlantic Ocean.

FIGURE 14.—*Morozovella praeangulata* (Blow), enlarged view of test wall showing pustules growing on a smooth "globorotaliid" surface (bar = 20 μm). Paleocene, Zone P3b, DSDP Site 527/28/6: 30-32 cm; Walvis Ridge, eastern South Atlantic Ocean.

FIGURE 15.—*Morozovella velascoensis* (Cushman), enlarged view of test wall showing different sized pustules growing on a smooth "globorotaliid" surface (bar = 20 μm). Paleocene, Zone P5, DSDP Site 213/16/1: 104 cm; Wharton Basin, eastern Indian Ocean.
PLATE 5

Acarinina and Praemurica Wall Texture

FIGURE 1.—Acarinina strabocella (Loeblich and Tappan), enlarged view of test wall showing a smooth (globorotaliid) surface with simple and coalescent pustules (bar = 10 μm). Paleocene, Zone P2, DSDP Site 356/25/5: 148-150 cm; São Paulo Plateau, South Atlantic Ocean.

FIGURE 2.—Acarinina nitida (Martin), enlarged view of test wall showing a smooth (globorotaliid) surface with simple and coalescent pustules, similar to Figure 1; wall texture, pustule morphology, and distribution is typical of extant globorotaliids (bar = 20 μm). Paleocene, Zone P4, DSDP Site 384/8/1: 136-138 cm; southeast Newfoundland Ridge, North Atlantic Ocean.

FIGURE 3.—Acarinina mckannai (White), enlarged view of test wall showing heavy, coalescing pustule growth on a smooth (globorotaliid) surface; wall texture, pustule morphology, and distribution is typical of extant globorotaliids (bar = 20 μm). Paleocene, Zone P4, DSDP Site 384/6/CC; southeast Newfoundland Ridge, North Atlantic Ocean.

FIGURE 4.—Acarinina subsphaerica (Subbotina), enlarged view of test wall showing heavy pustule growth; wall texture, pustule morphology, and distribution is typical of extant globorotaliids (bar = 20 μm). Paleocene, Zone P4, DSDP Site 465/5/1: 65-67 cm; Hess Rise, central Pacific Ocean.

FIGURES 5–8.—Neogloboquadrina dutertrei (d'Orbigny), overall view of thin (Figure 5), medium (Figures 6, 7), and thick (Figure 8) walled specimens showing development of globoquadrinid wall texture by growth and coalescing of pustules to form a cancellate wall texture. A calcite crust is formed in the final stage (Figure 8). (Figure 5: bar = 50 μm; Figures 6–8: bar = 100 μm.) Recent, plankton net catch, eastern North Atlantic.

FIGURES 9–11.—Neogloboquadrina dutertrei (d'Orbigny): 9, 10, enlarged views of test wall of same specimen showing pores separated by elongated, subparallel ridge-like structures, which are connected by short, less developed ridges, thereby forming the cancellate wall texture. (Figure 9: bar = 20 μm; Figure 10: bar = 10 μm.) Recent, sediment trap, off Barbados. 11, two enlarged views of test wall of single specimen showing gametogenetic calcification and early formation of a calcite crust. The wall thickens as the individual sinks to deeper water, e.g., deep chlorophyll maximum. (Bars = 20 μm and 5 μm, respectively.) Recent, plankton net catch, off Bermuda.

FIGURES 12–15.—Hedbergella momouensis (Olsson), views of test wall showing the development and distribution of pustules on a smooth surface: 12, overall view of specimen (bar = 40 μm); 13, enlarged view of ultimate chamber with small scattered pustules; 14, enlarged view of penultimate chamber showing growth and coalescing of pustules; 15, enlarged view of 4th chamber showing coalescing of pustules around pores, which is an initial step toward the development of a cancellate wall texture. (Figures 13–15: bars = 10 μm.) Topotype, upper Maastrichtian, Redbank Formation, New Jersey.

FIGURES 16–18.—Praemurica taurica (Morozova): 16, overall view of test showing the globoquadrinid-type (praemuricate) wall texture (bar = 40 μm); 17, enlarged view of test wall of another specimen showing the praemuricate cancellate wall (bar = 10 μm); 18, enlarged view of test wall of another specimen showing elongate, subparallel ridges connected by short, less developed ridges surrounding the pores (bar = 10 μm). Paleocene, Zone P1a, Millers Ferry, Alabama, core 225, Figures 16, 17, from sample 216 and Figure 18 from sample 194.
PLATE 6

Praemurica and Microperforates

FIGURES 1–4.—Praemurica pseudoinconstans (Blow): 1, overall view of test showing the globoquadrinid-type (praemuricate) wall texture (bar = 40 μm); 2, 4, enlarged view of 6th and 3rd chambers, respectively, showing the typical praemuricate wall texture of elongate, subparallel ridges connected by shorter, less developed ridges surrounding the pores, and showing light gametogenous calcification (bar = 10 μm); 3, enlarged view of another specimen showing the praemuricate wall texture (bar = 10 μm). Paleocene, Zone P1a, Millers Ferry, Alabama, core 225, sample 194.

FIGURE 5.—Igorina pusilla (Bolli), enlarged view of test wall showing the praemuricate wall texture (bar = 10 μm). Paleocene, Zone P4, Glendola Well, New Jersey, sample 286–287 feet.

FIGURE 6.—Igorina albeari (Cushman and Bermúdez), enlarged view of test wall showing the typical praemuricate wall texture of subparallel ridges connected by shorter, less developed ridges surrounding the pores (bar = 20 μm). Paleocene, Zone P3b, DSDP Site 356/24/2: 92–94 cm; São Paulo Plateau, South Atlantic Ocean.

FIGURES 7–10.—Globigerinita glutinata (Egger): 7, overall view of early adult form showing microperforate wall and scattered small pustules (bar = 100 μm); 8, mature adult form showing heavy pustulose wall texture and bulla with scattered small pustules (bar = 100 μm); 9, enlarged view of test wall of another specimen showing microperforate wall with multifaceted pustules covering pores (bar = 20 μm); 10, enlarged view of test wall of another specimen showing microperforate wall with small rounded pustules overgrowing pores (bar = 5 μm). Recent, plankton net sample. North Atlantic Ocean.

FIGURES 11, 12.—Globoconusa daubjergensis (Bronnimann): 11, overall view of test showing microperforate wall with scattered pustules (bar = 50 μm); 12, enlarged view of another specimen showing microperforate wall with sharp-pointed pustules (bar = 10 μm). Paleocene, Zone P1c, Brightseat Formation, Maryland.

FIGURES 13, 14.—Chiloguembelina crinila (Glaessner): 13, overall view of test showing microperforate wall covered with coarse rounded pustules (bar = 50 μm); 14, enlarged view of 3rd chamber showing microperforate wall and rounded pustules overgrowing pores (bar = 10 μm). Paleocene, Zone P4, Whitesville Well, New Jersey, sample 180–185 feet.

FIGURES 15–18.—Chiloguembelina morsel (Kline): 15–17, overall view and enlarged views of test wall showing microperforate texture with coarse multifaceted pustules overgrowing pores (compare to Figure 9) (Figure 15: bar = 40 μm; Figures 16, 17: bar = 10 μm). Paleocene, Zone P2, DSDP Site 356/24/2: 92–94 cm; São Paulo Plateau, South Atlantic Ocean. 18, enlarged view of test wall, partially recrystallized, showing multifaceted pustules (bar = 20 μm). Paleocene, ODP Hole 690B/16/5: 76–80 cm; Maud Rise, Southern Ocean.
PLATE 7

Diagenesis

FIGURES 1, 2.—Subbotina cancellata Blow, overall view and enlarged view of recrystallized and corroded specimen; diagenesis obscures original wall texture, although a spine hole is visible in center of picture (Figure 1: bar = 40 μm; Figure 2: bar = 10 μm). Paleocene, Zone P2, DSDP Hole 398D/39/4: 145-147 cm; western Iberian continental margin, eastern North Atlantic Ocean.

FIGURE 3.—Eoglobigerina edita (Subbotina), enlarged view of test wall showing corrosion and dissolution (bar = 4 μm). Paleocene, Zone Pa, Millers Ferry, Alabama, core 226, sample 8.

FIGURE 4.—Subbotina trivialis (Subbotina), enlarged view of heavily recrystallized and overgrown test wall showing euhedral calcite crystals closing off pores, although a spine hole is still visible in center of picture (bar = 20 μm). Paleocene, Zone P1, DSDP Hole 390A/11/4: 80-82 cm; Blake-Bahama Basin, North Atlantic Ocean.

FIGURES 5, 6.—Parasubbotina pseudobulloides (Plummer), enlarged views of corroded and recrystallized test wall; diagenesis has nearly obliterated original wall texture, but a few spine holes are preserved (Figure 5: bar = 10 μm; Figure 6: bar = 4 μm). Paleocene, Zone P1a, Millers Ferry, Alabama, core 226, sample 85.

FIGURE 7.—Acarinina strabocella (Loeblich and Tappan), enlarged view of recrystallized wall showing fine subhedral crystals; recrystallized pustules show euhedral crystal surfaces (bar = 10 μm). Paleocene, Zone P3, ODP Hole 750A/11/1: 149-150 cm; southern Kerguelen Plateau, Southern Ocean.

FIGURE 8.—Praemurica inconstans (Subbotina), enlarged view of recrystallized and overgrown test wall, showing closed off pores and obscured original wall texture (bar = 10 μm). Paleocene, Zone P1c, DSDP Site 577/12/1: 49-51 cm; Shatsky Rise, western Pacific Ocean.

FIGURE 9.—Subbotina cf. triangularis (White), enlarged view of partially dissolved wall showing calcitic pore linings that are visible due to dissolution (bar = 10 μm). Paleocene, Zone P5, DSDP Site 2/3/16; Wharton Basin, eastern Indian Ocean.

FIGURE 10.—Subbotina cf. velascoensis (Cushman), enlarged view of cross section showing recrystallized wall with overgrowth on inner wall, but POM is still visible (bar = 10 μm). Paleocene, Zone P2, DSDP Site 398D/39/4: 145-147 cm; western Iberian continental margin, eastern North Atlantic Ocean.

FIGURE 11.—Subbotina sp., enlarged view of heavily recrystallized wall (bar = 4 μm). Paleocene, Zone P2a, DSDP Site 577/12/5: 113-114 cm; Shatsky Rise, western Pacific Ocean.

FIGURE 12.—Subbotina triangularis (White), enlarged view of cross section showing heavily recrystallized wall completely obscuring the original wall texture (bar = 10 μm). Paleocene, Zone P4, DSDP Site 549/20/2: 69-71 cm; Goban Spur, eastern North Atlantic Ocean.

FIGURES 13, 14.—Parvularugoglobigerina eugubina (Luterbacher and Premoli Silva), overall view and enlarged view showing completely recrystallized test wall; original microperforate wall is obscured (Figure 13: bar = 40 μm; Figure 14: bar = 10 μm). Paleocene, Zone P4, DSDP Site 577/12/5: 125-126 cm; Shatsky Rise, western Pacific Ocean.

FIGURE 15.—Chilenguembelina wilcixensis (Cushman and Ponton), enlarged view of recrystallized wall showing recrystallized pustules; microperforate wall is obscured (bar = 10 μm). Paleocene, ODP Hole 690B/16/5: 76-80 cm; Maud Rise, Southern Ocean.
PLATE 8

Russian Primary Type Specimens
(bars = 100 μm)

Figures 1–3.—Guembelitria irregularis Morozova, 1961:17, pl. 1: fig. 9, holotype no. 3510/13a, Moscow GAN; Danian, Tarkhankut, Crimea. See “Discussion” for Guembelitria cretacea.

Figures 4–6.—Globigerina (Eoglobigerina) trifolia Morozova, 1961:12, pl. 1: fig. 1, holotype no. 3510/4, Moscow GAN; Danian, Tarkhankut, Crimea. See “Discussion” for Globoconusa daubjergensis.

Figures 7–9.—Acarinina multiloculata Morozova, 1961:15, pl. 2: fig. 5, holotype no. 3510/10, Moscow GAN; Montian, Balka Nasypkoiskaya, Crimea. Probably a reworked specimen of Hedbergella planispira (Tappan, 1940).

Figures 10–12.—Globigerina (Eoglobigerina) eobulloides Morozova, 1959:1115, text-fig. 1a–c, holotype no. 3508/1, Moscow GAN; Danian, Tarkhankut, Crimea. See Eoglobigerina eobulloides.

Figures 13–15.—Globigerina (Eoglobigerina) hemisphaerica Morozova, 1961:11, pl. 1: fig. 4, holotype no. 3510/3, Moscow GAN; Danian, Tarkhankut, Crimea. See “Discussion” for Eoglobigerina edita.

Figures 16–18.—Globigerina (Eoglobigerina) theodosica Morozova, 1961:11, pl. 1: fig. 6, holotype no. 3510/2, Moscow GAN; Danian, Tarkhankut, Crimea. See “Discussion” for Eoglobigerina edita.
PLATE 9

Russian Primary Type Specimens
(bars = 100 μm)

FIGURES 1–3.—*Globigerina (Eoglobigerina) tetragna* Morozova, 1961:13, pl. 1: fig. 2, holotype no. 3510/5, Moscow GAN; Danian, Pre-Caspian Basin, Novouzensk. See “Discussion” for *Eoglobigerina edita*.

FIGURES 4–6.—*Globigerina (Eoglobigerina) pentagona* Morozova, 1961:13, pl. 1: fig. 3, holotype no. 3510/6, Moscow GAN; Danian, Tarkhankut, Crimea. See “Discussion” for *Eoglobigerina edita*.

FIGURES 7–9.—*Globigerina fringa* Subbotina, 1953:62, pl. 3: fig. 3, holotype no. 2175, St. Petersburg VNIGRI (323/39); Danian, Pecten horizon, Azov-Black Sea flysch, Anapa, Caucasus. See “Discussion” for *Subbotina cancellata*.

FIGURES 10–12.—*Globigerina trivialis* Subbotina, 1953:64, pl. 4: fig. 4a–c, holotype no. 4004, St. Petersburg VNIGRI (378/30); Elburgan Fm., Kuban River section, northern Caucasus. See *Subbotina trivialis*.

FIGURES 13–15.—*Globigerina (Globigerina) microcellulosa* Morozova, 1961:14, pl. 1: fig. 11, holotype no. 3510/7, Moscow GAN; Danian, Tarkhankut, Crimea. See “Discussion” for *Subbotina triloculinoides*.

FIGURES 16–18.—*Globigerina varianta* Subbotina, 1953:63, pl. 3: fig. 5a–c, holotype no. 3994, St. Petersburg VNIGRI (378/20); zone of rotaliform *Glororotalia*, Elburgan Fm., Kuban River section, northern Caucasus. See *Parasubbotina varianta*. 
PLATE 10

Russian Primary Type Specimens

(bars = 100 μm)

FIGURES 1-3.—Globigerina (Eoglobigerina) taurica Morozova, 1961:10, pl. 1: fig. 5, holotype no. 3510/1, Moscow GAN; Danian, Tarkhankut Peninsula, Crimea. See Praemurica taurica.

FIGURES 4-6.—Globigerina inconstans Subbotina, 1953:58, pl. 3: fig. 1, holotype no. 3992, St. Petersburg VNIGRI (378/18); zone of rotaliform globorotaliids, Elburgan Fm., Kuban River, northern Caucasus. See Praemurica inconstans.

FIGURES 7, 8.—Acarinina praecursoria Morozova, 1957:1111, text-fig. 1, holotype no. 3507/1, Moscow GAN; Danian, Khokhodz’ River, northern Caucasus. See “Discussion” for Praemurica inconstans and for Praemurica uncinata.

FIGURES 9-11.—Acarinina indolensis Morozova, 1959:1116, text-fig. 1, holotype no. 3508/2, Moscow GAN; Danian, Tarkhankut Peninsula, Crimea. See “Discussion” for Praemurica uncinata.

FIGURES 12-14.—Globorotalia imitata Subbotina, 1953:206, pl. 16: fig. 14a-c, holotype no. 4073, St. Petersburg VNIGRI (378/112); zone of rotaliform globorotaliids (Danian?), Elburganian horizon, Kuban River, northern Caucasus. See Globanomalina imitata.

FIGURES 15-17.—Globorotalia planoconica Subbotina, 1953:210, pl. 17: fig. 4a-c, holotype no. 4081, St. Petersburg VNIGRI (378/118); zone of conical globorotaliids, lower to middle Eocene (probably lower Eocene), Series F1, Khieu River, Caucasus. See Globanomalina planoconica.
FIGURES 1–3.—*Globorotalia convexa* Subbotina, 1953:209, pl. 17: fig. 2a–c, holotype no. 4079, St. Petersburg VNIGRI (378/116); zone of conical globorotaliids, lower to middle Eocene (probably lower Eocene), Series F1, Khieu River, Caucasus. See “Discussion” for *Igorina tadjikistanensis*.

FIGURES 4–6.—*Globorotalia tadjikistanensis* Bykova, 1953:86, pl. 3: fig. 5a–c, holotype no. 2794-a (upper specimen), St. Petersburg VNIGRI (350/10); Suzakian Stage (middle Paleocene), Ak-Tau, southern part of Tadzhik Basin, Kazakhstan. See “Discussion” for *Igorina tadjikistanensis*.

FIGURES 7–9.—*Globorotalia tadjikistanensis* Bykova, 1953:86, paratype no. 2794-a (middle specimen), St. Petersburg VNIGRI (350/10); Suzakian Stage (middle Paleocene), Ak-Tau, southern part of Tadzhik Basin, Kazakhstan. See *Igorina tadjikistanensis*.

FIGURES 10–15.—*Globorotalia angulata* (White) var. *kubanensis* Shutskaya, 1956, specimens from remaining collections of Shutskaya (no. 645-32), St. Petersburg VNIGRI; zone of *Acarinina conicotruncata*, PC1 (middle Paleocene), Khieu River, Caucasus. Holotype in Moscow is lost, hence the identity of this taxon cannot be determined. Further confusing the taxonomic status of this taxon is the specimen represented by Figures 10–12, which is probably referable to *Morozovella apanthesma* (Loeblich and Tappan), and the specimen represented by Figures 13–15, which is probably referable to *Morozovella acutispira* (Bolli and Cita). The holotype figure, in contrast, resembles *Morozovella conicotruncata* (Subbotina).
PLATE 12

Russian Primary Type Specimens
(bars = 100 µm)

FIGURES 1–3.—Acarinina acarinata Subbotina, 1953:229, pl. 22: fig. 5, paratype no. 4129, St. Petersburg VNIGRI (378/160); zone of compressed globorotaliids, Paleocene–lower Eocene, Series F1, Khieu River, Caucasus. See “Discussion” for Acarinina nitida.

FIGURES 4–6.—Acarinina intermedia Subbotina, 1953:227, pl. 20: fig. 15, holotype no. 4095, St. Petersburg VNIGRI (378/124); zone of compressed globorotaliids, Paleocene?, Goryache Klynch horizon, Kuban River, Caucasus. See “Discussion” for Acarinina nitida.

FIGURES 7–9.—Guembelitria dammula Voloshina, 1961, hypotype; Paleocene, P0, Bjala (K/T section no. 2b, 1–2 cm above boundary), Bulgaria. See “Discussion” for Guembelitria cretacea.

FIGURES 10–12.—Globanomalina imitata (Subbotina, 1953), hypotype; Paleocene, P1b/c, Bjala (K/T section no. 2b, sample Sum 24/12), Bulgaria. See Globanomalina imitata.
PLATE 13

USNM Primary Type Specimens
(bars = 50 μm)

FIGURE 1.—Rectogümbelina cretacea Cushman, 1932, holotype, USNM CC16308; upper Maastrichtian, Arkadelphia Clay, Hope, Arkansas.

FIGURE 2.—Tubitextularia laevigata Loeblich and Tappan, 1957 (= Rectoguembelina cretacea Cushman), holotype, USNM P5820; lower Paleocene, McBreide Limestone Mbr., Clayton Fm., Wilcox Co., Alabama.

FIGURE 3.—Guembelitria cretacea Cushman, 1933, holotype, USNM CC19022; upper Maastrichtian, Navarro Fm., Texas.

FIGURES 4, 5.—Woodringina hornerstownensis Olsson, 1960, holotype, USNM 626457; Zone P3b, Hornerstown Fm., New Jersey.

FIGURES 6, 7.—Woodringina claytonensis Loeblich and Tappan, 1957, holotype, USNM P5685; lower Danian, Pine Barren Mbr., Clayton Fm., Alabama.

FIGURE 8.—Woodringina kelleri MacLeod, 1993 (= Woodringina claytonensis Loeblich and Tappan); Zone Pa, DSDP Site 577A/12/2: 44–46 cm; Shatsky Rise, northwestern Pacific Ocean.

FIGURES 9, 10.—Gümbelina midwayensis Cushman, 1940, holotype, USNM CC35715; basal Midway Fm., Sumter Co., Alabama.

FIGURES 11, 16.—Gümbelina trinitatensis Cushman and Renz, 1942, holotype, USNM CC38198; Paleocene, Soldado Fm., Trinidad.

FIGURES 12, 13.—Chilogümbelina midwayensis strombiformis Beckmann, 1957 (= Chiloguembelina midwayensis (Cushman)), holotype, USNM P5771; Globorotalia pseudomenardii Zone, Lizard Springs Fm., Trinidad.

FIGURES 14, 15.—Gümbelina morsei Kline, 1943, holotype, USNM 487301; Danian, Porters Creek Clay, Clay Co., Mississippi.

FIGURES 17, 18.—Chiloguembelina subtriangularis Beckmann, 1957, holotype, USNM P5783; Globorotalia pusilla pusilla Zone, lower Lizard Springs Fm., Trinidad.

FIGURES 19, 20.—Gümbelina wilcoxensis Cushman and Ponton, 1932, holotype, USNM 16218; Wilcox Fm., Ozark, Alabama.
PLATE 14

USNM Primary Type Specimens
(bars = 50 μm)

FIGURES 1–3.—*Globigerina compressa* Plummer, 1926, lectotype, Chicago Field Museum UC55091; upper Danian, Zone P2, Wills Point Fm., Midway Group, Navarro Co., Texas.

FIGURES 4, 8, 12.—*Globorotalia ehrenbergi* Bolli, 1957, holotype, USNM P5060; upper Paleocene, Lizard Springs Fm., Trinidad.

FIGURES 5–7.—*Globorotalia pseudomenardii* Bolli, 1957, holotype, USNM P5061; *Globorotalia pseudomenardii* Zone, Lizard Springs Fm., Trinidad.

FIGURES 9–11.—*Globorotalia uncinata* Bolli, 1957, holotype, USNM P5048; *Globorotalia uncinata* Zone, lower Lizard Springs Fm., Trinidad.

FIGURES 13, 14.—*Globorotalia trinidadensis* Bolli, 1957 (= *Praemurica inconstans* (Subbotina)), holotype, USNM P5044; *Globorotalia trinidadensis* Zone, lower Lizard Springs Fm., Trinidad.

FIGURES 15, 16.—*Globigerina triloculinoides* Plummer, 1926, paratype, USNM 370088; Zone P2, Wills Point Fm., Midway Group, Navarro Co., Texas, Plummer station 23.
PLATE 15

USNM Primary Type Specimens
(bars = 50 μm)

FIGURES 1–3.—Globorotalia strabocella Loeblich and Tappan, 1957, holotype, USNM P5879; Nanafalia Fm., Alabama.

FIGURES 4, 7, 8.—Globigerina soldadoensis Brönnimann, 1952, holotype, USNM 370085; Lizard Springs Fm., Trinidad; type locality of Globorotalia velascoensis Zone of Bolli, 1957a = Zone P5.

FIGURES 5, 6.—Globigerina aquiensis Loeblich and Tappan, holotype, USNM P5839; Aquia Fm., Aquia Creek, Virginia.

FIGURES 9, 10.—Globigerina chascanona Loeblich and Tappan, 1957 (= Acarinina subsphaerica (Subbotina)), holotype, USNM P5842; Zone P4, uppermost Homerstown Fm., New Jersey.

FIGURES 11, 12, 15.—Globorotalia crassata (Cushman) var. aequa Cushman and Renz, 1942, holotype. USNM CC38210; near base of Globorotalia subbotinae Zone, Soldado Fm., Trinidad.

FIGURES 13, 14.—Globigerina daubjergensis Brönnimann, 1953, holotype, USNM CC64879; Danian, Daubjerg Quarry, Denmark.
PLATE 16

USNM Primary Type Specimens
(bars = 50 μm)

FIGURES 1–3.—*Globorotalia albeari* Cushman and Bermúdez, 1949, holotype, USNM CC47413; *Globorotalia pseudomenardii* Zone, Madruga Fm., Cuba.

FIGURES 4–6.—*Globorotalia pusilla laevigata* Bolli, 1957 (= *Igorina albeari* (Cushman and Bermúdez)), holotype, USNM P5065; *Globorotalia pseudomenardii* Zone, Lizard Springs Fm., Trinidad.

FIGURES 7–9.—*Globorotalia pusilla pusilla* Bolli, 1957, holotype, USNM P5064; *Globorotalia pusilla pusilla* Zone, Guayaguayare Well 159, Trinidad Leasholds, Ltd., Lizard Springs Fm., Trinidad.

FIGURES 10–12.—*Globigerina spiralis* Bolli, 1957, holotype, USNM P5030; *Globorotalia uncinata* Zone, lower Lizard Springs Fm., Trinidad.
PLATE 17

USNM Primary Type Specimens
(bars = 50 μm)

FIGURES 1–3.—Globorotalia apanthesma Loeblich and Tappan, 1957, holotype, USNM P5860; Zone P4, Aquia Fm., Virginia.

FIGURES 4–6.—Globorotalia occlusa Loeblich and Tappan, 1957, holotype, USNM P5874; Zone P4, Velasco Shale, Tamaulipas, Mexico.

FIGURES 7–9.—Pseudogloborotalia pasionensis Bermúdez, 1961, holotype, USNM 639063; sample G-58, Rio de Pasion, El Petén, Guatemala.

FIGURES 10–12.—Pulvinulina velascoensis Cushman, 1925, holotype, USNM CC4347; Velasco Fm., San Luis Potosi, Tampico Embayment, eastern Mexico.
PLATE 18

Eoglobigerina edita (Subbotina, 1953)
(Figures 1–14: bars = 50 µm; Figure 15: bar = 20 µm; Figure 16: bar = 10 µm)

FIGURE 1.—Zone Pa, Millers Ferry, Alabama, core 226, sample 85.

FIGURES 2, 3, 5, 6.—Zone Pla, DSDP Site 356/28/2: 144–145 cm; São Paulo Plateau, South Atlantic Ocean.

FIGURES 4, 15, 16.—Zone Pla, Millers Ferry, Alabama, core 225, sample 194; Figures 15, 16, views of wall texture of 3rd chamber of Figure 4.

FIGURE 7.—Zone Pla, Millers Ferry, Alabama, core 225, sample 216.

FIGURES 8–14.—Zone Plc, Brightseat Fm., Maryland.
PLATE 19

*Eoglobigerina eobulloides* Morozova, 1959

(Figures 1–12: bars = 50 µm; Figures 13, 15: bars = 10 µm; Figure 14: bar = 4 µm)

**FIGURES 1, 2, 5, 13–15.** —Zone Pa, Millers Ferry, Alabama, core 226, sample 85; Figures 13–15, views of 3rd chamber of Figure 5 showing spinose cancellate wall texture.

**FIGURES 3, 7, 11, 12.** —Zone Pi, Millers Ferry, Alabama, core 226, sample 216.

**FIGURES 4, 6.** —Zone Pi, DSDP Hole 350A/11/4: 80–82 cm; Greenland.

**FIGURE 8.** —Zone P0, Millers Ferry, Alabama, core 225, sample 349.

**FIGURE 9.** —Zone Pa, Millers Ferry, Alabama, core 226, sample 84.

**FIGURE 10.** —Zone Pi, Brightseat Fm., Maryland.
PLATE 20

*Eoglobigerina spiralis* (Bolli, 1957)

(Figures 1-9, 11: bars = 50 μm; Figure 10: bar = 4 μm)

**Figures 1-6, 10.**—Zone P1c, Midway Fm., Texas, Plummer station 14; Figure 10, view of 5th chamber of Figure 5 showing spinose wall texture.

**Figures 7-9.**—Zone P2, DSDP Site 356/25/5: 109-111 cm.

**Figure 11.**—Zone P2, DSDP Site 356/26/4: 30-32 cm; São Paulo Plateau, South Atlantic Ocean.
PLATE 21

*Parasubbotina pseudobulloides* (Plummer, 1926)

(Figures 1–11: bars = 50 μm; Figures 12–15: bars = 5 μm)

**FIGURES 1–4, 8, 12.**—Zone P2, Midway Group, Texas, sample 8030; Figure 12, view of 2nd chamber of Figure 4 showing cancellate spinose wall texture.

**FIGURES 5, 9.**—Zone P1a, Millers Ferry, Alabama, surface sample 30 feet.

**FIGURES 6, 10, 11, 13, 14.**—Zone P1a, Millers Ferry, Alabama, core 225, sample 216; Figures 13, 14, views of 4th chamber of Figure 6 showing cancellate spinose wall texture.

**FIGURES 7, 15.**—Zone P1a, Millers Ferry, Alabama, core 226, sample 85; Figure 15, view of 2nd chamber of Figure 7 showing cancellate spinose wall texture.
PLATE 22

Parasubbotina aff. pseudobulloides (Plummer, 1926)
(Figures 1–3: bars = 50 μm; Figures 4, 5: bars = 10 μm)

Figures 1–5.—Zone Pa, Millers Ferry, Alabama, core 226, sample 85; Figures 4, 5, views of 2nd chamber of Figure 3 showing weakly developed cancellate spinose wall texture, slightly recrystallized.

Parasubbotina varianta (Subbotina, 1953)
(Figures 6–13: bars = 50 μm; Figures 14, 15: bars = 10 μm; Figure 16: bar = 4 μm)

Figures 6–8, 10–12, 14–16.—Zone P2, DSDP Site 356/25/5: 148–150 cm; São Paulo Plateau, South Atlantic Ocean; Figure 14 (view of 2nd chamber of Figure 6) and Figure 15 (view of 3rd chamber of Figure 12), showing cancellate spinose wall texture.

Figure 9.—Zone P1c, Mexia Clay Mbr., Midway Group, Texas.

Figure 13.—Zone P1a, Millers Ferry, Alabama, core 225, sample 194.
PLATE 23

*Parasubbotina variospira* (Belford, 1984)

(Figures 1–14, 16: bars = 100 μm; Figure 15: bar = 200 μm)

**Figures 1–10, 13, 15, 16.**—Zone P3, DSDP Site 384/10/CC.

**Figures 11, 12, 14.**—Zone P3, DSDP Site 384/9/CC; southeast Newfoundland Ridge, North Atlantic Ocean.
PLATE 24

Subbotina cancellata Blow, 1979
(bars = 100 μm)

FIGURES 1–12.—Zone P1c, DSDP Site 356/26/3: 90–92 cm; São Paulo Plateau, South Atlantic Ocean.

FIGURE 13.—Zone P4, Vincentown Fm., Glendola Well, New Jersey, sample 286–287 feet.

FIGURE 14.—Zone P4, DSDP Site 549/20/5: 20–22 cm; Goban Spur, eastern North Atlantic Ocean.
FIGURES 1–15.—Morphotypes showing a range of variation in the number of chambers in the final whorl and in the coarseness of the cancellate wall texture; Figure 7 shows transitional morphology to Subbotina trivialis (Subbotina, 1953). See “Discussion” under S. cancellata on the relationship with Globigerina fringa Subbotina, 1950. Zone P1c, DSDP Site 356/27/6: 38–40 cm; São Paulo Plateau, South Atlantic Ocean.
PLATE 26

Subbotina triangularis (White, 1928)

(Figures 1–11: bars = 100 µm; Figure 12: bar = 10 µm; Figure 13: bar = 4 µm)

Figures 1, 3, 7, 8, 12, 13.—Zone P4, Vinicentown Fm., Glendola Well, New Jersey, sample 286–287 feet; Figure 12 (view of 3rd chamber of Figure 11) and Figure 13 (view of 2nd chamber of Figure 8) showing spinose wall texture.

Figures 2, 4–6, 9, 11.—Zone P4, Velasco Fm., Tamaulipas, Mexico.

Figure 10.—Upper Paleocene, Khieu River, foraminifer beds.
PLATE 27

Subbotina triloculinoides (Plummer, 1926)
(Figures 1-11: bars = 50 μm; Figures 12, 13: bars = 5 μm)

FIGURE 1.—Zone P4, DSDP Site 549/20/2; 69-71 cm.
FIGURES 2, 6, 7.—Zone P1c, Mexia Clay Mbr., Midway Group, Texas.
FIGURES 3, 10.—Zone P1b, Eureka Core, Gulf of Mexico, sample 6817-6817.5 feet.
FIGURES 4, 9, 12, 13.—Zone P1c, Wills Point Fm., Milam Co., Texas; Figure 12, view of 2nd chamber of Figure 9 showing cancellate spinose wall texture; Figure 13, view of spine hole on interpore ridge.
FIGURE 5.—Zone P1b, Eureka Core, Gulf of Mexico, sample 6820-6820.5 feet.
FIGURE 8.—Zone P1, DSDP Hole 390A/11/4; 80-82 cm; Blake-Bahama Basin, North Atlantic Ocean.
FIGURE 11.—Zone P4, DSDP Site 549/20/5; 20-22 cm; Goban Spur, eastern North Atlantic Ocean.
PLATE 28

*Subbotina trivialis* (Subbotina, 1953)

(Figures 1–11: bars = 100 μm; Figure 12: bar = 10 μm; Figure 13: bar = 4 μm)

**FIGURE 1.**—Zone P1c, upper Midway, Milam Co., Texas, sample 8030.

**FIGURES 2, 5, 9.**—Zone P1, DSDP Hole 390A/11/4: 80–82 cm; Maud Rise, Southern Ocean.

**FIGURES 3, 10, 12, 13.**—Zone P1a, Millers Ferry, Alabama, core 225, sample 194; Figures 12, 13, views of wall of Figure 10 showing cancellate spinose wall texture.

**FIGURE 4.**—Zone P1a, Eureka Core, Gulf of Mexico, sample 6826.5–6827.0 feet.

**FIGURES 6–8, 11.**—Zone P1a, DSDP Site 356/28/2: 144–145 cm; São Paulo Plateau, South Atlantic Ocean.
PLATE 29

Subbotina velascoensis (Cushman, 1925)
(Figures 1–10, 12: bars = 100 μm; Figure 11: bar = 10 μm)

Figures 1, 3–6, 10.—Zone P4, Velasco Fm., Tamaulipas, Mexico.

Figures 2, 8, 9, 11, 12.—Zone P4, Giendola Well, New Jersey, sample 286–287 feet; Figure 11, view of wall of Figure 8 showing cancellate spinose wall texture.

Figure 7.—Zone P4, Nerinea Fm., Pondicherry, South India.
PLATE 30

Hedbergella holmdelensis Olsson, 1964
(bars = 50 μm)

FIGURES 1–16.—Topotypes, upper Maastrichtian, Navesink Fm., New Jersey.

FIGURE 17.—Zone P0, Millers Ferry, Alabama, core 225, sample 346.
PLATE 31

_Hedbergella monmouthensis_ (Olsson, 1960)

(Figures 1–6, 8–13: bars = 50 μm; Figures 7, 14: bars = 10 μm; Figure 15: bar = 4 μm)

FIGURES 1–11.—Topotypes, upper Maastrichtian, Redbank Fm., New Jersey; Figure 7, enlarged view of apertural lips of Figure 1.

FIGURES 12–15.—Zone P0, Millers Ferry, Alabama, core 225, sample 346; Figures 14, 15, views of wall of Figure 13 showing development of primitive pore pits.
PLATE 32

_Globanomalina archeocompressa_ (Blow, 1979)

(bars = 10 μm)

**Figures 1–9.**—Zone P0, Millers Ferry, Alabama, core 225, sample 342.

**Figure 10.**—Zone P0, Millers Ferry, Alabama, core 225, sample 346.

_Globanomalina compressa_ (Plummer, 1926)

(bars = 100 μm)

**Figures 11–13, 15, 16.**—Zone P1c, DSDP Site 356/26/3: 90–92 cm; São Paulo Plateau, South Atlantic Ocean.

**Figure 14.**—Zone P2, DSDP Hole 398D/39/4: 100–102 cm; western Iberian continental margin, eastern North Atlantic Ocean.
PLATE 33

Globanomalina australiformis (Jenkins, 1965)

(Figures 7, 10, 11, 13: bars = 100 μm; Figures 1–4, 6: bars = 40 μm; Figures 8, 9: bars = 50 μm;
Figures 5, 12: bars = 10 μm)

FIGURES 1–6.—Topotypes, Subbotina triloculinoidea Zone, N143/910N.2, Waipara, New Zealand; Figure 5, view of 3rd chamber of Figure 3 showing wall texture.

FIGURES 8, 9.—Lower Paleocene, ODP Hole 738B/23X/CC; Kerguelen Plateau, southern Indian Ocean.

FIGURES 7, 10–13.—Zone P1c, ODP Hole 747C/2R/4: 90–92 cm; Kerguelen Plateau, southern Indian Ocean; Figure 12, view of 4th chamber of Figure 13 showing wall texture.
PLATE 34

*Globanomalina chapmani* (Parr, 1938)  
(bars = 50 μm)

**FIGURES 1, 2, 5, 6.**—Zone P4, Vincentown Fm., Glendola Well, New Jersey, sample 286–287 feet.
**FIGURE 4.**—Zone P4, Vincentown Fm., Whitesville Well, New Jersey, sample 215–220 feet.
**FIGURES 3, 7.**—Zone P4, Nerinea Fm., Pondicherry, South India, sample PT14.

*Globanomalina planoconica* (Subbotina, 1953)  
(bars = 50 μm)

**FIGURES 8–17.**—Zone P4, Velasco Fm., Tamaulipas, Mexico, John Cruz Collection, sample 17.
PLATE 35

Globanomalina compressa (Plummer, 1926)
(Figures 1–3, 5–13, 17: bars = 100 µm; Figure 4: bar = 40 µm)

FIGURES 1, 3, 5, 7, 11.—Zone P1c, Mexia Clay Mbr., Midway Group, Texas.
FIGURE 4.—Zone P2, Wills Point Fm., Texas.
FIGURES 2, 6, 8–10.—Zone P1c, Brightseat Fm., Maryland.
FIGURES 12, 13, 17.—Zone P1c, DSDP Site 356/26/3: 90–92 cm; São Paulo Plateau, South Atlantic Ocean.

Globanomalina ehrenbergi (Bolli, 1957)
(bars = 100 µm)

FIGURES 14–16.—Zone P1c, Mexia Clay Mbr., Midway Group, Texas.
PLATE 36

Globanomalina planocompressa (Shutskaya, 1965)
(Figures 1–4: bars = 40 μm; Figures 5, 6: bars = 100 μm)

FIGURE 1.—Zone Pla, Millers Ferry, Alabama, core 225, sample 194.
FIGURES 2, 3, 6.—Zone Pla, Millers Ferry, Alabama, surface sample 30 feet.
FIGURE 4.—Zone Plb, Eureka Core, Gulf of Mexico, sample 6817–6817.5 feet.
FIGURE 5.—Zone Plc, Brightseat Fm., Maryland.

Globanomalina imitata (Subbotina, 1953)
(Figures 8–13, 15, 16: bars = 40 μm; Figures 7, 14: bars = 100 μm)

FIGURES 7, 16.—Zone Plc, Mexia Clay Mbr., Midway Group, Texas.
FIGURES 8–12.—Zone P4, Vincentown Fm., Whitesville Well, New Jersey, sample 210–215 feet; Figure 12, view showing inner whorl of conical-shaped chambers with pustulose surface.
FIGURES 13–15.—Globanomalina aff. imitata transitional to G. ovalis, Zone P4, Nerinea Fm., Pondicherry, South India, sample PT14.
PLATE 37

Globanomalina ovalis Haque, 1956
(bars = 50 μm)

Figures 1–15.—Zone P4, Nerinea Fm., Pondicherry, South India, sample PT14.
PLATE 38

_Globanomalina pseudomenardii_ (Bolli, 1957)
(bars = 50 μm)

**FIGURES 1–7.**—Zone P4, Velasco Fm., Tamaulipas, Mexico.

**FIGURES 8, 10–16.**—Zone P4, Vincentown Fm., Glendola Well, New Jersey, sample 286–287 feet.

**FIGURE 9.**—Zone P4, Nerinea Fm., Pondicherry, South India, sample PT14.
PLATE 39

Acarinina coalingensis (Cushman and Hanna, 1927)
(bars = 100 μm)

Figures 1, 4, 13–15.—Zone P5, DSDP Site 465/3/1: 59–61 cm; Hess Rise, central North Pacific Ocean.
Figures 2, 3, 8, 12, 16.—Zone P5, DSDP Hole 20C/6/4: 17–19 cm; Brazil Basin, South Atlantic Ocean.
Figures 5–7, 9–11.—Zone P5, ODP Hole 758A/28/1: 50–52 cm; Ninetyeast Ridge, Indian Ocean.
PLATE 40

Acarinina mckannai (White, 1928)

(bars = 100 μm)


FIGURES 5–7.—Zone P4, DSDP Site 384/6/CC; southeast Newfoundland Ridge, North Atlantic Ocean.

FIGURE 8.—Zone P4, DSDP Site 384/7/1: 60–62 cm; southeast Newfoundland Ridge, North Atlantic Ocean.

FIGURES 9–11.—Zone P4, DSDP Site 527/27/1: 30–32 cm; Walvis Ridge, South Atlantic Ocean.

FIGURES 12, 16.—Zone P4, ODP Hole 758A/28/5: 50–52 cm; Ninetyeast Ridge, Indian Ocean.

FIGURE 13.—Late Paleocene, ODP Hole 738C/16R/1: 55–60 cm; Kerguelen Plateau, southern Indian Ocean.

FIGURES 14, 15.—Zone P4, Vincentown Fm., Glendola Well, New Jersey, sample 219–221 feet.
PLATE 41

_Acarinina nitida_ (Martin, 1943)

(Figures 1–4, 7, 10: bars = 40 μm; Figures 13–15: bars = 50 μm; Figures 5, 6, 8, 9, 11, 12, 16: bars = 100 μm)

**FIGURES 1–3, 7.**—Zone P4, DSDP Site 384/9/2: 136–138 cm.

**FIGURES 4, 10.**—Zone P4, DSDP Site 384/8/4: 136–138 cm; southeast Newfoundland Ridge, North Atlantic Ocean.

**FIGURES 5, 8, 9, 11, 12.**—Zone P4, Vincentown Fm., Glendola Well, New Jersey, sample 219–221 feet.

**FIGURE 6.**—Zone P5, ODP Hole 758A/28/3: 50–52 cm; Ninetyeast Ridge, Indian Ocean.

**FIGURE 13.**—Lower Eocene, ODP Hole 738C/10R: 277.78 mbsf.

**FIGURES 14, 15.**—Lower Eocene, ODP Hole 738C/10R/3: 98–102 cm; Kerguelen Plateau, southern Indian Ocean.

**FIGURE 16.**—Upper Paleocene, ODP Hole 690B/25/3: 90–92 cm; Maud Rise, Southern Ocean.
PLATE 42

Acarinina soldadoensis (Brönnimann, 1952)

(bars = 100 μm)

Figure 4.—Zone P5, ODP Hole 758A/28/3: 50–52 cm.
Figures 5–7.—Zone P6a, DSDP Hole 20C/3/1: 1–19 cm; Brazil Basin, South Atlantic Ocean.
Figures 8, 12–14.—Zone P5, DSDP Site 465/3/1: 59–61 cm; Hess Rise, central North Pacific Ocean.
Figures 9–11.—Zone P5, DSDP Site 213/16/1: 104–106 cm; eastern Indian Ocean.
Figures 15, 16.—Zone P4, ODP Hole 758A/28/5: 50–52 cm; Ninetyeast Ridge, Indian Ocean.
PLATE 43

Acarinina strabocella (Loeblich and Tappan, 1957)
(Figures 1, 2, 5: bars = 40 μm; Figures 3, 4, 6–16: bars = 100 μm)

FIGURE 1.—Zone P3b, Hornerstown Fm., New Jersey, NJT 12-1A.
FIGURES 2, 3, 13.—Zone P2, DSDP Site 356/25/5: 148–150 cm; São Paulo Plateau, South Atlantic Ocean.
FIGURES 4, 7, 8, 10, 11, 14, 16.—Zone P2, ODP Hole 750A/11/2: 19–21 cm.
FIGURES 5, 6, 9, 12.—Zone P2/3, ODP Hole 750A/11/1: 149–150 cm; Kerguelen Plateau, southern Indian Ocean.
FIGURE 15.—Zone P3, DSDP Site 384/9/6: 136–138 cm; southeast Newfoundland Ridge, North Atlantic Ocean.
PLATE 44

*Acarinina subsphaerica* (Subbotina, 1947)

(bars = 100 μm)

FIGURES 1, 5, 16.—Zone P4, DSDP Site 384/7/CC; southeast Newfoundland Ridge, North Atlantic Ocean.

FIGURES 2, 3, 8, 10, 13.—Zone P4, DSDP Site 465/5/1: 65–67 cm.

FIGURE 4.—Upper Paleocene, ODP Hole 738C/15R: 322.07 mbsf; southern Kerguelen Plateau, Southern Ocean.

FIGURES 6, 7.—Zone P4, DSDP Site 527/27/1: 30–32 cm; Walvis Ridge, South Atlantic Ocean.

FIGURES 9, 11.—Zone P5, ODP Hole 758A/28/3: 50–52 cm; Ninetyeast Ridge, Indian Ocean.

FIGURE 12.—Zone P4, ODP Hole 761B/17/6: 49–51 cm; Wombat Plateau, eastern Indian Ocean.

FIGURES 14, 15.—Zone P4, DSDP Site 465/4/4: 62–64 cm; Hess Rise, central North Pacific Ocean.
PLATE 45

*Morozovella acuta* (Toulmin, 1941)

(bars = 100 µm)

**FIGURES 1, 3, 5, 6, 9–11.**—Zone P4, Velasco Fm., Tamaulipas, Mexico.

**FIGURES 2, 12–14.**—Zone P3, DSDP Site 465/5/4: 63–64 cm; Hess Rise, central North Pacific Ocean.

**FIGURES 4, 7, 8.**—Zone P4, Vincentown Fm., Glendola Well, New Jersey, sample 230–232 feet.
PLATE 46

_Morozovella acutispira_ (Bolli and Cita, 1960)

(bars = 100 μm)

FIGURES 1–6.—Zone P3b, DSDP Site 527/28/6: 30–32 cm; Walvis Ridge, South Atlantic Ocean.

FIGURES 7, 12.—Zone P4, Vincentown Fm., Whitesville Well, New Jersey, sample 212–220 feet.

FIGURES 8, 9.—Zone P4?, ODP Hole 864C/13/2: 73–75 cm; East Pacific Rise, eastern central Pacific Ocean.

FIGURES 10, 11.—Zone P4, DSDP Site 465/3/4: 62–64 cm; Hess Rise, central North Pacific Ocean.

FIGURES 13–15.—Topotypes, Zone P4, Paderno d’Adda, northern Italy.
PLATE 47

*Morozovella aequa* (Cushman and Renz, 1942)

(Figures 1–3, 7–10, 13–16: bars = 100 μm; Figures 4–6, 11, 12: bars = 200 μm)

**FIGURES 1–3.**—Zone P5, ODP Hole 758A/28/5: 50–52 cm.

**FIGURES 4, 6, 7.**—Zone P5, ODP Hole 758A/28/1: 50–52 cm, Ninetyeast Ridge, Indian Ocean.

**FIGURES 5, 11, 12.**—Zone P5, DSDP Site 465/3/1: 59–61 cm.

**FIGURES 8–10.**—Zone P4, DSDP Site 465/3/3: 98–100 cm; Hess Rise, central North Pacific Ocean.

**FIGURES 13, 14, 16.**—Zone P4, Vincentown Fm., Glendola Well, New Jersey, sample 230–232 feet.

**FIGURE 15.**—Zone P4, Velasco Fm., Tamaulipas, Mexico.
PLATE 48

Morozovella angulata (White, 1928)
(bars = 100 μm)


Figures 4, 5, 7.—Zone P3, DSDP Site 465/6/5: 66–68 cm; Hess Rise, central North Pacific Ocean.

Figure 6.—Zone P2, DSDP Site 384/11/1: 86–88 cm.

Figures 8–10.—Zone P2, DSDP Site 527/30/1: 50–52 cm; Walvis Ridge, South Atlantic Ocean.

Figure 12.—Zone P2, DSDP Site 384/11/3: 30–32 cm.

Figures 13–16.—Zone P2, DSDP Site 384/10/CC; southeast Newfoundland Ridge, North Atlantic Ocean.
PLATE 49

*Morozovella apanthesma* (Loeblich and Tappan, 1957)

(bars = 100 μm)

**FIGURES 1–6.** Zone P4, DSDP Site 465/4/1: 62–64 cm.

**FIGURES 7–9.** Zone P3, DSDP Site 465/6/5: 66–68 cm.

**FIGURES 10, 11.** Zone P3, DSDP Site 384/10/5: 24–26 cm; southeast Newfoundland Ridge, North Atlantic Ocean.

**FIGURES 12–15.** Zone P3a, DSDP Site 465/7/CC; Hess Rise, central North Pacific Ocean.
PLATE 50

*Morozovella conicotruncata* (Subbotina, 1947)

(Figures 1, 5, 9–15: bars = 100 μm; Figures 2–4, 6–8: bars = 200 μm)

**FIGURES 1–3.—Zone P3, DSDP Site 384/10/2: 136–138 cm.**

**FIGURES 4–6.—Zone P3, DSDP Site 465/6/5: 66–68 cm.**

**FIGURES 7–9.—Zone P3b, ODP Hole 758A/31/1: 50–52 cm; Ninetyeast Ridge, Indian Ocean.**

**FIGURES 10–12.—Zone P3, DSDP Site 465/6/3: 61–63 cm; Hess Rise, central North Pacific Ocean.**

**FIGURES 13–15.—Zone P3, DSDP Site 384/10/3: 10–12 cm; southeast Newfoundland Ridge, North Atlantic Ocean.**
PLATE 51

*Morozovella occlusa* (Loeblich and Tappan, 1957)
(bars = 100 μm)

**FIGURES 1-3.**—Zone P4, DSDP Site 465/4/1: 62–64 cm.

**FIGURES 4, 8, 9.**—Zone P4, Velasco Fm., Tamaulipas, Mexico.

**FIGURES 5, 6.**—Zone P4, DSDP Site 384/6/CC; southeast Newfoundland Ridge, North Atlantic Ocean.

**FIGURE 7.**—Zone P4, ODP Hole 758A/29/4: 50–52 cm; Ninetyeast Ridge, Indian Ocean.

**FIGURES 10, 11.**—Zone P4, DSDP Site 465/4/4: 62–64 cm.

**FIGURES 12, 15.**—Zone P4?, ODP Hole 864C/13/2: 73–75 cm; East Pacific Rise, eastern central Pacific Ocean.

**FIGURES 13, 14.**—Zone P4, DSDP Site 465/3/3: 98–100 cm; Hess Rise, central North Pacific Ocean.
PLATE 52

Morozovella pasionensis (Bermúdez, 1961)

(Figures 4, 5, 7, 8, 12, 14: bars = 100 \mu m; Figures 1–3, 6, 9–11, 13, 15: bars = 200 \mu m)

Figures 1–3, 10, 14.—Zone P3, DSDP Site 465/5/2: 62–64 cm.
Figures 4, 7, 13.—Zone P4, DSDP Site 465/3/3: 98–100 cm; Hess Rise, central North Pacific Ocean.
Figures 5, 8, 12.—Zone P4, ODP Site 865B/14/3: 138–140 cm; Allison Guyot, central equatorial Pacific Ocean.
Figure 6.—Zone P4, DSDP Site 384/7/1: 90–92 cm.
Figure 9.—Zone P4, DSDP Site 384/6/CC.
Figure 11.—Zone P4, DSDP Site 384/7/2: 106–108 cm.
Figure 15.—Zone P4, DSDP Site 384/6/3: 30–34 cm; southeast Newfoundland Ridge, North Atlantic Ocean.
PLATE 53

*Morozovella praeangulata* (Blow, 1979)

(bars = 100 μm)

**FIGURES 1–3, 11–13.**—Zone P3b, DSDP Site 356/24/2: 92–94 cm; São Paulo Plateau, South Atlantic Ocean.

**FIGURES 4–6.**—Zone P3, DSDP Site 384/10/5: 24–26 cm.

**FIGURE 7.**—Zone P3b, DSDP Site 465A/1/1: 52–54 cm; Hess Rise, central North Pacific Ocean.

**FIGURE 8.**—Zone P3, DSDP Site 384/10/CC.

**FIGURES 9, 10.**—Zone P2, DSDP Site 384/11/1: 86–90 cm; southeast Newfoundland Ridge, North Atlantic Ocean.
PLATE 54

_Morozovella subbotinae_ (Morozova, 1939)

(Figures 1–3: bars = 50 μm; Figures 4–12: bars = 100 μm)

**Figures 1–3.**—Zone AP6a, ODP Hole 738C/10R: 277.78 mbsf; southern Kerguelen Plateau, southern Indian Ocean.

**Figures 4, 5.**—Zone P5, ODP Hole 756A/28/1: 50–52 cm; Ninetyeast Ridge, Indian Ocean.

**Figures 6–9.**—Zone P4–P5, DSDP Site 465/3/1: 59–61 cm; Hess Rise, central North Pacific Ocean.

**Figures 10–12.**—Zone P5, DSDP Site 213/16/1: 104–106 cm; eastern Indian Ocean.

_Morozovella gracilis_ (Bolli, 1957)

(bars = 100 μm)

**Figures 13–15.**—Zone P5, DSDP Site 213/16/1: 104–106 cm; eastern Indian Ocean.
PLATE 55

*Morozovella velascoensis* (Cushman, 1925)

(Figures 2, 3, 7, 12: bars = 100 μm; Figures 1, 4–6, 8–11, 13–15: bars = 200 μm)

**Figures 1–3.** Zone P5, DSDP Site 213/16/1: 104–106 cm; eastern Indian Ocean.

**Figures 4–6.** Zone P4, DSDP Site 465/3/1: 59–61 cm.

**Figures 7–9.** Zone P4, ODP Hole 758A/28/1: 50–52 cm.

**Figures 10, 12.** Zone P4, DSDP Site 465/3/4: 62–64 cm; Hess Rise, central Pacific Ocean.

**Figure 11.** Zone P5, ODP Hole 758A/28/1: 50–52 cm; Ninetyeast Ridge, Indian Ocean.

**Figures 13–15.** Zone P4, DSDP Site 384/9/CC; southeast Newfoundland Ridge, North Atlantic Ocean.
PLATE 56

_Igorina albeari_ (Cushman and Bermúdez, 1949)

(Figures 1–12, 16: bars = 100 μm; Figures 13, 15: bars = 40 μm; Figure 14: bar = 10 μm)

Figures 1–3, 9.—Zone P4, DSDP Site 465/3/3: 98–100 cm; Hess Rise, central North Pacific Ocean.

Figures 4, 8, 12.—Zone P4, DSDP Site 384/8/1: 126–128 cm; southeast Newfoundland Ridge, North Atlantic Ocean.

Figures 5–7, 10, 11.—Zone P4, ODP Hole 758A/29/4: 50–52 cm; Ninetyeast Ridge, Indian Ocean.

Figures 13, 16.—Zone P4, DSDP Site 356/24/2: 92–94 cm.

Figures 14, 15.—Zone P4, DSDP Site 356/24/1: 110–112 cm; São Paulo Plateau, South Atlantic Ocean.
PLATE 57

*Igorina pusilla* (Bolli, 1957)

(Figures 1, 2, 5, 9–11, 13–16: bars = 100 μm; Figures 3, 4, 6–8, 12: bars = 40 μm)

FIGURES 1, 2.—Zone P4, DSDP Site 384/7/3: 130–132 cm; southeast Newfoundland Ridge, North Atlantic Ocean.

FIGURES 3, 4.—Zone P3b, DSDP Site 3/21/CC; Gulf of Mexico.

FIGURE 5.—Zone P3, ODP Hole 761B/18X/2: 52–54 cm.

FIGURES 6–8, 12.—Zone P4, Vincentown Fm., Glendola Well, New Jersey, sample 286 feet.

FIGURES 9, 10.—Zone P3, DSDP Site 465/6/5: 66–68 cm.

FIGURE 11.—Zone P3, DSDP Site 465/5/4: 63–64 cm; Hess Rise, central Pacific Ocean.

FIGURES 13–16.—Zone P4, ODP Hole 761B/18X/1: 52–54 cm; Wombat Plateau, Indian Ocean.
PLATE 58

*Igorina tadjikistanensis* (Bykova, 1953)

(Figure 1: bar = 40 μm; Figures 2-12: bars = 100 μm)

**FIGURES 1, 2, 4, 6, 8, 10, 12.**—Zone P4, Velasco Fm., Tamaulipas, Mexico.

**FIGURES 3, 5, 7, 9, 11.**—Zone P4, Vincentown Fm., Glendola Well, New Jersey, sample 230–232 feet.
PLATE 59

*Praemurica inconstans* (Subbotina, 1953)

(bars = 100 μm)

**FIGURES 1–3, 13, 15.**—Zone P3, DSDP Site 465/7/CC; Hess Rise, central Pacific Ocean.

**FIGURES 4–7, 12, 16.**—Zone P1c, DSDP Site 356/26/4: 117–118 cm; São Paulo Plateau, South Atlantic Ocean.

**FIGURES 8–11.**—Zone P1c, DSDP Site 527/30/4: 30–32 cm; Walvis Ridge, South Atlantic Ocean.

**FIGURE 14.**—Zone P2, DSDP Site 384/11/3: 30–32 cm; southeast Newfoundland Ridge, North Atlantic Ocean.
PLATE 60

*Praemurica pseudoinconstans* (Blow, 1979)

(Figures 1–11: bars = 50 μm; Figures 12, 13: bars = 10 μm)

**FIGURES 1, 3, 6.**—Zone Pa, Millers Ferry, Alabama, core 226, sample 85.

**FIGURES 2, 10–13.**—Zone P1a, Millers Ferry, Alabama, core 225, sample 194; Figure 12 (view of 2nd chamber of Figure 11) and Figure 13 (view of 4th chamber of Figure 10) showing cancellate nonspinose wall texture.

**FIGURE 4.**—Zone P1a, DSDP Site 384/13/2: 140–142 cm; southeast Newfoundland Ridge, North Atlantic Ocean.

**FIGURE 5.**—Zone P2, DSDP Site 356/25/5: 148–150 cm; São Paulo Plateau, South Atlantic Ocean.

**FIGURES 7, 9.**—Zone P1a, Millers Ferry, Alabama, core 225, sample 216.

**FIGURE 8.**—Zone P1a, DSDP Hole 465A/3/3: 120–122 cm; Hess Rise, central Pacific Ocean.
PLATE 61

*Praemurica taurica* (Morozova, 1961)

(Figures 2, 4, 7, 9, 11, 12: bars = 100 μm; Figures 1, 3, 5, 6, 8, 10, 15: bars = 40 μm; Figures 13, 14: bars = 10 μm)

**Figures 1, 3.**—Zone P1a, Millers Ferry, Alabama, core 225, sample 216.

**Figures 2, 4.**—Zone P1a, Millers Ferry, Alabama, core 225, sample 194.

**Figure 5.**—Zone Pa, Millers Ferry, Alabama, core 226, sample 5.

**Figure 6.**—Zone P1a, ODP Hole 750A/15/2: 8–12 cm; southern Kerguelen Plateau, southern Indian Ocean.

**Figures 7, 9, 13, 14.**—Zone P1a, Millers Ferry, Alabama, sample 30 feet above Prairie Bluff; Figures 13, 14, views of wall of Figure 9 showing cancellate nonspinose wall texture.

**Figure 8.**—Zone Pa, Millers Ferry, Alabama, core 225, sample 334.

**Figure 10.**—Zone Pa, Millers Ferry, Alabama, core 226, sample 15.

**Figures 11, 12, 15.**—Zone P1c, DSDP Site 356/26/CC; São Paulo Plateau, South Atlantic Ocean.
PLATE 62

Praemurica uncinata (Bolli, 1957)
(bars = 100 μm)

FIGURES 1–3, 5–7, 16.—Zone P3, DSDP Site 465/7/CC; Hess Rise, central Pacific Ocean.
FIGURES 4, 8, 9, 12–15.—Zone P2, DSDP Site 384/11/3: 30–32 cm.
PLATE 63

*Guembelitria cretacea* Cushman, 1933

(Figures 1–5, 7–12: bars = 50 μm; Figure 6: bar = 10 μm)

**FIGURES 1–4.**—Upper Maastrichtian, Redbank Fm., New Jersey.

**FIGURES 5, 6, 10–12.**—Zone Pa, Millers Ferry, Alabama, core 226, sample 18; Figure 6, view of wall of Figure 5 showing typical pore mounds of this species; Figure 12, specimen showing transitional morphology to *Woodringina*.


**FIGURES 8, 9.**—Zone Pa, DSDP Site 577/12/5: 115–117 cm; Shatsky Rise, northwestern Pacific Ocean.
PLATE 64

Globoconusa daubjergensis (Brönnimann, 1953)
(Figures 1–7, 10–12: bars = 50 µm; Figures 8, 9: bars = 10 µm)

FIGURES 1–3, 5, 6, 8, 9.—Zone P1c, Brightseat Fm., Maryland; Figure 8 (view of ultimate chamber of Figure 6) and Figure 9 (view of ultimate chamber of Figure 5) showing microperforate wall texture and poreless sharp pustules.

FIGURE 4.—Zone P0, Brazos River, Texas.

FIGURE 7.—Zone P0a, Millers Ferry, Alabama, core 225, sample 256.

FIGURES 10–12.—Zone P1c, Midway Fm., Texas, Plummer station 14.
Plate 65

*Parvularugoglobigerina alabamensis* (Liu and Olsson, 1992)

(Figures 1–5: bars = 50 μm; Figure 6: bar = 10 μm)

Figure 1.—Zone Pla, Millers Ferry, Alabama, core 225, sample 265.

Figures 2, 3.—Zone Pla, Millers Ferry, Alabama, core 225, sample 266.

Figure 4.—Zone Pla, Millers Ferry, Alabama, core 226, sample 20.

Figures 5, 6.—Zone Pla, Millers Ferry, Alabama; Figure 5, holotype, sample 40 feet above Prairie Bluff Chalk; Figure 6, view of wall of 3rd chamber of holotype showing microperforate pore mound texture.

*Parvularugoglobigerina extensa* (Blow, 1979)

(bars = 50 μm)

Figures 7, 9–12.—Zone Pa, DSDP Site 577/12/5: 94–96 cm; Shatsky Rise, northwestern Pacific Ocean.

Figure 8.—Zone Pa, El Kef, Tunisia.

Figure 13.—Zone Pa, type level of *P. eugubina*, Gubbio section, central Appennines, Italy.
PLATE 66

*Parvularugoglobigerina eugubina* (Luterbacher and Premoli Silva, 1964)

(Figures 1–4, 6–12: bars = 50 μm; Figure 5: bar = 10 μm)

FIGURES 1–5.—Zone Pa, Millers Ferry, Alabama, core 225, sample 328; Figure 5, view of wall of 2nd chamber of Figure 2 showing microperforate wall texture with a few incipient pore mounds.

FIGURES 6, 8, 9, 12.—Zone Pa, DSDP Site 577/12/5: 115–117 cm.

FIGURES 7, 10.—Zone Pa, El Kef, Tunisia.

FIGURE 11.—Zone Pa, DSDP Site 577/12/5: 134–136 cm; Shatsky Rise, northwestern Pacific Ocean.
PLATE 67

*Parvularugoglobigerina eugubina* (Luterbacher and Premoli Silva, 1964)

(Figures 1-10, 12, 13: bars = 50 μm; Figures 11, 14: bars = 10 μm)

FIGURES 1–9.—Zone Pa, type level of *P. eugubina*, Gubbio section, central Appennines, Italy.

FIGURES 10–12.—Zone Pa, DSDP Site 577/12/5: 125–126 cm; Shatsky Rise, northwestern Pacific Ocean;
Figure 11, view of Figure 10 showing recrystallized wall that obscures microperforate wall texture.

FIGURES 13, 14.—Zone Pa, Millers Ferry, Alabama, core 226, sample 20; Figure 14, view of wall of 4th chamber
of Figure 13 showing microperforate wall texture and scattered pore mounds.
PLATE 68

Woodringina claytonensis Loeblich and Tappan, 1957
(Figures 1–5: bars = 50 μm; Figure 6: bar = 10 μm)

Figure 1.—Zone P0, Brazos River, Texas.

Figures 2, 6.—Zone P1a, DSDP Hole 390A/11/5: 135–136 cm; Blake–Bahama Basin, North Atlantic Ocean; Figure 6, view of 2nd chamber of Figure 2 showing microperforate wall texture and blunt pustules.

Figure 3.—Zone Pa, Millers Ferry, Alabama, core 226, sample 18.

Figure 4.—Zone P1a, Midway Group, Texas, Plummer station 4.

Figure 5.—Zone Pa, DSDP Site 577/12/5: 115–117 cm; Shatsky Rise, northwestern Pacific Ocean, specimen showing intermediate morphology with Guembelitria cretacea.

Woodringina hornerstownensis Olsson, 1960
(bars = 50 μm)

Figures 7, 8.—Topotypes, Zone P3, Hornerstown Fm., New Jersey.

Figures 9, 10, 13, 14.—Zone Pa, DSDP Site 577/12/5: 113–114 cm; Shatsky Rise, northwestern Pacific Ocean.

Figures 11, 12.—Zone P1c, Midway Fm., Texas, Plummer station 14.
PLATE 69

_Chiloguembelina crinita_ (Glaessner, 1937)

(Figures 1–7: bars = 50 μm; Figure 8: bar = 10 μm)

FIGURES 1–8.—Zone P4, Glendola Well, New Jersey, sample 230–232 feet; Figure 8, view of 2nd chamber of Figure 3 showing pustulose wall texture.

_Chiloguembelina morsei_ (Kline, 1943)

(Figures 9–14: bars = 50 μm; Figure 15: bar = 10 μm)

FIGURES 9, 10.—Danian, ODP Hole 690C/14R/1: 76–80 cm; Maud Rise, Southern Ocean.

FIGURES 11–15.—Zone P2, DSDP Site 356/25/5: 148–150 cm; São Paulo Plateau, South Atlantic Ocean; Figure 15, view of 3rd chamber of specimen showing pustulose wall texture.

_Chiloguembelina midwayensis_ (Cushman, 1940)

(Figures 16, 18–22: bars = 50 μm; Figure 17: bar = 10 μm)

FIGURES 16–22.—Zone P2, DSDP Site 356/25/5: 148–150 cm; São Paulo Plateau, South Atlantic Ocean; Figure 17, view of 3rd chamber of Figure 18 showing pustulose wall texture.
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Chiloguembelina subtriangularis Beckmann, 1957
(Figures 1–3, 5–7: bars = 50 μm; Figure 4: bar = 10 μm)

FIGURES 1–7.—Zone P2, DSDP Site 356/25/5: 148–150 cm; São Paulo Plateau, South Atlantic Ocean; Figure 4, view of 2nd chamber of Figure 7 showing pustulose wall texture.

Chiloguembelina trinitatensis (Cushman and Renz, 1942)
(Figures 8–10: bars = 5 μm; Figure 14: bar = 20 μm)

FIGURES 8, 9.—Zone P5, DSDP Site 152/4/3: 20–24 cm.
FIGURES 10, 14.—Zone P5, DSDP Site 152/4/2: 16–18 cm; Caribbean Sea; Figure 14, view of 3rd chamber of Figure 10 showing pustulose wall texture.

Chiloguembelina wilcoxensis (Cushman and Ponton, 1932)
(Figures 11–13, 15–17: bars = 50 μm; Figure 18: bar = 20 μm)

FIGURES 11–13, 16–18.—Upper Paleocene, ODP Hole 690B/16X/5: 76–80 cm; Maud Rise, Southern Ocean; Figure 12, dissection of Figure 11 showing the asymmetrical position of apertures in earlier formed chambers; Figure 18, view of 2nd chamber of Figure 17 showing pustulose wall texture.

FIGURE 15.—Hypotype, specimen illustrated in Beckmann, 1957, pl. 21: fig. 13; lower Eocene, type Globorotalia rex Zone, Lizard Springs Fm., Trinidad.
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*Zeauvigerina waiparaensis* (Jenkins, 1965)
(Figures 1-4, 6-15, 17, 18: bars = 50 μm; Figures 5, 16: bars = 10 μm)

**FIGURES 1-5.** — *Z. waiparaensis* sensu stricto: Maastrichtian, ODP Hole 750A/46R/1: 130–131 cm; Figure 5, apertural view of Figure 4 showing equidimensional lip partially surrounding aperture.

**FIGURE 11.** — *Z. waiparaensis* sensu stricto: Maastrichtian, ODP Hole 750A/18X/CC.

**FIGURE 12.** — *Z. waiparaensis* sensu stricto: Maastrichtian, ODP Hole 750A/18R/CC.

**FIGURES 6-8.** — *Z. waiparaensis* forma *prolata*: Maastrichtian, ODP Hole 750A/17R/1: 52–54 cm.

**FIGURES 9, 10.** — *Z. waiparaensis* forma *palmula*: Late Paleocene, ODP Hole 738C/13R/CC.

**FIGURES 13-16.** — *Z. waiparaensis* forma *improcera*: Maastrichtian, ODP Hole 750A/16R/1: 130–131 cm; Kerguelen Plateau, southern Indian Ocean; Figure 16, apertural view of Figure 15 showing equidimensional lip partially surrounding aperture.

**FIGURES 17, 18.** — *Z. waiparaensis* forma *velata*: Maastrichtian, ODP Hole 738C/21R/CC; Kerguelen Plateau, southern Indian Ocean.

*Zeauvigerina aegyptiaca* Said and Kenawy, 1956
(bars = 50 μm)

**FIGURES 19, 20.** — Upper Paleocene, DSDP Site 98/12/1: 119–120 cm; Bahama Platform, western Atlantic Ocean.

*"Zeauvigerina" virgata* (Khalilov, 1967)
(Figures 21, 22: bars = 50 μm; Figure 23: bar = 20 μm)

**FIGURES 21-23.** — Upper Paleocene, ODP Hole 750A/11R/2: 40–41; Kerguelen Plateau, southern Indian Ocean; Figure 23, apertural view of Figure 22.

*Rectoguembelina cretacea* Cushman, 1932
(bars = 50 μm)

**FIGURES 24-26.** — Upper Paleocene, DSDP Site 357/30/CC; Rio Grande Rise, South Atlantic Ocean.

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