Zeitschrift: Eclogae Geologicae Helvetiae
Herausgeber: Schweizerische Geologische Gesellschaft
Band: 55 (1962)
Heft: 2

Artikel: Planktonic foraminifera from the type Ilerdian
Autor: Gartner, S. / Hay, William W.
DOI: https://doi.org/10.5169/seals-162937

Planktonic Foraminifera from the Type Ilerdian

By **S. Gartner, Jr.**, and **William W. Hay**
Geology Department, University of Illinois

With 1 table and 2 plates (I and II)

During the spring of 1960, it was possible for W. W. HAY, accompanied by H. SCHAUB, to visit the type section of the Ilerdian stage recently proposed by HOTTINGER and SCHAUB, and to collect a series of samples for study. The trip was made during a year of postdoctoral study at the University of Basel, Switzerland, sponsored by the United States' National Science Foundation. The authors are greatly indebted to L. HOTTINGER and H. SCHAUB for their help and suggestions in carrying out this program of research.

The Paleocene Problem

When the term *Paléocène* was proposed by SCHIMPER in 1874, it was stated to include the *sables de Bracheux*, the *travertin de Sézanne*, the *lignites du Soissonais*, and the *argile plastique*. He had concluded from a study of the flora at Sézanne that these deposits were older than Eocene, but younger than Cretaceous. Although originally defined by its flora, the term Paleocene as applied to terrestrial deposits is now defined on the basis of fossil mammals. The Bracheux sand contains a shallow water marine fauna which has been described in detail by FARCHAD (1936) and serves as the basis for correlation with marine deposits elsewhere. Unfortunately, the molluscs are largely provincial, and correlation with distant areas is uncertain. MANGIN (1957) has suggested that in view of the continental nature of the type locality the term "Paleocene" be dropped altogether and "Lower Eocene" substituted for it. However, the term "Lower Eocene" is even more ambiguous than "Paleocene", and its substitution would only result in further confusion.

For the present, it seems wise to avoid the problem of correlation of marine and non-marine Paleocene terminology. Two sets of stage names, one for continental and one for marine deposits, would add to the objectivity of correlations and avoid semantic pitfalls.

However, until recently there was no marine standard for Upper Paleocene deposits. The interval represented by all or part of the Sparnacian and Landenian could be correlated with marine deposits only on the basis of position in the section, and considerable uncertainty existed. However, in 1960, HOTTINGER and SCHAUB proposed a new stage to represent marine Upper Paleocene. This stage, the Ilerdian, has its type locality in the Tremp basin in the Province of Lerida,

Spain. Works already published or in press (HOTTINGER 1960, SCHAUB 1960) describe the larger Foraminifera of the type Ilerdian. The purpose of the present study is to examine the planktonic foraminifera in order to determine the correlation of the Ilerdian with the planktonic foraminiferal zones already established for the lower Tertiary.

Correlation

In Table I several of the planktonic foraminiferal zonations which have been proposed are compared and correlated. There is a marked similarity between the zonations, although not precisely the same criteria were employed in each case.

The *Globigerina daubjergensis* assemblage characteristic of the *Globorotalia trinidadensis* zone of BOLLI (1957), of the *compressa-daubjergensis* zone of LOEBLICH and TAPPAN (1957a), and of the *Globigerina daubjergensis* subzone of HAY (1960) can be correlated with the type Danian (see LOEBLICH and TAPPAN, 1957b; TROELSEN, 1957; BERGGREN, 1960c). There has been no agreement on the correlation of the stages of the Paleocene of the Paris basin with the planktonic foraminiferal zones, because, except for HAYNES' (1955, 1956) record of *Globorotalia velascoensis* var. *acuta* TOULMIN from the Thanet sand, no diagnostic planktonic foraminifera have been found there. LOEBLICH and TAPPAN (1957b) have reported *Globigerina daubjergensis* BRÖNNIMANN and *Globorotalia pseudobulloides* (PLUMMER) from the *tuffeau de Ciply*, the unit immediately beneath the *calcaire de Mons* (type Montian), concluding that the Montian stage of Belgium is equivalent to the Danian stage of Denmark. They placed the Montian along with the Danian at the base of the Paleocene, and correlated them with their *Globorotalia compressa–Globigerina daubjergensis* zone. HOFKER (1959, 1961), on the other hand, recorded *Globorotalia pseudomenardii* BOLLI, *Globorotalia ehrenbergi* BOLLI, and *Globorotalia pusilla laevigata* BOLLI from the *tuffeau de Ciply*, and stated that the specimens of LOEBLICH and TAPPAN are probably *Globigerina triloculinoides* PLUMMER. Consequently HOFKER correlated the Montian with the *Globorotalia pusilla pusilla* and the *Globorotalia pseudomenardii* zones established by BOLLI (1957) in Trinidad. This correlation was accepted by BOLLI and CITA (1960). In the course of the present investigation a number of samples from the *tuffeau de Ciply* were examined, but only one specimen of planktonic foraminifer has been found. This specimen resembles closest *Globigerina daubjergensis* BRÖNNIMANN. Neither LOEBLICH and TAPPAN nor HOFKER has illustrated the planktonics from the *tuffeau de Ciply*, and until these are described in detail and illustrated the exact correlation remains in doubt. Correlation of the *calcaire de Mons* also remains uncertain, because no planktonic foraminifera are known from it. The *Globorotalia angulata* zone of LOEBLICH and TAPPAN was correlated with the Landenian, based on HAYNES' record of specimens similar to *Globorotalia velascoensis* var. *acuta* TOULMIN from the Thanet sand of England.

In contrast to the sparse and ambiguous planktonic foraminiferal faunules from the Paris basin region, deposits in southern Europe contain assemblages that can be correlated with the established zones.

The lower part of the type Ilerdian on the west side of the Tremp basin contains the following species of planktonic foraminifera:

Globorotalia acarinata (SUBBOTINA)
Globorotalia aequa CUSHMAN and RENZ
Globorotalia esnaensis (LEROY)
Globorotalia velascoensis CUSHMAN ssp. *parva* REY
Globorotalia pseudomenardii BOLLI
Globorotalia cf. *G. uncinata* BOLLI
Globigerina aquiensis LOEBLICH and TAPPAN
Globigerina chascanona LOEBLICH and TAPPAN
Globigerina sp. cf. *G. inaequispira* SUBBOTINA
Globigerina varianta SUBBOTINA

This assemblage may be assigned to the *Globorotalia pseudomenardii* zone as defined by BOLLI (1957).

Ilerdian deposits at Mont Cayla near Agel in southern France have yielded the following species of planktonic foraminifera:

Globorotalia angulata (WHITE)
Globorotalia convexa SUBBOTINA
Globorotalia esnaensis (LEROY)
Globorotalia mckannai (WHITE)
Globorotalia nicoli MARTIN
Globorotalia caylaensis n. sp.
Globigerina aquiensis LOEBLICH and TAPPAN
Globigerina soldadoensis BRÖNNIMANN
Globigerina triloculinoides PLUMMER

This assemblage is less distinctive and might belong to either the *Globorotalia pseudomenardii* or *Globorotalia velascoensis* zones of BOLLI, or to LOEBLICH and TAPPAN's *Globorotalia angulata* zone.

The *Globorotalia pseudomenardii* zone is distinguished from the *Globorotalia velascoensis* zone by the presence of the species *G. pseudomenardii*. The *G. velascoensis* zone assemblage has been found to overlie the *G. pseudomenardii* zone consistently in Mexico (HAY, 1960), but the species *G. velascoensis* is restricted geographically and has not been found as far north as *G. pseudomenardii*. Distinction between planktonic foraminiferal zones in the Gulf and Atlantic coastal regions of the United States is not as easy as further to the south in the Caribbean region because the faunas tend to become impoverished. Thus the zonation proposed by LOEBLICH and TAPPAN (1957a) is apparently quite different from that of BOLLI. Examination of the distribution chart given by LOEBLICH and TAPPAN reveals that *G. pseudomenardii* BOLLI is present in a number of deposits in the United States: the Matthews Landing marl and Salt Mountain limestone of Alabama, the Aquia formation of Virginia and Maryland, and the Hornerstown and Vincentown formations of New Jersey. It is also present in the Nanafalia formation, the base of the Wilcox group in Alabama, which was considered "*rex* zone" (Eocene) by LOEBLICH and TAPPAN. The Nanafalia formation has long been called Eocene as a matter of convention. BRAMLETTE and SULLIVAN (1961) have suggested that it is Middle Paleocene on the basis of a nanofossil assemblage from it, and the presence of *Globorotalia pseudomenardii* BOLLI substantiates this view. The "*rex* zone"

assemblage of LOEBLICH and TAPPAN is not the same as that of the *Globorotalia rex* zone of BOLLI in the upper Lizard Springs formation of Trinidad. *Globorotalia pseudomenardii* BOLLI has not been reported from the Coal Bluff marl of Alabama which overlies the Matthews Landing marl and underlies the Salt Mountain limestone, indicating that the species is more subject to ecologic control than some others. It now seems fully justifiable to correlate the "*angulata* zone" and "*rex* zone" of LOEBLICH and TAPPAN with the *Globorotalia pseudomenardii* zone of BOLLI. From the distribution chart of LOEBLICH and TAPPAN, it would appear that only the *Globigerina daubjergensis* and *Globorotalia pseudomenardii* zones of BOLLI can be identified in the Atlantic and Gulf coastal regions of the United States and that the other zones recognized by BOLLI and by HAY are represented either by deposits which contain no planktonics or by local hiati.

In the literature, the presence of *Globorotalia pseudomenardii* is often indicated by reference to *Globorotalia membranacea* (EHRENBERG). However, *Globorotalia membranacea* (EHRENBERG) is actually a Pliocene species and a junior synonym of *Globorotalia cultrata* (D'ORBIGNY) and not closely related to its Paleocene homeomorph.

In California *Globorotalia membranacea* (EHRENBERG) has been reported from the Penutian, Bulitian and Ynezian stages by MALLORY (1959), and a re-evaluation of the California Paleocene planktonic Foraminifera might permit more detailed correlation with the Caribbean region.

In Central America, HAY (1960) found the *Globorotalia pseudomenardii* zone distinctly developed in the Velasco formation of northeastern Mexico. In Guatemala (VINSON, 1962) *Globorotalia membranacea* (EHRENBERG) (=*Globorotalia pseudomenardii* BOLLI), has been recorded from the Cambio formation, but refined zoning has not been done.

In South America specimens very similar to *Globorotalia pseudomenardii* BOLLI have been reported from lower Eocene Chacra shale of Peru (WEISS, 1950). However, *Globorotalia crassata aequa* CUSHMAN and RENZ (=*Globorotalia aequa* CUSHMAN and RENZ), which is commonly associated with *Globorotalia pseudomenardii* BOLLI, has been noted only from below this unit. A more detailed study might reveal the presence of a distinctly developed *Globorotalia pseudomenardii* zone.

In Europe the *Globorotalia pseudomenardii* zone has been recognized by BOLLI and CITA (1960a) in the Paleocene section of Paderno d'Adda of northern Italy, where all zones of the Paleocene seem to be well developed in marine deposits. In Austria (KÜHN, 1960) *Globorotalia membranacea* (EHRENBERG) (=*Globorotalia pseudomenardi* BOLLI) has been recorded from the "Danian II" of the Gams basin. A cursory examination of samples from the Aquitaine basin of France on the road N134 bis, between Gan and Rebenacq, near kilometerstone "Laruns 26" has shown *Globorotalia pseudomenardii* BOLLI to be present there also, associated with the typical fauna of this zone. DURAND-DELGA and MAGNÉ have reported *Globorotalia membranacea* (EHRENBERG) (=*Globorotalia pseudomenardii* BOLLI) from several Paleocene sections in the eastern Betic Cordillera of southern Spain.

In the northern Caucasus region of the USSR *Globorotalia membranacea* (EHRENBERG) (=*Globorotalia pseudomenardii* BOLLI) has been recorded from the zone of *Globorotalia crassata* CUSHMAN (SUBBOTINA, 1953). *Globorotalia crassata*

(CUSHMAN) of SUBBOTINA is in part equivalent to *Globorotalia aequa* CUSHMAN and RENZ, a species which is almost everywhere abundant in the *Globorotalia pseudomenardii* zone.

<table>
<tr><th>Trinidad
BOLLI. 1957
Zone</th><th colspan="2">Gulf and Atlantic Coastal Regions, North America
LOEBLICH and TAPPAN, 1957a</th><th colspan="2">Tampico Embayment, Mexico
HAY, 1960</th></tr>
<tr><td>Globorotalia velascoensis</td><td colspan="2">?</td><td colspan="2">Globorotalia velascoensis</td></tr>
<tr><td rowspan="2">Globorotalia pseudomenardii</td><td colspan="2">rex zone</td><td colspan="2" rowspan="2">Globorotalia pseudomenardii</td></tr>
<tr><td rowspan="2">angulata zone</td><td>velascoensis-acuta-spiralis subzone</td></tr>
<tr><td>Globorotalia pusilla pusilla</td><td>pseudobulloides subzone</td><td rowspan="3">Globigerina zone</td><td rowspan="2">Globorotalia uncinata subzone</td></tr>
<tr><td>Globorotalia uncinata</td><td colspan="2">?</td></tr>
<tr><td>Globorotalia trinidadensis</td><td colspan="2">compressa-daubjergensis zone</td><td>Globigerinoides daubjergensis subzone</td></tr>
</table>

Table I. Comparison and correlation of some zonations of the Paleocene based on planktonic foraminifera

Along the south side of the Mediterranean *Globorotalia pseudomenardii* BOLLI has been recorded as *Globorotalia membranacea* (EHRENBERG) from Morocco to Israel. In Morocco, REY (in CUVILLIER et al, 1955) noted what corresponds to the *Globorotalia pseudomenardii* zone as the lower of three zones above the *Globotruncana* beds of the Prerif region. *Globorotalia pseudomenardii* BOLLI is not known in Algeria, however MAGNÉ and SIGAL (in CUVILLIER et al, 1955) have recorded a fauna (zone c) similar to that of LOEBLICH and TAPPAN's "*angulata* zone" fauna, and refer it to the Montian (Paleocene). Further east in Tunisia, according to DALBIEZ and GLINTZBOECKEL (in CUVILLIER et al, 1955), the zone of *Truncorotalia* (with a *Globorotalia pseudomenardii* zone assemblage) can be recognized. BUROLLET and MAGNIER (1960) have similarly recorded this zone of *Truncorotalia* from the El Haria formation of Libya. REISS (1952) has recorded *Globorotalia membranacea* (EHRENBERG) (= *Globorotalia pseudomenardii* BOLLI) from the Taguiya marls of Israel.

LYS (1960) has noted *Globorotalia membranacea* (EHRENBERG) (= *Globorotalia pseudomenardii* BOLLI) in deposits in the Majunga basin of Madagascar.

It appears from the foregoing that *Globorotalia pseudomenardii* BOLLI has a world wide distribution in Paleocene marine sediments, and a restricted stratigraphic range. It is a key for correlation of the Paleocene in widely separated areas.

List of samples studied

Mont Cayla, near Agel, Aude, France:

Marne bleue —Locality 15 of HOTTINGER (1958)
Marne blanche—Locality 14 of HOTTINGER (1958).

Section along road from Tremp to Puente de Montañana, Lerida, Spain[1]):

A—Turritella marl at km 20
B—Marl from bottom of cut at km 18.9
C—Marl with assilinids from top of cut at km 18.9.

SYSTEMATIC DESCRIPTION

In the systematic description the suprageneric classification of LOEBLICH and TAPPAN (1961) is followed.

There remains some doubt as to the correct placement of some species, as for example *Globorotalia mckannai* (WHITE), which could be placed in the genus *Globigerina* with equal justification. For the sake of order and uniformity the definitions of the genera given by BOLLI, LOEBLICH, and TAPPAN (1957) are followed.

All type material is deposited in the collection of the Department of Geology of the University of Illinois.

Phylum Protozoa
Subphylum Sarkodina
Class Rhizopodea
Subclass Granuloreticulosia
Order Foraminiferida
Superfamily Globerinacea

Family Globorotaliidae

Subfamily Globorotaliinae

GENUS GLOBOROTALIA

Type species: *Pulvinulina menardii* (D'ORBIGNY) var. *tumida* BRADY, 1877.

Remarks: "*Globorotalia* differs from *Globotruncana* CUSHMAN in having an interiomarginal, extraumbilical-umbilical aperture and a simple umbilicus, and in lacking the umbilical tegilla and accessory intralaminal and infralaminal apertures. It differs from *Truncorotaloides* BRÖNNIMANN and BERMUDEZ in lacking the secondary sutural aperture on the spiral side." (BOLLI, LOEBLICH, and TAPPAN, 1957, p. 41.) *Globigerina* D'ORBIGNY differs in having an interiomarginal aperture restricted to the umbilicus.

[1]) In September, 1962, HAY ,HOTTINGER and SCHAUB visited the section along the road from Tremp to Puente de Montañana again. The exposures at km 20 and 18.9 are above the highest occurence of alveolinids of the *Alv. cucumiformis* zone and below the lowest occurence of those of the *Alv. corbarica* zone. The nummulitids found at the top of the cut at km 18.9 include *Nummulites atacicus*, *N. globulus*, *N. exilis*, *N. spirectypus* and *Assilina leymeriei* and are characteristic of *N. atacicus* zone (SCHAUB, personal communication).

Globorotalia acarinata (SUBBOTINA)

1953. *Acarinina acarinata* SUBBOTINA, Trudy. Vses. Neft. Naukno-Issledov. Geol.-Razved. Inst., new ser., v. *76*, p. 229, pl. XXII, figs. 4–9.

Remarks: *Globorotalia acarinata* (SUBBOTINA) is similar to *Acarinina crassaformis* (GALLOWAY and WISSLER) of SUBBOTINA, but is distinguished by its rounded periphery and convex spiral side. *Globorotalia acarinata* (SUBBOTINA) differs from *Acarinina interposita* SUBBOTINA in having chambers which increase more rapidly in size and are more compressed. This species is placed in the genus *Globorotalia* as redefined by BOLLI, LOEBLICH, and TAPPAN, 1957, since the position of the aperture is exteriomarginal, umbilical-extraumbilical.

Occurrence: This species was originally described by SUBBOTINA from the lower Tertiary of the northern Caucasus region of the USSR.

In the section along the road from Tremp to Puente de Montañana *Globorotalia acarinata* (SUBBOTINA) was found at localities A, B, and C.

Globorotalia angulata (WHITE)

Pl. I, figs. 6a–c

1928. *Globigerina angulata* WHITE, Journ. Paleont., v. *2*, no. 3, p. 191, pl. 27, figs. 13a–c.
1953. *Acarinina conicotruncata* (SUBBOTINA), Trudy Vses. Neft. Naukno.-Issledov. Geol.-Razved. Inst., new ser., vol. *76*, p. 220, pl. XX, figs. 5a–12c.
1957. *Globorotalia angulata* (WHITE), BOLLI, US Nat. Mus. Bull. 215, p. 74, pl. 17, figs. 7–9.
1957. *Globorotalia angulata* (WHITE), LOEBLICH and TAPPAN, US Nat. Mus. Bull. 215, p. 187, pl. 45, figs. 2a–c; pl. 50, figs. 4a–c; pl. 55, figs. 2a–c, 6a–7c; pl. 58, figs. 2a–c; pl. 64, figs. 5a–c.
1960. *Globorotalia angulata* (WHITE), OLSSON, Journ. Paleont., v. *34*, no. 1, p. 44, pl. 8, figs. 14–16.
1960. *Globorotalia angulata* (WHITE), HAY, Report, Internat. Geol. Congr., XXI Session, Norden, Part V, Section 5, p. 73.
1960. *Globorotalia angulata* (WHITE), LYS, idem., p. 123.
1960. *Truncorotalia angulata* (WHITE), BUROLLET and MAGNIER, idem., p. 136.
1960. *Globorotalia angulata* (WHITE), BOLLI and CITA, idem., p. 156.
1960. *Truncorotalia angulata* (WHITE), KÜHN, idem., p. 167.
1960. *Globorotalia angulata* (WHITE), BOLLI and CITA, Riv. Ital. Paleont., v. LXVI, no. 3, p. 18, pl. XXXXIII, figs. 8a–c.
1960. *Globorotalia angulata* (WHITE), BERGGREN, Stockholm Contr. Geol., v. VI:5, p. 74.
1961. *Pseudogloborotalia angulata* (WHITE), BERMUDEZ, Memoria del III Congreso Geologico Venezolano, Tomo III Boletin de Geologia, Publicacion especial 3, p. 1337–1338.

Remarks: *Globorotalia angulata* (WHITE) differs from *Globorotalia aequa* CUSHMAN and RENZ in that it usually has a greater number of chambers per volution, the chambers increase in size more rapidly, and the sutures on the spiral side are more nearly straight and tangential. *Globorotalia angulata* (WHITE) differs from *Globorotalia caylaensis* n. sp. in that it has a more lobate periphery, angular margin, and nearly plano-convex coiling. The last volution of *Globorotalia caylaensis* n. sp. usually rises above the plane of the periphery so that the spiral side is broadly convex.

Globorotalia angulata abundocamerata BOLLI is an extreme variation of the central form, but its range is not significantly different from *Globorotalia angulata* (WHITE). SUBBOTINA includes typical *Globorotalia angulata abundocamerata* BOLLI in *Acarinina conicotruncata* (SUBBOTINA), a junior synonym of *Globorotalia angulata* (WHITE) (see BERGGREN, 1960b).

Hypotype: T-1801.

Maximum diameter: 0.27 mm.

Occurrence: *Globorotalia angulata* (WHITE) was first described by WHITE as ranging "from the base of the Velasco formation up into the lower part of the middle portion of that formation". SUBBOTINA has recorded the species from the zone of Danian foraminifers which BERGGREN regards as belonging somewhere between the middle and the top of the Paleocene.

BOLLI has found *Globorotalia angulata* (WHITE) from the top of the *Globorotalia uncinata* zone to the middle of the *Globorotalia pseudomenardii* zone of the Lizard Springs formation of Trinidad, and LOEBLICH and TAPPAN have recorded it from the Vincentown formation of New Jersey, the Salt Mountain limestone of Alabama, the Aquia formation of Maryland–Virginia, the Velasco formation of Mexico, the Matthews Landing marl member of the Porters Creek clay of Alabama, and the Hornerstown formation of New Jersey. HAY has recorded the species from the top of the *Globorotalia uncinata* subzone to the top of the *Globorotalia velascoensis* zone in the Velasco formation of Mexico. LYS states that in the Paleocene of Madagascar *Globorotalia angulata* (WHITE) occurs abundantly in a zone above the Danian and below the zone characterized by *Globorotalia velascoensis* (CUSHMAN). BUROLLET and MAGNIER have found this species to range throughout the zone of *Truncorotalia* in Libya. BOLLI and CITA have noted the species from the top of the *Globorotalia uncinata* through the bottom of the *Globorotalia pseudomenardii* zones of the Paleocene of Paderno d'Adda of northern Italy. KÜHN lists the species from the "Danian II" of Austria.

Globorotalia angulata (WHITE) is found in abundance in the "marne bleue" of Mont Cayla.

Globorotalia aequa CUSHMAN and RENZ

Pl. II, figs. 1a–2b

1942. *Globorotalia crassata* (CUSHMAN) var. *aequa* CUSHMAN and RENZ, Contr., Cushman Lab. Foram. Res., v. *18*, no. 2, p. 12, pl. 3, figs. 3a–c.

1953. *Globorotalia crassata* (CUSHMAN) var. *aequa* CUSHMAN and RENZ, HAMILTON, Journ. Paleont. v. *27*, no. 2, p. 230, pl. 30, figs. 21, 22.

1953. *Globorotalia crassata* CUSHMAN, SUBBOTINA (in part), Trudy Vses. Neft. Naukno-Issledov. Geol.-Razved. Inst., new ser., v. *76*, p. 211, pl. 27, figs. 7a–12c.

1957. *Globorotalia aequa* CUSHMAN and RENZ, BOLLI, US Nat. Mus. Bull. 215, p. 74, pl. 17, figs. 1–3; pl. 18, figs. 13–15.

1957. *Globorotalia aequa* CUSHMAN and RENZ, LOEBLICH and TAPPAN, idem., p. 186, pl. 46, figs. 7a–8c; pl. 50, figs. 6a–c; pl. 55, figs. 8a–c; pl. 59, figs. 6a–c; pl. 60, figs. 3a–c; pl. 64, figs. 4a–c.

1960. *Globorotalia aequa* CUSHMAN and RENZ, HAY, Report, Internat. Geol. Congr., XXI Session, Norden, Part V, Section 5, p. 73.

1960. *Globorotalia aequa* CUSHMAN and RENZ, BOLLI and CITA, Riv. ital. Paleont., v. LXVI, no. 3, pp. 17–18, pl. 31, figs. 5a–c.

1960. *Globorotalia aequa* CUSHMAN and RENZ, BERGGREN, Stockholm Contr. Geol., v. VI:5, p. 78.

1961. *Pseudogloborotalia aequa* (CUSHMAN and RENZ), BERMUDEZ, Memoria del III Congreso Geologico Venezolano, Tomo III Boletin de Geologia, Publicacion especial 3, Caracas, Venezuela, p. 1336, pl. 16, fig. 4.

Remarks: Within the species *Globorotalia aequa* CUSHMAN and RENZ two groups can be recognized. One is identical with the holotype in always having $3^1/_2$

chambers in the last volution, so that the last chamber makes up nearly half of the final volution, giving the test a sub-rectangular appearance in umbilical and spiral view (see pl. II, figs. 1a–c, see also LOEBLICH and TAPPAN, 1957, pl. 59, figs. 6a–c, pl. 64, figs. 4a–c).

Members of the other group are more common and usually have 4–4$^1/_2$, rarely 5 or 5$^1/_2$ chambers in the last volution. The chambers increase in size less rapidly and are arranged more compactly. Both groups show a preference for sinistral coiling. The two groups are present both in Spain and in the *Globorotalia pseudomenardii* zone of the Velasco formation (see pl. II, figs. 2a–b; see also BOLLI, 1957, pl. 17, figs 1–3; LOEBLICH and TAPPAN, idem., pl. 60, figs. 3a–c), and in a sample from the type Spilecciano of Italy.

Globorotalia aequa CUSHMAN and RENZ differs from *Globorotalia angulata* (WHITE) in that it has fewer chambers in the last volution with the chambers increasing in size more rapidly. *Globorotalia acuta* TOULMIN has a larger umbilicus, a more pronounced umbilical shoulder, a greater number of chambers in the final volution, a less lobate periphery, and a flatter spiral side.

Specimens from Tremp differ slightly from the holotype in having a weak beaded keel and an umbilical shoulder in mature specimens. The sutures on the spiral side are weakly beaded.

Hypotypes: T-1802, T-1803.

Maximum diameters: 0.40 mm, 0.34 mm.

Occurrence: This species was first described by CUSHMAN and RENZ from Soldado Rock near Trinidad. HAMILTON has recorded the species from Paleocene deposits on seamounts in the Pacific Ocean. SUBBOTINA has noted the species in the lower Tertiary of the northern Caucasus region of the USSR.

BOLLI has found that in Trinidad the species ranges from the bottom of the *Globorotalia pseudomenardii* zone through the *Globorotalia rex* zone of the Lizard Springs formation. LOEBLICH and TAPPAN have recorded *Globorotalia aequa* CUSHMAN and RENZ from the Vincentown limesand of New Jersey, from the Velasco formation of Mexico, from the Aquia formation of Maryland–Virginia, from the Nanafalia formation of Alabama, and from the Coal Bluff marl member of the Naheola formation of Alabama.

HAY has also recorded it from the *Globorotalia pseudomenardii* and the *Globorotalia velascoensis* zones of the Velasco formation of Mexico, and BOLLI and CITA have noted the species from the *Globorotalia velascoensis* zone of the Paleocene of Paderno d'Adda in Italy.

In the Ilerdian of Tremp this species is found at localities A, B, and C.

Globorotalia caylaensis n. sp.

Pl. I, figs. 2a–c

1953. *Globorotalia* aff. *G. angulata* (WHITE), HAMILTON, Journ. Paleont., v. 27, no. 2, p. 229, pl. 31, figs. 19–20.

Diagnosis: Radial periphery faintly lobate; axial periphery rounded; umbilicus small, deep, open, surrounded by coarse spines; sutures on umbilical side straight, radial, depressed; sutures on spiral side slightly curved; aperture exteriomarginal, umbilical-extraumbilical.

Description: Test trochoid, biconvex, equatorial periphery faintly lobate, axial periphery rounded; test calcareous perforate, entirely covered by spines which are coarse around the umbilicus; all chambers exposed on the spiral side, but only those of the last volution are distinct; 5–6 chambers of the last volution visible on the umbilical side; sutures on umbilical side straight, radial, flush, becoming depressed in last volution of mature specimens; sutures on spiral side slightly curved, tangential, depressed near periphery; umbilicus small, deep, open; aperture interiomarginal lunate arch, extending over about 2/3 of the base of the apertural face, usually with narrow lip, umbilical-extraumbilical, sinistral coiling prevalent.

Remarks: *Globorotalia caylaensis* n. sp. differs from *Globorotalia mckannai* (WHITE) in that the latter has a more convex spiral side, more globular chambers, wider umbilicus, and a more lobate periphery and rounded margin. *Globorotalia angulata* (WHITE) has a larger umbilicus, more angular margin sometimes with a faintly developed keel, and a more extraumbilical position of the aperture.

Holotype: T-1810, Pl. I, figs. 2a–c.

Paratypes: T-1810 (1–15).

Locus typicus: Mont Cayla (Aude, eastern Aquitaine, France).

Stratum typicum: marne bleue.

Maximum diameter of holotype: 0.32 mm.

Range of max. diameter: 0.20–0.32 mm.

Occurrence: This species occurs in the "marne bleue" of Mont Cayla.

HAMILTON has found similar specimens in a Paleocene fauna from the Hess guyot in the Pacific.

Globorotalia convexa SUBBOTINA

Pl. I, figs. 4a–c

1953. *Globorotalia convexa* SUBBOTINA, Trudy Vses. Neft. Naukno-Issledov. Geol.-Razved. Inst., new ser., v. *76*, p. 209, pl. XVII, figs. 2a–3c.

1957. *Globorotalia convexa* SUBBOTINA, LOEBLICH and TAPPAN, US Nat. Mus. Bull. 215, p. 188, pl. 48, figs. 4a–c; pl. 50, figs. 7a–c; pl. 53, figs. 6a–8c; pl. 57, figs. 5a–6c; pl. 61, figs. 4a–c; pl. 63, figs. 4a–c.

1960. *Globorotalia convexa* SUBBOTINA, OLSSON, Journ. Paleont., v. *34*, no. 1, p. 45, pl. 9, figs. 13–15.

1960. *Globorotalia convexa* SUBBOTINA, HAY, Report, Internat. Geol. Congr., XXI Session, Norden, Part V, Section 5, p. 72.

1960. (*?*) *Globorotalia convexa* SUBBOTINA, BERGGREN, Stockholm Contr. Geol., v. V:3, p. 91, pl. XI, figs. 1a–c.

1961. *Pseudogloborotalia convexa* (SUBBOTINA), BERMÚDEZ, Memoria del III Congreso Geologico Venezolano. Tomo III Boletin de Geologia, Publicacion especial 3, 1960, Caracas, Venezuela, p. 1340.

Remarks: This species is distinguished from *Globorotalia pseudoscitula* GLAESSNER in having a more rounded margin, lacking a keel, having a small or closed umbilicus, and in having the entire surface of the test covered with fine nodes and spines. *Globorotalia mckannai* (WHITE) has a more broadly rounded margin, more inflated chambers, larger umbilicus, and an umbilical-extraumbilical aperture.

Hypotype: T-1804.

Maximum diameter: 0.20 mm.

Occurrence: *Globorotalia convexa* SUBBOTINA was originally described from lower Tertiary deposits of the northern Caucasus region of the USSR. LOEBLICH and TAPPAN have noted its occurrence in the Vincentown and the Hornerstown formation of New Jersey, the Aquia formation of Maryland–Virginia, the Salt Mountain limestone and Nanafalia formation of Alabama, and the Velasco formation of Mexico. It has also been recorded by OLSSON from the lower Tertiary of New Jersey, and HAY has recorded it from the *Globorotalia pseudomenardii* and *Globorotalia velascoensis* zones in the Velasco formation of the Tampico embayment in Mexico.

The specimen figured by BERGGREN from the lower Eocene of northwestern Germany is questionably referred to this species, as the figure does not resemble very closely SUBBOTINA's figures of the species.

Globorotalia convexa SUBBOTINA is found in the "marne bleue" of the Ilerdian of Mont Cayla.

Globorotalia esnaensis (LEROY)

Pl. II, figs 4a–c

1953. *Globigerina esnaensis* LEROY, Geol. Soc. Amer. Mem. 54, p. 31, pl. 6, figs. 8–10.
1953. *Acarinina pseudotopilensis* SUBBOTINA, Trudy Vses. Neft. Naukno-Issledov. Geol.-Razved. Inst., new ser., v. *76*, p. 227, pl. XXI, figs. 8a–9c; pl. XXII, figs. 1a–3c.
1957. *Globorotalia esnaensis* (LEROY), LOEBLICH and TAPPAN, US Nat. Mus. Bull. 215, p. 189, pl. 57, figs. 7a–c (?); pl. 61, figs. 1a–2c, 9a–c.
1960. (*?*) *Globorotalia esnaensis* (LEROY), BERGGREN, Stockholm Contr. Geol., v. V:3, p. 92, pl. V, figs. 3a–c; pl. VI, figs. 1a–c; pl. X, figs. 3a–c.
1960. *Globorotalia wilcoxensis* CUSHMAN and PONTON, BERGGREN, idem., p. 97, pl. XIII, figs. 3a–4c.
1961. (?) *Globigerina esnaensis* LEROY, BERMÚDEZ, Memoria del III Congreso Geologico Venezolano, Tomo III Boletin de Geologia, Publicacion especial 3, 1960, Caracas, Venezuela, p. 1180, pl. 1, figs. 6a–c.

Remarks: *Globorotalia esnaensis* (LEROY) is similar to *Globorotalia wilcoxensis* CUSHMAN and PONTON, but differs in having a rounded margin. *Globorotalia wilcoxensis* CUSHMAN and PONTON has an angular margin along which spines and nodes are prominently developed. *Globorotalia quadrata* (WHITE) and *Globorotalia whitei* WEISS both have less rapidly increasing chambers, and *Globorotalia quadrata* (WHITE) also has a cancellate surface rather than the nodose surface characteristic of *Globorotalia esnaensis* (LEROY).

As noted by BERMUDEZ, *Acaranina pseudotopilensis* SUBBOTINA is probably a synonym of *Globorotalia esnaensis* (LEROY). Specimens from Tremp support this conclusion. *Globorotalia pseudotopilensis* (SUBBOTINA) of LOEBLICH and TAPPAN (1957, p. 194, pl. 60, figs. 2a–c) is probably *Globigerina topilensis* (CUSHMAN), and has little affinity with *Globorotalia esnaensis* (LEROY).

BERGGREN's specimens of *Globorotalia esnaensis* (LEROY) all appear to have a convex spiral side and a more rounded margin, differing from LEROY's holotype which has a flat spiral side, and subangular periphery. Specimens figured by BERGGREN as *Globorotalia wilcoxensis* CUSHMAN and PONTON agree more closely with description and figures of *Globorotalia esnaensis* (LEROY).

The specimen figured by BERMÚDEZ as *Globigerina esnaensis* LEROY has globular chambers and a broadly rounded margin, and should probably not be included in *Globorotalia esnaensis* (LEROY), which has a more angular margin.

Some of the confusion surrounding this species stems from the fact that LOEBLICH and TAPPAN figure specimens "similar to the holotype of *Globorotalia esnaensis* (LEROY) in all respects, except that they are about half its size." One of the four specimens figured by LOEBLICH and TAPPAN is questionably referred to the species by them (pl. 57, figs. 7a–c), a second specimen is indicated to be atypical (pl. 61, figs. 9a–c), and the remaining two specimens lack the quadrate outline LEROY mentioned as characterizing the species.

Hypotype: T-1805.

Maximum diameter: 0.30 mm.

Occurrence: This species was originally described by LEROY as occurring throughout the Esna shale of the Maqfi section of Egypt. SUBBOTINA's specimens are from the lower Tertiary of the northern Caucasus region of the USSR. LOEBLICH and TAPPAN recorded *Globorotalia esnaensis* (LEROY) from the Nanafalia formation of Alabama, and from the Aquia formation of Maryland–Virginia. BERGGREN cites the species from the Røsnaes clay of the Røgle Klint of Denmark. BERMÚDEZ obtained his specimens from the Capdevilla and Universidad formations of Cuba.

In the type Ilerdian *Globorotalia esnaensis* (LEROY) is found at locality C, and in the "marne blanche" and "marne bleue" of Mont Cayla.

Globorotalia mckannai (WHITE)

Pl. I, figs. 1a–c

1928. *Globigerina mckannai* WHITE, Journ. Paleont., v. *2*, no. 3, p. 194, pl. 27, figs. 16a–c.
1950. *Globigerina cretacea* var. *esnehensis* NAKKADY, Journ. Paleont., v. 24, n. 6, p. 689, pl. 90, figs. 14–16.
1952. *Globigerina gravelli* BRÖNNIMANN, Bull. Amer. Paleont., v. *34*, no. 143, p. 12, pl. I (II), figs. 16–18.
1953. *Acarinina pentacamerata* SUBBOTINA, Trudy Vses. Neft. Naukna.-Issledov. Geol.-Razved. Inst., new ser., v. 76, p. 233, pl. 23, figs. 8a–c; pl. 24, figs. 1a–9c.
1957. *Globigerina gravelli* BRÖNNIMANN, BOLLI, US Nat. Mus. Bull. 215, p. 72, pl. 16, figs. 1–3.
1957. *Globorotalia mckannai* (WHITE), BOLLI, idem., p. 79, pl. 19, figs. 16–18.
1957. *Globigerina mckannai* WHITE, LOEBLICH and TAPPAN, idem., p. 181, pl. 47, figs. 7a–c; pl. 53, figs. 1a–2c; pl. 57, figs. 8a–c; pl. 62, figs. 5a–7c.
1957. *Globorotalia strabocella* LOEBLICH and TAPPAN, idem., p. 195, pl. 61, figs. 6a–c.
1960. *Globorotalia strabocella* LOEBLICH and TAPPAN, OLSSON, Journ. Paleont., v. 34, no. 1, p. 48, pl. 10, figs. 10–12.
1960. *Globorotalia mckannai* (WHITE), HAY, Report, Internat. Geol. Congress, XXI Session, Norden, Part V, Section 5, p. 74.
1960. *Globorotalia* cf. *mckannai* (WHITE), BOLLI and CITA, idem., p. 156.
1960. *Globorotalia mckannai* (WHITE), BOLLI and CITA, Riv. Ital. Paleont., v. LXVI, no. 3, p. 23, pl. XXXI, figs. 6a–c.
1960. *Globigerina mckannai* WHITE, BERGGREN, Stockholm Contr. Geol., v. V:3, p. 68, pl. I, figs. 4a–c; pl. IX, figs. 2a–4c; pl. X, figs. 1a–c.
1961. *Globigerina mckannai* WHITE, BERMÚDEZ, Memoria del III Congresso Geologico Venezolano. Tomo III Boletin de Geologia, Publicacion especial 3, Caracas, Venezuela, p. 1189.

Remarks: *Globorotalia mckannai* (WHITE) differs from *Globigerina spiralis* BOLLI in that the latter has more rounded, globular chambers, more nearly umbilical aperture, and is generally smaller. *Globigerina soldadoensis* BRÖNNIMANN has more globular chambers, more lobate periphery, and a flatter spiral side.

As LOEBLICH and TAPPAN have pointed out *G. gravelli* BRÖNNIMANN is a synonym of *Globorotalia mckannai* (WHITE) as is *Acarinina pentacamerata* SUBBOTINA. *Globorotalia strabocella* LOEBLICH and TAPPAN is also considered a synonym of *Globorotalia mckannai* (WHITE).

Hypotype: T-1806.

Maximum diameter: 0.27 mm.

Occurrence: Originally described from the Velasco formation of Mexico by WHITE, NAKKADY observed the species from immediately below and above the lower boundary of the Eocene of Egypt. BRÖNNIMANN's records of the species are from the Lizard Springs formation and the Ramdat marl of Trinidad. BOLLI has noted its occurrence from the *Globorotalia pseudomenardii* zone through the *Globorotalia aragonensis* zone in Trinidad.

SUBBOTINA has recorded the species from the lower Tertiary of the northern Caucasus region of the USSR. LOEBLICH and TAPPAN have recorded it from the Vincentown formation of New Jersey, the Salt Mountain limestone of Alabama, and the Velasco formation of Mexico. HAY has recorded *Globorotalia mckannai* (WHITE) from the Velasco formation, ranging through the *Globorotalia pseudomenardii* and the *Globorotalia velascoensis* zones. LOEBLICH and TAPPAN have recorded the species under the name *Globorotalia strabocella* LOEBLICH and TAPPAN from the Nanafalia formation of Alabama and the Vincentown formation of New Jersey. OLSSON has also recorded it as *Globorotalia strabocella* LOEBLICH and TAPPAN from the early Tertiary of New Jersey. BERGGREN has noted *Globorotalia mckannai* (WHITE) from the Røsnaes clay at Røgle Klint, Denmark, and from the lower Eocene of northwestern Germany. BERMÚDEZ has observed the species in the Habana formation of Cuba.

Globorotalia mckannai (WHITE) is common in the "marne bleue" of the Ilerdian of Mont Cayla.

Globorotalia nicoli MARTIN

Pl. II, figs. 3a–c

1943. *Globorotalia nicoli* MARTIN, Stanford Univ. Pub. Univ. Ser. Geol. Sci., v. III, no. 3, p. 27, pl. VII, figs. 3a–c.

Remarks: *Globorotalia nicoli* MARTIN differs from *Globorotalia esnaensis* (LEROY) in having less inflated chambers and a less lobate periphery. *Globorotalia nicoli* is biconvex whereas *Globorotalia esnaensis* (LEROY) usually has a nearly flat spiral side. *Globorotalia convexa* SUBBOTINA is more equally biconvex, has a closed umbilicus, more chambers per volution, and a more acute peripheral angle.

Hypotype: T-1807.

Maximum diameter: 0.27 mm.

Occurrence: This species was originally described by MARTIN from the Lodo formation of California.

It is found in the "marne bleue" of the Ilerdian of Mont Cayla.

Globorotalia velascoensis (CUSHMAN) *parva* REY

Pl. II, figs. 5a–c

1954. *Globorotalia velascoensis* (CUSHMAN) var. *parva* REY, Bull. Geol. Soc. France, ser. 6, v. *4*, p. 209, pl. XII, figs. 1a–b.

1960. *Globorotalia velascoensis* (CUSHMAN) var. *parva* REY, BOLLI and CITA, Riv. Ital. Paleont., v. LXVI, no. 3.

Remarks: This subspecies differs from typical *Globorotalia velascoensis* in having a less pronounced keel and in lacking a deep umbilicus.

Hypotype: T-1808.

Maximum diameter: 0.43 mm.

Occurrence: BOLLI and CITA have recorded *Globorotalia velascoensis* (CUSHMAN) var. *parva* REY from the *Globorotalia pseudomenardii* zone and the lowermost part of the *Globorotalia velascoensis* zone in the Paderno d'Adda section of the Paleocene of northern Italy.

In the Ilerdian of Tremp this subspecies is found at locality C.

Globorotalia pseudomenardii BOLLI

Pl. I, fig. 5

1928. *Globorotalia membranacea* (EHRENBERG) of WHITE, Journ. Paleont., v. *2*, p. 280, pl. 38, figs. 1a–c.

1953. *Globorotalia membranacea* (EHRENBERG), of SUBBOTINA, Trudy Vses. Neft. Naukno-Issledov. Geol.-Razved. Inst., new ser., v. *76*, p. 250, pl. XVI, figs. 7a–13c.

1957. *Globorotalia pseudomenardii* BOLLI, BOLLI, US Nat. Mus. Bull. 215, p. 77, pl. 20, figs. 14–17.

1957. *Globorotalia pseudomenardii* BOLLI, LOEBLICH and TAPPAN, US Nat. Mus. Bull. 215, p. 193, pl. 45, figs. 10a–c; pl. 47, figs. 4a–c; pl. 49, figs. 6a–c; pl. 54, figs. 10a–13c; pl. 59, figs. 3a–c; pl. 60, figs. 8a–c; pl. 63, figs. 1a–c.

1960. *Globorotalia pseudomenardii* BOLLI, HAY, Report, Internat. Geol. Congress, XXI Session, Norden, Part V, Section 5, p. 73.

1960. *Globorotalia pseudomenardii* BOLLI, LYS, idem., p. 124.

1960. *Globorotalia membranacea* (EHRENBERG), of BUROLLET and MAGNIER, idem., p. 136.

1960. *Globorotalia pseudomenardii* BOLLI, BOLLI and CITA, idem., p. 155.

1960. *Globorotalia membranacea* (EHRENBERG), of KÜHN, idem., p. 167.

1960. *Globorotalia pseudomenardii* BOLLI, BOLLI and CITA, Riv. Ital. Paleont., v. LXVI, no. 3, p. 26, pl. XXXIII, figs. 2a–c.

1960. *Globorotalia pseudomenardii* BOLLI, BERGGREN, Stockholm Contr. Geol., v. VI:5, p. 75.

1961. *Globorotalia pseudomenardii* BOLLI, BERMÚDEZ, Memoria del III Congreso Geologico Venezolano, Tomo III Boletin de Geologia, Publicacion especial 3, Caracas, Venezuela, p. 1298, pl. 15, fig. 9.

Remarks: *Globorotalia pseudomenardii* BOLLI differs from *Globorotalia compressa* PLUMMER and *Globorotalia elongata* GLAESSNER in having less depressed sutures, and in having a distinct peripheral keel. Only two specimens of this species were found. One resembles closely specimens figured by BOLLI, and LOEBLICH and TAPPAN as well as specimens from the Velasco formation of Mexico. It has four chambers in the last volution which increase in size rapidly and give the test a quadrilobate appearance (see pl. I, fig. 5). The spiral side of this specimen has been destroyed.

The second specimen has six chambers in the last volution and consequently the chambers are compressed and increase in size less rapidly. Nearly identical specimens were found in the Velasco assemblage.

Globorotalia membranacea (EHRENBERG) was originally described from Pliocene chalk beds thought at the time to be Cretaceous (HAY, in press). The name *Globorotalia membranacea* (EHRENBERG) cannot be used for the Paleocene form, for as

BOLLI points out (1957, p. 77) the Paleocene form has no genetic relationship to similar but considerably younger forms.

Specimens referred to *Globorotalia membranacea* (EHRENBERG) by SUBBOTINA belong to *Globorotalia compressa* PLUMMER, *Globorotalia ehrenbergi* BOLLI, and *Globorotalia pseudomenardii* BOLLI.

Hypotype: T-1809.

Maximum diameter: 0.34 mm.

Occurrence: The distribution of this species around the world has been discussed at length in the introduction. It has been found at locality C in the Tremp section.

Globorotalia cf. *Globorotalia uncinata* BOLLI

1957. *Globorotalia uncinata* BOLLI, US Nat. Mus. Bull. 215, p. 74, pl. 17, figs. 13–15.
1960. *Globorotalia uncinata* BOLLI, HAY, Report, Internat. Geol. Congress, XXI Session, Norden, Part V, Section 5, p. 72.
1960. *Globorotalia uncinata* BOLLI, BOLLI and CITA, idem., p. 154.
1960. *Globorotalia uncinata* BOLLI, BOLLI and CITA, Riv. Ital. Paleont., v. LXVI, no. 3, pp. 30–31, pl. XXXII, figs. 5a–c, 7a–c.

Remarks: These specimens resemble closely the specimens of *Globorotalia uncinata* BOLLI figured by BOLLI from the Lizard Springs formation of Trinidad, and by BOLLI and CITA from the Paleocene of Paderno d'Adda. They differ in having a slightly more convex spiral side, somewhat higher chambers, and in being smaller. Some specimens have a small but distinct keel developed on the early chambers of the last volution.

Globorotalia perclara LOEBLICH and TAPPAN is similar but has a more lobate periphery, a rounded margin, and more inflated chambers.

Occurrence: *Globorotalia uncinata* BOLLI was originally described from the *Globorotalia uncinata* zone of the Lizard Springs formation of Trinidad. It has also been recorded by HAY from the Velasco formation of Mexico, and by BOLLI and CITA from the Paleocene deposits at Paderno d'Adda of northern Italy.

The specimens from the Ilerdian were found at locality C.

Family Globigerinidae

Subfamily Globigerininae

GENUS GLOBIGERINA

Type species: *Globigerina bulloides* D'ORBIGNY, 1826.

Remarks: *Globigerina* differs from *Globorotalia* in having an interiomarginal aperture restricted to the umbilicus, while in *Globorotalia* the aperture extends to a more or less extraumbilical position.

Globigerina aquiensis LOEBLICH and TAPPAN

1957. *Globigerina aquiensis* LOEBLICH and TAPPAN, US Nat. Mus. Bull. 215, p. 180, pl. 51, figs. 4a–5c; pl. 56, figs. 4a–6c.
1960. *Globigerina aquiensis* LOEBLICH and TAPPAN, BERGGREN, Stockholm Contr. Geol., v. V:3, p. 65, pl. 1, figs. 1a–2c.
1961. *Globigerina kozlowskii* BROTZEN and POZARYSKA, Rev. Micropaleont., v. 4, no. 3, p. 102, pl. 1, figs. 1–14; pl. 2, figs. 1–17; pl. 3.

Remarks: *Globigerina aquiensis* LOEBLICH and TAPPAN differs from *Globigerina spiralis* BOLLI in having fewer chambers per volution, more inflated chambers, and a smaller umbilicus. *Globigerina chascanona* LOEBLICH and TAPPAN is smaller, more tightly coiled, and has a closed umbilicus.

Occurrence: This species was originally described by LOEBLICH and TAPPAN from an exposure of the Aquia formation on the west bank of the Potomac River near the mouth of Aquia Creek. They also recorded it from the Vincentown formation of New Jersey. BERGGREN has noted the species from the lower Eocene of northwestern Germany. BROTZEN and POZARYSKA have cited *Globigerina kozlowskii* BROTZEN and POZARYSKA (=*Globigerina aquiensis* LOEBLICH and TAPPAN) from middle and upper Paleocene deposits of Poland.

In the section near Tremp *Globigerina aquiensis* LOEBLICH and TAPPAN occurs at localities A, B, and C. It is also found in the "marne blanche" of the Ilerdian at Mont Cayla.

Globigerina chascanona LOEBLICH and TAPPAN

1957. *Globigerina chascanona* LOEBLICH and TAPPAN, US Nat. Mus. Bull. 215, pp. 180–181, pl. 49, figs. 4a–5c; pl. 61, figs. 8a–c.
1960. *Globigerina chascanona* LOEBLICH and TAPPAN, BERGGREN, Stockholm Contr. Geol., v. V:3, p. 66, pl. I, figs. 3a–c; pl. VII, figs. 3a–4c.

Remarks: This distinctive species is distinguished by its high spire and its small size. *Globigerina chascanona* LOEBLICH and TAPPAN differs from *Globigerina aquiensis* LOEBLICH and TAPPAN in having a more acute spire, a more spinose surface, and in being much smaller. *Globigerina spiralis* BOLLI has more chambers per volution, is larger, has a less acute spiral side, and has an open umbilicus.

Occurrence: This species was described by LOEBLICH and TAPPAN from the Hornerstown formation of New Jersey, and was also recorded by them from the Nanafalia formation of Alabama. BERGGREN has noted this species from the lower Eocene of northwestern Germany.

In the section near Tremp *Globigerina chascanona* LOEBLICH and TAPPAN occurs as a rare form at location C.

Globigerina sp. cf. *Globigerina inaequispira* SUBBOTINA

1957. *Globigerina inaequispira* SUBBOTINA, of LOEBLICH and TAPPAN, US Nat. Mus. Bull. 215, p. 181, pl. 61, figs. 3a–c.

Test free, trochoid, $2^1/_2$–3 volutions of rapidly enlarging, subglobular chambers, all visible on the spiral side; only 3–$3^1/_2$ chambers of last volution visible on umbilical side; sutures distinct, depressed, radial; wall calcareous perforate; test covered with nodes over entire surface; aperture umbilical and interiomarginal, sometimes with narrow lip.

Remarks: Specimens of this species were found in several samples from the Ilerdian section along the road from Tremp to Puente de Montañana; *Globigerina inaequispira* SUBBOTINA differs from these specimens in that it has a much more lobate periphery, and may have a combination of spinose and reticulate surface, the spines being most prominent near the umbilicus.

Occurrence: LOEBLICH and TAPPAN have recorded this species from the Nanafalia formation of Alabama.

In the section along the road from Tremp to Puente de Montañana this species is found at localities A, B, and C.

Globigerina soldadoensis BRÖNNIMANN

Pl. I, figs. 3a–c

1952. *Globigerina soldadoensis* BRÖNNIMANN, Bull. Amer. Paleont., v. *34*, no. 143, p. 9, pl. I (II), figs. 1–9.
1953. *Acarinina interposita* SUBBOTINA, Trudy Vses. Neft. Naukno-Issledov. Geol.-Razved. Inst., new ser., v. 76, p. 231, pl. XXIII, figs. 6a–7c.
1957. *Globigerina soldadoensis* BRÖNNIMANN, BOLLI, US Nat. Mus. Bull. 215, p. 71, pl. 16, figs. 7–12; p. 162, pl. 35, figs. 9a–c.
1960. *Globigerina soldadoensis* BRÖNNIMANN, BERGGREN, Stockholm Contr. Geol., v. VI:5, p. 99.
1961. *Globigerina soldadoensis* BRÖNNIMANN, BERMÚDEZ, Memoria del III Congreso Geologico Venezolano. Tomo III Boletin de Geologia, Publicacion especial 3, 1960, Caracas, Venezuela, pp. 1199–1200.

Remarks: *Globigerina soldadoensis* BRÖNNIMANN differs from *Globorotalia mckannai* (WHITE) in that it has a more nearly flat spiral side, more inflated chambers and lobate periphery, and more rapidly increasing chamber size.

As BERGGREN (1960b, p. 99) has observed *Acarinina interposita* SUBBOTINA is probably a synonym of *Globigerina soldadoensis* BRÖNNIMANN. LOEBLICH and TAPPAN (1957, p. 182) noted that the aperture in *G. soldadoensis* BRÖNNIMANN extends as far extraumbilically as it does in *Globorotalia mckannai* (WHITE), which is probably the nearest related species. BOLLI placed them in separate genera, at the same time he left *Globigerina gravelli* BRÖNNIMANN, a synonym of *Globorotalia mckannai* (WHITE) in the genus *Globigerina*. SUBBOTINA placed both species in the genus *Acarinina*, but according to LOEBLICH and TAPPAN (1957, p. 42) *Acarinina* is a synonym of *Globorotalia*.

Hypotype: T-1811.

Maximum diameter: 0.27 mm.

Occurrence: *Globigerina soldadoensis* BRÖNNIMANN was first described from the Lizard Springs formation and the Ramdat marl of the Navet formation of Trinidad. SUBBOTINA has recorded the species from the lower Tertiary of the northern Caucasus region of the USSR.

This species is found in the "marne bleue" of the Ilerdian of Mont Cayla.

Globigerina triloculinoides PLUMMER

1926. *Globigerina triloculinoides* PLUMMER, Texas Univ. Bull. no. 2644, p. 134, pl. 8, fig. 10.
1957. *Globigerina triloculinoides* PLUMMER, BOLLI, US Nat. Mus. Bull. 215, p. 70, pl. 15, figs. 18–20; pl. 17, figs. 25–26.
1957. *Globigerina triloculinoides* PLUMMER, TRØLSEN, idem., p. 129, pl. 30, figs. 4a–c.
1957. *Globigerina triloculinoides* PLUMMER, LOEBLICH and TAPPAN, idem., p. 183, pl. 40, figs. 4a–c; pl. 41, figs. 2a–c; pl. 42, figs. 2a–c; pl. 43, figs. 5a–c, 8a–9c; pl. 45, figs. 3a–c; pl. 46, figs. 1a–c; pl. 47, figs. 2a–c; pl. 52, figs. 3–7; pl. 56, figs. 8a–c; pl. 62, figs. 3a–c.
1960. *Globigerina triloculinoides* PLUMMER, JELETZKY, Report Internat. Geol. Congress, XXI Session, Norden, Part V, Section 5, p. 33.
1960. *Globigerina triloculinoides* PLUMMER, NAGGAPA, idem., p. 43.
1960. *Globigerina triloculinoides* PLUMMER, HAY, idem., p. 73.
1960. *Globigerina triloculinoides* PLUMMER, LYS, idem., p. 124.
1960. *Globigerina triloculinoides* PLUMMER, REYMENT, idem., p. 134.
1960. *Globigerina triloculinoides* PLUMMER, BUROLLET and MAGNIER, idem., p. 136.
1960. *Globigerina triloculinoides* PLUMMER, MANGIN, idem., p. 145.

1960. *Globigerina triloculinoides* PLUMMER, BOLLI and CITA, idem., p. 155.
1960. *Globigerina triloculinoides* PLUMMER, KÜHN, idem., p. 167.
1960. *Globigerina triloculinoides* PLUMMER, BERGGREN, idem., p. 185.
1961. *Globigerina triloculinoides* PLUMMER, BERMÚDEZ, Memoria del III Congreso Geologico Venezolano, Tomo III Boletin de Geologia, Publicacion especial 3, 1960, Caracas, Venezuela, p. 1204, pl. 5, fig. 7.
1961. *Subbotina triloculinoides* (PLUMMER), BROTZEN and POZARYSKA, Rev. Micropaleont., v. 4, no. 3, p. 160, pl. 4, fig. 4.

Remarks: This species is characterized by its three-chambered appearance, rapidly increasing globular chambers, and coarsely reticulate surface. *Globigerina inaequispira* SUBBOTINA has more ovate chambers, a less coarsely reticulate surface, and a more compressed spiral side.

Occurrence: *Globigerina triloculinoides* PLUMMER was originally described from the Midway group of Texas. Since that time it has been described and recorded from many parts of the world. In North America it has been cited from early Tertiary deposits from along the Gulf and Atlantic coast, from southern California, and from the Mississippi embayment. The species has also been noted from many other early Tertiary deposits including those of South America, Europe, Africa, Pakistan and southeastern USSR. *Globigerina triloculinoides* PLUMMER has been reported to range from late Cretaceous through early Eocene deposits (BERMÚDEZ, 1961). Most of the recorded occurrences are from the Paleocene. The many similar forms occurring in late Paleocene and early Eocene deposits are closely related to and probably derived from *Globigerina triloculinoides* PLUMMER.

The species is abundant in the "marne bleue" of the Ilerdian of Mont Cayla.

Globigerina varianta SUBBOTINA

1953. *Globigerina varianta* SUBBOTINA, Trudy Vses. Neft. Naukno-Issledov. Geol.-Razved. Inst., new ser., v. *76*, p. 63, pl. 3, figs. 5a–12c; pl. 4, figs. 1a–3c; pl. 15, figs. 1a–3c.
1957. *Globorotalia varianta* (SUBBOTINA), LOEBLICH and TAPPAN, US Nat. Mus. Bull. 215, p. 196, pl. 44, figs. 1a–2b; pl. 45, figs. 4a–c.

Remarks: *Globigerina varianta* SUBBOTINA differs from *Globigerina triloculinoides* PLUMMER in having less globular chambers, more chambers per volution, and in having rounded nodes or bumps over the entire surface of the test instead of the coarse pits and reticulae diagnostic of *Globigerina triloculinoides* PLUMMER.

Occurrence: Originally described by SUBBOTINA from the lower Tertiary of the northern Caucasus region of the USSR, this species has been recorded by LOEBLICH and TAPPAN from the Mexia clay member of the Wills Point formation of Texas, and from the Matthews Landing marl member of the Porters Creek clay of Alabama.

In the Ilerdian the species occurs at locality C.

BIBLIOGRAPHY

BERGGREN, W. A. (1960a): *Some planktonic foraminifera from the lower Eocene (Ypresian) of Denmark and northwestern Germany.* Stockholm Contr. Geol. V:*3*, pp. 48–108, 13 pls.
– (1960b): *Paleogene biostratigraphy and planktonic foraminifera of SW Soviet Union, An analysis of recent Soviet investigations.* Stockholm Contr. Geol., VI:*5*, pp. 63–125.
– (1960c): *Biostratigraphy, planktonic foraminifera, and the Cretaceous Tertiary boundary in Denmark and southern Sweden.* Report, Internat. Geol. Congr., XXI Session, Norden, Section 5, pp. 181–192.

BERMÚDEZ, P. J. (1961): *Contribution al estudio de las Globigerinidea de la region Caribe-Antillana (Paleoceno-Reciente)*. Memoria del III Congreso Geologica Venezolano, Tomo III Boletin de Geologia, Publicacion especial 3, 1960, Caracas, Venezuela, pp. 1119–1393, 20 pls.

BOLLI, H. M., 1957, *The genera Globigerina and Globorotalia in the Paleocene–lower Eocene Lizard Springs formation of Trinidad*. US Nat. Mus. Bull. *215*, pp. 51–81, pls. 15–20, text-figs 11–13.

BOLLI, H.M., and CITA, M. B. (1960a): *Upper Cretaceous and Lower Tertiary planktonic foraminifera from the Paderno d'Adda section, northern Italy*. Report, Internat. Geol. Congr., XXI Session, Norden, Section 5, pp. 150–161.

– (1960b): *Globigerine e Globorotalie del Paleocene de Paderno d'Adda (Italia)*: Riv. Ital. Paleont., v. LXVI, no. 3, pp. 1–38, pls. XXXI–XXXIII.

BOLLI, H. M., CITA, M. B. and SCHAUB, H. (1962): *Il limite cretaceo-terziario nella catena del Monte Baldo*. Mem. Soc. Geol. It., *III*, pp. 149–168, text-figs. 1–5.

BOLLI, H. M., LOEBLICH, A. R., Jr., and TAPPAN, H. (1957): *Planktonic foraminifera families Hantkeninidae, Orbulinidae, Globorotaliidae, and Globotruncanidae*. US Nat. Mus. Bull. *215*, pp. 3–50, pls. 1–11, text-figs. 1–9.

BRAMLETTE, M. N. and SULLIVAN, F. R. (1961): *Coccolithophoroids and related nannoplankton of the early Tertiary in California*. Micropaleontology, *7*, no. 2, pp. 129–180, 14 pls., 1 text-fig.

BRÖNNIMANN, P., 1952, *Trinidad Paleocene and Lower Eocene Globigerinidae*. Bull. Amer. Paleont., *34*, no. 134, pp. 1–34, pls. 1–3.

BROTZEN, F. and POZARYSKA, K. (1961): *Foraminifères du Paléocène et de l'Eocène inférieur en Pologne septentrionale*. Remarques paléogèographiques, Revue de Micropaléontologie, *4*, no. 3, pp. 121–134, 3 pls.

BUROLLET, P. F. and MAGNIER, PH. (1960): *Remarques sur la limite Crétacé Tertiaire en Tunisie et en Libye*. Report, Internat. Geol. Congr., XXI Session, Norden, Section 5, pp. 136–144.

CUSHMAN, J. A., and RENZ, H. H. (1942): *Eocene, Midway, foraminifera from Soldado Rock, Trinidad*. Contr. Cushman Lab. Foram. Res., *18*, no. 1, pp. 1–14, 3 pls.

– (1948): *Eocene foraminifera of the Navet and Hospital Hill formations of Trinidad, B.W.I.* Cushman Lab. Foram. Res., Spec. Publ., *24*, 42 pp., 8 pls.

CUVILLIER, J. et al. (1955): *Études micropaléontologiques de la limite Crétacé-Tertiaire dans les Mers Mésogéennes*. Proc. 4th World Petroleum Congr., Sect. I d, pp. 517–544, 6 tables, 2 pls., 3 text-figs.

DURAND-DELGA, M. and MAGNÉ, J. (1958): *Données stratigraphiques et micropaléontologiques sur le Nummulitique de l'est des Cordillères bétiques (Espagne)*. Rev. Micropal., *1*, pp. 155–175, pl. 1–2, tables 1–4, text-figs. 1–6.

FARCHAD, H. (1936): *Etude du Thanétien (Landénien marin) du Bassin de Paris*. Soc. géol. France, Mem., n.s., *13*, n. 30, pp. 1–103, pl. 1–6.

HAMILTON, E. L. (1953): *Upper Cretaceuos, Tertiary, and Recent foraminifera from the mid-Pacific, flat-topped seamounts*. Journ. Paleont., *27*, pp. 204–237, pls. 29-32, 5 text-figs.

HAY, W. W. (1960): *The Cretaceous–Tertiary boundary in the Tampico embayment, Mexico*. Report, Internat. Geol. Congr., XXI Session, Norden, Section 5, pp. 70–77.

HAYNES, J. (1955): *Pelagic foraminifera in the Thanet beds and the use of Thanetian as a stage name*. Micropaleontology, *I*, p. 189.

– (1956): *Certain smaller British Paleocene Foraminifera, Part I*. Contr. Cushman Found. Foram. Res., *7*, pp. 79–101, pl. 14–18, text-figs. 1–2.

HOFKER, J. (1959): *Arguments for a Lower Paleocene age of the section above the upper Md. in the Quarry of Curfs, near Houtham*. Natuurhist. Maandblad., *48*, pp. 18–30.

– (1961): *Les foraminifères planctoniques du Montien de la localité type*. Revue de Micropaléontologie, *4*, no. 1, pp. 53–57.

HOTTINGER, L. (1958): *Géologie du Mont Cayla* (Aude, Aquitaine orientale). Eclogae geol. Helv., *51*, p. 437–451, pl. 1, text-figs. 1–8.

– (1960): *Recherches sur les Alvéolines paléocènes et éocènes*. Mem. suisses de Pal. *75/76*, pp. 1–243, pl. 1–18, table 1, text-figs. 1–117.

HOTTINGER, L., and SCHAUB, H. (1960): *Zur Stufenteilung des Paleocaens und des Eocaens. Einführung des Ilerdien und des Biarritzien*. Eclogae geol. Helv., *53*, pp. 454–479.

KÜHN, O. (1960): *Neue Untersuchungen über die Dänische Stufe in Österreich*. Report, Internat. Geol. Congr., XXI Session, Norden, Section 5, pp. 162-169.

LEROY, L. W. (1953): *Biostratigraphy of the Maqfi section, Egypt.* Geol. Soc. America, Mem. *54*, 73 pp., 13 pls.

LOEBLICH, A. R., Jr. and TAPPAN, H. (1957a): *Planktonic foraminifera of the Paleocene and early Eocene from the Gulf and Atlantic coastal plains.* US Nat. Mus. Bull. *215*, pp. 173–198, text-figs. 27–28, pls. 40–64.

– – (1957b): *Correlation of the Gulf and Atlantic coastal plain Paleocene and Lower Eocene by means of planktonic foraminifera.* Journ. Paleont., *31*, pp. 1109–1137.

– – (1961): *Suprageneric classification of the Rhizopodea.* Journ. Paleont., *35*, pp. 245–330.

LYS, M. (1960): *La limite Crétacé–Tertiaire et l'Eocène inférieur dans le bassin de Majunga (Madagascar).* Report, Internat. Geol. Congr., XXI Session, Norden, Section 5, pp. 120–130.

MALLORY, V. S. (1959): *Lower Tertiary biostratigraphy of the California Coast Ranges.* Amer. Assoc. Petrol Geol., pp. 1–416, pl. 1–42, tables 1–19, figs. 1–7.

MANGIN, J. P. (1957): *Remarques sur le terme Paléocène et sur la limite Crétacé-Tertiaire.* Soc. Géol. France, C. R., pp. 319–322, text-fig. 1.

MARTIN, L. T. (1943): *Eocene foraminifera from the type Lodo formation, Fresno County, California.* Stanford Univ. Publ., Univ. Ser. Geol. Sci., *3*, no. 3, pp. 91–125, text-figs. 1–3, pls. 5–9.

NAGGAPA, Y. (1960): *The Cretaceous–Tertiary boundary in the India–Pakistan subcontinent.* Report, Internat. Geol. Congr., XXI Session, Norden, Section 5, pp. 150–161, tables 1–4, text-fig. A.

NAKKADY, S. E. (1950): *A new foraminiferal fauna from the Esna shales and Upper Cretaceous Chalk of Egypt.* Journ. Paleont., *24*, pp. 675–692, pl. 89–90.

OLSSON, R. K. (1960): *Foraminifera of latest Cretaceous and earliest Tertiary age in the New Jersey coastal plain.* Journ. Paleont., *34*, pp. 1–58, 2 text-figs., 12 pls.

REISS, Z. (1952): *On the Upper Cretaceous and Lower Tertiary Microfaunas of Israel.* Bull. Res. Counc. Israel, *2*, pp. 37–50.

REYMENT, R. A. (1960): *Notes on the Cretaceous–Tertiary transition in Nigeria.* Report, Internat. Geol. Congr., XXI Session, Norden, Section 5, pp. 131–135.

SCHAUB, H. (1960): *Über einige Nummuliten und Assilinen der Monographie und der Sammlung d'Archiac.* Ecl. geol. Helv. *53*, pp. 443–459, 4pls., 1 text-fig.

SCHIMPER, W. PH. (1874): *Paléontologie végétale.* III. Paris, pp. 1–896.

SUBBOTINA, N. N. (1953): *Globigerinidae, Hantkeninidae, i Globorotalidae, Iskopaemie Foraminiferi SSSR.* Trudy Vsesoiuznogo Neftyanogo Nauchno-Isladovatel'skogo: Geologo Razvedochnogo Instituta (Vnigri), 249 pp., 5 text-figs., 25 pls., 3 tables.

TROELSEN, J. C. (1957): *Some planktonic foraminifera of the type Danian and their stratigraphic importance.* US Nat. Mus. Bull. *215*, pp. 125–131, text-figs. 22–24, pl. 30.

VINSON, G. L. (1962): *Upper Cretaceous and Tertiary stratigraphy of Guatemala.* Bull., Amer. Assoc. Petrol. Geol., *46*, no. 4, pp. 425–456, 14 text-figs.

WEISS, L. (1955): *Planktonic index foraminifera of northwestern Peru.* Micropaleontology, *1*, no. 4, pp. 301–319.

WHITE, M. P. (1928–29): *Some index foraminifera of the Tampico embayment area of Mexico.* Journ. Paleont., v. 2, no. 3, pp. 177–215; no. 4, pp. 280–316; *3*, no. 1, pp. 30–58, 2 figs., 10 pls.

Plate I

Figs. 1a–c. *Globorotalia mckannai* (WHITE). × 120, a, umbilical view; b, side view; c, spiral view.

Figs. 2a–c. *Globorotalia caylaensis* n. sp. Holotype. × 120, a, umbilical view; b, side view; c, spiral view.

Figs. 3a–c. *Globigerina soldadoensis* BRÖNNIMANN. × 120, a, umbilical view; b, side view; c, spiral view.

Figs. 4a–c. *Globorotalia convexa* SUBBOTINA. × 120, a, umbilical view; b, side view; c, spiral view.

Fig. 5. *Globorotalia pseudomenardii* BOLLI. × 120, umbilical view.

Figs. 6a–c. *Globorotalia angulata* (WHITE). × 120, a, umbilical view; b, side view; c, spiral view.

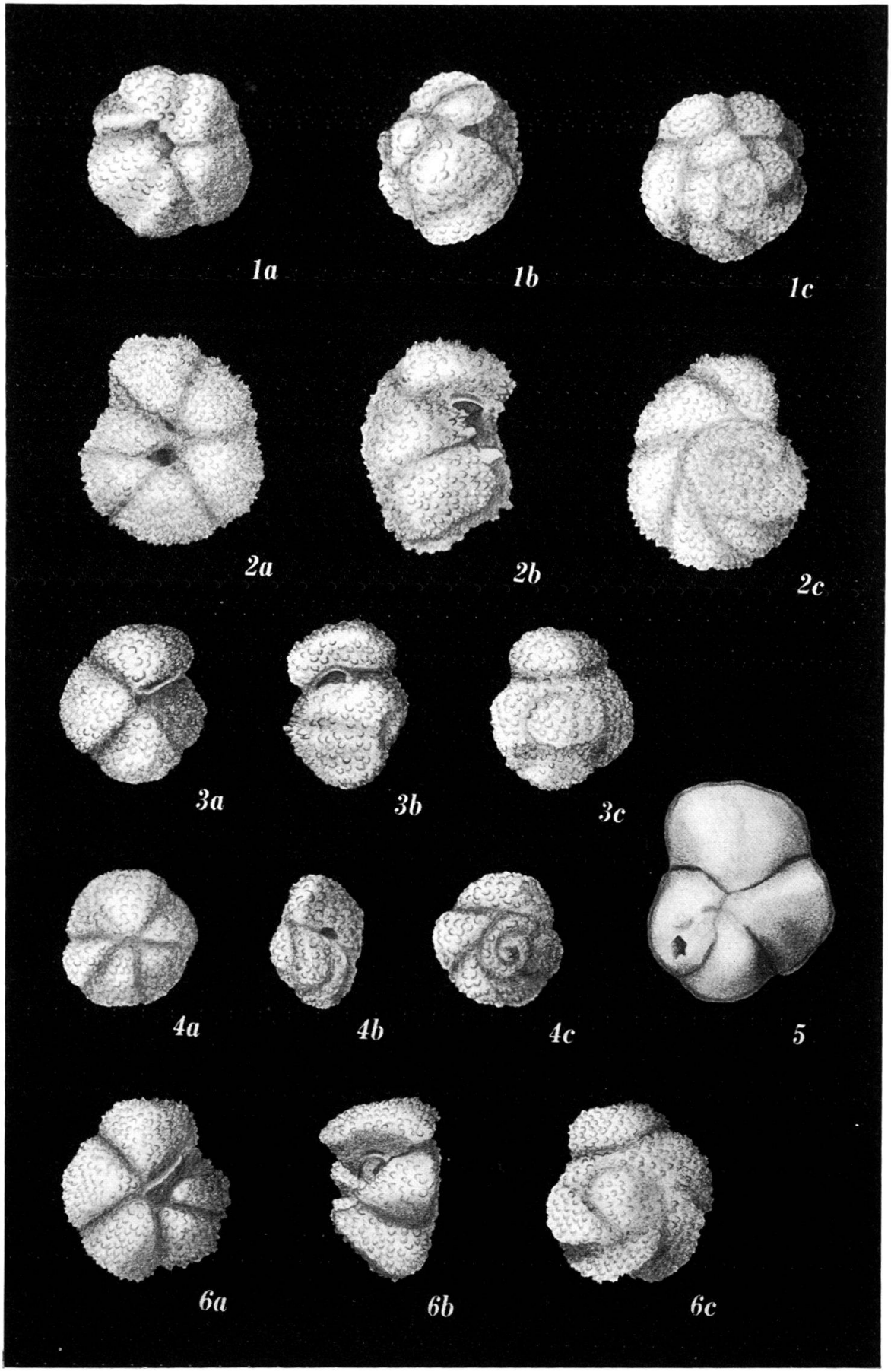

1a
1b
1c
2a
2b
2c
3a
3b
3c
4a
4b
4c
5
6a
6b
6c

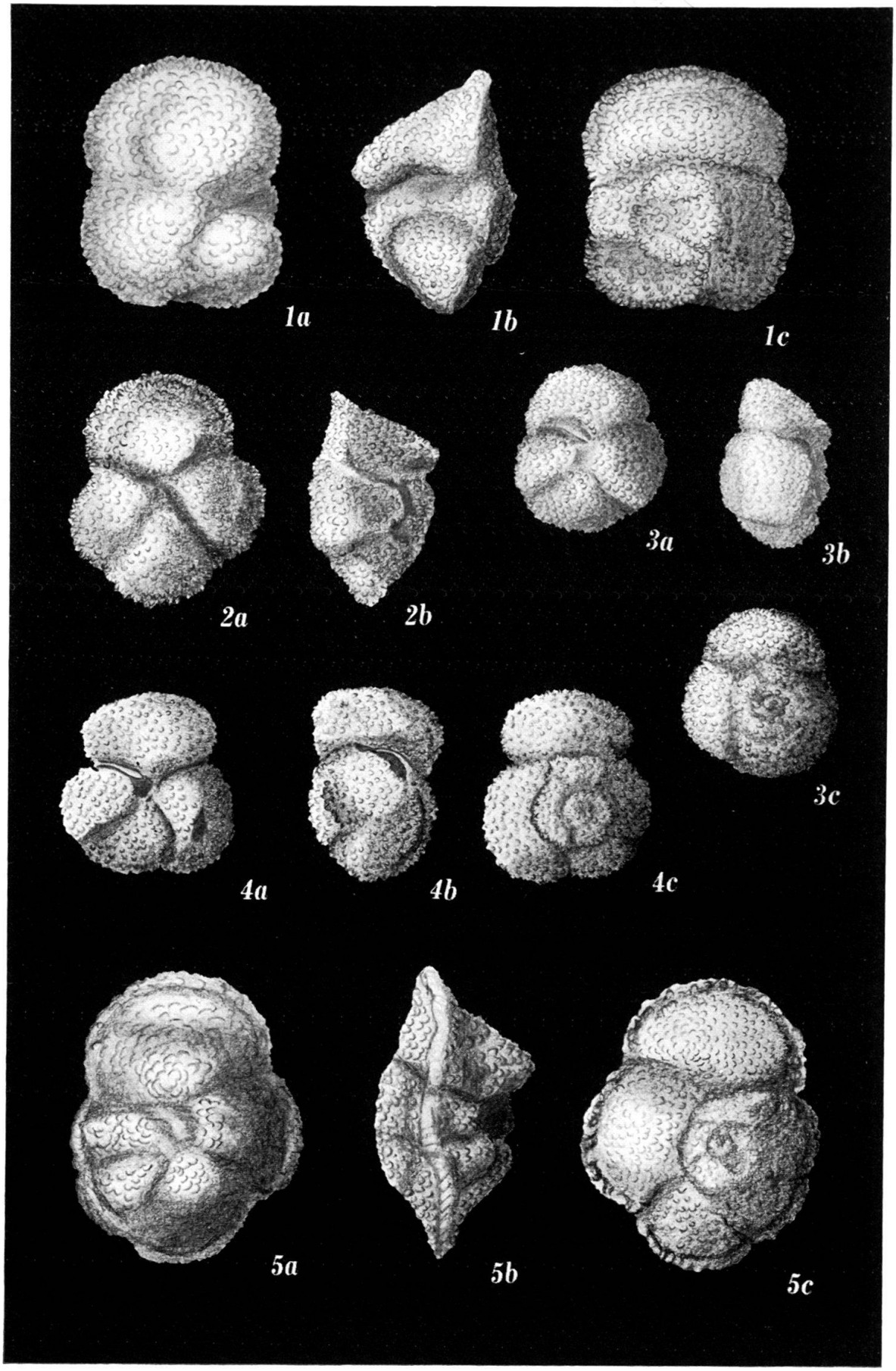
Plate II

Figs. 1a–2b. *Globorotalia aequa* CUSHMAN and RENZ. × 120, 1a and 2a, umbilical view; 1b and 2b, side view; 1c, spiral view.

Figs. 3a–c. *Globorotalia nicoli* MARTIN. × 120, a, umbilical view; b, side view; c, spiral view.

Figs. 4a–c. *Globorotalia esnaensis* (LEROY). × 120, a, umbilical view; b, side view; c, spiral view.

Figs. 5a–c. *Globorotalia velascoensis* (CUSHMAN) var. *parva* REY. × 120; a, umbilical view; b, side view; c, spiral view.


1a
1b
1c
2a
2b
3a
3b
3c
4a
4b
4c
5a
5b
5c