PLANKTIC FORAMINIFERA AND CALCAREOUS NANNOPLANKTON
BIOSTRATIGRAPHY OF THE NEogene OF MEXICO
PART II - LOWER PILOCENE

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I. ABSTRACT

Six outcrop localities in the Isthmus of Tehuantepec, Mexico, are assigned to the
Lower Pliocene Zones N. 18 or N. 19 on the basis of concurrent range zones of
planktic foraminifera and calcareous nannofossils. Beds at one of the localities have
been referred to the Encanto “Formation” by Mexican geologists. Microfossil lists for
the localities follow the taxonomic procedures of Kennett and Srinivasan (1983) or
Haman et al. (1980), differing only when inconsistent with the experience or interpre-
tations of this writer. Illustrations have been included for taxa that were not ident-
ified from the Middle Pliocene of Mexico in this series (Akers, 1979).

II. INTRODUCTION

This is the second part in a series of reports on calcareous nannofossils and
planktic foraminifera from some Neogene beds of Mexico. Part 1 (Akers, 1979) and
the addendum to Part 1 (Akers, 1981) dealt

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with the Middle Pliocene "formations" (Neogene Zone 20) to which the names Agueguexquite, Filisola, Concepcion Superior, and Concepcion Inferior have been applied.

The introductory remarks for Part 1 of this series are also appropriate for Part 2 and should be reviewed for the objectives of documenting the calcareous microplankton of the Mexican Tertiary. In general, it may be repeated that the fossil groups considered in this project afford assignment of the Mexican beds to transoceanic Neogene Zones 18 and 19 (Blow, 1969; Berggren and Van Couvering, 1974) and that the proposed geochronologic revisions for these sections are necessary, if Mexican successions are to conform stratigraphically with the rest of the world.

The stratigraphic ranges of index species, as determined by data from the Deep Sea Drilling Program, as well as data from land based sections, are the bases of chronologic assignments. Unlike material from tropical deep sea sites, the Mexican outcrops do not contain a high diversity of planktic microfossils. The forms recorded herein were found only after relatively prolonged microscopic examination, rather than after only a few minutes, as in the case of highly fossiliferous material from deep sea cores. Thus, chronostratigraphic interpretations are offered for assemblages that are less than ideal for this purpose.

Several index fossils are illustrated herein as well as in the previous report (Akers, 1979) on the Middle Pliocene of Mexico. In general, however, the plan was to include taxa not figured in Part 1. Useful species for chronostratigraphic purposes are charted in Figure 2 with their respective occurrences in tropical Neogene zones recognized by the Deep Sea Drilling Program.

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PLATE 1

Figures
1. *Globigerina* cf. *G. incisa* (Bronnimann and Resig)
   - Locality TU 1153
     - a. Edge view, ×107
     - b. Umbilical view, ×105
     - c. Spiral view, ×100

2. *Globigerina nepenthes* Todd
   - Locality TU 1323
     - a. Spiral view, ×135
     - b. Edge view, ×135
     - c. Umbilical view, ×135

3. *Globigerina* cf. *G. nepenthes* Todd, juvenile(?)
   - Locality TU 1324
     - a. Umbilical view, ×225
     - b. Spiral view, ×230

4. *Globigerina calida* (Parker)
   - Locality TU 1153
     - a. Edge view, ×72
     - b. Umbilical view, ×70
     - c. Spiral view, ×72

5. *Globigerina glutinata* (Egger)
   - Locality TU 1323
     - a. Edge view, ×145
     - b. Umbilical view, ×140
     - c. Spiral view, ×145

6. *Globigerina conglobatus conglobatus* (Brady)
   - Locality TU 1153
     - a. Spiral view, ×65
     - b. Umbilical view, ×62
     - c. Edge view, ×65
III. ACKNOWLEDGMENTS

Thanks go to the editorial committee: Drew Haman and Kenneth L. Finger, Chevron Oil Field Research Company. The Mexican sites would not have been studied, and the manuscript would not have been written without the field guidance and the constant encouragement of Emily and Harold Vokes. Figure 1, showing the location of five of the six Lower Pliocene sites, is the contribution of Emily Vokes. Chevron USA (Eastern Region) supported the research and permission to publish was given by Chevron Oil Field Research Company.

IV. BIOSTRATIGRAPHY, NEOGENE ZONES 18 AND 19

A. LOCALITY TU 1144

An unnamed formation is exposed at locality TU 1144 in roadcuts on Mexico Highway 185, about 42 km south of Acayucan, state of Veracruz. Beds three to four meters in thickness are exposed in the area approximately 3 km due east of Istal (formerly Santa Rosa), Veracruz (see Perrilliat, 1972, p. 10). The lithology is a hard, calcareous clay of uniform buff color, and the small amount of residue on a No. 200 U.S. Standard Series Sieve consists of the tests of foraminifera and aggregates of limonite. No quartz sand was observed in the residue. Calcareous nanofossils are so abundant in the clay that the material may be termed a calcareous nanofossil lutite. Samples were collected by H. E. and E. H. Vokes and W. H. Akers, 1979.

The following planktic foraminifera were found in residues from TU 1144:

- *Biorbulina bilobata* (d’Orbigny)
- *Candeina nitida nitida* d’Orbigny
- *Globigerina bulloides bulloides* d’Orbigny
- *G. decoraperta* Takayanagi and Saito
- *G. nepenthes* Todd
- *Globigerinita glutinata* (Egger)

Figures
1. *Globigerinoides mitra* Todd
   Locality TU 1144
   a. Side view, ×90
   b. View of primary aperture, ×90
   c. Side view showing supplementary aperture, ×90
2. *Globorotalia (Truncorotalia) crassiformis* (Galloway and Wissler)
   Locality TU 1153
   a. Umbilical view, ×110
   b. Edge view, ×110
   c. Spiral view, ×115
3. *Globorotalia (Menardella) miocenica* Palmer
   Locality TU 1144
   a. Umbilical view, ×105
   b. Edge view, ×105
   c. Spiral view, ×105
4. *Globorotaloides hexagona hexagona* (Natland)
   Locality TU 1153
   a. Spiral view, ×147
   b. Umbilical view, ×150
   c. Edge view, ×152
5. *Globorotaloides hexagona hexagona* (Natland)
   Locality TU 1332
   a. Spiral view, ×150
   b. Umbilical view, ×147
   c. Edge view, ×150

PLATE 2
Globigerinoides conglobatus conglobatus (Brady)
G. mitra Todd
G. obliquus extremus Bolli and Bermudez
G. obliquus obliquus Bolli
G. quadrilobatus quadrilobatus (d'Orbigny)
Globoquadridina altispira altispira (Cushman and Jarvis)
G. altispira globosa Bolli
G. venezuelana (Hedberg)
Globorotalia (Obandyella) margaritae Bolli and Bermudez
G. cf. G. (O.) margaritae Bolli and Bermudez
G. (Menardella) cultrata limbata (Fornasini)
G. (M.) miocenica Palmer
Hastigerina (H.) siphonifera siphonifera (d'Orbigny)
Neoglobigoina acostaensis (Blow)
N. humerosa (Takayanagi and Saito)
Orbulina universa d'Orbigny
Prophaeroidinella parkerae Ujije
Sphaeroidinellopsis seminulina seminulina (Schwager)
S. subdehiscens subdehiscens (Blow)
Turborotalita humilis (Brady)

The following calcareous nanoplankton have been identified from TU 1144:

Cyclarhocolithus doronicoides (Black and Barnes) Wise
C. pelagicus (Wallich) Schiller
C. sp.
Cyclococolithina leptopora (Murray and Blackman) Wilcoxon
Discoaster brouweri Tan
D. pentaradiatus Tan
D. surculus Martini and Bramlette
D. sp.
Discolithina sp.
Emiliania annula (Cohen) Bukry
Gephyrocapsa reticulata Nishida
Helicopontosphaera sp.
Reticulofenestra pseudoumbilica (Gartner) Gartner
Sphenolithus abies Deflandre
Syracosphaera sp.
Umbilicosphaera mirabilis Lohmann

Geologic Age of Beds at TU 1144 and Correlation with Other Strata

The concurrence of Globigerinoides mitra and Globigerinoides conglobatus conglobatus indicates a position in Lower Pliocene, Zone N. 18. Globigerinoides mitra became extinct by the end of that time, and Globigerinoides conglobatus conglobatus first appeared near the base of Zone N. 18 (Figure 2).

PLATE 3

Figures
1. Pulleniatina primalis Banner and Blow
   Locality TU 1153
   a. Umbilical view, ×100
   b. Edge view, ×95
   c. Spiral view, ×98
2. Sphaeroidinellopsis seminulina seminulina (Schwager)
   Locality TU 1323
   a. Edge view, ×97
   b. Spiral view, ×91
   c. Umbilical view, ×91
3. Sphaeroidinellopsis seminulina seminulina (Schwager)
   Locality TU 1144
   a. Umbilical view, ×69
   c. Spiral view, ×69
4. Turborotalita humilis (Brady)
   Locality TU 1144
   a. Spiral view, ×240
   b. Edge view, ×250
   c. Umbilical view, ×240
5. Turborotalita humilis (Brady)
   Locality TU 1144
   a. Spiral view, ×240
   b. Edge view, ×245
   c. Umbilical view, ×240
Blow (1969, p. 254) has referred the following land based sections to Zone N. 18 as follows: Donni Sandstone of Saipan, Janum Formation of Guam, Bowden Formation (median part) of Jamaica, and Trubi Marl (lowest part) of Sicily. He recognized N. 18 also on Vanua Levu Island (Fiji), in Papua, Java, Borneo, and Venezuela. The Lami Limestone of Viti Levu Island, Fiji, has been referred to Zone N. 18 (Adams, Rodda and Kiteley, 1979, p. 324, 327, 329). The zone is present in deep-water cores from the Indo-Pacific and Atlantic (including Caribbean and Gulf of Mexico provinces).

B. LOCALITY TU 1324

Locality TU 1324 is on the road to IstaI (Santa Rosa), which is the former railroad right-of-way, 5 km west of Mexico Highway 185, at a point 16 km north of the side road to Jesus Carranza, Veracruz, Mexico. The lithology at this exposure, as at TU 1144, is a hard, calcareous clay of uniform buff color. The residue on a No. 200 U.S. Standard Series Sieve is conspicuously the tests of foraminifera, both planktics and benthics, with abundant quartz grains that are smaller in diameter than most of the foraminifera. The material was collected by E. H. and H. E. Vokes and W. H. Akers, 1979.

The following planktic foraminifera were identified at TU 1324:

- Biorbulina bilobata (d’Orbigny)
- Candeina nitida nitida d’Orbigny
- Globigerina bulloides bulloides d’Orbigny
- G. decoraperta Takayanagi and Saito
- G. cf. G. incisa (Bronnimann and Resig)
- G. nepenthes Todd
- G. cf. G. nepenthes Todd, juvenile(?)
- Globigerinita glutinata (Egger)
- G. uvula (Ehrenberg)
- Globigerinoides conglobatus conglobatus (Brady)
- G. obliquus extremus Bolli and Bermudez
- G. obliquus obliquus Bolli
- G. quadrilobatus quadrilobatus (d’Orbigny)
- G. ruber (d’Orbigny)
- Globorotalina altispira altispira (Cushman and Jarvis)
- G. altispira globosa Bolli
- G. venezuelana (Hedberg)
- Globorotalia (Obanydella) margaritae Bolli and Bermudez
- G. (O.) scitula (Brady)
- G. (Menardella) cultrata limbata (Fornasini)
- G. (M.) miocenica Palmer
- Globorotaloides hexagona hexagona (Natland)
- Hastigerina (H.) siphonifera siphonifera (d’Orbigny)
- Neogloboquadrina acostaensis (Blow)
- N. humerosa (Takayanagi and Saito)
- orbitullina universa d’Orbigny
- Prospotailinella parkeriana Ujie
- Sphaeroidellopsis seminulina seminulina (Schwager)
- Turborotalita humilis (Brady)

A rich calcareous nanoflora is present at TU 1324, and the following are only a few of the significant species that were identified:

- Ceratolithus rugosus Bukry and Bramlette
- Discosta brouweri Tan
- D. pentaradiatus Tan
- D. surculus Martini and Bramlette
- Sphenolithus abies Deflandre

Geologic Age of Beds at TU 1324 and Correlations with Other Strata

Globigerina nepenthes is typically developed at TU 1324, and, although this development has been observed in older beds, it is characteristic of Zone N. 19 in association with the microassemblage listed above. Ceratolithus rugosus was recorded in low frequency. Calcification of other, more slender forms creates a close resemblance to C. rugosus. If the identification of the species here is correct, the occurrence with Globigerina nepenthes indicates Zone N. 19. If the Ceratolithus species is in actuality an older one that is highly calcified, the beds can still be referred no lower than Zone N. 18, because of the presence of Globorotaloides hexagona hexagona and Globigerinoides conglobatus conglobatus, forms that are not known to occur below Zone N. 18. The precise age of these beds notwithstanding, the microplankton are quite similar to the assemblage at TU 1144, and both assemblages are typical of the Lower Pliocene.

Blow (1969, p. 257) has referred Zone N. 19 to beds in Jamaica, Papua (New Guinea), Java, Sicily, Fiji (Vanua Levu Island), Guam, and Saipan. The Suva Marl Formation of Viti Levu Island, Fiji, is a highly fossiliferous sequence that only recently has been studied thoroughly and assigned to Zone N. 19 (Adams, Rodda and
PLATE 4

Figures
1. *Amaurolithus delicatus* Gartner and Bukry, ×2100
   Locality TU 1332
2. *Amaurolithus delicatus* Gartner and Bukry, ×2626
   Locality TU 1332
3. *Ceratolithus rugosus* Bukry and Bramlette, ×2500
   Locality TU 1324
4. *Helicopontosphaera sellii* Bukry and Bramlette, ×3150
   Locality TU 1332
5. *Helicopontosphaera sellii* Bukry and Bramlette, ×2100
   Locality TU 1332
6, 7. *Amaurolithus primus* (Bukry and Percival) Gartner and Bukry, 1975, ×2100
   Locality TU 1333
Kiteley, 1979, p. 327). The zone has been recognized in many deep-sea cores from the Indo-Pacific and the Atlantic (including Gulf of Mexico and Caribbean provinces).

C. LOCALITY TU 1323

This locality is a roadcut at Istat (Santa Rosa), on the side road that was the old railroad right-of-way, 10 km west of Mexico Highway 185, at a point 16 km north of the side road to Jesus Carranza, Veracruz, Mexico. The lithology, like that at nearby TU 1324, is a hard, calcareous clay of uniform buff color. The residue on a No. 200 U.S. Standard Series Sieve is different in general appearance from that at TU 1324 in lacking quartz grains (conspicuous at TU 1324) and in having abundant fragments of mollusks. Beds here were collected by H. E. and E. H. Vokes and W. H. Akers.

The planktic foraminiferal assemblage includes the following:

Biorbulina bilobata (d’Orbigny)
Candeina nitida nitida d’Orbigny
Globigerina bulloides apertura Cushman
G. bulloides bulloides d’Orbigny
G. decoraperta Takayanagi and Saito
G. nepenthes Todd
Globigerinita glutinata (Egger)
Globigerinoides conglobatus conglobatus (Brady)
G. obliquus extremus Bolli and Bermudez
G. obliquus obliquus Bolli
G. quadrilobatus quadrilobatus (d’Orbigny)
G. quadrilobatus sacculifer (Brady)
G. ruber (d’Orbigny)
Globothracina alternipora alternipora (Cushman and Jarvis)
G. altispira globosa Bolli
G. venezuelana (Hedberg)
Globorotalia (Obandyella) margaritae Bolli and Bermudez
G. (O.) scitula (Brady)
G. (Menardella) cultrata limbata (Fornasini)
Globorotaloides hexagona hexagona (Natland)
Hasigerina (H.) sipho nifera sipho nifera
(d’Orbigny)
Neogloboquadrina acostaensis (Blow)
Orbulina universa d’Orbigny
Prosphaeroidinella parkerae Ujiie
Sphaeroindelopsis seminulina seminulina (Schwager)
S. subdehiscent subdehiscent (Blow)
Turborotalita humilis (Brady)

The nanoflora at TU 1323 is a typical Lower Pliocene assemblage resembling those from TU 1144 and TU 1324.

Geologic Age of Beds at TU 1323

The rich microfossil assemblages at TU 1323 are typical of the Lower Pliocene biota of bathyal middle and low latitude regions in both the Indo-Pacific and the Atlantic-Caribbean-Gulf of Mexico provinces. The age of the beds is Early Pliocene, somewhere between Zones N. 18 and N. 19. Further examination may reveal additional species of planktic foraminifera or calcareous nanofossils that will indicate a precise biostratigraphic position. More definitive index fossils have not yet been identified. The occurrence here of Globigerinoides conglobatus conglobatus and Globorotaloides hexagona hexagona indicates a position no lower than Zone N. 18, and the presence of Globigerina nepenthes indicates a position no higher than Zone N. 19.

D. LOCALITY TU 1332

This locality is behind the power substation on the west side of Mexico Highway 185, 8.2 km north of the junction (at Campo Nuevo) to Medias Aguas; 47.3 km north of Rio Jaltepec, Veracruz, Mexico. The lithology, like that at the other Lower Pliocene localities of this report, is a hard, calcareous clay of uniform buff color. The residue on a No. 200 U.S. Standard Series Sieve is predominantly tests of benthic and planktic foraminifera without quartz grains and mollusk fragments. Collected by E. H. and E. H. Vokes and W. H. Akers, 1979.

The following planktic foraminifera were identified at TU 1332.

Biorbulina bilobata (d’Orbigny)
Globigerina bulloides bulloides d’Orbigny
G. decoraperta Takayanagi and Saito
Globigerinita glutinata (Egger)
Globigerinoides conglobatus conglobatus (Brady)
G. obliquus extremus Bolli and Bermudez
G. obliquus obliquus Bolli
G. quadrilobatus quadrilobatus (d’Orbigny)
G. quadrilobatus sacculifer (Brady)
Globothracina alternipora alternipora (Cushman and Jarvis)
G. altispira globosa Bolli
G. venezuelana (Hedberg)
Globorotalia (Obandyella) margaritae Bolli and Bermudez
Figure 1. Lower Pliocene exposures discussed in this report, Isthmus of Tehuantepec, Mexico.
G. (Menardella) cultrata limbata (Fornasini)  
Hastigerina (H.) siphonifera siphonifera  
(d’Orbigny)  
Neogloboquadrina acostaensis (Blow)  
Orbulina universa d’Orbigny  
Sphaeroidinellopsis seminulina seminulina  
(Schwager)  
S. subdehiscens subdehiscens (Blow)  
Turborotalita humilis (Brady)

The following calcareous nanofossils were identified at TU 1332, but they are only a few of the species that constitute a rich nanoflora at this locality:

*Amoaulolithus delicatus* Gartner and Bukry  
*Discocaster brownieri* Tan  
*D. pentaradiatus* Tan  
*D. surculus* Martini and Bramlette  
*D. variabilis* Martini and Bramlette  
*Helicostomosphaera sellii* Bukry and Bramlette  
H. kampferri Hay and Mohler  
*Sphenolithus abies* Deflandre

**Geologic Age of Beds at TU 1332**

As at TU 1323, the stratigraphic position of the strata exposed at TU 1332 is somewhere between Zones N. 18 and N. 19, Lower Pliocene. The occurrence of *Globigerinoides conglobatus conglobatus* indicates a position not lower than Zone N. 18, and *Amoaulolithus delicatus* suggests a position not higher than Zone N. 19.

**E. LOCALITY TU 1153**

This roadcut on Mexico Highway 180, at Km 16, east of Acayucan, Veracruz, Mexico, exposes a mottled, buff and light gray clay. Residue on a No. 200 U.S. Standard Series Sieve is largely tests of foraminifera and accicular limonite. The locality is on the Potrérillos Dome and has been mapped as Lower Miocene and referred to the Encanto Formation (Contreras Velazquez et al., 1956, map). Samples were collected by H. E. and E. H. Vokes, 1974.

The following planktic foraminifera were identified at TU 1153:

*Biorbulina bilobata* (d’Orbigny)  
*Candeina nitida* nitida d’Orbigny  
*Globigerina bulloides apertura* Cushman  
*G. bulloides bulloides* d’Orbigny  
*G. decoraperta* Takayanagi and Saito  
G cf. *G. incisa* (Bromnimann and Resig)  
*G. nepentes* Todd  
*G. nepenthes* Todd, juvenile(?)  
*Globigerinella calida* (Parker)  
*G. wula* (Ehrenberg)  
*Globigerinoides conglobatus conglobatus* (Brady)  
*Globigerinella glutinata* (Egger)  
*G. obliquus* extrems Bolli and Bermudez  
*G. obliquus* obliquus Bolli  
*G. quadrilobatus quadrilobatus* (d’Orbigny)  
*G. quadrilobatus acculifer* (Brady)  
*G. ruber* (d’Orbigny)  
*Globocaudina altispira altispira* (Cushman and Jarvis)  
*G. altispira globosa* Bolli  
*G. venezuelana* (Hedberg)  
*Globorotalia (Obandyella) margaritae* Bolli and Bermudez  
*G. (Menardella) cultrata limbata* (Fornasini)  
*G. (Truncorotalia) crassaformis* (Galloway and Wissler)  
*Globorotaloides hexagona hexagona* (Natland)  
*Hastigerina (H.) siphonifera siphonifera* (d’Orbigny)  
*Neogloboquadrina acostaensis* (Blow)  
*N. numerosa* (Takayanagi and Saito)  
*Orbulina universa* d’Orbigny  
*Pulvinatina prinalis* Banner and Blow  
*Sphaeroidinellopsis seminulina seminulina* (Schwager)  
*S. subdehiscens subdehiscens* (Blow)  
*Turborotalita humilis* (Brady)

The beds at TU 1153 are rich in calcareous nanofossils, containing the species listed for other Lower Pliocene sites.

**Geologic Age of Beds at TU 1153**

The coincidence of *Globigerina nepenthes* with *Globorotaloides hexagona hexagona* and *Globigerinella calida* indicates a stratigraphic position in Zone N. 19 or the upper part of Zone N. 18. The nanoflora and the planktic foraminifera are typical of the Lower Pliocene.

**F. LOCALITY TU 1333**

Fresh excavations in railroad cuts behind a newly constructed grain elevator, just north of the road junction at Campo El Chapo, Veracruz, Mexico, were sampled by H. E. and E. H. Vokes with the writer during the summer of 1980. Soft clay yielded rich foraminiferal and calcareous nanofossil assemblages of probable bathyal origin. *Melonis affinis* (Reuss), *Uvigerina hispida* Schwager, and *Amphimorphina staintorthi* (Cushman and Renz) are prominent benthics. The following planktic foraminifera occur at this site:
Biorbulina bilobata (d’Orbigny)
Globigerina decoraperta Takayanagi and Saito
G. neponthes Todd
Globigerinoides conglobatus conglobatus (Brady)
G. obliquus extremus Bolli and Bermudez
G. obliquus obliquus Bolli
G. quadrilobatus quadrilobatus (d’Orbigny)
G. ruber (d’Orbigny)
Globoquadrina altispira altispira (Cushman and Jarvis)
G. altispira globosa (Bolli)
G. venezuelana (Hedberg)
Globorotalia (Obandyella) margaritae Bolli and Bermudez
G. (Menardella) cultrata limbata (Fornasini)
Neogloboquadrina acostaensis (Blow)
N. humerosa (Takayanagi and Saito)
Orbulina universa d’Orbigny
Sphaeroidellapospis seminulina seminulina (Schwager)
S. subdehiscens subdehiscens (Blow)

The following calcareous nannoplankton were identified at TU 1333:
Amaurolithus delicatus Gartner and Bukry
A. primus (Bukry and Percival) Gartner and Bukry
A. tricornculatus (Gartner) Gartner and Bukry
Ceratolithus acutus Gartner and Bukry
Discoaster broweri Tan
D. pentaradiatus Tan
D. surculus Martini and Bramlette
Helicopontosphaera sellii Bukry and Bramlette
Reticulofenestra pseudoubilica (Gartner) Gartner
Sphenolithus abies Deflandre

**Geologic Age of Beds at TU 1333**

Concurrence of Globigerinoides conglobatus conglobatus and Amaurolithus delicatus indicates a stratigraphic position in Zone N. 18 or N. 19, Lower Pliocene.

**V. TAXONOMY**

See Part 1 (Akers, 1979, p. 9-16), for taxonomy of additional forms listed from the Lower Pliocene localities but not included below.

**A. PLANKTIC FORAMINIFERA**

Globigerina incisa (Bronnimann and Resig). Pl. 1, fig. 1a-c


Remarks: The species may have become extinct in the Caribbean-Gulf of Mexico region later than it disappeared from the Pacific, as Bronnimann and Resig (1971, p. 1278-1279) do not record it above Zone N. 20 in deep-sea cores from the southwestern Pacific. Many specimens from the Lower Pliocene of Mexico do not have sutures so deeply incised as seen in specimens from the northern Gulf Coast and elsewhere.

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**Figure 2. Index Microfossils for the Lower Pliocene (Zones N. 18 and N. 19) of Mexico.**
Specimens illustrated from TU 1153 show secondary calcification in the sutures. They are assigned tentatively here.

_Globigerina nepenthes_ Todd. Pl. 1, fig. 2a-c

Remarks: Forms listed and illustrated as _G. cf. G. nepenthis_ Todd, juvenile(?) have been found by the writer in fine sieve fractions (pl. 1, fig. 3a-b). The maximum diameter of most specimens is 200 microns. The writer has found these forms in beds that yield typical adults of _G. nepenthis_ including TU 1324 and TU 1153 of Mexico, the Bowden Formation of Jamaica (Blow’s “Holotype” beds for his Zones N 18 and N 19), the Suva Marl Formation of Fiji (Zone N 19), and the Lower Pliocene of several continental slope core holes in the northern Gulf of Mexico.

_Globigerinella calida_ (Parker). Pl. 1, fig. 4a-c
_Globigerina calida_ PARKER, 1962, Micropaleontology, vol. 8, no. 2, p. 221, pl. 1, fig. 9-13, 15.

Remarks: Kennett and Srinivasan (1983, p. 240) consider this form to range from N 19 to the Holocene.

_Globigerinita glutinata_ (Egger). Pl. 1, fig. 5a-c
_Globigerinita glutinata_ (Egger), PARKER, 1962, Micropaleontology, vol. 8, no. 2, p. 246, pl. 9, fig. 1-16.
_Globigerinoides conglobatus conglobatus_ (Brady). Pl. 1, fig. 6a-c
_Globigerinoides conglobatus conglobatus_ (Brady), PARKER, 1962, Micropaleontology, vol. 8, no. 2, p. 229, pl. 3, fig. 1-5.

_Globigerinoides mitra_ Todd. Pl. 2, fig. 1a-c


_Globorotalia_ (Truncorotalia) crassaformis_ (Galloway and Wissler). Pl. 2, fig. 2a-c

Remarks: Specimens from the Pliocene of Mexico are rare and small and are referred here, sensu lato.

_Globorotalia_ (Menardella) miocenica_ Palmer. Pl. 2, fig. 3a-c
_Globorotalia menardii_ (d’Orbigny) miocenica _PALMER, 1945, Bull. Amer. Paleontology, vol. 29, no. 115, p. 70, pl. 1, fig. 10.

_Globorotaloides hexagona hexagona_ (Natlnd). Pl. 2, fig. 4a-c, 5a-c
_Globorotalia hexagona_ (Natlnd), PARKER, 1962, Micropaleontology, vol. 8, no. 2, p. 244, pl. 8, fig. 5-13.

_Pulleniatina primalis_ Banner and Blow. Pl. 3, fig. 1a-c
Pulleniatina primalis BANNER and BLOW, 1967, Micropaleontology, vol. 13, no. 1, p. 142, pl. 1, fig. 3-8; pl. 3, fig. 2.


Turborotalita humilis (Brady). Pl. 3, fig. 4a-c, 5a-c Truncatulin a humilis BRADY, 1884, Rept. Voy. Challenger, Zoology, vol. 9, p. 665, pl. 94, fig. 7.


Globigerinita humilis (Brady), PARKER, 1962, Micropaleontology, vol. 8, no. 2, p. 249, pl. 10, fig. 1-25.


Globorotalia sp. cf. Turborotalita humilis (Brady), SEILGIE and CUCURULLO, 1971, Carib. Jour. Sci., vol. 11, no. 3-4, p. 110, pl. 4, fig. 61a-63b, 65a, b.

Remarks: The writer agrees with Seilg, and Cucurullo (1971, p. 110) that forms having a less complex bulla and fewer infralaminal apertures are probably ancestral to those forms cited as typical of the species. These authors may also be correct in referring the less complex form to Globanomalina pumilio Parker, 1962.

B. CALCAREOUS NANNOFOSILS

Amaurolitbus delicatus Gartner and Bukry, Pl. 4, Fig. 1, 2


VI. LITERATURE CITED


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PERRILLIAT [MONTOYA], M. C., 1972, Monografia de los Moluscos del Mioceno medio de Santa Rosa, Veracruz, Mexico. Parte 1 (Gasteropoda: Fissurellidae a Olividae): Paleontologia Mexicana, no. 32, 119 p., 51 pls., 1 map.


