13. MAESTRICHTIAN FORAMINIFERS FROM SITE 605, DEEP SEA DRILLING PROJECT LEG 93, NORTHWEST ATLANTIC[1]

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ABSTRACT

Upper Cretaceous clayey limestones of Cores 66 to 71 from Site 605 in the northwest Atlantic contain a highly diversified and well-preserved fauna of planktonic foraminifers.

The local *Racemiguembelina fructicosa, Globotruncana contusa*, and *Globotruncana stuarti* biozones correlate with standard Biozones UC17, UC16, and UC15, indicating a late Maestrichtian age for all the cores.

The co-occurrence of warm-water Tethyan taxa and "cool" boreal taxa points to a transitional biogeoprovince in the northwest Atlantic during late Maestrichtian times.

INTRODUCTION

This chapter documents the Maestrichtian foraminifers recovered from Cores 66 to 71, DSDP Site 605, located at 38°44.52′N, 72°36.55′W, on the upper continental rise at a water depth of 2194 m, 180 km ESE of New Jersey (Fig. 1). A total of 42 samples were taken from a 55-m sequence of Maestrichtian clayey limestone rich in foraminifers and nannofossils, with minor occurrences of quartz grains and pyrite (Fig. 2). Core photographs show no indication of tectonic disturbance or mass transport. There are gradual changes in the color of the sediment and the cores are strongly bioturbated.

METHODS

All samples were dried, dissolved in a mixture of water and sodium carbonate, and washed over a 65-μm sieve. Some samples required an "explosion" treatment before they could be washed; that is the sediment was saturated with gasoline and disaggregated in boiling water. We used a sample splitter on the >125-μm residue to obtain a random collection of 100–200 planktonic foraminifers. Larger portions of the residues were used to extract all benthic foraminifers >125 μm and to determine the percentage of benthic foraminifers in the total foraminiferal fauna (P/B ratio, Fig. 2). Benthic foraminifers were identified only to the generic level.

The preservation of the foraminifers is usually good, but never excellent. Larger specimens are often damaged. Palaeontologic material has been deposited at the Institute for Earth Sciences, Free University, Amsterdam.

RESULTS

Taxonomy of the planktonic foraminifers largely follows the work of van Hinte (1963), Martin (1972), and Robaszynski et al. (1984). Benthic genera are identified from Loeblich and Tappan (1964). The faunas are dominated by planktonic foraminifers with minor amounts of benthic foraminifers, and rare ostracode and echinoid fragments. The planktonic fauna indicates a late Maestrichtian age for our samples (Fig. 3).

Planktonic and benthic foraminifers in the samples are listed in Table 1. The stratigraphic distribution of selected benthic marker species is given in Figure 4.

Local Zonation

In this section of Hole 605, we found highly diverse faunas of obvious late Maestrichtian age. The Late Cretaceous section at Site 605 is subdivided into three local biozones (Fig. 3): an upper *Racemiguembelina fructicosa* Total Range Zone in which *R. fructicosa* is common to abundant; a middle *Globotruncana contusa* Partial Range Zone, with the top defined by the appearance of *R. fructicosa*; and a lower *Globotruncana stuarti* Partial Range Zone for which the top is defined by the appearance of *G. contusa*. We did not use *Abathomphalus mayaroensis*, because this species occurs only in very small numbers in this section.

The *R. fructicosa* Zone is subdivided into an upper *Planoglobulina brazoensis* Total Range Subzone and a lower *Rugoglobigerina scotti* Partial Range Subzone in which *R. fructicosa* but not *P. brazoensis* occurs.

This local zonation correlates to the global schemes (e.g., van Hinte, 1976, and Robaszynski et al., 1984) if we use the range of *A. mayaroensis*, which, however, is rare to statistically absent in this section. Its occurrence in Sample 605-71,CC is thought to be due to caving. We conclude that our local *R. fructicosa* Zone represents the global *A. mayaroensis* Zone. Our local *G. contusa* and *G. stuarti* zones represent the global Zones UC16 and UC15 of van Hinte (1976), which include the larger part of the *G. gansseri* Zone of Robaszynski et al. (1984).

The ranges of selected benthic index species such as *Bolivinoides draco draco* Marsson, *B. decoratus giganteus* Hiltermann and Koch, *Bolivina incrassata* group, *Stensioeina pommerana* Brotzen, and *Osangularia cordieriana navarroana* (Cushman) are given in Figure 4. The range of *Bolivinoides draco draco* has been corre-

[1] van Hinte, J. E., Wise, S. W., Jr., et al., *Init. Repts. DSDP*, 93: Washington (U.S. Govt. Printing Office).

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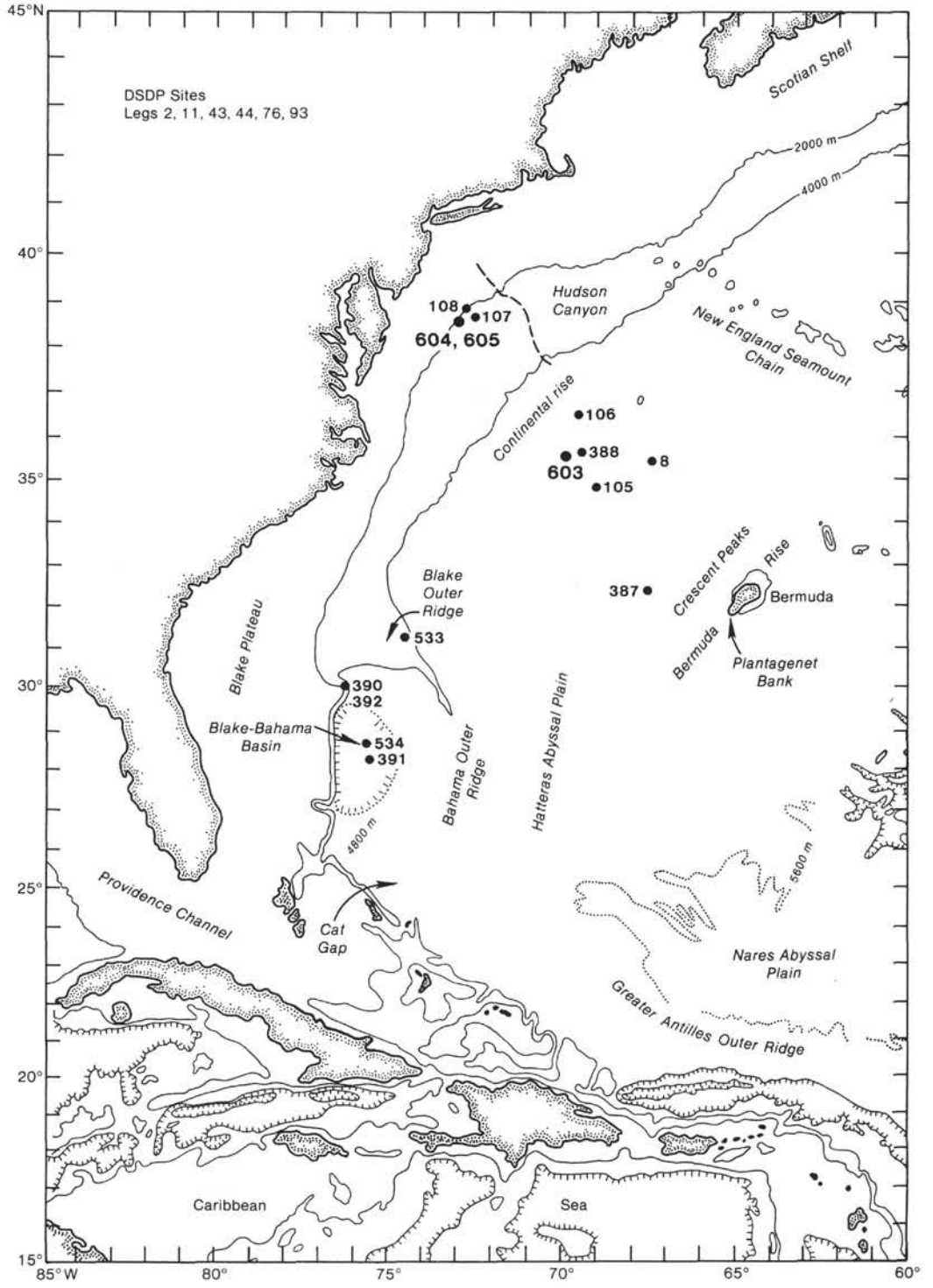

Figure 1. Location of Site 605.

lated with planktonic index species (van Hinte, 1967, 1976) and, at Site 605, further indicates that the *R. fructicosa* Zone does indeed represent the latest Maestrichtian.

The local zonation presented here is comparable with those of Cita and Gartner (1971) and McNulty (1979), as shown in Figure 5.

Percentage of Benthic Foraminifers

Figure 2 shows the percentage of benthic foraminifers in the total foraminiferal fauna for each sample. This percentage (with an average of 4.6%) shows little variation throughout the samples, with the distinct exception of the percentages obtained from Samples 605-

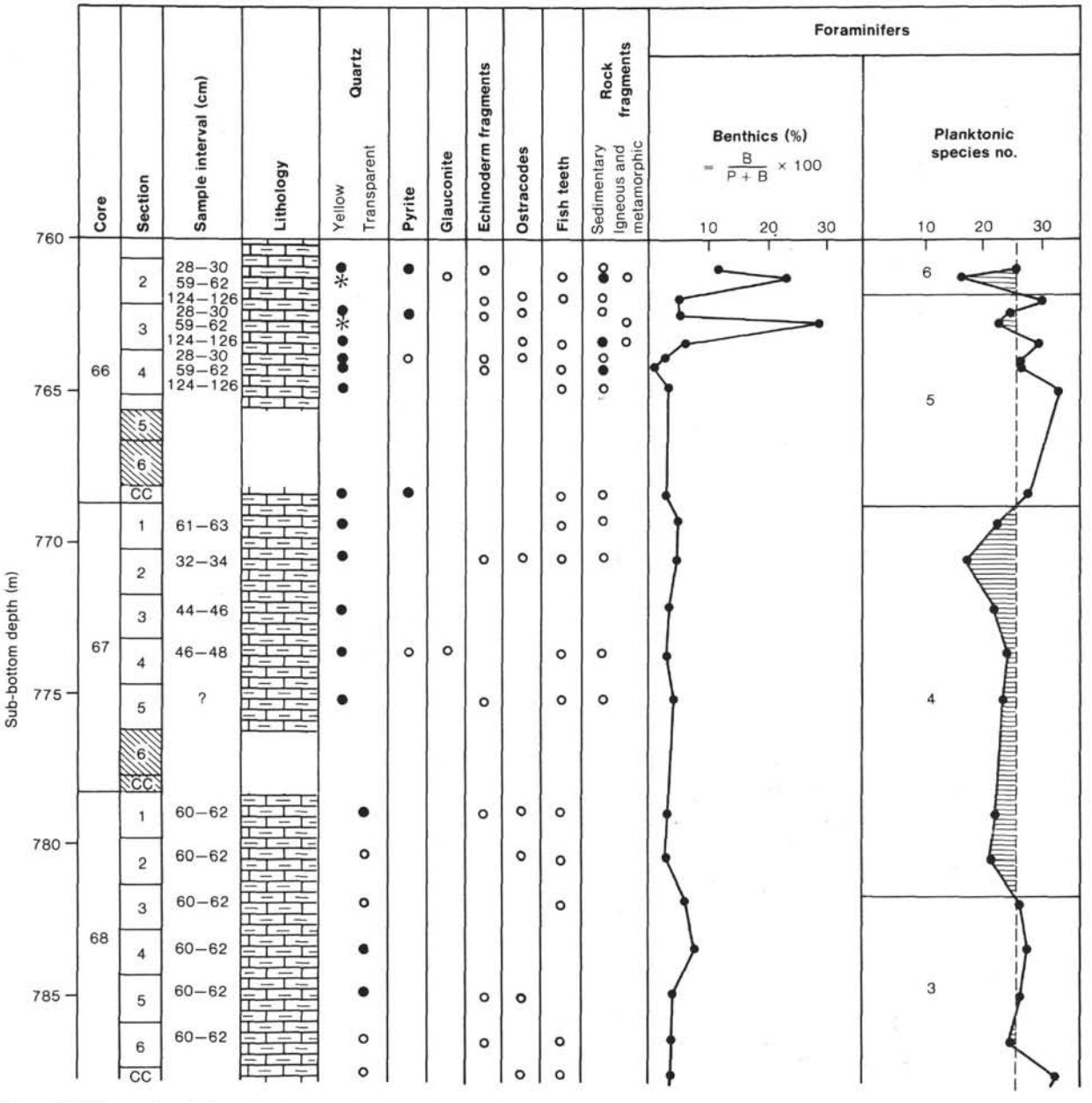

Figure 2. Lithography of Cores 66–71, showing biogenic and lithogenic components in wash residues and the percentage of benthic foraminifers. The sequence is subdivided into six units using planktonic species numbers. Shaded intervals show where species numbers are lower than the overall average.

66-3, 59–62 cm, 605-66-2, 28–30 cm and 605-66-2, 59–62 cm. These samples contain from 10–30% benthic foraminifers, which may be indicative of mass transport. The low percentage of benthics is indicative of a pelagic, bathyal paleoenvironment.

Species Number

The average number of planktonic species in our samples is 25 (Fig. 2). The sequence can be subdivided into smaller units using the planktonic species number. Each unit shows small variations around an average species number within each unit, but, between units species number shifts considerably. It is below 25 species in units 1, 4, and 6. In unit 6 this corresponds with a high % benthic peak in Sample 605-66-2, 59–62 cm. The same correspondence, though less pronounced, is found in Sample 605-66-3, 59–62 cm. This may point to gravitational processes, which introduced increased numbers of benthic foraminifers in the depositional environment and diluted the planktonic faunas.

Benthic diversity was investigated to the superfamily level (Fig. 6). The results show that the benthic faunas are relatively stable and generally are dominated either by agglutinated forms or by cassidulinids. Agglutinated forms dominate in the upper (605-66-2, 28–30 cm to 605-67-2, 32–34 cm) and lower (605-69-4, 60–62 cm to 605-71-4, 60–62 cm) part of the section.

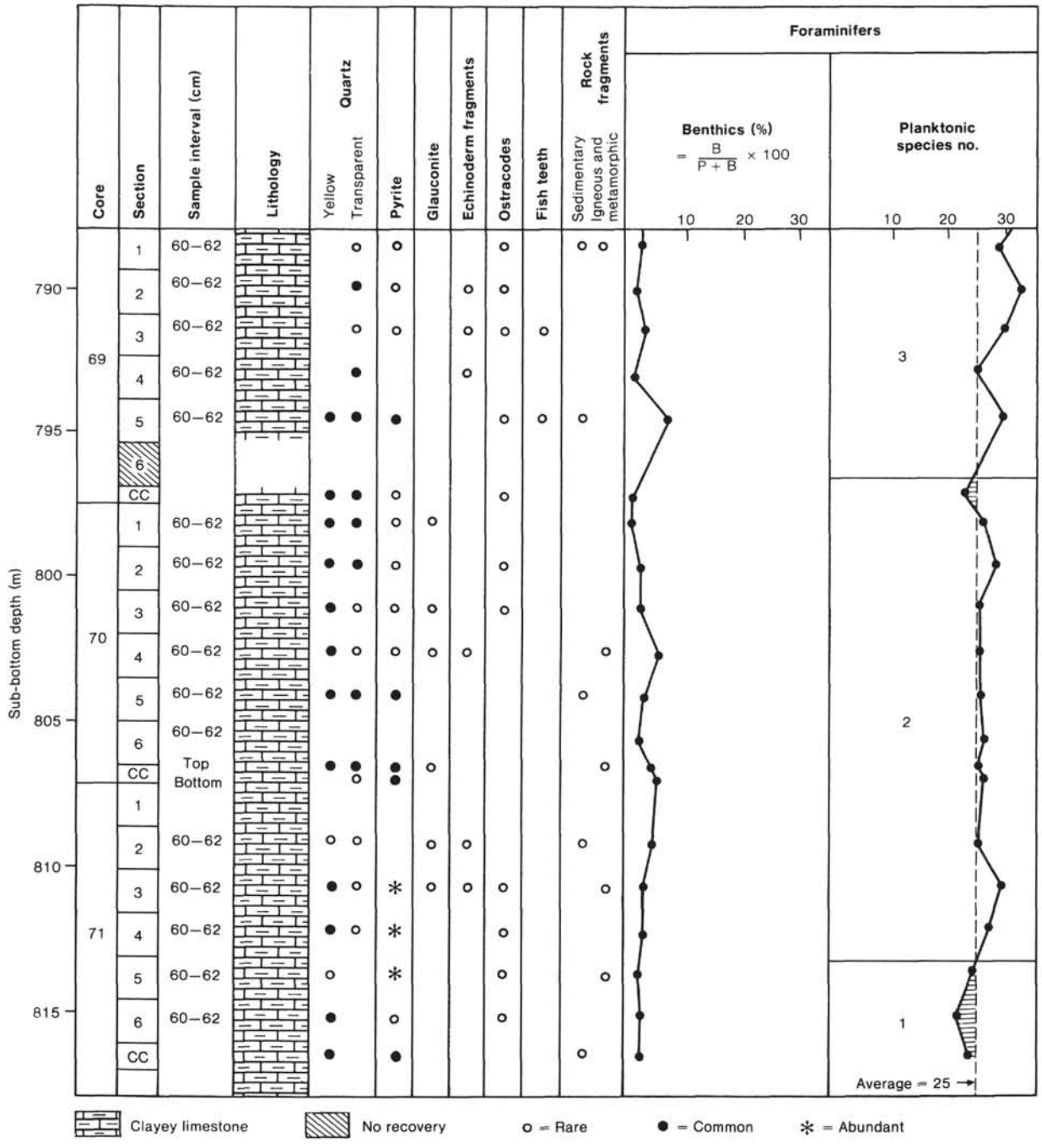

Figure 2. (Continued).

Depth of Deposition

It is assumed that subsidence caused by lithospheric cooling of the crust was negligible by Maestrichtian time. We derived the paleodepth by using a correction factor of 0.726, after Hardenbol et al. (1981), on the post-Maestrichtian sediments in our section. This gives a paleodepth of (760 + 2194) − (0.726 × 760) = 2402 m. The present water depth at Site 605 is 2194 m. The actual paleodepth of the Maestrichtian section would have been somewhat shallower because of post-Maestrichtian compaction of the pre-Maestrichtian section.

Paleoenvironment

Watermasses are characterized by their foraminiferal fauna in the present and in the past (Bé, 1977; Vincent and Berger, 1981). Nyong (1984), discussing the Late Cretaceous planktonic foraminiferal faunas of the North Atlantic, noted a "transitional" biogeographic province located at 40°N (Fig. 7) and characterized by the co-occurrence of "cold"-water species of *Rugoglobigerina, Archaeoglobigerina*, and *Hedbergella* and warm-water species of the globotruncanids and heterohelicids, coming from the Tethyan biogeoprovince.

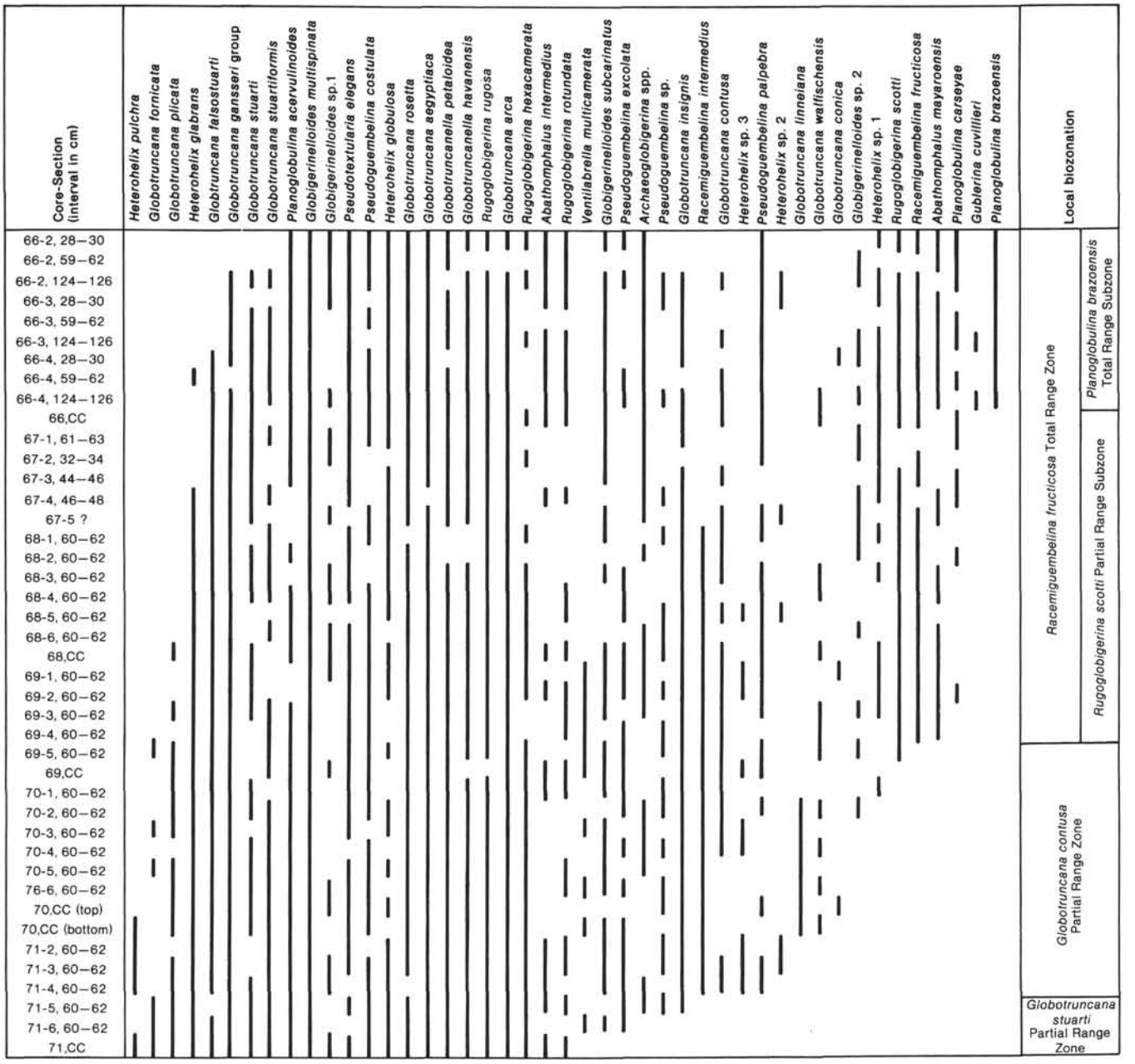

Figure 3. Distribution chart of the planktonic foraminifers from Site 605, and local biozonation.

The dominant fauna consists of warm-water taxa, but "cold"-water forms are also present at Site 605. The dominance of the warm-water species suggests that a clockwise circulation late in the Cretaceous in this area brought warm water northward. This circulation pattern is similar to that of the modern North Atlantic. (See Olsson and Wise [this volume] for further discussion of the biogeography of the Upper Cretaceous calcareous plankton at this site.)

A paleodepth of ~2400 m for our benthic assemblages is consistent with the relative stability of the percentage of benthic foraminifers and the constant relative abundancies of the benthic superfamilies throughout the section (Fig. 6).

The depositional scenario for this section is a gently subsiding continental rise environment over which a northerly surface current flowed.

TAXONOMIC REMARKS

Genus *GLOBOTRUNCANA* Cushman, 1927

Globotruncana aegyptiaca Nakkady
(Pl. 1, Fig. 1–3)

Globotruncana aegyptiaca Nakkady, 1950, p.690, pl. 80, fig. 20, is an abundant species in our samples and dominates the planktonic foraminiferal faunas in this section. It shows variation in number of chambers in the last whorl (3–6), in the inflation of the chambers, and in the convexity of the spiral side, most specimens having a flat sprial side. *Globotruncana aegyptiaca* is very close to *G. ventrico-*

Table 1. Maestrichtian foraminifers, Hole 605.

1. Most common planktonic species

Globotruncana aegyptiaca Nakkady
G. arca (Cushman)
G. falsostuarti Sigal
G. insignis Gandolfi
G. rosetta (Carsey)
Globotruncanella havanensis (Voorwijk)
G. petaloidea (Gandolfi)
Rugoglobigerina rugosa (Plummer)
Heterohelix globulosa (Ehrenberg)
Planoglobulina acervulinoides (Egger)
Pseudotextularia elegans (Rzehak)
Pseudoguembelina excolata (Cushman)
P. costulata (Cushman)
Globigerinelloides multispinata (Lalicker)
G. subcarinatus (Brönnimann)
Globigerinelloides spp.

2. Less common planktonic species

Abathomphalus mayaroensis (Bolli)
A. intermedius (Bolli)
Globotruncana conica White
G. contusa (Cushman)
G. fornicata Plummer
G. gansseri Bolli
G. plicata White
G. linneiana (d'Orbigny)
G. stuarti (de Lapparent)
G. stuartiformis Dalbiez
G. walfischensis Todd
Rugoglobigerina hexacamerata Brönnimann
R. rotundata Brönnimann
R. scotti (Brönnimann)
Planoglobulina brazoensis Martin
P. carseyae (Plummer)
Racemiguembelina fructicosa (Egger)
R. intermedia (de Klasz)
Ventilabrella multicamerata de Klasz
Heterohelix glabrans (Cushman)
H. pulchra (Brotzen)
Gublerina cuvillieri Kikoine
Pseudoguembelina palpebra Brönnimann and Brown
Pseudoguembelina sp. 1
Heterohelix spp.
Hedbergella spp.

3. Common benthic genera

Bathysiphon
Reophax
Ammodiscus
Glomospira
Textularia
Spiroplectammina
Clavulina
Pseudobolivina
Dorothia
Haplophragmoides
Rzehakina
Trochammina
Lagena
Nodosaria
Dentalina
Astacolus
Pyrulina
Lenticulina
Praebulimina
Pyramidina
Pseudouvigerina
Bolivina
Bolivinoides
Pleurostomella
Anomalinoides
Gavelinella
Gyroidinoides
Gyroidina
Pullenia
Conorotalites
Albamina
Osangularia
Quadrimorphina

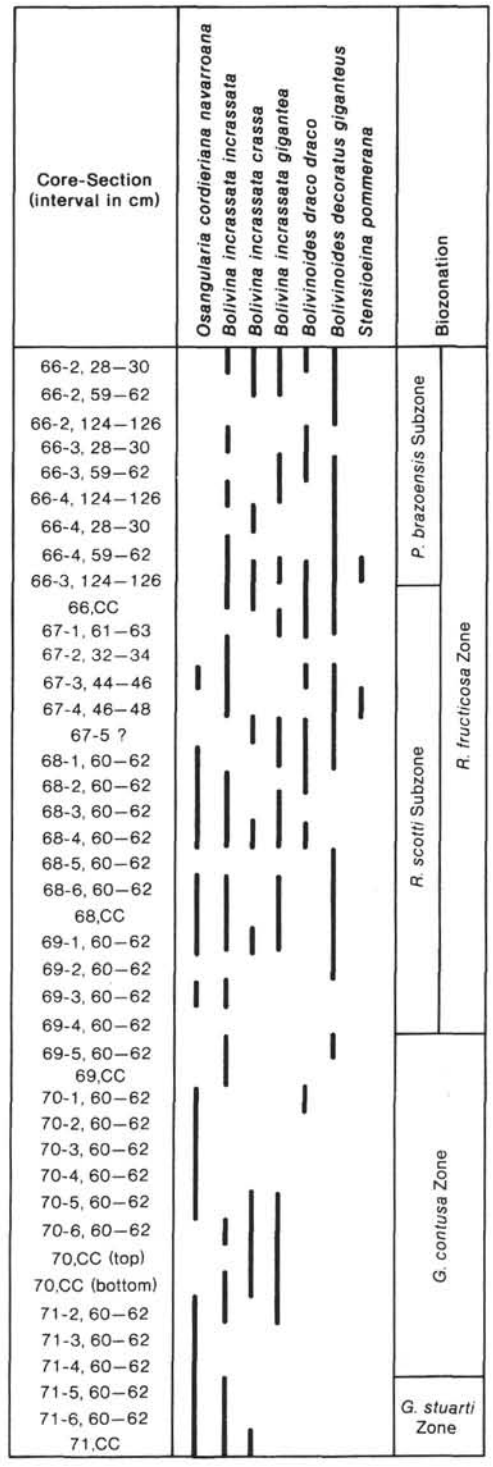

Figure 4. Distribution chart of selected age-diagnostic benthic species.

sa, but its chambers increase more rapidly in size. Some specimens from Sample 605-69-2, 60–62 cm to Sample 605-71,CC, resemble *G. gagnebini* Tilev (sensu Postuma, 1962) in having all chambers (3–5) inflated on the spiral side and rugosite on both sides.

Globotruncana arca (Cushman)

(Pl. 1, Figs. 4–6)

Pulvinulina arca Cushman, 1926, p. 43, pl. 3, fig. 1.

Globotruncana arca is present in all samples, with the exception of Sample 605-66-2, 59–62 cm. In this fauna, most specimens of *G.*

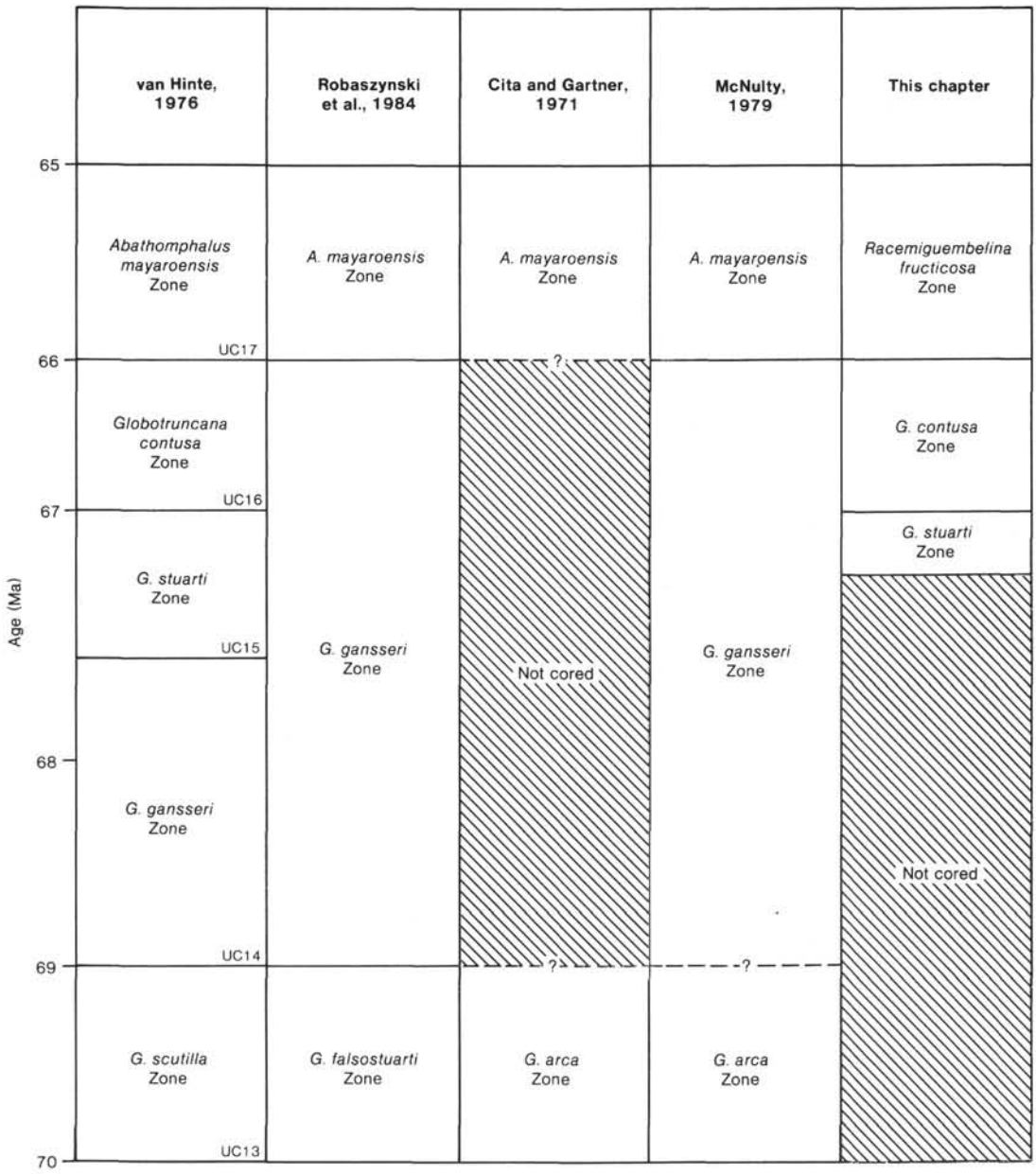

Figure 5. Local biozonation at Site 605, compared with biozonations of Site 10, Leg 2 (Cita and Gartner, 1971), Site 384, Leg 43 (McNulty, 1979), and global schemes of van Hinte, 1976, and Robaszynski et al., 1984.

arca have only 5–6 chambers in the last whorl. A few specimens lack a second keel on the final chambers, like *G. orientalis* El Naggar, which has here been included in *G. arca*.

Globotruncana conica White
(Pl. 3, Figs. 4–6)

A few specimens of *Globotruncana conica* White (1928, p. 285, pl. 38, fig. 7a–c) were found in Samples 605-69-1, 60–62 cm, and 605-70,CC (top); they are easily recognized by their high trochospire, smooth, circular outline, single keel, and flat umbilical side.

Globotruncana contusa (Cushman)
(Pl. 4, Figs. 4–9)

Pulvinulina arca Cushman var. *contusa* Cushman, 1926, p. 23.
Globotruncana (Globotruncana) contusa (Cushman) sp. *patelliformis* Gandolfi, 1955, p. 54, pl. 4, fig. 2a–c.

Globotruncana contusa occurs in low numbers in this section, except for Sample 605-66-4, 124–126 cm, where it is abundant. This species is characterized by a moderately high to high trochospire, and a polygonal outline. For a discussion of the taxonomic problems involving this species we refer to Robaszynski et al.(1984). We consider *G. patelliformis* to fall within the morphological range of *G. contusa*.

Globotruncana falsostuarti Sigal
(Pl. 1, Figs. 7, 8)

Globotruncana falsostuarti Sigal (1952, p. 43, fig. 6) is common at the base of the section and becomes rare toward the top. It is absent in the upper five samples. *Globotruncana falsostuarti* has two keels, which are typically closer together in the middle of each chamber, the umbilical keel being usually less well developed or absent on the last few chambers. Specimens with fully developed keels are common in the lower part of the section, whereas the number of

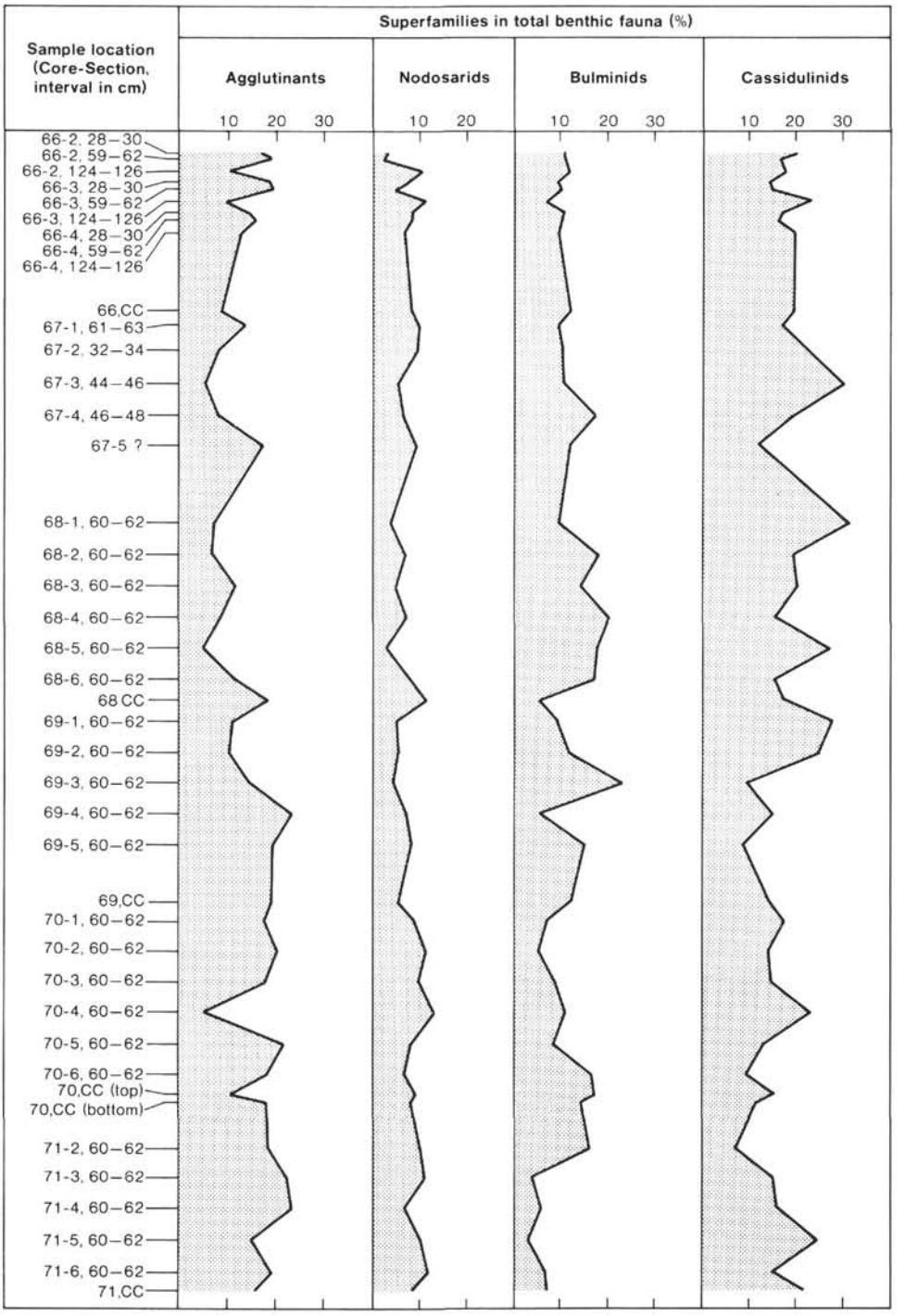

Figure 6. Percentages of benthic foraminiferal superfamilies in total foraminiferal fauna from Site 605.

specimens lacking an umbilical keel on the final chamber increases toward the upper part of the section.

Globotruncana fornicata Plummer
(Pl. 4, Figs. 1–3)

Globotruncana fornicata Plummer (1931, p. 130, pl. 13, fig. 4a–c) rarely occurs in the lower part of the section. Specimens are small, with low to moderately high trochospire, and a subpolygonal to rounded peripheral outline.

Globotruncana gansseri Bolli
(Pl. 3, Figs. 1–3; Pl. 7, Figs. 1–6)

Globotruncana gansseri Bolli, 1951, pl. 35, figs. 1–3.
Globotruncana lugeoni Tilev var. *angulata* Tilev, 1951, fig. 1a–c. 13a–c.
Globotruncana (Globotruncana) wiedenmayeri wiedenmayeri Gandolfi, 1955, pl. 7, fig. 4a–c.
Globotruncana (Globotruncana) rosetta (Carsey) sp.*pettersi* Gandolfi, 1955, p. 68, pl. 6, fig. 3a–c.
Globotruncana gansseri ranges throughout the section in low numbers. *Globotruncana gansseri* sensu Robaszynski et al. (1984) is

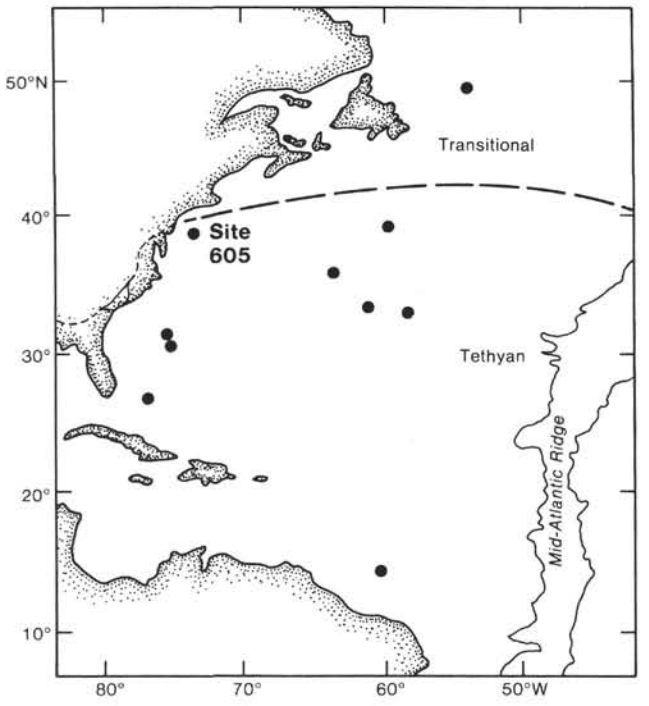

Figure 7. The position of two biogeographic provinces in the western North Atlantic in the Late Cretaceous, modified after Nyong (1984).

only present in Samples 605-67-1, 61–63 cm to 605-68-2, 60–62 cm, where it is abundant. It is characterized in these samples by the presence of one keel, sometimes with a row of pustules parallel to the keel on the umbilical side, an almost flat spiral side, and rugosities on the earlier chambers of the last whorl. *Globotruncanita angulata* (Tilev) and *Globotruncanita pettersi* (Gandolfi) sensu Robaszynski et al. (1984) are considered synonyms of *Globotruncana gansseri* in this study. These smooth forms range throughout the section, whereas *G. gansseri* s.s. appears only in the local *Racemiguembelina fructicosa* Zone. Separating these forms in this section results in a very short range of *G. gansseri*.

Globotruncana insignis Gandolfi
(Pl. 2, Figs. 1, 2)

Globotruncana (Globotruncana) rosetta (Carsey) ssp. *insignis* Gandolfi, 1955, p. 67, pl. 6, fig. 2a–c.

Globotruncana insignis is a common species in this section. Most specimens have a flat spiral side and are slightly lobate. The species is distinguished from *G. gansseri* by the acute peripheral angle and narrow umbilicus with tegilla in the final chambers.

Globotruncana linneiana (d'Orbigny)
(Pl. 2, Figs. 3–5)

Rosalina linneiana d'Orbigny, 1839, p. 101, pl. 5, fig. 10–12.

A few specimens of *Globotruncana linneiana* were encountered in the lower part of the section. *G. linneiana* is easily recognized by its lobate outline, flattened lateral view, and by the widely spaced keels on all chambers of the last whorl.

Globotruncana plicata White

Globotruncana conica White var. *plicata* White, 1928, p. 285, *Globotruncana plicata* is common in the lower part of the section. It differs from *G. contusa* in having a lobate peripheral outline, smaller number of whorls, and depressed sutures between the final chambers on the spiral side.

Globotruncana rosetta (Carsey)
(Pl. 1, Figs. 9–11; Pl. 2, Figs. 6, 7)

Globigerina rosetta Carsey, 1926, p. 44, pl. 5, fig. 3a–b.

Globotruncana arca (Cushman) var. *esnehensis* Nakkady, 1950, p. 690, pl. 90, figs. 23–26.

Globotruncana dupeublei Caron, Gonzalez Donoso, Robaszynski, and Wonders, 1984, p. 188, pl. 7m, fig. 1–2 *in* Robaszynski et al. (1984).

Globotruncana rosetta is a common species in most samples. It has a slightly convex to flat spiral side, and a convex umbilical side. A second keel is present on the earlier chambers of the last whorl, but absent on the final chambers. As such, it is in the center of a morphological series with *G. dupeublei/G. insignis/G. esnehensis* on the single-keeled end, and *G. orientalis/G. ventricosa* on the double-keeled end. It differs from *G. falsostuarti* in that the two keels are not close together in the middle of each chamber.

Globotruncana stuarti (de Lapparent)
(Pl. 3, Figs. 10, 13)

Rosalina stuarti de Lapparent, 1918, p. 11, pl. 4, lower three figures.

Globotruncana stuarti occurs infrequently and in low numbers in our samples; its test is often damaged. This bioconvex species has subrectangular spiral chambers in the last whorl.

Globotruncana stuartiformis Dalbiez
(Pl. 3, Figs. 11, 12)

Globotruncana (Globotruncana) elevata Brotzen, ssp. *stuartiformis* Dalbiez, 1955, p. 169, pl. 10a–c.

A few specimens of *Globotruncana stuartiformis* were found in our samples. Typically, they have an asymmetrical profile in lateral view, in that the umbilical side is more highly convex than the spiral side, and triangularly shaped last chambers on the spiral side.

Globotruncana walfischensis Todd
(Pl. 4, Figs. 10–12)

Globotruncana walfischensis Todd (1970, p. 153, pl. 5, fig. 8a–b) appears in low numbers throughout the section. It is characterized by small size, circular outline, and concavo-convex shape, and by weakly developed keels on the final chambers.

Genus *GLOBOTRUNCANELLA* Reiss, 1957, emended Robaszynski et al., 1984

Globotruncanella havanensis (Voorwijk)
(Pl. 5, Figs. 1, 2)

Globotruncana havanensis Voorwijk, 1937, p. 195, pl. 1, figs. 25, 26, 29.

Globotruncanella havanensis (Voorwijk) van Hinte, 1963, p. 94, pl. 10, fig. 3, pl. 11, figs, 4–5, pl. 12, fig. 1 (redescription of holotype)

Globotruncanella havanensis is almost always present in our samples. It is characterized by its lobate outline, globular chambers in the earlier whorls, and flattened chambers in the last whorl, which tilt towards the umbilicus. A few specimens show a true keel, resembling *G. pschadae* Keller.

Globotruncanella petaloidea (Gandolfi)
(Pl. 5, Figs. 3–5)

Globotruncana (Rugoglobigerina) petaloidea Gandolfi ssp. *petaloidea* Gandolfi, 1955, p. 52, pl. 3, fig. 13a–c.

Globotruncanella petaloidea is present in most samples. It has a strongly lobate outline, and always four chambers in the last whorl; these chambers are less pinched in lateral view than those of *G. havanensis*.

Genus *ABATHOMPHALUS* Bolli, Loeblich, and Tappan, 1957

Abathomphalus intermedius (Bolli)
(Pl. 5, Figs. 6–7)

Globotruncana intermedia Bolli, 1951, pl. 35, figs. 7–9.

A few specimens of *Abathomphalus intermedius* were found in this section. *A. intermedius* can be distinguished from *A. mayaroensis*

by its smaller size, convex spiral side, and weakly developed keels. Intermediate forms between *A. mayaroensis* and *A. intermedius* are present.

***Abathomphalus mayaroensis* (Bolli)**
(Pl. 5, Figs. 8–10)

Globotruncana mayaroensis Bolli, 1951, pl. 35, figs. 10–12.
Abathomphalus mayaroensis is very rare in the upper part of the section. The few specimens found are easily recognized by their two widely space keels and flat spiral side.

Genus *ARCHAEOGLOBIGERINA* Pessagno, 1967

***Archaeoglobigerina* spp.**
(Pl. 9, Figs. 12–14)

These species occur throughout the section. They differ from the rugoglobigerinids in lacking costellae or pustules arranged in a particular pattern.

Genus *RUGOGLOBIGERINA* Brönnimann, 1952

***Rugoglobigerina hexacamerata* Brönnimann**
(Pl. 7, Fig. 7, 8)

Rugoglobigerina (Rugoglobigerina) reicheli hexacamerata Brönnimann, 1952, p. 23, pl. 2, figs. 10–12.
Rugoglobigerina hexacamerata occurs rarely in most samples. It can be distinguished from *R. rugosa* by its slower increase in chamber size, and by the presence of 6–7 chambers in the last whorl.

***Rugoglobigerina rotundata* Brönnimann**
(Pl. 6, Figs. 1–3)

Rugoglobigerina (Rugoglobigerina) rugosa rotundata Brönnimann, 1952, p. 43, pl. 4, figs. 7–9.
Rugoglobigerina rotundata occurs infrequently and in low numbers throughout the section. It is characterized by a high trochospire, and is much larger in size than other species of this genus.

***Rugoglobigerina rugosa* (Plummer)**
(Pl. 6, Figs. 4–6)

Globigerina rugosa Plummer, 1926, p. 38, pl. 2, fig. 10a.
This is the most common rugoglobigerinid in our section. It is characterized by its flat sprial side and rapidly increasing chamber size. It has 4 to 5 chambers in the last whorl.

***Rugoglobigerina scotti* (Brönnimann)**
(Pl. 6, Figs. 7–12)

Trinitella scotti Brönnimann, 1952, p. 57, pl. 4, fig. 4–6.
Rugoglobigerina scotti occurs in the upper part of the section, where it is abundant in Samples 605-66-4, 28–30 cm to 605-66-4, 124–126 cm. *R. scotti* is characterized by the compressed chambers, varying from 4–6, in the last whorl. The four-chambered types appear from Sample 605-68-4, 60–62 cm upward, the 5–6-chambered types appear throughout its range.

Genus *HETEROHELIX* Ehrenberg, 1843

***Heterohelix glabrans* (Cushman)**
(Pl. 7, Fig. 9)

Guembelina glabrans Cushman, 1938, p. 15, pl. 3, fig. 1a–2.
Heterohelix glabrans is common in the lower part of the section. It has a flattened biserial test with the chambers increasing rapidly in size.

***Heterohelix globulosa* (Ehrenberg)**
(Pl. 7, Fig. 11)

Textularia globulosa Ehrenberg, 1840, p. 135, pl. 4, figs. 1–8.
Heterohelix globulosa is present in almost every sample. Some specimens may resemble *H. striata* (Ehrenberg) in possessing striae.

***Heterohelix pulchra* (Brotzen)**
(Pl. 7, Fig. 10)

Guembelina pulchra Brotzen, 1936, p. 121, pl. 9, figs. 2, 3.
Heterohelix pulchra can be found in the lowermost samples. It is characterized by its small size and reniform chambers.

***Heterohelix* sp. 1**
(Pl. 8, Fig. 3)

Heterohelix sp. 1 occurs in the upper part of the section, in low numbers. This species resembles *H. pulchra*, but differs in its larger size and greater number of chambers.

***Heterohelix* sp. 2**
(Pl. 8, Fig. 4)

Heterohelix sp. 2 is a rare species, easily recognized because the last chamber is elongated in the direction of growth.

***Heterohelix* sp. 3**
(Pl. 8, Fig. 8)

Heterohelix sp. 3 is a rare species in the lower part of the section. It is characterized by its small size and the slow increase in chamber size. It resembles *H. moremani* (Cushman).

Genus *VENTILABRELLA* Cushman, 1928

***Ventilabrella multicamerata* de Klasz**
(Pl. 8, Fig. 9)

Ventilabrella multicamerata de Klasz (1953, p. 230, pl. 5, fig. 1a–b) is a rare species in the lower part of the section. It is characterized by vermicular ornamentation on the early chambers and by indistinct chambers in the later portion.

Genus *PSEUDOGUEMBELINA* Brönnimann and Brown, 1953

***Pseudoguembelina costulata* (Cushman)**
(Pl. 8, Fig. 5)

Guembelina costulata Cushman, 1938, pp. 16–17, pl. 3, figs. 7–9.
Pseudoguembelina costulata is a common species in this section. It differs from *P. excolata* (Cushman) by its smaller size, more slender test, and finer striations.

***Pseudoguembelina excolata* (Cushman)**
(Pl. 8, Fig. 6)

Guembelina excolata Cushman, 1926, p. 20, pl. 2, fig. 9.
Pseudoguembelina excolata occurs infrequently throughout the section. It is characterized by its coarse striae.

***Pseudoguembelina palpebra* Brönnimann and Brown**
(Pl. 8, Fig. 11)

Pseudoguembelina palpebra Brönnimann and Brown (1953, p. 155, figs. 9a–10b) can be found throughout the section in low numbers. It is characterized by its inflated chambers, which, in the early part, increase rapidly in size.

***Pseudoguembelina* sp. 1**
(Pl. 8, Fig. 7)

Pseudoguembelina sp. 1 is a rare species in this section. It differs from *Pseudoguembelina palpebra* in being more slender and in possessing less inflated chambers.

Genus *PSEUDOTEXTULARIA* Rzehak, 1891

***Pseudotextularia elegans* (Rzehak)**
(Pl. 8, Figs. 1, 2)

Cuenolina elegans Rzehak, 1891, p. 4.
Pseudotextularia elegans is common throughout the section. It is characterized by its large basal aperture, slender biserial view, and triangular side view.

Genus *RACEMIGUEMBELINA* Montanaro Gallitelli, 1957

***Racemiguembelina fructicosa* (Egger)**
(Pl. 8, Fig. 13)

Guembelina fructicosa Egger, 1899, p. 35, pl. 14, figs. 8, 9.
Racemiguembelina fructicosa is abundant in the upper part of the section. It has a conical shape and is therefore easily distinguished from other species.

Racemiguembelina intermedia (de Klasz)
(Pl. 8, Fig. 12)

Pseudotextularia intermedia de Klasz, 1953, p. 231–232, pl. 5, fig. 2a–c.

Racemiguebelina intermedia ranges from Samples 605-71-4, 60–62 cm to 605-68-1, 60–62 cm. It is characterized by a biserial test with accessory aperatures only between the last chambers. It is morphologically close to *Pseudotextularia elegans*.

Genus *PLANOGLOBULINA* Cushman, 1927, emend. Martin, 1972

Planoglobulina acervulinoides (Egger)
(Pl. 8, Fig. 10)

Pseudotextularia acervulinoides (Egger) Cushman, 1926, p. 17, pl. 2, fig. 5.

Planoglobulina acervulinoides is common throughout the section. This species has a flabelliform test and differs from *Planoglobulina brazoensis* Martin in having a more planar test and more widely spaced striations.

Planoglobulina brazoensis Martin
(Pl. 9, Fig. 1–3)

Planoglobulina brazoensis Martin (1972, pp. 82–83, pl. 3, fig. 7a–c, pl. 4, fig. 1a–2) occurs only in Core 66, the uppermost part of the section. Its flabelliform test is inflated in the early portion and has globular chambers in the multiserial portion, with widely spaced, coarse striae.

Planoglobulina carseyae Plummer

Ventilabrella carseyae Plummer, 1931, p. 178, pl. 9, fig. 9a–b.

Planoglobulina carseyae is relatively rare species in the upper samples. This species differs from *P. brazoensis* in having more chambers in the biserial portion; these chambers increase more slowly in size and have finer striations.

Genus *GLOBIGERINELLOIDES* Cushman and ten Dam, 1948

Globigerinelloides multispinata (Lalicker)
(Pl. 9, Figs. 4, 5)

Biglobigerinella multispinata Lalicker, 1948, p. 624, pl. 92.

Globigerinelloides multispinata is common in all samples. It varies in the number of chambers in the last whorl (4–6) and the degree of inflation of chambers, and may develop a bipartite primary aperture that is occasionally covered by thin-walled chambers. *G. messinae* (Brönnimann) is considered a junior synonym.

Globigerinelloides subcarinatus (Brönnimann)
(Pl. 9, Figs. 6, 7)

Globigerinella messinae ssp *subcarinata* Brönnimann, 1952, p. 44, pl. 1, figs. 10, 11.

Globigerinelloides subcarinatus ranges through the whole section. Its planispiral test has a last whorl with 5 chambers and a pinched periphery in lateral view. Some specimens tend to develop an elongated last chamber.

Globigerinelloides sp. 1
(Pl. 9, Fig. 10)

A few specimens of *Globigerinelloides* sp. 1 were encountered. Its test has 6–7 chambers in the last whorl; these increase slowly in size and are pinched in lateral view.

Globigerinelloides sp. 2
(Pl. 9, Figs. 8, 9)

This species is present throughout the section in low numbers. It differs from *Globigerinelloides* sp. 1 in having more chambers in the last whorl; they are rounded in lateral view.

Genus *GUBLERINA* Kikoine, 1948

Gublerina cuvillieri Kikoine
(Pl. 9, Fig. 11)

Gublerina cuvillieri Kikoine (1948, p. 26, pl. 2, fig. 10) is a very rare species in this section. It has a biserial test, in which the final chambers are separated by a nonseptal portion.

Genus *HEDBERGELLA* Brönnimann and Brown, 1958

Hedbergella spp.

Small specimens of *Hedbergella* are present throughout the section in the 75–125-μm fraction.

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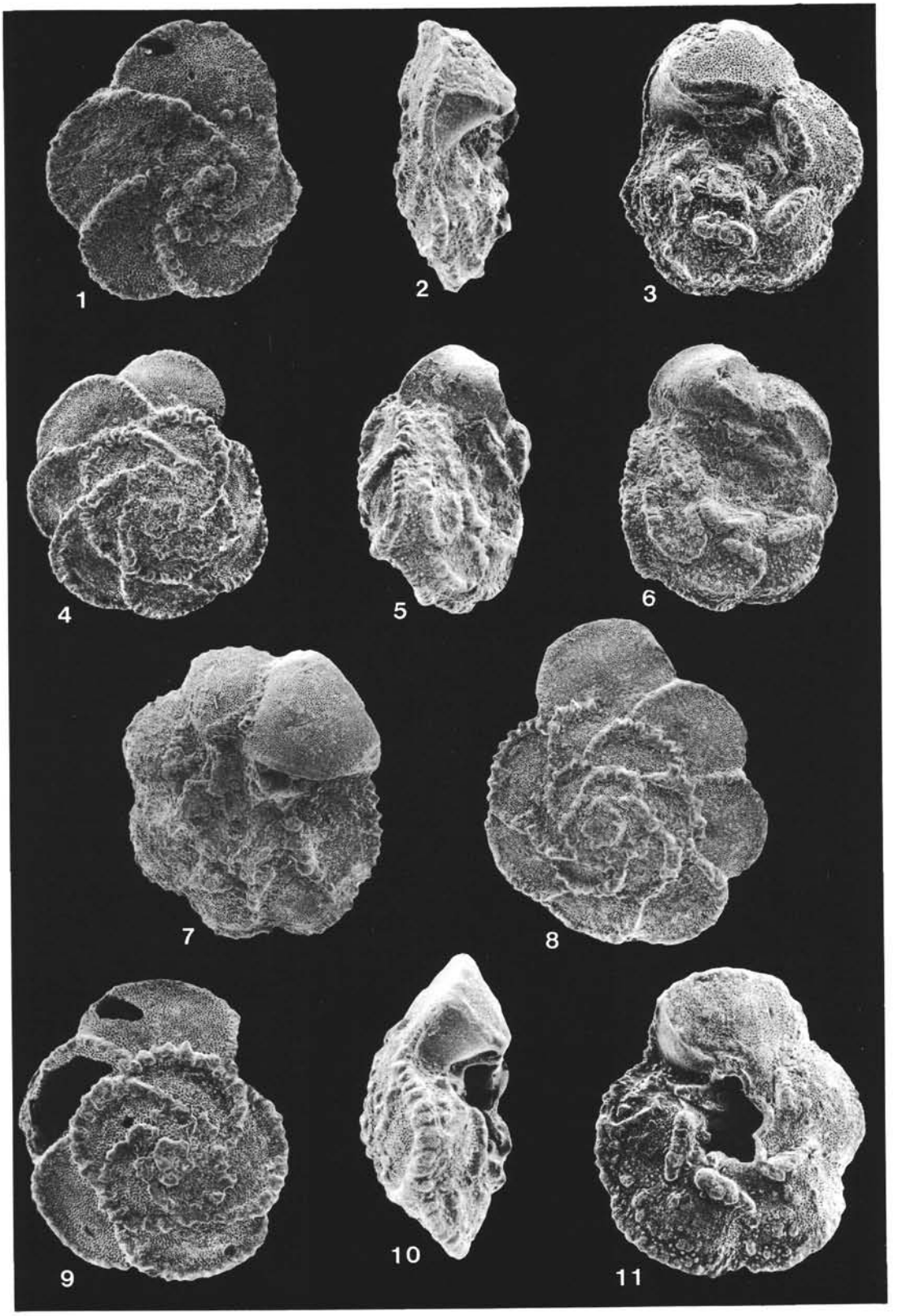

Plate 1. **1–3.** *Globotruncana aegyptiaca* Nakkady, 65×, Sample 605-66-2, 59–62 cm, (1) spiral side; (2) side view, same specimen; (3) umbilical side, same specimen. **4–6.** *Globotruncana arca* (Cushman), 52×, Sample 605-71-2, 60–62 cm, (4) spiral side; (5) side view, same specimen; (6) umbilical side, same specimen. **7, 8.** *Globotruncana falsostuarti* Sigal, 52×, Sample 605-69-1, 60–62 cm, (7) umbilical side; (8) spiral side. **9–11.** *Globotruncana rosetta* (Carsey), 65×, Sample 605-66-2, 59–62 cm, (9) spiral side; (10) side view specimen; (11) umbilical view, same specimen. Note that it has only 5 chambers in the last whorl and a faint second keel on the earlier chambers.

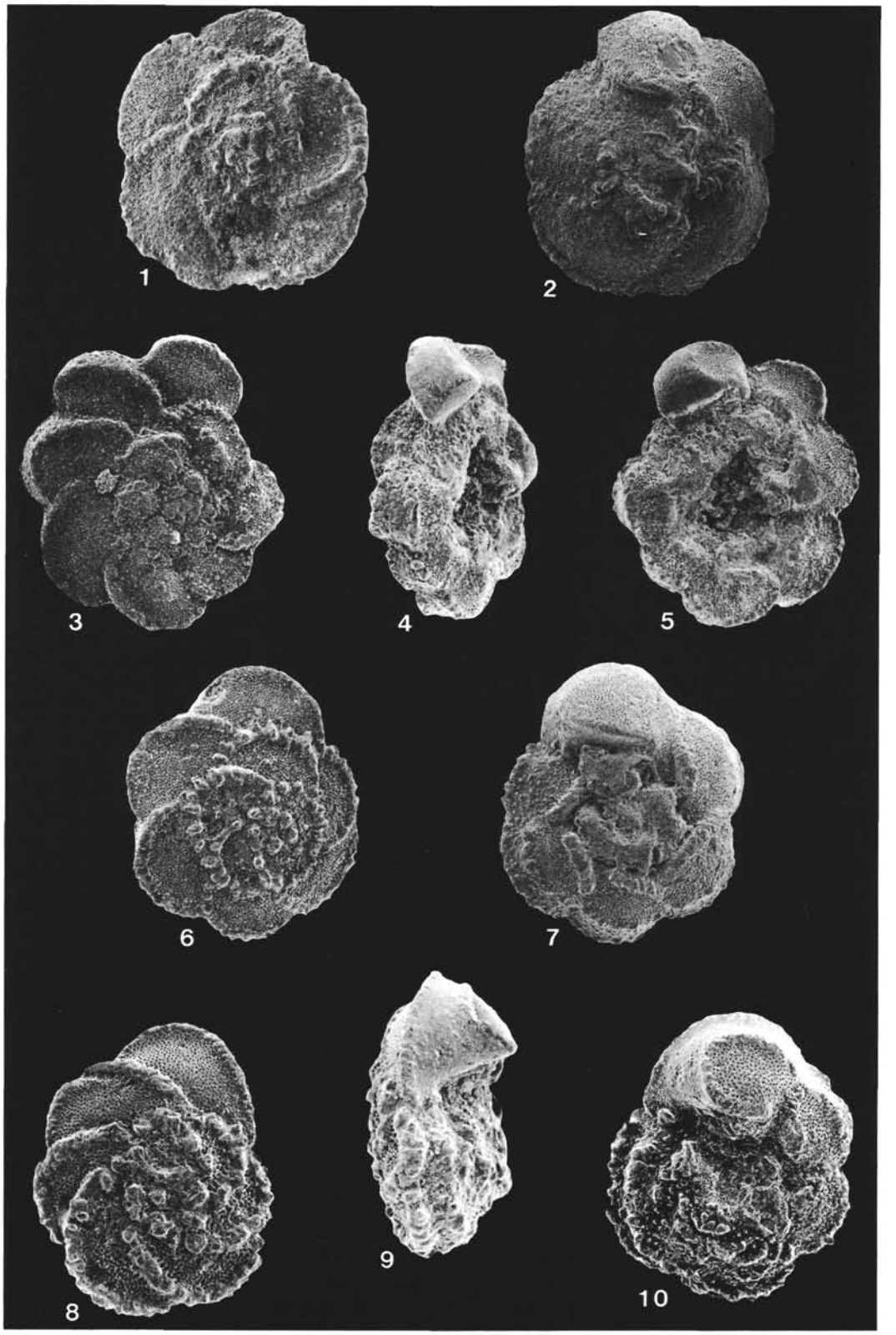

Plate 2. **1, 2.** *Globotruncana insignis* Gandolfi, 65×, Sample 605-68,CC, (1) spiral side; (2) umbilical side, same specimen, showing narrow umbilicus. **3–5.** *Globotruncana linneiana* (d'Orbigny), 84.5×, Sample 605-70,CC (bottom), (3) spiral side; (4) side view, same specimen; (5) umbilical side, same specimen. **6, 7.** *Globotruncana rosetta* (Carsey), 65×, Section 605-76-5, (6) spiral side; (7) umbilical side, same specimen. **8–10.** *Globotruncana aegyptiaca* Nakkady, 84.5×, Sample 605-66-3, 124–126 cm, (8) spiral side; (9) side view, same specimen; (10) umbilical side, same specimen. The six chambers in the last whorl and the slow increase in chamber size place this specimen morphologically close to *G. ventricosa* White.

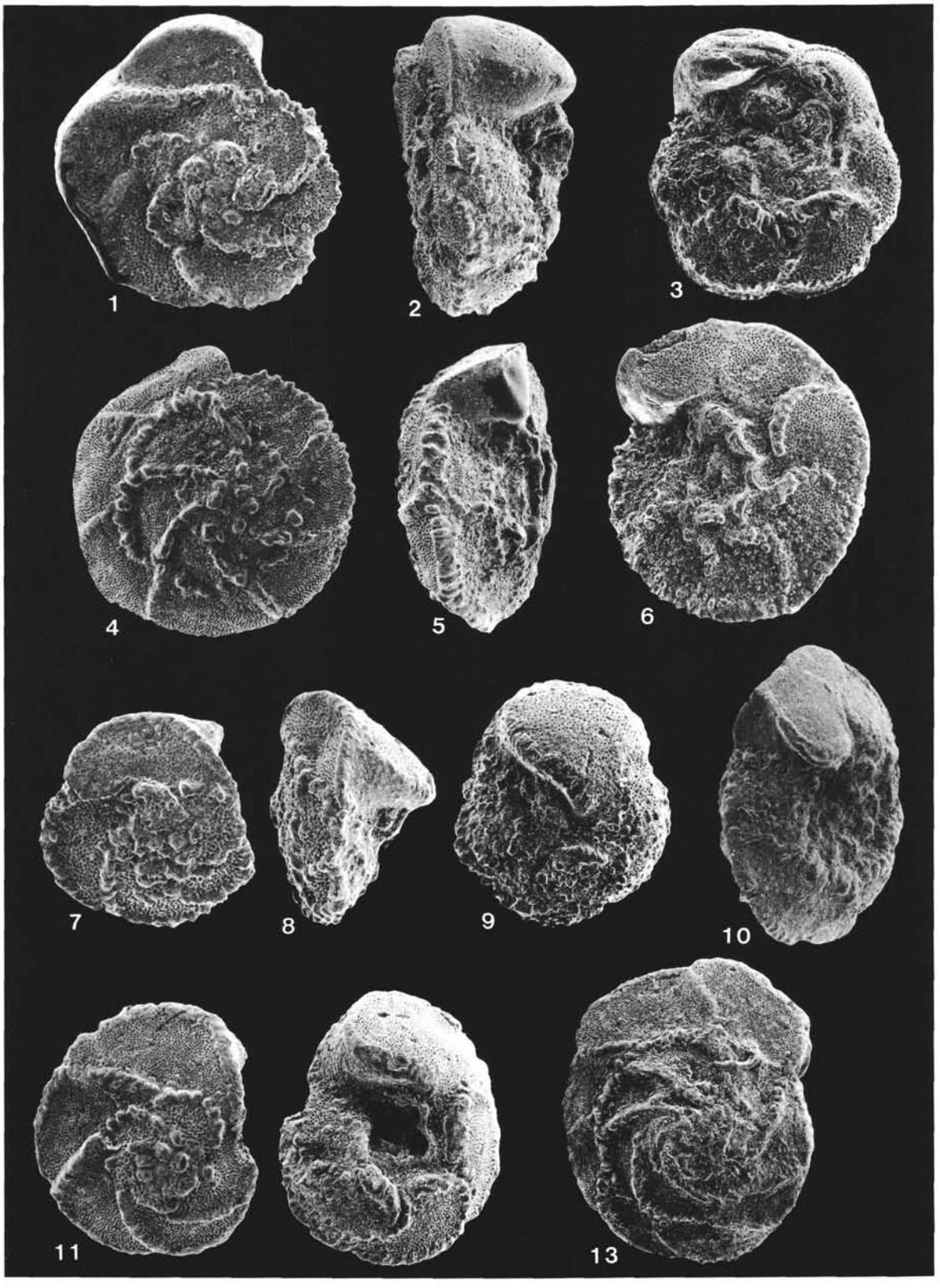

Plate 3. **1–3, 7–9.** *Globotruncana gansseri* Bolli, 84.5×, (1–3) Sample 605-71-3, 60–62 cm (1, spiral side; 2, side view, same specimen, showing faint row of pustules parallel to the keel; 3, umbilical side, same specimen); (7–9) Sample 605-70-1, 60–62 cm (7, spiral side; 8, side view, same specimen; 9, umbilical side, same specimen). **4–6.** *Globotruncana conica* (White) 65×, Sample 605-69-3, 60–62 cm, (4) spiral side; (5) side view, same specimen; (6) umbilical side, same specimen. **11, 12.** *Globotruncana stuartiformis* (Dalbiez), 65×, Sample 605-71-4, 60–62 cm, (11) spiral side; (12) umbilical side, same specimen. **10, 13.** *Globotruncana stuarti* (de Lapparent), 45.5×, Sample 605-68,CC, (10) side view; (13) spiral side, same specimen.

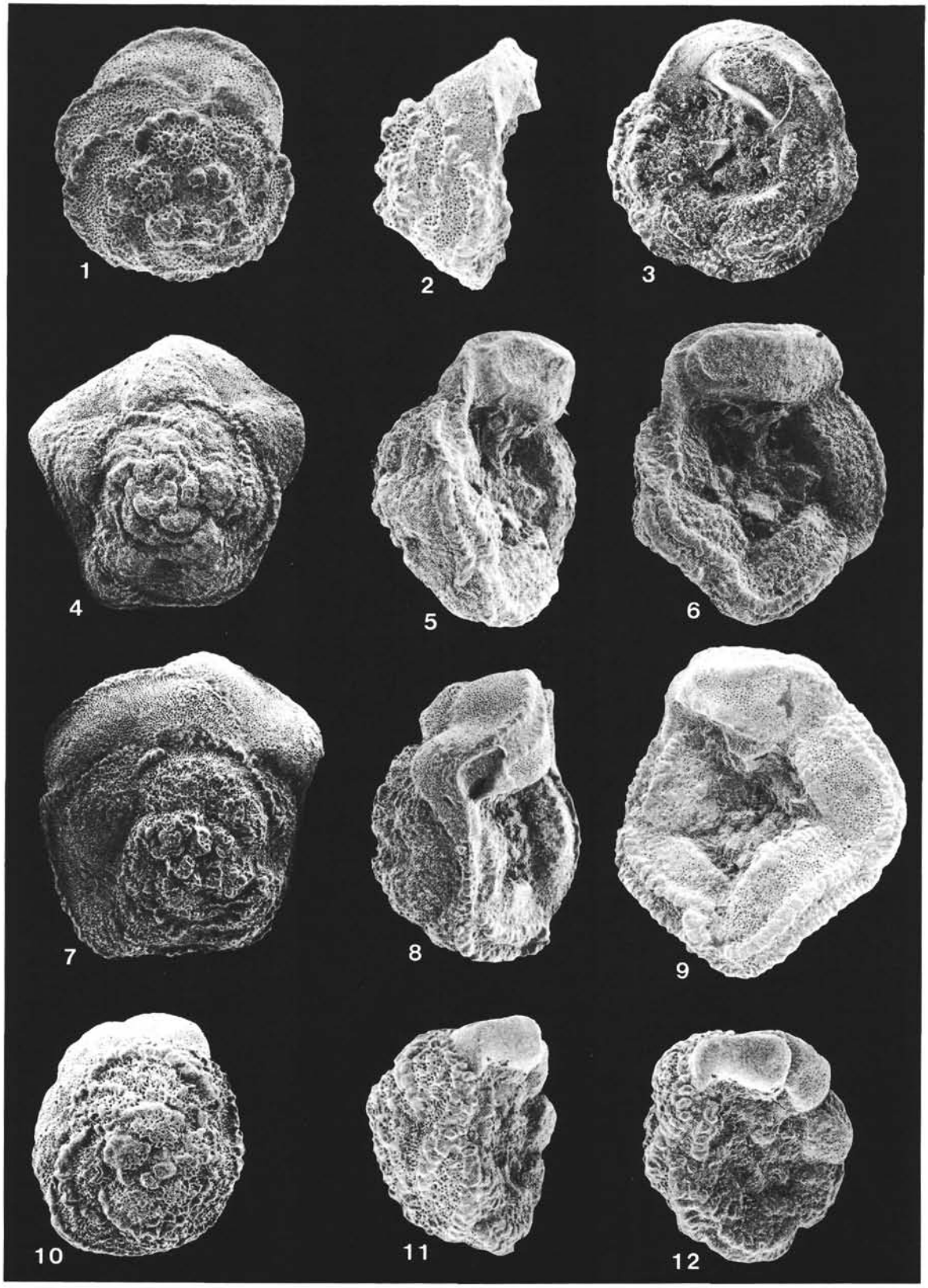

Plate 4. **1–3.** *Globotruncana fornicata* Plummer, 91×, Sample 605-70-3, 60–62 cm, (1) spiral side; (2) side view, same specimen; (3) umbilical side, same specimen. **4–9.** *Globotruncana contusa* (Cushman), (4–6) 45.5×, Sample 605-69-3, 60–62 cm (4, spiral side; 5, side view, same specimen; 6, umbilical side, same specimen); (7–9) 71.5×, Sample 605-70-3, 60–62 cm, (7, spiral side; 8, side view, same specimen; 9, umbilical side, same specimen). **10–12.** *Globotruncana walfischensis* (Todd), 65×, Sample 605-71,CC, (10) spiral side; note rounded outline; (11) side view, same specimen; note rounded cup shape; (12) umbilical side.

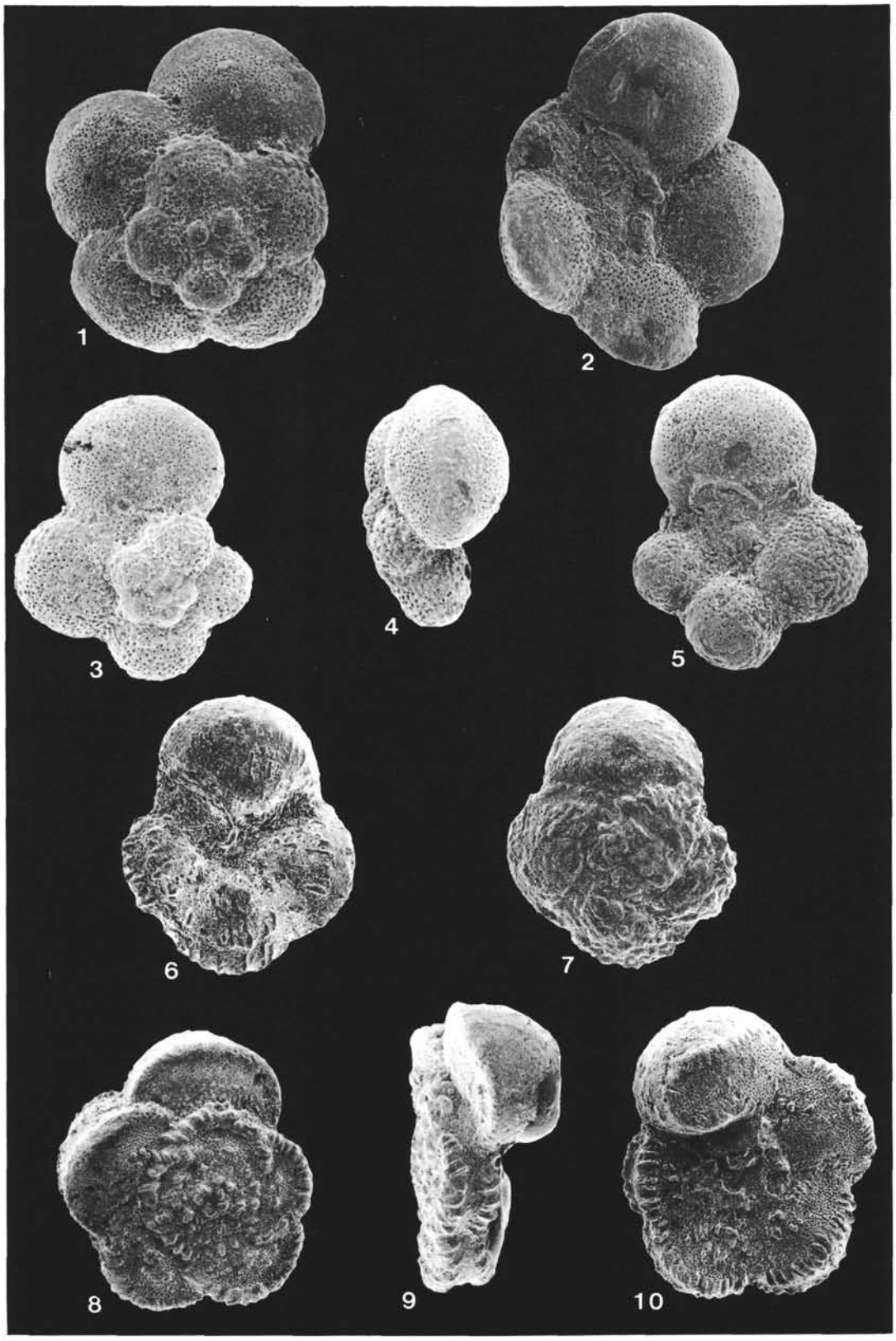

Plate 5. **1, 2.** *Globotruncanella havanensis* (Voorwijk), 104×, Sample 605-70,CC, (1) spiral side; (2) umbilical side, same specimen, showing flattened chambers which are tilted toward the umbilicus. **3–5.** *Globotruncanella petaloidea* (Gandolfi), 104×, Sample 605-68-4, 60–62 cm, (3) spiral side; (4) side view, same specimen, showing less pinched chambers, not tilted toward, the umbilicus; (5) umbilical side. **6, 7.** *Abathomphalus intermedius* (Bolli), 97.5×, Sample 605-66-2, 28–30 cm, (6) umbilical side; (7) spiral side, same specimen. **8–10.** *Abathomphalus mayaroensis* (Bolli), 52×, Sample 605-66-2, 60–62 cm, (8) spiral side; (9) side view, same specimen; (10) umbilical side, same specimen; note narrow umbilicus.

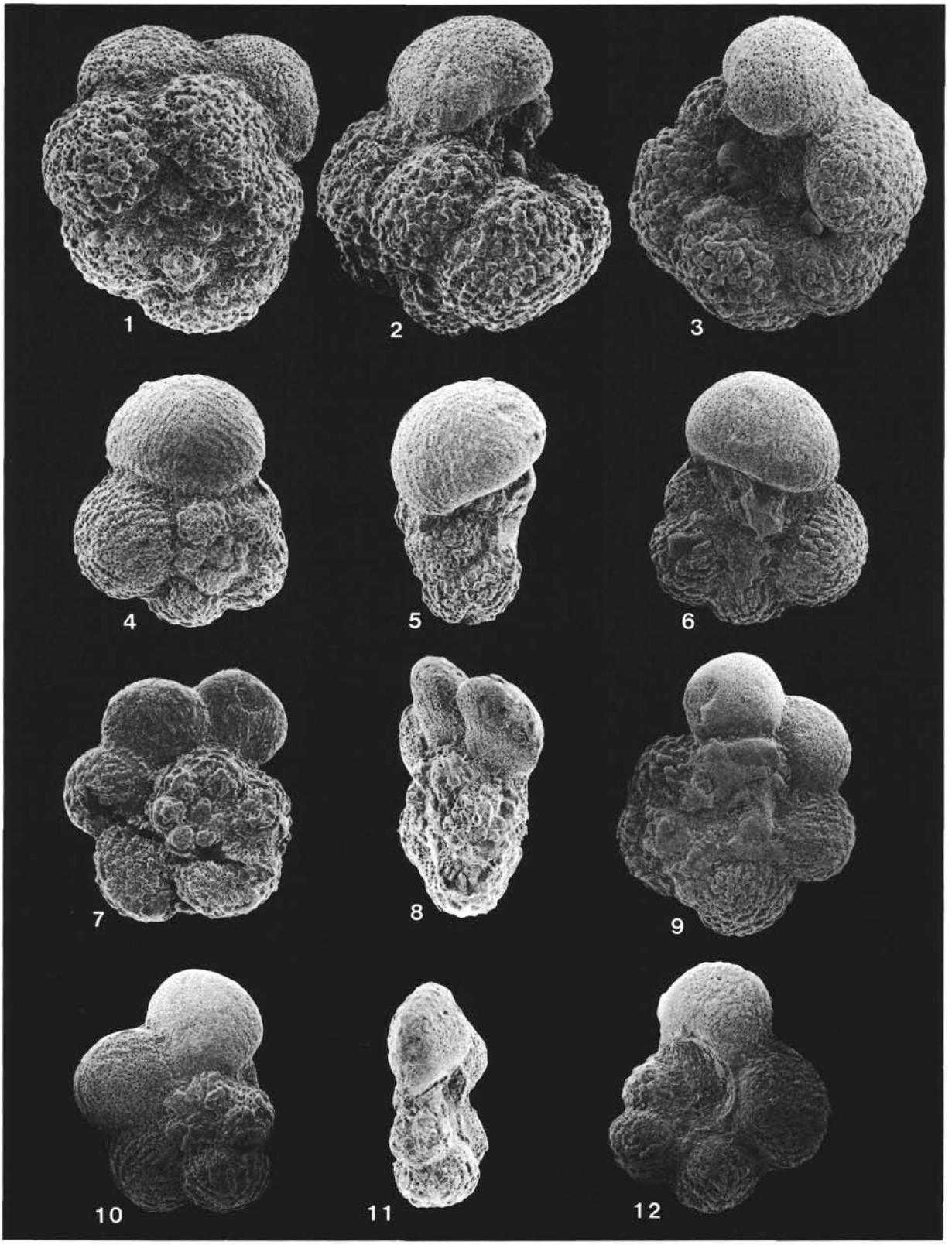

Plate 6. **1–3.** *Rugoglobigerina rotundata* Brönnimann, 78×, Sample 605-66,CC, (1) spiral side, showing lack of costellae in a meridional pattern; (2) side view, showing displacement of final chambers toward the umbilicus; (3) umbilical side, same specimen. **4–6.** *Rugoglobigerina rugosa* (Plummer), 84.5×, Sample 605-67-3, 44–46 cm, (4) spiral side; (5) side view, same specimen; (6) umbilical side, same specimen. **7–12.** *Rugoglobigerina scotti* (Brönnimann), 78×, Sample 605-66,CC, (7) spiral side; (8) side view, same specimen, showing flattened final chambers; (9) umbilical side. (10) spiral side of smaller specimen; (11) side view, same specimen; (12) umbilical side, same specimen.

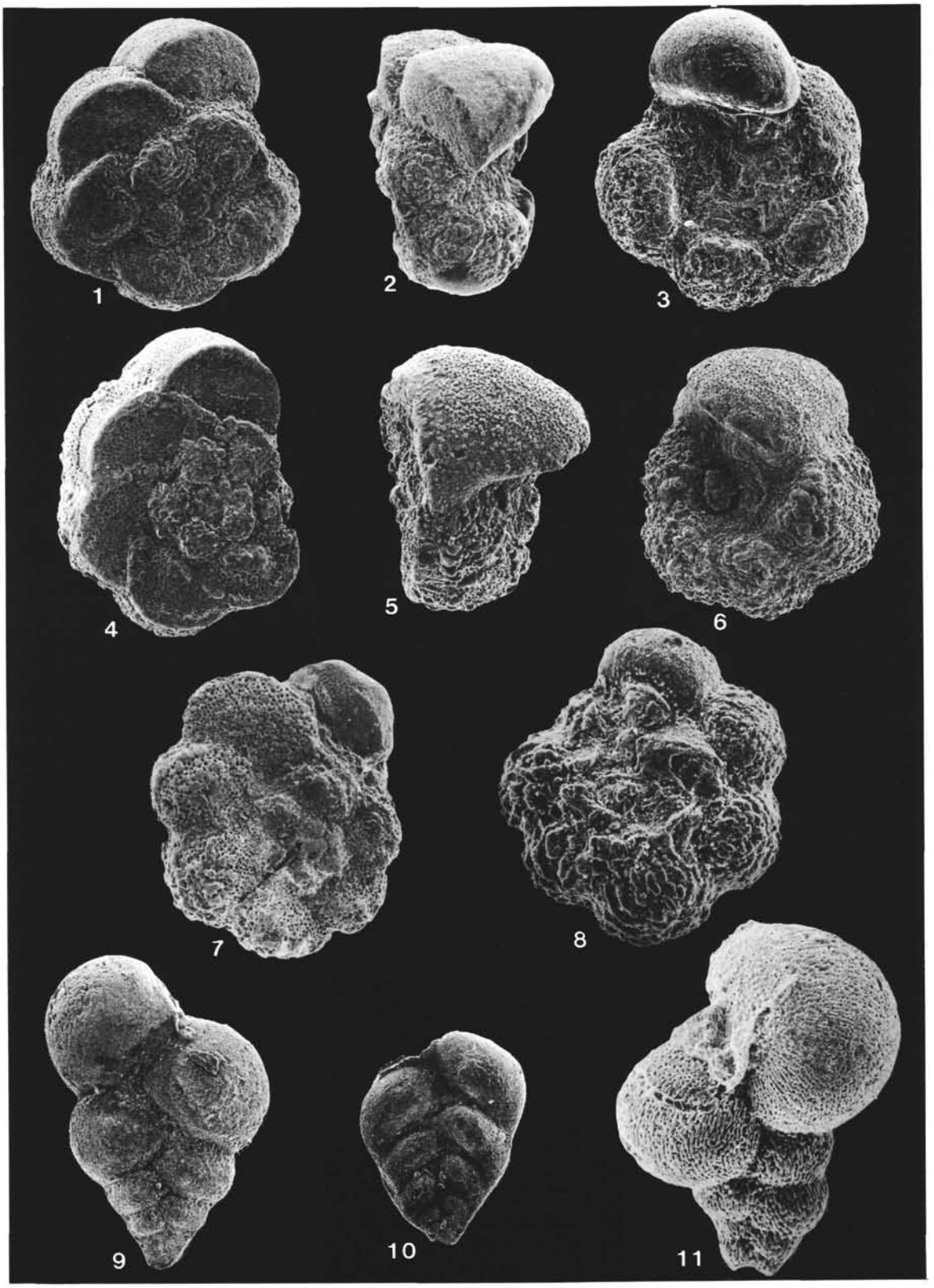

Plate 7. **1–6.** *Globotruncana gansseri* Bolli, 84.5×, (1–3) Sample 605-67-4, 46–48 cm (1, spiral side showing slightly imbricate chamber arrangement; 2, side view, same specimen; 3, umbilical side showing lack of adumbilical ridge); (4–6) Sample 605-68-1, 60–62 cm (4, spiral side; 5, side view showing row of pustules along the keel; 6, umbilical side, same specimen). **7, 8.** *Rugoglobigerina hexacamerata* Brönnimann, 97.5×, Sample 605-68-3, 60–62 cm, (7) spiral side; (8) umbilical side, same specimen. **9.** *Heterohelix glabrans* Cushman, 97.5×, Sample 605-69-2, 60–62 cm, side view showing chambers increasing rapidly in size. **10.** *Heterohelix pulchra* (Brotzen), 123.5×, Sample 605-71,CC, side view showing reniform chambers. **11.** *Heterohelix globulosa* (Ehrenberg), 113.8×, Sample 605-69-5, 60–62 cm, side view; this specimen resembles *Heterohelix striata* (Ehrenberg) in possessing very fine striae.

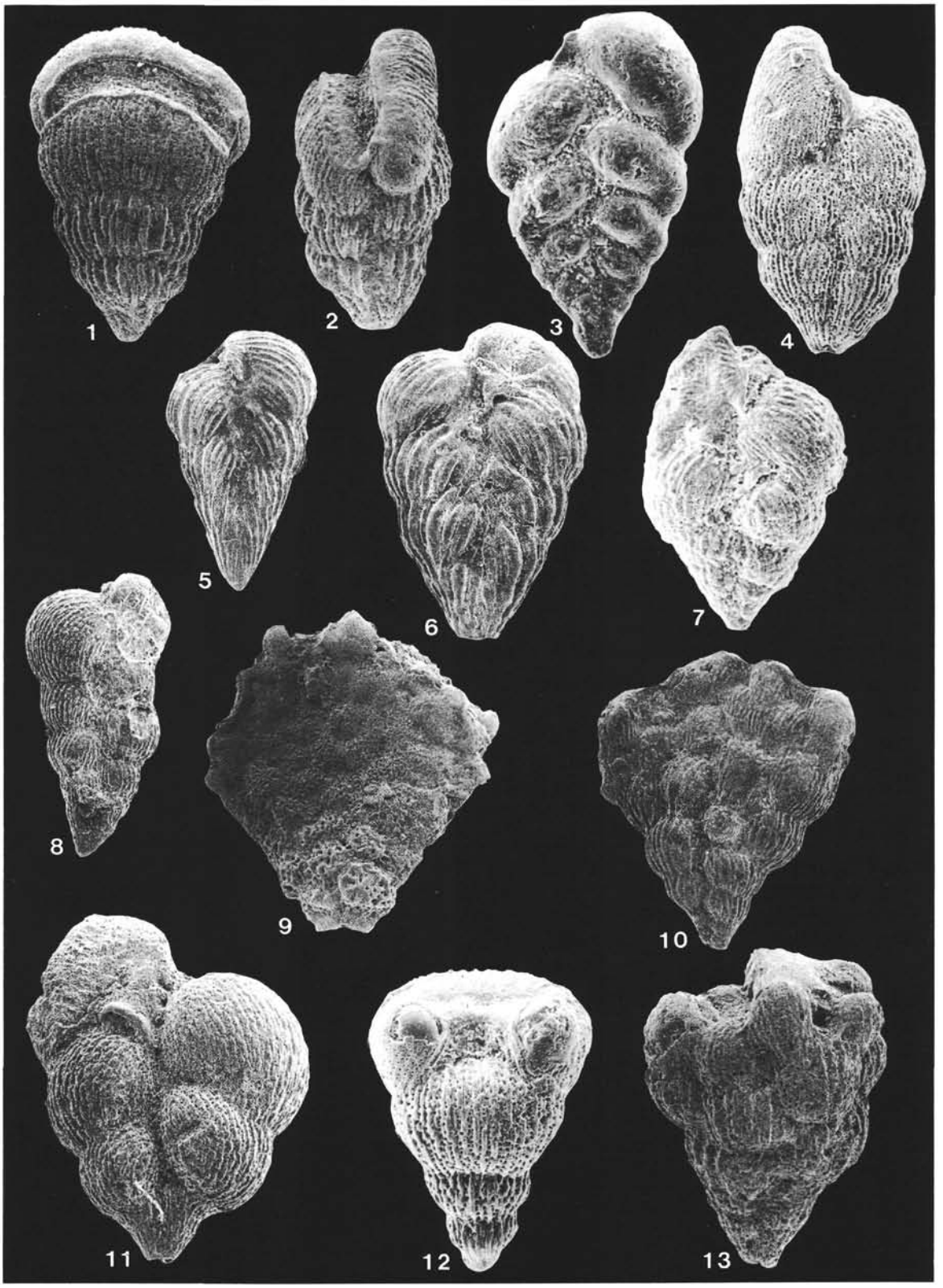

Plate 8. **1, 2.** *Pseudotextularia elegans* (Rzehak), 78×, Sample 605-69-4, 60–62 cm, (1) side view, typical flared outline; (2) side view; chambers do not increase in size after the first few. **3.** *Heterohelix* sp. 1., 97.5×, Sample 605-66,CC, side view. **4.** *Heterohelix* sp. 2, 97.5×, Sample 605-66,CC, side view; note elongation in the direction of growth. **5.** *Pseudoguembelina costulata* (Cushman), 110.5×, Sample 605-69-2, 60–62 cm, side view. **6.** *Pseudoguembelina excolata* (Cushman), 97.5×, Sample 605-68-4, 60–62 cm, side view. **7.** *Pseudoguembelina* sp. 1, 97.5×, Sample 605-66-4, 124–126 cm, side view. **8.** *Heterohelix* sp. 3, 97.5×, Sample 605-69-2, 60–62 cm, side view showing fine striae. **9.** *Ventilabrella multicamerata* de Klasz, 65×, Sample 605-69-3, 60–62 cm, side view. **10.** *Planoglobulina acervulinoides* (Egger), 52×, Sample 605-71-3, 60–62 cm, side view. **11.** *Pseudoguembelina palpebra* Brönnimann and Brown, 97.5×, Sample 605-66,CC, side view showing accessory aperature. **12.** *Racemiguembelina intermedia* (de Klasz), 97.5×, Sample 605-71-4, 60–62 cm, side view. **13.** *Racemiguembelina fructicosa* (Egger), 97.5×, Sample 605-69-4, 60–62 cm, side view.

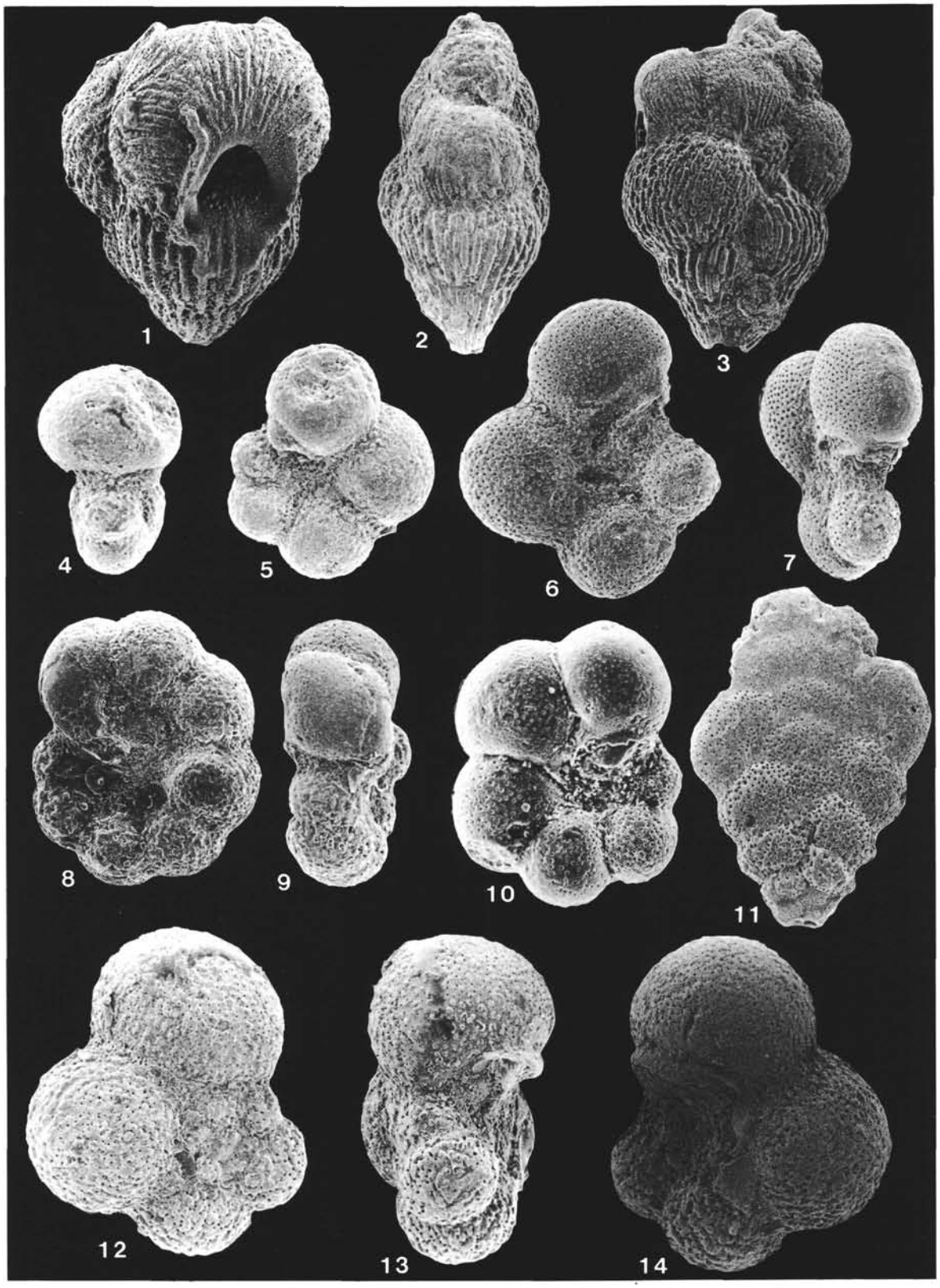

Plate 9. **1–3.** *Planoglobulina brazoensis* Martin (1), 117×, Sample 605-66-2, 59–62 cm, side view showing accessory aperture and rapid increase in chamber size of the early chambers; (2–3) 78×, Sample 605-66-2, 59–62 cm, (2, side view; 3, serial view, same specimen). **4, 5.** *Globigerinelloides multispinata* (Lalicker), 117×, Sample 605-67-2, 32–34 cm, (4) side view; (5) umbilical view, same specimen. **6, 7.** *Globigerinelloides subcarinatus* (Brönnimann), 117×, Sample 605-67-3, 44–46 cm, (6) umbilical view; (7) side view showing lateral compression of chambers. **8, 9.** *Globigerinelloides* sp. 2, 117×, Sample 605-67-3, 44–46 cm, (8) umbilical view; (9) side view. **10.** *Globigerinelloides* sp. 1, 117×, Sample 605-67-3, 44–46 cm, umbilical view. **11.** *Gublerina cuvillieri* Kikoine, 84.5×, Sample 605-66-3, 124–126 cm, side view. **12–14.** *Archaeoglobigerina* sp. 123.5×, Sample 605-67-3, 44–46 cm, (12) spiral side, (13) side view, (14) umbilical side.