

32. BIOSTRATIGRAPHY OF LOWER CRETACEOUS BLAKE NOSE AND BLAKE-BAHAMA BASIN FORAMINIFERS DSDP LEG 44, WESTERN NORTH ATLANTIC OCEAN

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ABSTRACT

Deep Sea Drilling Project Sites 390 and 392, Blake Nose, penetrated about 30 meters of nanofossil ooze and limestone rich in excellently preserved Lower Cretaceous planktonic (over 12 taxa) and benthic (over 50 taxa) foraminifers. Range charts are presented and four standard planktonic zones and one benthic zone are recognized which allow a detailed regional correlation.

Drilling at DSDP Site 391 (Blake-Bahama Basin) penetrated about 400 meters of dark and variegated claystone and light limestone and shale with sparse, poorly preserved foraminifers assigned to four assemblages or zones, comprising Valanginian, Barremian, Aptian-Albian, and Upper Cretaceous sediments.

One assemblage zone (*Dorothia praeahauteriviana*) correlates Site 391 to Sites 101 and 105, DSDP Leg 11; another (*Plectorecurvoidea* assemblage zone) may be diagnostic for the dark and variegated claystone facies both in the Atlantic and in the Pacific oceans.

The taxonomy and stratigraphic ranges of over 50 taxa are discussed and figured. Attention is focused on the intraspecific variation within the plexus *Gavelinella-Lingulogavelinella* on the basis of three previously described forms. Phylogenetic trends in the group of *Gaudryina dividens-Spiroplectinata* are more complicated than previously established.

INTRODUCTION

During Leg 44 of the Deep Sea Drilling Project in the western North Atlantic Ocean, three sites, 389, 390, and 392, were occupied on the edge of the Blake Plateau in water approximately 2650 meters deep. This region is known as the Blake Nose (Figure 1), a northeast-jutting spur of the Blake Plateau, about 500 km east of Florida, USA.

The main objective of drilling at the Blake Nose sites was to provide more detailed information on the presence of the Cretaceous reef complex that circles the Gulf of Mexico, extends through Cuba and the Bahamas, and rims the escarpment of the Blake Plateau (see Site 389 Report, this volume).

Drilling at Site 389 was an abortive attempt to spud in on the Blake Nose; only Quaternary microfossils were recovered. The successful and detailed coring at nearby Holes 390, 390A, and 392A yielded a Lower Cretaceous (Barremian-Albian), uppermost Cretaceous and Paleogene marine sequence over 170 meters thick as determined from assemblages rich in nanofossils, foraminifers, and also (Paleogene) radiolarians. The pelagic nature of the post-Barremian sediment, well above the calcium carbonate compensation depth (CCD) and the virtual absence of overburden have contributed to the excellent preservation of foraminifer tests.

We drilled another site, 391, south of the Blake Nose near the center of the Blake-Bahama Basin (Figure 1) in

water 4963 meters deep. The site was located on the landward side of the quiet magnetic zone where we hoped to recover Middle and possibly Lower Jurassic strata overlying basaltic basement. The four holes of this site yielded a composite section from uppermost Jurassic through Lower Cretaceous (1412 T. D.-649 m), immediately overlain by thick Miocene and thinner

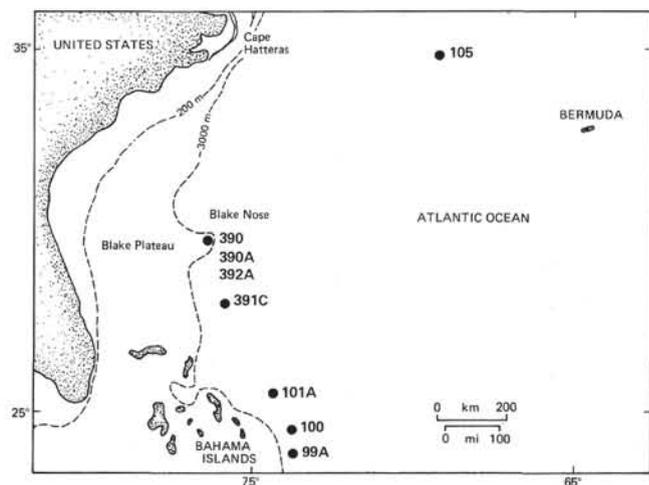


Figure 1. Location of Blake Nose Sites 390, 392 and Blake-Bahama Site 391, Leg 44, Deep Sea Drilling Project. Sites 99, 100, 101, and 105, Leg 11, where Lower Cretaceous strata were cored are also shown.

Quaternary beds. The presence of Upper Cretaceous strata could not be determined conclusively.

Upper Jurassic and Lower Cretaceous foraminifers (in Hole 391C) are few and poorly preserved: many core samples are barren. We attribute this in part to syndepositional dissolution of tests at depth. The foraminiferal biostratigraphy is accordingly meager, especially if compared to the record in the Blake Nose sites.

The multiple biostratigraphic and paleoecologic interpretations at each site are presented in the individual site reports (Part I, this volume).

This chapter is an account of the planktonic and benthic foraminifer biostratigraphy from the Lower Cretaceous beds, mainly at Sites 390 and 392. Some time was spent in examination of the variation in many taxa, details of which are in the Appendix on taxonomy. Most taxa are illustrated in Plates 1-11. Some of the determinations are provisional, pending more complete documentation of the variation in morphology and comparison to type material.

The Lower Cretaceous foraminifer stratigraphy of Site 391 shows little resemblance to the one of DSDP Sites 99, 100, 101, and 105, as studied by Luterbacher (1972). We make a brief comparison below in the paragraph on Regional Correlation.

PREVIOUS LITERATURE

Piston coring and dredgings along the Blake Escarpment, which separates the 1000-meter level of the Blake Plateau from the 5000-meter depth of the Blake-Bahama Basin, has revealed the presence of Neocomian to Aptian algal limestone and (?Albian-Cenomanian pelagic sediments (Sheridan and Osburn, 1974; Loeblich and Tappan, 1961; see also Saito et al., 1974). Other than *Orbitolina* and miliolids, no foraminifers were found in the limestone. Loeblich and Tappan (1961) identified the pelagic foraminifers from Core A167-25. According to these authors, "The benthonic foraminifera in the core include some species typical of outcropping strata ranging from the Trinity (lower Albian) through Fredericksburg and Washita (Albian-Cenomanian) in the Gulf Coast." The planktonic species include *Hedbergella washitensis* (Carsey), *H. planispira* (Tappan), *H. trocoidea* (Gandolfi), *Globigerinelloides bentonensis* (Morrow), *G. eaglefordensis* (Moreman), *Praeglobotruncana delrioensis* (Plummer), and *Rotalipora greenhornensis* (Morrow), which lead the authors to postulate a mid-Cenomanian age for the cored sediment.

During DSDP Leg 11 (Miami-Hoboken) Lower Cretaceous sediments were cored in Holes 99A, 100, and 101A, immediately northeast of the Bahama's in the Blake-Bahama Abyssal Plain and in Hole 105, near the northern end of the Hatteras Abyssal Plain, approximately 600 km to the east of Cape Hatteras (see Figure 1).

The sediments cored are Tithonian-Neocomian light gray limestone and nannofossil ooze with thin interbeds of carbonaceous clay and chert and Hauterivian-lower Cenomanian black and green carbonaceous clay. Foraminifers, described by Luterbacher (1972), almost

invariably occur rarely and in patches. Species include:

A) Tithonian-Valanginian: *Vaginulina* sp. aff., *V. biochei* (Terquem), *Lenticulina nodosa* (Reuss) *L. subalata* (Reuss), *Fronicularia simplicissima* Ten Dam, and age-diagnostic calpionellids belonging in the genera *Calpionella*, *Calpionellopsis*, *Remaniella*, and *Tintinnopsella*.

B) ?Valanginian: *Dorothia praeauteriviana* Dieni and Massari.

C) Upper Valanginian-Hauterivian: *Lenticulina ouachensis ouachensis* (Sigal), *L. ouachensis multicella* Bartenstein, Bettenstaedt, and Bolli and an age-diagnostic aptychi faunule.

D) Hauterivian-Albian: *Hedbergella infracretacea* (Glaessner), *H. hauterivica* (Subbotina), *H. globigerinelloides* (Subbotina), *G. ultramicrus* (Subbotina), *Hoglundina?* sp., and *Gavelinella* sp. aff. *G. barremiana* Bettenstaedt.

E) Upper Albian-lower Cenomanian: *Rotalipora apenninica apenninica* (Renz), *R. apenninica primitiva* Borsetti, *Praeglobotruncana delrioensis* (Plummer), *Planomalina buxtorfi* (Gandolfi), *Hedbergella trocoidea* (Gandolfi), and *H. amabilis* Loeblich and Tappan.

BIOSTRATIGRAPHY

The Lower Cretaceous planktonic biostratigraphy of Sites 390, 391, and 392 follows van Hinte's (1976) zonal scheme in consultation with taxonomic and biostratigraphic data mainly by Bolli (1959), Moullade (1966), Sigal (1965; 1966), Hermes (1969), Kuhry (1971), and Longoria (1974). I recognized four formal zones (Figure 2) in sediments from Sites 390 and 392:

Ticinella breggiensis Zone (LC17)—upper Albian
Ticinella primula Zone (LC15-16)—middle Albian
Globigerinelloides algerianus Zone (LC11)—upper Aptian

Globigerinelloides blowi Zone (LC9)—lower Aptian
 The informal Barremian benthic zone of *Gavelinella barremiana-Lenticulina (Marginulopsis) sigali*, erected for Sites 390, 391, and 392 is correlated to the Barremian-lower Aptian planktonic zone of *Hedbergella sigali* (LC8).

For the benthic foraminifers, I used the ranges of species as given by a number of authors quoted in the text, including Bartenstein et al. (1957, 1966, 1973); Simon and Bartenstein (1962); Sigal (1965); Moullade (1966); Michael (1966, 1967); Ohm (1967); Dailey (1970); Luterbacher (1972); Scheibnerova (1974); van Hinte (1976); and Bartenstein (1976a, b). Two informal benthic zones erected in the sites include *Gaudryina* ex. gr. *dividens* Zone (upper Aptian-middle Albian) and *Gavelinella barremiana-Lenticulina (M.) sigali* Zone (Barremian) (Figures 2, 3, 4). I also recognized three intervals in sediments from Site 391 with more or less age-diagnostic assemblages (Figure 2): *Plectrocurvoides* assemblage (?Albian-Upper Cretaceous), *Hedbergella trocoidea* assemblage (upper Aptian-lower Albian), and *Dorothia praeauteriviana* assemblage (Valanginian). Figure 2 shows the correlation of the Lower Cretaceous beds in Sites 390, 391, and 392 on the basis of foraminifer stratigraphy. It also gives the predominant

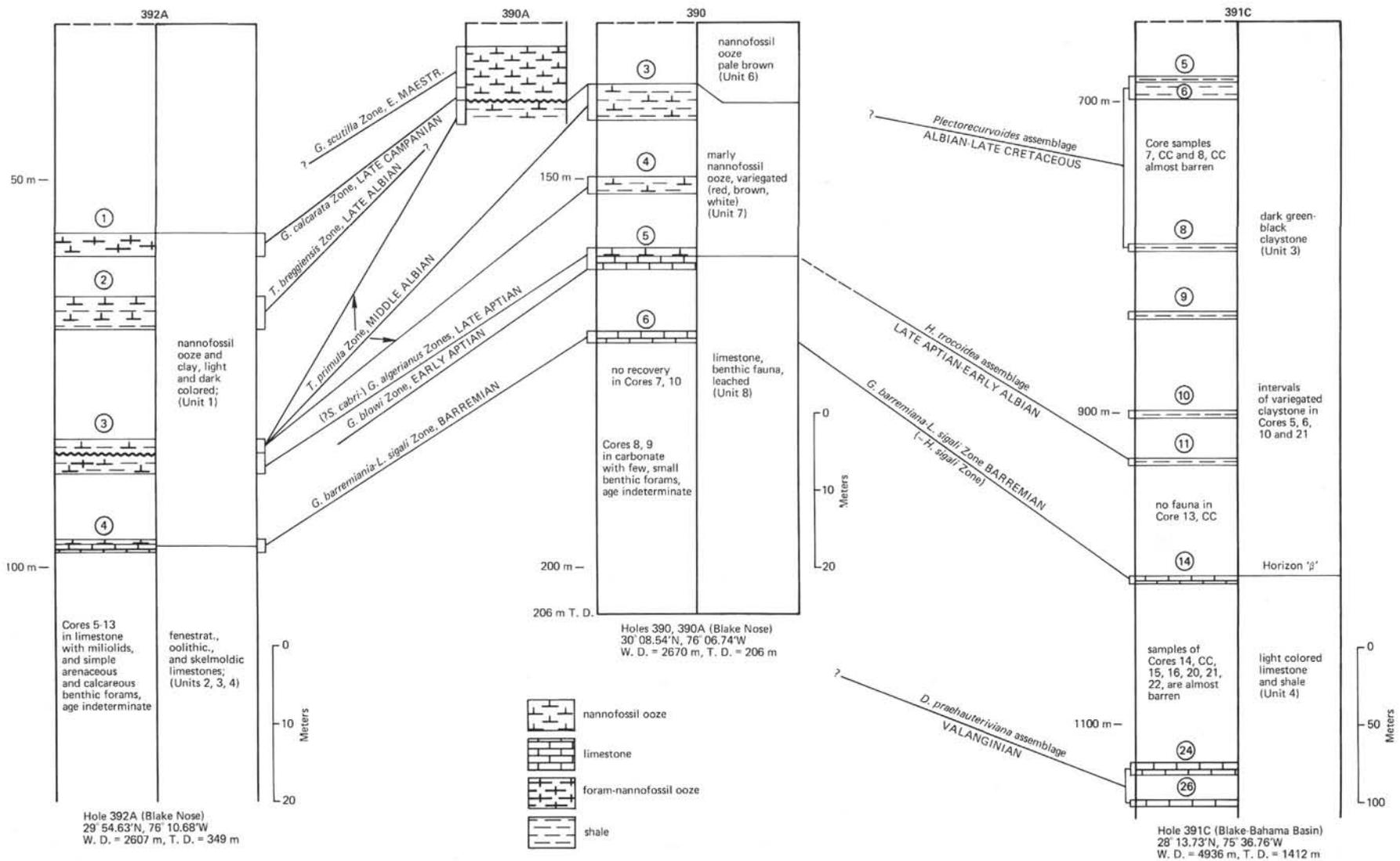


Figure 2. Lower Cretaceous foraminifer biostratigraphy and lithology of Blake Nose Sites (390 and 392), and Blake-Bahama Basin Site (391), Leg 44, Deep Sea Drilling Project. Hole 392A, Core 1, and the upper part of Hole 390A, Core 14, consist of Campanian-Maestrichtian pelagic sediments.

relatively poorly preserved (?reworked) specimens in Hole 390-3-3, 80-82 cm of *Hedbergella* aff. *trocoidea* (Gandolfi) (Plate 10, Figures 7, 8) and of some reworked *H. trocoidea* in Sample 392A-3-1, 46-48 cm, planktonic species from the underlying *Globigerinelloides algerianus* Zone are absent. The interpretation "reworked" in Section 392A-3-1 stems from the opaque, sugary preservation of the (few) specimens which are like that in the *G. algerianus* Zone and unlike the smooth, translucent tests in this zone.

The presence of *Ticinella primula* Luterbacher, the absence of *Globigerinelloides ferreolensis* (Moullade) and of specimens clearly belonging to *Hedbergella trocoidea* (Gandolfi) and the absence of *Ticinella breggiensis* (Gandolfi) indicates Moullade's (1966) and van Hinte's (1976) middle Albian partial range zone with *Ticinella primula* (LC15-16).

Other taxa which have their lower stratigraphic occurrence in this Blake Nose interval are *Hedbergella delrioensis* (Carsey) (Plate 10, Figures 1, 2); *H. planispira* (Tappan) (Plate 11, Figures 14-16); *Osangularia insigna* Dailey (Plate 7, Figures 1-4); *Pleurostomella obtusa* Berthelin (Plate 3, Figures 6-8, 11); *Valvulineria gracillima* Ten Dam (Plate 8, Figures 11, 12); *Lingulogavelinella ciryi* Malapris-Bizouard (Plate 5, Figures 13-17); *Epistomina cretosa* Ten Dam (Plate 8, Figures 3, 4); *E. chapmani* Ten Dam (Plate 8, Figure 5); *Reinholdella ultima* Dailey (Plate 8, Figures 7, 8); *Orthokarstenia shastaensis* Dailey (Plate 3, Figures 1-4); and *Dorothia oxycona* Reuss. *Dorothia* aff. *spissa* (Berthelin), *Lamarckina lamplughii* (Sherlock), *Vaginulina* aff. *recta* Karrer, and *Tristix excavatus* (Reuss) (Plate 3, Figure 10) are confined to this interval.

Many of the benthic species are only represented by a few specimens (see Figures 2, 3), and their scattered presence in Albian beds of the Blake Nose could be a function of sampling. Most of the above species are known from Aptian/Albian strata (see Appendix) except possibly *Osangularia insigna* Dailey from the (upper) Albian-Cenomanian of California (Dailey, 1970).

Gaudryina ex. gr. *dividens* Grabert and *Conorotalites aptiensis* (Bettenstaedt) do not range stratigraphically above this zone on the Blake Nose, in agreement with a lower-middle Albian upper limit elsewhere (see Grabert, 1959; Simon and Bartenstein, 1962; Sigal, 1965; Bartenstein, 1976b).

Nannofossils in the *Ticinella primula* Zone on the Blake Nose are, respectively, assigned an upper Aptian-lower Albian and lower-middle Albian age (special chapters by Schmidt and Roth, this volume).

***Ticinella breggiensis* Zone (LC17; upper Albian nannofossil ooze and clay, variegated; Hole 392A, Core 2)**

In Hole 390A in the lower part of Core 14, the middle Albian *Ticinella primula* Zone is immediately overlain by the upper Campanian *Globotruncana calcarata* Zone (Site 390 Report; Part I of this volume). At Site 392 the Albian section below the disconformity with the upper Campanian strata appears more complete.

Core 2 of Hole 392A has a rich, largely pelagic assemblage with *Ticinella breggiensis* (Gandolfi) (Plate 11, Figure 1), and *Hedbergella amabilis* Loeblich and Tappan (Plate 11, Figures 11-13), which are restricted to this interval. *H. planispira* Tappan, *H. aff. delrioensis* (Carsey), and *Ticinella primula* Luterbacher also occur. Specimens transitional between *T. primula* and *T. breggiensis* are common (Plate 11, Figure 2).

Most workers agree that *T. breggiensis* occurs in the upper Albian (see Longoria, 1974, p. 96 for a summary of the literature). A few references, including Sigal (1966), mention a middle Albian appearance. In van Hinte's (1976) zonal scheme (sensu Moullade, 1966) this species characterizes the *T. breggiensis* total range zone of lower upper Albian. It evolved from *T. primula* as is also suggested in our material.

Among the benthic species specimens of *Dentalina debilis* (Berthelin) (Plate 3, Figure 9) and *Lingulina loryi* (Berthelin) were not found below this zone. However, these species appear to be relatively long ranging (Hauterivian-Albian/Cenomanian, see Maync, 1973; Dailey, 1973). The other benthic species present also occur in the underlying zone of *Ticinella primula* Luterbacher. *Epistomina* ex. gr. *spinulifera* (Reuss) (Plate 8, Figures 1, 2) occurs with some relatively large specimens which are much better preserved than the few individuals present in the zone of *G. barremiana-L. (M.) sigali*.

Nannofossils in Hole 392A, Core 2 have been assigned to the lower-middle Albian (Schmidt, this volume).

***Plectorecurvoides* Assemblage (?Albian-Upper Cretaceous; dark green-black claystone; rare variegated intervals, Hole 391C, Cores 5 to 8, possibly as deep as Core 10)**

In Hole 391C, Samples 5, CC, 6, CC, and 8, CC between 677.5 meters and ± 800 meters below sea bottom there is an exclusively siliceous arenaceous foraminifer assemblage. Many other samples in this dark claystone interval lack foraminifers.

Taxa determined include *Plectorecurvoides* sp. (common) (Plate 1, Figures 1, 2); *Bolivinopsis* (Plate 1, Figure 5); *Uvigerinammina* sp. (Plate 1, Figure 7); *Trochammina globigeriniformis* (Parker and Jones) (Plate 1, Figure 4); *Trochammina* sp. (Plate 1, Figure 3); *Recurvoides* sp., *Hormosina* sp., *Bathysiphon* sp., *Glomospira* sp. (Plate 1, Figure 6); *Glomospirella* sp. (Plate 1, Figure 8); *Rheophax* sp.; ?*Textularia* sp.; *Ammobaculites* spp.; and *Spirillina* sp.; there are serpulids in Sample 6, CC. All specimens are relatively small.

The best and most diversified arenaceous fauna is in variegated claystone beds, as in Sample 5, CC. The arenaceous fauna may well be characteristic of the dark, variegated claystone. Luterbacher (1972) reported a fauna of simple-structured arenaceous foraminifers from the Lower Cretaceous black clay interval at Site 101, Blake-Bahama Basin, with age-undiagnostic genera *Rhizammina*, *Bathysiphon*, *Reophax*, *Haplophragmoides*, ?*Ammovertella*, and

"*Spirillina*." Krasheninnikov (1973) found a fauna, quite similar to the 391C fauna in variegated clays in the Pacific Ocean; he assigned it to the Upper Cretaceous.

In the case of *Plectorecurvodes* assemblage in Hole 391C, I tentatively assigned it to the Albian-Upper Cretaceous on the basis of the ranges of *Uvigerinamina*, *Bolivinopsis*, *Plectorecurvodes*, and *Glomospirella* (see Loeblich and Tappan, 1964).

In Samples 391C, 9-2, 48-50 cm, and 10-2, 73-74 cm, isolated, poorly preserved, and small calcareous tests of *Hedbergella* and *Patellina* were found which would indicate a Cretaceous age. Tiny, well preserved tests of *Globigerina* and radiolarians found in Sample 5, CC and some deeper samples are probably contaminants, either from cavings or introduced during handling of the samples and/or residues.

Nannofossils in Cores 9 and 10 of Hole 391C are upper Aptian-lower Albian (Schmidt, this volume), palynomorphs in Cores 6-8 are dated as upper Albian, and in Cores 8-14 as upper Aptian-lower Albian (Habib, this volume).

BLAKE NOSE BARREMIAN-ALBIAN BIOSTRATIGRAPHIC RECORD

A comparison of the Barremian-Albian zones recognized in the Blake Nose Sites 390 and 392 with the standard zonation as compiled from many sources by van Hinte (1976) shows one conspicuous gap (Table 1). The gap is formed by the absence of Zones LC12-LC14, uppermost Aptian-lower Albian. The most notable species missing are "*Globigerinelloides*" *gyroidinaeformis* Moullade and *Ticinella bejaouaensis* Sigal.

At Hole 390 this gap might be caused by the lack of samples between Cores 5 (LC11) and 4 (LC15-16). However, in Hole 392A, LC11 almost immediately underlies LC15-16 within Core 3 (Figure 2).

Zone LC11 in Hole 392A has been recognized as high as Sample 3-2, 121-123 cm, whereas a sample of Core 3-1, 46-48 cm belongs in Zone LC15-16. The contact (or a highly condensed section representing uppermost Aptian-lower Albian strata) appears to be missing in the core.

Another gap in the Aptian-Albian Blake Nose record, as discussed earlier, is the absence of the

TABLE 1
Barremian-Albian Zones Recognized in the Blake Nose Sites
Compared with Standard Zonation

Standard Zones	Blake Nose (x = present)
<i>T. breggiensis</i> LC17	x
<i>T. praeticinensis</i> LC16	}x
<i>T. bejaouaensis</i> - <i>G. gyroidinaeformis</i> - <i>T. primula</i> LC15	
<i>T. bejaouaensis</i> - <i>G. gyroidinaeformis</i> LC14	
<i>G. ferreolensis</i> - <i>T. bejaouaensis</i> LC13	
<i>H. trocoidea</i> - <i>G. ferreolensis</i> LC12	
<i>Gl. algerianus</i> LC11	x
<i>S. cabri</i> LC10	?x
<i>G. blowi</i> LC9	x
<i>H. sigali</i> LC8	x (equivalent p.p.)

Ticinella breggiensis Zone (LC17) in Hole 390A. At this site the upper Campanian *Globotruncana calcarata* Zone immediately overlies the middle Albian *Ticinella primula* Zone in Core 14 (Figure 2).

The absence of the lower Aptian *Globigerinelloides blowi* Zone (LC9) in Hole 392A may result from the lack of samples in the interval between Cores 3 and 4.

REGIONAL CORRELATION

It is beyond the scope of this study to compare and correlate the Blake Nose (Sites 390, 392) and Blake Bahama Basin (Site 391) foraminifers with Lower Cretaceous assemblages known from earlier studies in North America, such as Texas, Oklahoma (Tappan, 1940, 1943; Loeblich and Tappan, 1949; Frizzel, 1954; Michael, 1972), Trinidad (Barstenstein et al., 1957, 1966, 1973), California (Dailey, 1970, 1973), Scotian and Grand Banks (e.g., Jenkins et al., 1974, Gradstein et al., 1975).

A regional correlation to Deep Sea Drilling Sites 99A, 100, 101A in the Blake-Bahama Basin and Site 105, in the Hatteras Abyssal Plain (see Figure 1 for location), cannot be made, with one exception. The single direct correlation, as mentioned earlier, is through the interval with *Dorothia praeauteriviana* Dieni and Massari in Hole 391C (Cores 24, 26) and in Holes 101A (Core 10) and 105 (Cores 19-21) dated Valanginian. Owing to a lack of age-diagnostic species in Holes 99A, 100, 101A, and 105, none of the Barremian-Albian zones and/or assemblages at Sites 390, 391, and 392 can be correlated. The lack of species may be explained by the very deep water, below the CCD, depositional environment.

Hole 101A, Core 4, and Site 105, Cores 11, 12, contain an assemblage with *Rotalipora apenninica* Renz and *Planomalina buxtorfi* (Gandolfi). This corresponds to the zone of *P. buxtorfi*-*R. apenninica* (LC19) (van Hinte, 1976) of Vraconian (latest Albian) age. The youngest Lower Cretaceous zone in the Blake Nose sites is UC17, early late Albian.

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APPENDIX

Stratigraphic list of the taxa occurring in the Lower Cretaceous Sediments of Hole 391C.

Specimens of all taxa are rare (1-9 specimens) unless stated otherwise.

4, CC; 5-1, 82-84 cm	Barren
5-1, 143-145 cm	Barren
5, CC	<i>Uverigerinammina</i> , <i>Plectrocurvoides</i> (common), <i>Bolivinopsis</i> , <i>Ammodiscus</i> , <i>Glomospira</i> , <i>Hormosina</i> , <i>Bathysiphon</i> , <i>Glomospirella</i>
6-2, 113-115 cm	Barren
6-4, 52-54 cm	Barren
6, CC	<i>Glomospira</i> , <i>Glomospirella</i> , <i>Plectrocurvoides</i> , <i>Trochammina</i> , <i>Bathysiphon</i> , ? <i>Textularia</i> , <i>Reophax</i> ; serpulids, fish teeth
7, CC	Barren except for common, pyritized radiolarians
8, CC	<i>Plectrocurvoides</i> , ? <i>Glomospirella</i> , <i>Trochammina globigerini formis</i> , <i>Trochammina</i> sp.
9-1, 33-35 cm	Barren
9-2, 48-50 cm	<i>Hedbergella</i> spp. (tiny)
9, CC	<i>Trochammina</i> , radiolarians
10-2, 73-74 cm	<i>Patellina</i> sp., <i>Spirillina</i> , sponge spicules
10-2, 105-107 cm	<i>Ammobaculites</i> , <i>Glomospira</i> , <i>Trochammina</i> , ? <i>Spirillina</i> , ? <i>Hormosina</i>
10-3, 57-59 cm	<i>Glomospirella</i>
10, CC	Barren
11-3, 45-47 cm	<i>Hedbergella trocoidea</i> , <i>H.</i> spp., <i>Globigerinelloides ferreolensis</i> , <i>Gavelinella</i> aff. <i>intermedia</i> , <i>Lenticulina</i> , Ostracoda
11-3, 83-85 cm; 13, CC	Barren, except for pyritized radiolarians
14-3, 66-68 cm	<i>Gavelinella barremiana</i> , <i>Hedbergella sigali</i> , <i>Lenticulina crepidularis</i>
14-3, 149-150 cm	? <i>Dorothia</i> , miliolids
14, CC	Barren, except for some aptychi and other ammonite fragments and pieces of "wood"
15-3, 143-146 cm (thin section)	miliolids, <i>Ophthalmidium</i> , <i>Lenticula</i> , <i>Epistomina</i> , crinoids, pelecypods, echinoid, and coral fragments
15, CC; 16-3, 95-97 cm	Barren
20-1, 136-138 cm	Barren
21, CC; 22, CC, and 24-3, 14-16 cm	<i>Dorothia</i> sp. (co), <i>Pseudonodosaria</i> , <i>Conorboides hofkeni</i> , <i>Lenticulina nodosa</i> , <i>Vaginulopsis</i> , <i>Eoguttulina</i> , radiolarians
25-1, 49-51 cm, 25-5, 100-112 cm; 25-2, 105-107 cm; 26-1, 100-102 cm; and 26-3, 60-62 cm	Radiolarians (common-frequent) <i>Dorothia prachauteriviana</i> (frequent), <i>Lenticulina nodosa</i> , <i>Lenticulina</i> spp. (common), <i>Haplophragmoides</i> ; radiolarians (common)

Cores 27 through 50 are virtually devoid of foraminifers, except for isolated specimens of *Glomospira*, *Spirillina*, *Vaginulopsis*, and *Ophthalmidium*. Foraminifers in Cores 50 to 52 have been dated Late Jurassic (see Site 391 Report, this volume).

ANNOTATED LIST OF SELECTED LOWER CRETACEOUS FORAMINIFERS

(Formal references have been kept to a minimum)

"*Globigerina*" *hoterivica* Subbotina (Plate 9, Figures 9-15)

Globigerina hoterivica Subbotina, 1953. Fossil foraminifera of the USSR, Globigerinidae, Hantkeninidae, and Globorotaliidae (translated from Russian), Collet's Publ. Ltd., 1971, p. 50, pl. 1, fig. 1-4.

Globigerina kugleri Bolli, 1959, Am. Paleontol. Bull., v. 39, no. 79, p. 27, pl. 23, fig. 3-5.

About 16 small, very poorly preserved *Globigerina*-like specimens occur in Section 390-6-1 and Sample 6, CC. Half of these are irregular

in shape and are reminiscent of those in rich assemblages of "*Globigerina*" *bathoniana* Pazdrowa of Middle Jurassic Grand Banks deposits (Gradstein, 1977), where over half of the specimens are no more than an irregular cluster of chambers. The more regularly structured forms in Section 390-6-1 and Sample 6, CC show the following features: low to medium high trochospire with globular chambers which increase in size slowly; four chambers in the last whorl; aperture arched often with lip; aperture mostly umbilical, rarely umbilical to extra-umbilical; apertural arch varies from less than one-third as high to almost as high as wide. From the description of *Globigerina graysonensis* Tappan (Tappan, 1940, 1943; Bolli, 1959; Longoria, 1974) and from a comparison to the holo-, para-, and hypotypes in the United States National Museum, Washington, the Blake Nose specimens do not fall within the range of variation of this species. The specimens are more similar to *Globigerina kugleri* Bolli (Bolli, 1959, and USNM holo- and paratypes; Marianos and Zingula, 1966, USNM hypotype). This species is probably a junior synonym of *Globigerina hoterivica* Subbotina (often spelled "*houterivica*"). Dailey (1973; sub *G. hoterivica*) includes *Globigerina* sp. A, Marianos and Zingula, in *G. hoterivica* but excludes *G. kugleri* sensu Marianos and Zingula because of a *Gubkinella*-like medium-high trochospire. From my observation of the USNM hypotype of *G. kugleri* sensu Marianos and Zingula, I include this specimen in *G. hoterivica*, which agrees with the variation described by Subbotina (1953, p. 53, fig. 2, 3) and also agrees with the variation among Blake Nose specimens. As such *G. hoterivica* resembles *G. graysonensis*, which shows considerable variation in height of the spire (Tappan, 1940, 1943; Bolli, 1959; Longoria, 1974).

G. hoterivica is known from the Hauterivian of the Caucasus (Subbotina, 1953), the Toco and Cucho formations (Barremian-Aptian) of Trinidad (sub *G. kugleri*; Bolli, 1959), the Budden Canyon Formation in California (Hauterivian-Barremian range; Marianos and Zingula, 1966; Dailey, 1973), and the lower Aptian of (?) Mexico (Longoria, 1974; sensu *Caucasella houterivica*). Luterbacher (1972) found it at DSDP Site 105. According to Michael (1967) it is also known from Northwest Germany. The total range is upper Hauterivian to lower Aptian. Van Hinte (1976) restricts the species to the upper Hauterivian. Also known (sub *G. kugleri*) from the Neocomian (?Valanginian)-Aptian of the Scotian Shelf (Gradstein et al., 1975; P. Ascoli, personal communication).

Globigerinelloides blowi (Bolli) (Plate 9, Figures 5-8)

Planomalina blowi Bolli, 1959, Am. Paleontol. Bull., v. 39, no. 79, p. 260, pl. 20, fig. 2-6.

Globigerinelloides blowi (Bolli), Moullade, 1966, Doc. Labo. Geol. Fac. Sci. Lyon, no. 15, p. 119-121, pl. 8, fig. 24-26.

First described as *Planomalina blowi* Bolli from the Aptian *Leupoldina protuberans* Zone, Cucho Formation, Trinidad (Bolli, 1959). Moullade's (1966) description and figures are particularly close to our specimens. Type specimens of the species in the USNM, Washington, have a more lobate periphery with deeper incised sutures. The stratigraphic range is given as *G. blowi* to *G. algerianus* zones (Aptian; van Hinte, 1976)—only found in Sample 390-5, CC assigned to the lower Aptian *G. blowi* Zone.

Globigerinelloides ferreolensis (Moullade) (Plate 9, Figures 1-4; Plate 10, Figures 14-17)

Biticinella ferreolensis Moullade, 1961, Rev. Micropal., v. 3, no. 4, p. 214, pl. 1, fig. 1-5.

Globigerinelloides ferreolensis (Moullade), 1966, Doc. Labo. Geol. Fac. Sci. Lyon, no. 15, p. 122-124, pl. 9, fig. 1-3.

Common at Sites 390 and 392 (*G. algerianus* Zone). Specimens have 7-8 chambers in the last whorl; the chamber shape is spherical to slightly ovate; test outline varies from roughly circular to somewhat elliptical. There is a tendency to a "*Biglobigerinella*" stage in three out of the several dozen specimens examined. The morphology is similar to that in the original figures and description of *G. ferreolensis* by Moullade (1966). Moullade defines the species as having 7-9 chambers in the last whorl with slightly ovate chambers which increase but slowly in size and with a tendency to a "*Biglobigerinellid*" stage.

From the original descriptions of *G. ferreolensis* and *G. barri* the two species seem to overlap morphologically. *G. barri* has 8-10 ovate

to nearly circular chambers, circular test outline (Bolli, Loeblich, and Tappan, 1957, p. 25, pl. 1, fig. 13-18b) or globular chambers with common "Biglobigerinellid" stage (Longoria, 1974). Longoria restricts *G. ferreolensis* to specimens with 7-9 globular chambers, ovate test outline, and no paired final chamber.

Globigerinelloides aff. saundersi (Bolli)
(Plate 10, Figure 4)

Planomalina saundersi Bolli, 1959, Am. Paleontol. Bull., v. 39, no. 79, p. 262, pl. 20, fig. 9-11.

Globigerinelloides saundersi (Bolli), Longoria, 1974, Rev. Esp. Micropal. num. extra., p. 88, 89, pl. 3, fig. 2, 6-12; pl. 9, fig. 8, 9. Three specimens in Sample 392A-3, CC, (?*S. cabri-*) *G. algerianus* Zone, which have 6-8 rather than 4-6 chambers in the last whorl as defined by Bolli (1959; see also Longoria, 1974).

Hedbergella amabilis Loeblich and Tappan
(Plate 11, Figures 11-13)

Hedbergella amabilis Loeblich and Tappan, 1961, Micropal., v. 7, no. 3, p. 274, pl. 3, fig. 1-10.

Flat trochospire, open umbilicus; smooth-walled, finely perforate chambers laterally somewhat flattened; sutures distinct, often constricted, giving rise to strongly lobate periphery; usually 6, rarely 5 or 7 chambers in the last whorl; last chambers often elongated. In the Blake Nose specimens there is a variation of specimens with little elongation of the last chamber to much elongated last chamber(s). Specimens transitional between *H. amabilis* and *H. planispira* (Tappan) are also present. Loeblich and Tappan (1961) reported this species from Cenomanian sediments in submarine Core A167-25 from the Blake Plateau. Pessagno (1967) gives a range from Cenomanian-Coniacian. On the Blake Nose, present in the *T. breggiensis* Zone.

Hedbergella planispira (Tappan)
(Plate 11, Figures 14-16)

Globigerina planispira Tappan, 1940, J. Paleontol., v. 14, no. 2, p. 122, pl. 19, fig. 12.

Hedbergella planispira (Tappan), Longoria, 1974, Rev. Esp. Micropal. num. extra., p. 64-65, pl. 11, fig. 4-16; pl. 20, fig. 4; pl. 23, fig. 1-7, 11-13, 17-18; pl. 24, fig. 10.

Outline circular to slightly oval; the few whorls occur in a flat coil; mostly 6 to 8 chambers in the last whorl; chambers of subglobular to globular shape, increasing slowly in size; wide umbilicus. During a visit to the USNM, Washington, I compared specimens to the holotype and paratypes by Tappan (1940; sub *Globigerina planispira*) from the Grayson Formation, Texas, to hypotypes from the Duck Creek Formation (Tappan, 1943) and to *Praeglobotruncana planispira* (Tappan) and *Praeglobotruncana modesta* Bolli (= *H. planispira*, see Loeblich and Tappan, 1961, p. 26) from the Maridale Formation, Trinidad (Bolli, 1959).

Cenomanian *H. trocoidea* (Gandolfi) identified by Loeblich and Tappan (1961) from submarine Core A167-25 on the Blake Plateau was incorporated in *H. planispira* by Pessagno (1967; see also Michael, 1972, p. 211).

Hedbergella aff. trocoidea (Gandolfi)
(Plate 10, Figures 7, 8)

Anomalina lorneiana d'Orbigny var. *trocoidea* Gandolfi, 1942, Riv. Ital. Paleontol., v. 48, no. 4, p. 98, pl. 2, fig. 1; pl. 4, fig. 2, 3; pl. 13, fig. 2-5.

Hedbergella trocoidea (Gandolfi) Longoria, 1974, Rev. Esp. Micropal. num. extra., p. 69-72, pl. 17, fig. 1-16; pl. 18, fig. 3-5.

Several specimens in Sample 390-3-3, 80-82 cm (*Ticinella primula* Zone) which resemble the species *sensu stricto* as found in large numbers in the *Globigerinelloides algerianus* Zone in Holes 390, 392A. However, the specimens lack the densely pustulose, beaded wall and have more constricted sutures.

Benthic Foraminifers

Conorboides hofkeri (Bartenstein and Brand)
(Plate 1, Figure 15)

Conorbis hofkeri Bartenstein and Brand, 1951, Verh. Senckenb. Naturf. Ges., 485, p. 325, 326, pl. 11, fig. 320.

Conorboides hofkeri (Bartenstein and Brand), Dieni and Massari, 1966, Palaeont. Ital., v. 61, p. 176, pl. 8, fig. 22.

Isolated and poorly preserved, recrystallized (pyritized) individuals in Sample 391C-24-3, 14-16 cm. The generic concept follows Loeblich and Tappan (1964) and Pazdro (1969, p. 20) with the characteristic open umbilicus, looping or non-looping umbilical apertures with little incision in the chamber walls, rapidly enlarging chambers and flat or concave umbilical side. Those features are more or less visible in Plate 1, Figure 15. Known from Berriasian-Valanginian strata (e.g., see Simon and Bartenstein, 1962; Dieni and Massari, 1966; Bartenstein, 1976b); also known from the Neocomian of the Canadian Atlantic margin (Gradstein et al., 1975). The occasional occurrence (?reworked) on the Scotian Shelf, Canada, in Barremian sediments (P. Ascoli, personal communication) needs further study.

Epistomina chapmani Ten Dam
(Plate 8, Figure 5)

Epistomina chapmani Ten Dam, 1948, Rev. Inst. Franc. Petr., v. 3, p. 166, pl. 1, fig. 5. Ohm, 1967, Palaeontographica, Bd. 127A, p. 144, pl. 19, fig. 8, 11; text-fig. 39.

A dozen or more specimens of a smooth-walled *Epistomina* occur in Hole 392 in the *Ticinella primula*-*T. breggiensis* zones. The umbilical side is more convex than the spiral side, there are 5-6 chambers in the last whorl. Three specimens are round in outline and keeled, the others are more lobate and non-keeled. Sutures are flush to slightly depressed and curved backward slightly; the chamber walls have a discontinuous pore pattern as often occurs in *E. supracretacea* Ten Dam and *E. elegans* (d'Orbigny). The dental apertures are discontinuous rather than continuous along the periphery as in *E. caracolla* and *E. supracretacea* (see Ohm, 1967) and close to the periphery. There is no umbo as is always present in *E. caracolla* (Roemer). The specimens are identified as *E. chapmani* Ten Dam known from the middle Barremian-Albian of Europe (incl. USSR) and California (Ohm, 1967; Dailey, 1973). The original description by Ten Dam mentions 8 chambers in the last whorl; Ohm illustrates specimens with 7 chambers. Pyritized specimens identified as *E. chapmani* by P. Ascoli from the Scotian Shelf Lower Cretaceous (P. Ascoli, personal communication) show a variation of 6-9 chambers in the last whorl.

Epistomina cretosa Ten Dam
(Plate 8, Figures 3, 4)

Epistomina cretosa Ten Dam, 1947, Geol. Mijnb., v. 8, no. 2, p. 29, fig. 6. Ohm, 1967, Palaeontographica, Bd. 127A, p. 148, pl. 20, fig. 2, text-fig. 43.

Known from upper Hauterivian through Albian strata (Ohm, 1967), but at the Blake Nose only found in Albian beds at Site 392. Grand Banks specimens from the Amoco IOE Puffin B-90 well (Jenkins et al., 1974) are less stoutly built and have less curved sutures than the ones from the Blake Nose.

Epistomina ornata (Roemer)
(Plate 4, Figure 11)

Planulina ornata (Roemer), 1841, Kreidegebirge, p. 98, pl. 15, fig. 25. *Epistomina ornata* (Roemer), Ohm, 1967, Palaeontographica, Bd. 127A, p. 135, pl. 3, fig. 1-2; pl. 5, fig. 7.

The Blake Nose specimens in Hole 390, Core 6 (Barremian) compare well with the specimens of this species from the Cuche Formation, Trinidad present in the USNM, Washington (Bartenstein et al., 1957). Its range seems to be upper Valanginian-lower Barremian as first established in West German localities. In Trinidad it occurs as high as middle Barremian (see Bartenstein et al., 1957; Simon and Bartenstein, 1962; Ohm, 1967; Dailey, 1973). In the Canadian Atlantic Shelf it is used as a Neocomian-Barremian marker in the Verrill Canyon Formation (Gradstein et al., 1975).

Gavelinella-Lingulogavelinella

Eighteen samples in Holes 390, 390A, and 392A, belonging in the *G. barremiana*/*L. sigali* to *T. breggiensis* zones (Barremian-upper Albian), contain rare to frequent occurrences of specimens of several taxa of gavelinellids; some of the gavelinellids have been assigned to genera and species described in the literature.

Gavelinella barremiana
(Plate 6, Figures 14-17)

Gavelinella barremiana Bettenstaedt, 1952, Senckenb., v. 33, p. 275, 276, pl. 2, fig. 26-29. Michael, 1966, Senckenb. Leth., v. 47, no. 5/6, p. 430-432, pl. 50, fig. 1-3.

In Samples 390-5, CC, 390-6-1, and 392A-4-1, 110-112 cm (*G. barremiana*-*L. sigali* Zone) specimens are relatively small (less than 250 μ m in diameter) and mostly flat or slightly convex; the sutures curve backward; the apertural side is involute with a narrow, mostly open umbilicus; the spiral, aboral side is evolute. Many specimens have slender tongue-like apertural flaps reaching over the umbilical suture; these are faintly visible in Plate 6, Figures 14, 17. From a comparison with the detailed description by Michael (1966) the specimens clearly belong in *Gavelinella barremiana* Bettenstaedt. According to Michael (1966) (see also Bartenstein, 1976b), the species is cosmopolitan and ranges from middle-upper Barremian, with forms transitional to *G. intermedia* in lower Aptian. Van Hinte (1976) restricts the species to the Barremian. Also known from the Cuche Formation (Barremian) in Trinidad (Bartenstein et al., 1957) and the Scotian Shelf and Grand Banks (Gradstein et al., 1975) where it is used as a Barremian (-lower Aptian) marker.

"Gavelinella" sp. A-C, G. intermedia (Berthelin) and G. intermedia (Berthelin)-G. ammonoides (Reuss)

In 15 samples in Holes 390, 390A, and 392A, assigned to the *G. blowi* through *T. breggiensis* zones, gavelinellids which show considerable and rather continuous variation in morphology occur rarely to frequently.

Gavelinella intermedia (Berthelin) is probably one of the more common forms. Other closely related specimens show features of such recently proposed genera as *Lingulogavelinella* and *Orithostella* (sensu Eicher and Worstell, 1970; Scheibnerova, 1971, 1974).

Because of the wide, rather continuous variation and absence of clear stratigraphic trends in the forms observed. I do not deem it useful, in this preliminary account to split this group into formal taxa. Also, there is no common opinion on the ranking of characters (if possible at all) to define such genera as *Gavelinella*, *Lingulogavelinella*, and *Orithostella* (compare Michael, 1966; Malapris-Bizouard, 1967; Scheibnerova, 1971, 1974; and Eicher and Worstell, 1970) and on the species level there are many potential synonyms in European and American literature. For these reasons I prefer to describe the variation without drawing detailed taxonomic conclusions. In order to draw such conclusions, a comparison to types and variations of established taxa is desirable.

On the distribution charter of Figures 2 and 3, specimens of *Gavelinella* sp. A-C, *G. intermedia*, and *G. intermedia-ammonoides* have been referred to as "G." *intermedia* group; data on distribution of individual members of this group are in the text.

Gavelinella sp. A
(Plate 5, Figures 1-7, 10-12)

Relatively large (up to 500 μ m in diameter), low trochospiral, flat or low biconvex to plano- or concavoconvex specimens with 8-10 narrow chambers in the last whorl. Sutures curve strongly backward, and may be partially limbate, but more often are slightly depressed; chamber wall is coarsely perforated. The aboral side is partially to fully evolute, and in the younger samples may show an imperforate boss; the oral side is more involute with a wide, shallow umbilicus; the aperture is a narrow slit at the base of the last chamber, reaching from over the subacute periphery to the relative involute (oral) side and continuing along the umbilical suture. Most specimens have distinct, tongue-like, apertural flaps which reach into the umbilicus and overlap each other in an imbricate manner, going backward along the suture; there is some variation in the shape and size of these flaps; the flaps are less perforate than the rest of the test or imperforate (Plate 5, Figure 4). Found in Sample 390-5-2, 60-62 cm (*G. algerianus* Zone) and 392A-2-1, 86-89 cm, 392A-2-2, 146-148 cm, 392A-2-3, 104-106 cm, 392A-2, CC, and 392A-3-1, 46-48 cm (*T. primula* and *T. breggiensis* zones).

Except for the larger size of the test, many of these specimens resemble *G. barremiana* as present in underlying samples which may have been ancestral to *Gavelinella* sp. A. Compare Plate 5, Figure 5 and Plate 6, Figure 17.

Gavelinella intermedia (Berthelin)
(Plate 6, Figures 5-13; Plate 7, Figure 13)

Anomalina intermedia Berthelin, 1880, Mem. Soc. Geol. France, v. 3, no. 1, p. 67, pl. 4, fig. 14-

Gavelinella intermedia (Berthelin), Michael, 1966, Senckenb. Leth., v. 47, no. 5/6, p. 432-434, pl. 50, fig. 4-13.

Gavelinella sp. A grades into a group of specimens with a more convex oral side and often less developed tongue-like imperforate flaps, especially in those (small) specimens with limbate sutures. The aboral side may have an imperforate boss. These specimens compare with *Gavelinella intermedia* (Berthelin) as described by Michael (1966; see also Scheibnerova, 1974). The taxon is most common in Sample 390-5-1, 87-89 cm, and also in 392A-2, CC, 392A-3-3, 50-52 cm (*G. algerianus*-*T. breggiensis* zones).

In Sample 390A-14-5, 119-121 cm and 390A-14, CC and also in 390-3-3, 80-82 cm (*T. primula* Zone) many specimens assigned to the *G. intermedia* group are relatively tightly asymmetrically-symmetrically coiled, and have a broadly rounded periphery (Plate 6, Figures 11, 12) and small apertural flaps (when visible).

Gavelinella sp. B
(Plate 5, Figure 8)

A third group present with rarely occurring individuals in Samples 390-5-1, 87-89 cm, 390-2-3, 80-82 cm, and possibly in 392A-3, CC (*G. algerianus*-*T. breggiensis* zones) shows a markedly flat to concave oral side, no limbate sutures and larger tongue-like flaps than *Gavelinella* sp. A. The flaps reach more than halfway along the chamber sutures, rarely observed in *Gavelinella* sp. A. The flaps are largely imperforate.

In 392A-3, CC some symmetrically biconvex specimens are possibly related to this form and resemble *Orithostella indica* Scheibnerova from the Albian of the Eastern Indian Ocean (DSDP Leg 27) (Scheibnerova, 1974).

Gavelinella sp. C
(Plate 7, Figures 14-16)

A fourth group, *Gavelinella* sp. C, is present in Samples 390A-14, CC, 392A-2-1, 84-86 cm, 392A-2, CC, and 392A-3-1, 46-48 cm (*T. primula* Zone). All specimens (rare to common) have a flat to low convex, rather evolute, oral side and usually a fully involute and almost always more convex aboral side. The umbilicus is generally very narrow. Some specimens are strongly tightly planoconvex. There is a limbate spiral suture; no distinct apertural flaps were observed. In the more planoconvex specimens the sutures are more curved backward, often with a sudden turn halfway. *Gavelinella* sp. C and more tightly coiled members of *Gavelinella intermedia*, as in Sample 390A-14, CC, may be the same taxon.

Gavelinella intermedia-ammonoides (Reuss)
(Plate 6, Figures 1-4)

In Samples 390-5-1, 87-89 cm, 390-3, CC, 392A-2-3, 104-106 cm, and 392A-3, CC (*G. algerianus*-*T. breggiensis* zones) there are rare, fairly small *Gavelinella*-type specimens in which the younger chambers of the last whorl increase considerably in width. The test is asymmetrically-symmetrically biconvex, with the spiral side often flatter. The aperture occurs on the umbilical side with a narrow lip. The umbilicus is narrow.

The specimens tend to *G. ammonoides* (Reuss) which according to Michael (1966) originated from *G. intermedia* in middle Albian time. Variants of *G. barremiana* and *G. intermedia* resembling *G. ammonoides*, also occur stratigraphically lower. In Samples 390-5-1, 87-89 cm and 392A-3, CC the specimens intergrade with *G. intermedia*.

G. ammonoides occurs in the middle Albian-Turonian of Europe (Michael, 1966). Bartenstein and Bolli (1973) list it as probably present in upper Aptian-lower Albian beds in Trinidad.

Lingulogavelinella ciryi Malapris-Bizouard
(Plate 5, Figures 9, 13-17)

Lingulogavelinella ciryi ciryi Malapris-Bizouard, 1967, Rev. Micropal., v. 10, no. 2, p. 137, 138, pl. 1, fig. 16-19; pl. 2, fig. 16-20.

L. aff. ciryi ciryi Malapris-Bizouard, Maync, 1973, Init. Rept. DSDP Leg 13, p. 1099, pl. 4, fig. 6-11.

In Samples 392A-2-2, 146-148 cm and 392A-3-1, 46-48 cm (*T. primula-T. breggiensis* zones) there are some specimens of a tiny gavelinellid (less than 300 μ m in diameter) which differ from other gavelinellids in the samples by its small size, low asymmetrically biconvex test, and rounded periphery. It has 7-8 chambers in the last whorl. Two specimens show sigmoid sutures with small crenulations in the last chambers (Plate 5, Figure 14). Imperforate apertural flaps, which may be triangular in shape (Plate 5, Figure 13) are well developed.

From the detailed description by Malapris-Bizouard (1967) we may be dealing with *Lingulogavelinella ciryi* known from the Albian (including Vraconian) of France and also mentioned by Maync (1973) in Albian beds in DSDP Site 120 on Gorrington Bank, North Atlantic Ocean.

Plexus of *Gaudryina dividens* Grabert-*Spiroplectinata lata* Grabert (Plate 2, Figures 1-18)

Gaudryina dividens Grabert, 1959, Abh. Senckenb. Naturf., Ges. 498, p. 9-11, pl. 1, fig. 35; pl. 2, fig. 16-30; pl. 3, fig. 53-59.

Gaudryina dividens var. *compacta* Grabert. *G. compacta* Grabert, 1959, Abh. Senckenb. Naturf., Ges. 498, p. 11, pl. 1, fig. 6-8; pl. 3, fig. 48-52.

Gaudryina dividens var. *reicheli* Bartenstein, Bettenstaedt, and Bolli. *G. reicheli* Bartenstein, Bettenstaedt, and Bolli, 1966, Ecol. Geol. Helv., v. 59, no. 1, p. 142, 143, pl. 1, fig. 34-37, 50-55. Bartenstein and Bolli, 1973, Ecol. Geol. Helv., v. 66, no. 2, p. 396, pl. 2, fig. 36-51. *Spiroplectamina californica* Dailey, 1970, Contrib. Cushman Found. Foram. Res., v. 21, pt. 3, p. 104, pl. 11, fig. 7, 8.

Spiroplectinata lata Grabert, 1959, Abh. Senckenb. Naturf., Ges. 498, p. 16, pl. 1, fig. 9, pl. 2, fig. 31-35, pl. 3, fig. 60-76.

In the 13 Blake Nose samples belonging to the *G. algerianus-T. primula* zones (upper Aptian-middle Albian) rare to frequent *Gaudryina* and *Spiroplectinata* occur which are widely varied in morphology and in size. Tests are triserial, triserial-biserial, or triserial-biserial-uniserial; the triserial portion, which is triangular in outline, may be greatly shortened and its sides may be strongly depressed. The biserial portion is also of variable length and may be roughly triangular to trapezoidal or rectangular, with parallel margins or strongly flattened and with diverging margins (flabelliform). Some specimens, especially in Sample 392A-3, CC have more rounded biserial chambers. Chambers of a uniserial part of the test are rounded in outline; the aperture is terminal in the form of a small, elongate or "circular" opening. The wall is composed of minute carbonate particles, including many nanofossils (Plate 2, Figure 3); there are scattered, relatively large pores in the wall. The USNM types in Washington and description of *Gaudryina subcretacea* Cushman and *G. alexandri* Cushman from the upper Lower Cretaceous, Duck Creek Formation (Texas, Oklahoma) do not fully compare with the Blake Nose specimens. *G. subcretacea* has a more flattened, triserial portion (see also Tappan, 1943, p. 490, pl. 78, fig. 28, 29) and might be a stunted and diagenetically flattened *G. alexandri*. *G. alexandri* differs from the Blake Nose specimens because of its more pronounced and sharper triserial and biserial periphery (see also Grabert, 1959, p. 10, 11, 45, 46).

From the detailed description and illustrations by Grabert, 1959 (see also Simon and Bartenstein, 1962, p. 285, 286) the Blake Nose specimens fall within the plexus of *Gaudryina dividens-Spiroplectinata* of Aptian-Albian age. This plexus, which in northwestern Europe includes several *Gaudryina* and *Spiroplectinata* species, shows a strong reduction of the triserial part through time and also a progressive increase in the flat biserial stage of the test. From a comparison to the literature, the Blake Nose specimens may be divided into approximately four typological taxa (abbreviated in Figures 2 and 3 as "*G. dividens* group").

Many specimens which are either triserial, triserial-biserial, or triserial-biserial-uniserial with a relatively long triserial part with strongly depressed sides and a roughly triangular to trapezoidal or rectangular outline of the biserial portion (Plate 2, Figures 9-13, 16-18) belong in *Gaudryina dividens* Grabert. Specimens with less depressed sides of the triangular portion (Plate 2, Figures 12, 13) have been described by Grabert (1959) as the variant *G. compacta*. Some specimens, especially in Samples 392A-3, CC and in 390-5-1, 87-89 cm (both upper Aptian) have more rounded biserial chambers and

resemble *G. reicheli* Bartenstein, Bettenstaedt, and Bolli (Plate 2, Figures 14, 15) from the Aptian-lower Albian of Trinidad and possibly California (cf. *Spiroplectinata californica* Dailey; see Bartenstein et al., 1966; Bartenstein and Bolli, 1973; Dailey, 1970, 1973). Isolated specimens in Sample 392A-3-1, 46-48 cm (*T. primula* Zone, middle Albian) and over one hundred specimens in Samples 390-5-1, 87-89 cm, 392A-3-3, 50-53 cm and 392A-3, CC (all belonging in the upper Aptian [*S. cabri-*] *G. algerianus* Zone) possess a strongly reduced triserial, depressed triangular test, and an often long biserial part with moderately to strongly flattened chambers much wider than high and rarely a uniserial test portion (Plate 2, Figures 1-8). Such specimens belong in *Spiroplectinata* and have been identified as *S. lata*, first described by Grabert from the lower-middle Albian of Germany where it originated from *G. dividens*. The Blake Nose *Spiroplectinata lata* specimens are readily separable from *Gaudryina* type one, with few transitional individuals.

Table 2, shows, in descending stratigraphic order, the number of specimens of this *Gaudryina-Spiroplectinata* plexus per sample at Site 390 (Holes 390, 390A) with triserial, triserial-biserial, or triserial-biserial-uniserial tests. The tabulation does not show a trend in time toward reduction of the triserial part, or an increase in the length of the biserial portion (Grabert, 1959).

In order to arrive at a more meaningful phylogenetic analysis, we need to eliminate the ontogenetic effect on the test-building plan. This requires more material so that we can analyze the phylogenetic trend on specimens which have reached a certain ontogenetic stage.

Table 3 shows the stratigraphic distribution of the four taxa recognized in the Blake Nose sites. It fails to show the postulated trend in time of *Gaudryina (G.)-Spiroplectinata (S.)*.

TABLE 2
Number of Specimens of the *Gaudryina-Spiroplectinata*
Plexus per Sample in Holes 390 and 390A

Comments	Sample (Interval in cm)	Number of Specimens			Total
		Triserial	Triserial- Biserial	Triserial- Biserial- Uniserial	
1-3 biserial pairs	390A-14-5, 119-121	7	21	4	32
4 specimens strongly flattened biserial pairs and reduced triserial pairs	390A-14, CC	3	10	3	16
1-5 biserial pairs	390-3-3, 80-82	8	27	2	37
	390-3, CC		3	10	14
	390-4-2, 75-77		4	3	7
	390-4, CC, 7-9	2	1		3
	390-4, CC	2			2
1-7 pairs biserial, relatively flat; reduced triserial part (38 specimens)	390-5-1, 87-89	3	40	5	48
reduced triserial, flat biserial part	390-5-2, 60-62			1	1

TABLE 3
Stratigraphic Distribution of the Four Taxa Recognized From Holes
390 and 390A (Blake Nose)

Sample	Location	Taxa
390-3-3, 80-82 cm	Middle Albian	<i>G. dividens</i> var. <i>compacta</i>
390-3, CC	Middle Albian	<i>G. dividens</i>
390-4-2, 75-77 cm	Middle Albian	<i>G. dividens</i>
390-4, CC, 7-9 cm	Middle Albian	<i>G. dividens</i> var. <i>compacta</i>
390-4, CC	Middle Albian	<i>G. dividens</i>
390-5-1, 87-89 cm	Upper Aptian	<i>G. dividens</i> , <i>G. dividens</i> var. <i>reicheli</i> , <i>S. lata</i> *
390-5-2, 60-62 cm	Upper Aptian	<i>S. lata</i>
390A-14-5, 119-121 cm	Middle Albian	<i>G. dividens</i> , <i>G. dividens</i> var. <i>compacta</i> *
390A-14, CC	Middle Albian	<i>G. dividens</i> *, <i>S. lata</i>
392A-2-1, 84-86 cm	Middle Albian	<i>G. dividens</i>
392A-2-2, 146-148 cm	Middle Albian	<i>G. dividens</i> var. <i>compacta</i>
392A-3-1, 46-48	Middle Albian	<i>G. dividens</i> * + <i>S. lata</i>
392A-3-3, 50-52 cm	Upper Aptian	<i>G. dividens</i> , <i>G. dividens</i> var. <i>compacta</i> *
392A-3, CC	Upper Aptian	<i>S. lata</i> , <i>G. dividens</i> var. <i>reicheli</i> *

Note: If more than one species occurs in sample, the predominate taxon is marked with an asterisk.

The presence of more *S. lata*-type specimens in the upper Aptian than in the Albian deposits suggests that the phylogenetic trend of *Gaudryina* *dividens* to *Spiroplectinata* spp. is more complicated than previously suggested. More detailed study, including a direct comparison to material from northwestern European localities, is desirable.

Lenticulina (Planularia) crepidularis (Roemer)
(Plate 4, Figure 9; Plate 1, Figure 12)

Planularia crepidularis N. Roemer, 1842, Neue Kreide-Form., p. 273, pl. 7B, fig. 4.

Lenticulina (Astacolus) crepidularis (Roemer), Bartenstein, Bettenstaedt, and Bolli, 1957, *Ecol. Geol. Helv.*, v. 50, p. 29, 30, pl. 3, fig. 55, pl. 4, fig. 82, 83.

This species is cosmopolitan and long ranging, but locally more common in the upper Valanginian-lower Barremian sediments (Simon and Bartenstein, 1962). It is also known from the Cucho Formation in Trinidad (Bartenstein et al., 1957) stratigraphically not higher than Barremian and on the Canadian Atlantic Shelf in the Verrill Canyon Formation where it is used as a Neocomian marker (Gradstein et al., 1975). At Sites 390, 391, and 392, it only occurs in the Barremian Zone of *G. barremiana*-*L. sigali*.

Lenticulina ex. gr. ouachensis Sigal
(Plate 4, Figures 4, 8)

Cristellaria ouachensis Sigal, 1952, XIX Congr. Geol. Intern. Monogr. Region (1), no. 26 (Alger), p. 16, fig. 10.

Lenticulina (Lenticulina) ouachensis ouachensis (Sigal), Bartenstein, Bettenstaedt, and Bolli, 1957, *Ecol. Geol. Helv.*, v. 59, no. 1, p. 25, 26, pl. 3, fig. 50; pl. 4, fig. 71, 76.

This includes a few specimens in the zones of *G. barremiana*/*L. sigali* and *G. blowi* (Barremian-lower Aptian) which show some variation in the extent of the umbilical collar. Specimens with a wide umbilical collar compare to specimens of *L. ouachensis-ouachensis* in the USNM, Washington, from the Cucho Formation, Trinidad (Bartenstein et al., 1957). The cosmopolitan species with its subspecies occurs in Valanginian to Aptian beds (Simon and Bartenstein, 1962; Sigal, 1965; Moullade, 1966; Dailey, 1973; Luterbacher, 1975). It has also been found at DSDP Sites 120 on Gorringe Bank off Portugal (Maync, 1973), 105, Hatteras Abyssal Plain (Luterbacher, 1972), and from the Canadian Atlantic Shelf (Gradstein et al., 1975).

(Marginulopsis) sigali Bartenstein, Bettenstaedt, and Bolli
(Plate 4, Figures 5-7)

Marginulopsis djaffaensis Sigal, 1952, XIX Congr. Geol. Intern. Monogr. Region (1), no. 26 (Alger), p. 15, fig. 9.

Lenticulina (Marginulopsis) sigali Bartenstein, Bettenstaedt, and Bolli, 1957, *Ecol. Geol. Helv.*, v. 57, no. 1, p. 32, 33, pl. 5, fig. 99; pl. 6, fig. 130, 121.c

An easily recognizable species which occurs in small numbers in Sites 390 and 392 where it defines the Barremian zone of *G. barremiana*-*L. (M.) sigali*. A paratype of this species in the USNM, Washington, from the Cucho Formation, Trinidad (Bartenstein et al., 1957) is very similar to some of the more slender specimens in Sample 392A-4, CC.

Lenticulina (Marginulopsis) sigali was first described as *Marginulopsis djaffaensis* from the

Lenticulina (Marginulopsis) sigali was first described as *Marginulopsis djaffaensis* Sigal from the Hauterivian and Barremian of Algeria (Sigal, 1952, 1965) and emended as *Lenticulina (Marginulopsis) sigali* Bartenstein, Bettenstaedt, and Bolli (1957). These authors and Moullade (1966, sub *Marginulina djaffaensis*) also give its range from Hauterivian-Barremian. Also known from Germany (Bartenstein et al., 1957), ?California (sub *Astacolus schreiteri* [Eichenberg]; Daily, 1973£; and the Scotian Shelf of Canada (P. Ascoli, personal communication).

Osangularia utaturensis (Sastri and Sastry)
(Plate 7, Figures 5-12)

Eponides utaturensis Sastri and Sastry, 1966, *Geol. Surv. India Rec.*, v. 94, p. 292, pl. 19, fig. 6.

Osangularia sp. aff. *brotzeni* (Gandolfi), Moullade, 1966, Doc.

Labo. Geol. Fac. Sci. Lyon, no. 15, p. 77-79, pl. 1, fig. 9-11, text-fig. 2.

Osangularia californica Dailey, 1970, *Contrib. Cush. Found. Foram. Res.*, v. 21, pt. 3, p. 108, 109, pl. 13, fig. 3, 4.

Osangularia utaturensis (Sastri and Sastry), Scheibnerova, 1974, *Initial Rept. DSDP Leg 27*, p. 714, pl. 4, fig. 27, 28; pl. 5, fig. 1-9; pl. 11, fig. 4, 5.

Osangularia utaturensis (sub *Eponides utaturensis* Sastri and Sastry, 1966) was originally described from the Utatur Formation, Madras, India, in beds regarded as upper Albian. Scheibnerova (1974) gives a detailed description, records it from DSDP Leg 27, eastern Indian Ocean, and mentions its presence in northern Australian strata. She regards the Aptian-Albian species *O. californica* Dailey (1970) from the Budden Canyon Formation, California, as a junior synonym of *O. utaturensis*. Luterbacher (1975) recently reported *O. californica* from the northwestern Pacific, DSDP Site 305, Leg 32.

Blake Nose specimens identified as this species closely adhere to Scheibnerova's (1971) detailed description. In Sample 390-4-2, 75-77 cm, rather flat instead of planoconvex specimens with a lobate rather than a more circular outline and with flaring chambers also occur (Plate 7, Figure 9).

From the figures and description of *Osangularia* sp. aff. *brotzeni* (Gandolfi) in Moullade (1966), the form and *O. utaturensis* might be the same species. Moullade (1966) gives a range for *O. sp. aff. brotzeni* from uppermost Aptian-middle Albian in the "Fosse vocontienne," southeast France. On the Blake Nose at Sites 390 and 392 *O. utaturensis* occurs in the *G. algerianus*-*T. breggiensis* zones (upper Aptian-upper Albian). It is especially common in the Blake Nose Albian strata.

Osangularia insigna Dailey
(Plate 7, Figures 1-4)

Osangularia insigna Dailey, 1970, *Contrib. Cush. Found. Foram. Res.*, v. 21, pt. 3, p. 109, pl. 13, fig. 5; pl. 14, fig. 1.

O. insigna secunda Dailey, 1970, *Ibid.*, p. 109, pl. 14, fig. 2.

Specimens assigned to this species (incl. *O. insigna secunda* Dailey, 1970) are mostly about half the size of *O. utaturensis*. Diagnostic features are the mostly symmetrical biconvex test, the large umbilical boss and the weakly curved sutures. There are 10-12 chambers in the last whorl. Dailey (1970) describes the species from the upper Albian-Cenomanian of California (Budden Canyon Formation). In Hole 392A, Blake Nose, it ranges through the zones of *T. primula*-*T. breggiensis* (middle-upper Albian).

Orthokarstenia shastaensis Dailey
(Plate 3, Figures 1-4)

Orthokarstenia shastaensis Dailey, 1970, *Contrib. Cush. Found. Foram. Res.*, v. 21, pt. 3, p. 107, pl. 12, fig. 8-10.

Test elongate; short initial triserial part is followed by one pair of biserial chambers in turn followed by up to five uniserial chambers which slowly increase in size; sutures are constricted; the calcareous perforate wall is finely spinose to papillate except often along the sutures which are smooth. The aperture is a rounded or elliptical opening on a short neck.

Dailey (1970) mentions the absence of a tooth plate, but assumes this to be a result of poor preservation. The Blake Nose specimens also lack a clear tooth plate, but in the aperture, remnants of some kind of tooth-plate-like structure seem present (Plate 3, Figures 3, 4). The Blake Nose specimens differ from the ones in the Budden Canyon Formation in having a finely spinose to papillate, rather than smooth to papillate wall; but this difference may relate to preservation.

Bartenstein and Bolli (1973, p. 414) erroneously placed *O. shastaensis* in synonymy of *Bigenerina clavellata* Loeblich and Tappan. The species also occurs in Trinidad (H. Bartenstein, personal communication).

In California, *O. shastaensis* is known from the Aptian through Cenomanian sediments and on the Blake Nose in the middle-upper Albian zones of *T. primula*-*T. breggiensis*.

Reinholdella ultima Dailey
(Plate 8, Figure 7)

Reinholdella ultima Dailey, 1970, *Contrib. Cush. Found. Foram. Res.*, v. 21, p. 110, pl. 14, fig. 5, 6.

This smooth *Reinholdella* species was first described from the Budden Canyon Formation, California where it ranges from Aptian through Cenomanian (Dailey, 1970). Bartenstein and Bolli (1973, p. 415) state that *Conorboides bulgaricus* Bartenstein, Bettenstaedt, and Kovatcheva from the Barremian of Bulgaria may be closely related. On the Blake Nose, *R. ultima* occurs in the middle-upper Albian zones of *T. primula*-*T. breggiensis*.

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PLATE 1
Hole 391C

- Figure 1 *Plectorecurvoides* sp.; 391C-5, CC; *Plectorecurvoides* assemblage. The biserial coil is vaguely visible in the last chamber pair. $\times 150$.
- Figure 2 *Plectorecurvoides* sp.; 391C-5, CC; *Plectorecurvoides* assemblage. $\times 150$.
- Figure 3 *Trochammina* sp.; 391C-8, CC; *Plectorecurvoides* assemblage. $\times 112$.
- Figure 4 *Trochammina globigeriniformis* (Parker and Jones) 391C-8, CC; *Plectorecurvoides* assemblage. $\times 200$.
- Figure 5 *Bolivinopsis* sp.; 391C-5, CC; *Plectorecurvoides* assemblage. $\times 250$.
- Figure 6 *Glomospira* sp.; 391C-6, CC; *Plectorecurvoides* assemblage. $\times 145$.
- Figure 7 *Uvigerammina* sp.; 391C-5, CC; *Plectorecurvoides* assemblage. $\times 200$.
- Figure 8 *Glomospirella* sp.; 391C-6, CC; *Plectorecurvoides* assemblage. $\times 100$.
- Figure 9 *Gavelinella intermedia* (Berthelin); 390A-14, CC; 66-68 cm; *G. barremiana*-*L. sigali* Zone. $\times 225$.
- Figure 10 *Gavelinella barremiana* Bettenstaedt; 391C-14-3, 66-68 cm; *G. barremiana*-*L. sigali* Zone. $\times 250$.
- Figure 11 *Hedbergella sigali* Moullade; 391C-14-3, 66-68 cm; *G. barremiana*-*L. sigali* Zone. $\times 350$.
- Figure 12 *Lenticulina crepidularis* (Roemer); 391C-14-3, 66-68 cm; *G. barremiana*-*L. sigali* Zone. $\times 250$.
- Figure 13 *Dorothia praehauteriviana* Dieni and Massari (small triserial stage only); 391C-26-3, 60-62 cm; *Dorothia praehauteriviana* assemblage. $\times 250$.
- Figure 14 *Dorothia praehauteriviana* Dieni and Massari; 391C-26-3, 60-62 cm; *Dorothia praehauteriviana* assemblage. $\times 70$.
- Figure 15 *Conorboides hofkeri* (Bartenstein and Brand); 391C-26-3, 60-62 cm; *Dorothia praehauteriviana* assemblage (pseudo-arenaceous appearance due to pyritization of test). $\times 300$.
- Figure 16 *Lenticulina ex gr. nodosa* (Reuss); 391C-26-3, 60-62 cm; *Dorothia praehauteriviana* assemblage. $\times 60$.

PLATE 1

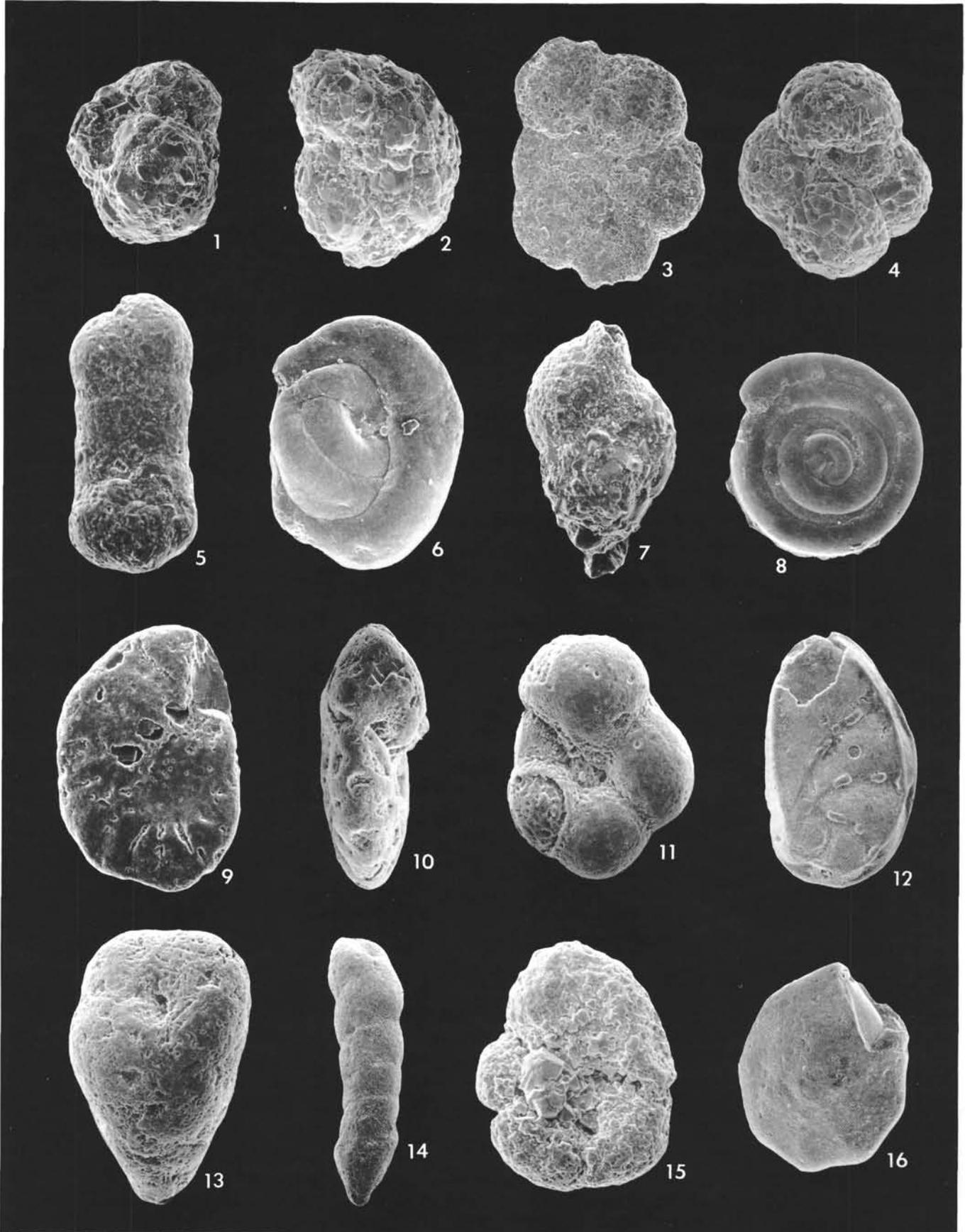


PLATE 2

Group of *Gaudryina dividens* Grabert at Sites 390, 392

- Figure 1 *Spiroplectinata lata* Grabert; 390-5-1, 87-89 cm; *Globigerinelloides algerianus* Zone. $\times 70$.
- Figure 2 *Spiroplectinata lata* Grabert; 390-5-1; 87-89 cm; *Globigerinelloides algerianus* Zone. $\times 67$.
- Figure 3 Carbonate particles, including nannofossils, are the building material of *Spiroplectinata lata* Grabert and other taxa in the group of *Gaudryina dividens* Grabert (detail of Figure 2). $\times 625$.
- Figure 4 *Spiroplectinata lata* Grabert; 392A-3-3, 50-52 cm; *Globigerinelloides algerianus* Zone. $\times 80$.
- Figure 5 *Spiroplectinata lata* Grabert; 392A-3-1, 46-48 cm; *Ticinella primula* Zone. $\times 130$.
- Figure 6 *Spiroplectinata lata* Grabert; 392A-3, CC; (?*Schackoina cabri*-) *Globigerinelloides algerianus* Zone. $\times 60$.
- Figure 7 *Spiroplectinata lata* Grabert; 392A-3-3, 50-52 cm; *Globigerinoides algerianus* Zone. $\times 50$.
- Figure 8 *Spiroplectinata lata* Grabert; 392A-3-3, 50-52 cm; *Globigerinelloides algerianus* Zone. $\times 57$.
- Figure 9 *Gaudryina dividens* Grabert; 390A-14-5, 119-121 cm; *Ticinella primula* Zone. $\times 185$.
- Figure 10 *Gaudryina dividens* Grabert; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 55$.
- Figure 11 *Gaudryina dividens* Grabert; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 55$.
- Figure 12 *Gaudryina dividens* Grabert var. *compacta* Grabert; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 55$.
- Figure 13 *Gaudryina dividens* Grabert var. *compacta* Grabert; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 55$.
- Figure 14 *Gaudryina dividens* Grabert var. *reicheli* Bartenstein, Bettenstaedt and Bolli; 390-5-1, 87-89 cm; *Globigerinelloides algerianus* Zone. $\times 80$.
- Figure 15 *Gaudryina dividens* Grabert var. *reicheli* Bartenstein, Bettenstaedt and Bolli; 392A-3, CC; (?*Schackoina cabri*-) *Globigerinelloides algerianus* Zone. $\times 60$.
- Figure 16 *Gaudryina dividens* Grabert; 392A-3-1, 46-48 cm; *Ticinella primula* Zone. $\times 110$.
- Figure 17 *Gaudryina dividens* Grabert; 390A-14-5, 119-121 cm; *Ticinella primula* Zone. $\times 50$.
- Figure 18 *Gaudryina dividens* Grabert; 392A-3-1, 46-48 cm; *Ticinella primula* Zone. $\times 60$.

PLATE 2

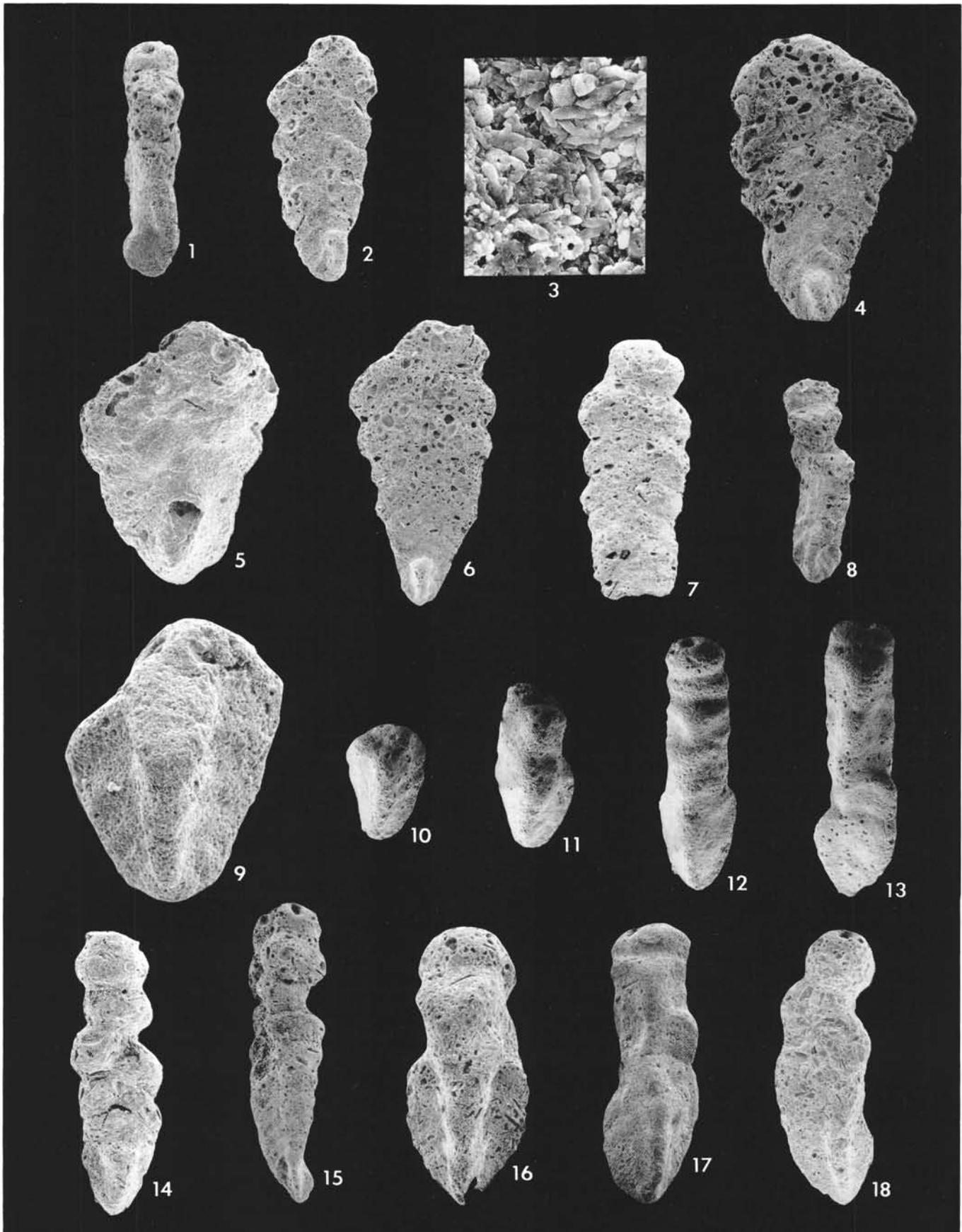


PLATE 3

Sites 390, 392

- Figure 1 *Orthokarstenia shastaensis* Dailey; 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 110$.
- Figure 2 *Orthokarstenia shastaensis* Dailey; 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 110$.
- Figure 3 *Orthokarstenia shastaensis* Dailey; 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 110$.
- Figure 4 *Orthokarstenia shastaensis* Dailey, a detail of aperture in earlier chamber; 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 325$.
- Figure 5 *Pleurostomella obtusa* Berthelin; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 100$.
- Figure 6 *Pleurostomella obtusa* Berthelin; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 100$.
- Figures 7, 8 *Pleurostomella obtusa* Berthelin; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 50$. (Figure 7; details of aperture of specimen in Figure 8. $\times 250$.)
- Figure 9 *Dentalina debilis* (Berthelin); 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 60$.
- Figure 10 *Tristix excavatus* (Reuss); 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 65$.
- Figure 11 *Pleurostomella obtusa* Berthelin; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 220$.
- Figure 12 *Dorothia trochus* (d'Orbigny); 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 100$.
- Figure 13 *Dorothia* sp.; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 90$.
- Figure 14 *Dorothia gradata* (Berthelin); 390-5-1, 87-89 cm; *Globigerinelloides algerianus* Zone. $\times 65$.
- Figure 15 *Dorothia gradata* (Berthelin); 390-5-1, 87-89 cm; *Globigerinelloides algerianus* Zone. $\times 65$.
- Figure 16 *Dorothia gradata* (Berthelin); 390-5-1, 87-89 cm; *Globigerinelloides algerianus* Zone. $\times 65$.
- Figure 17 *Dorothia gradata* (Berthelin); 390-5-1, 87-89 cm; *Globigerinelloides algerianus* Zone. $\times 65$.

PLATE 3

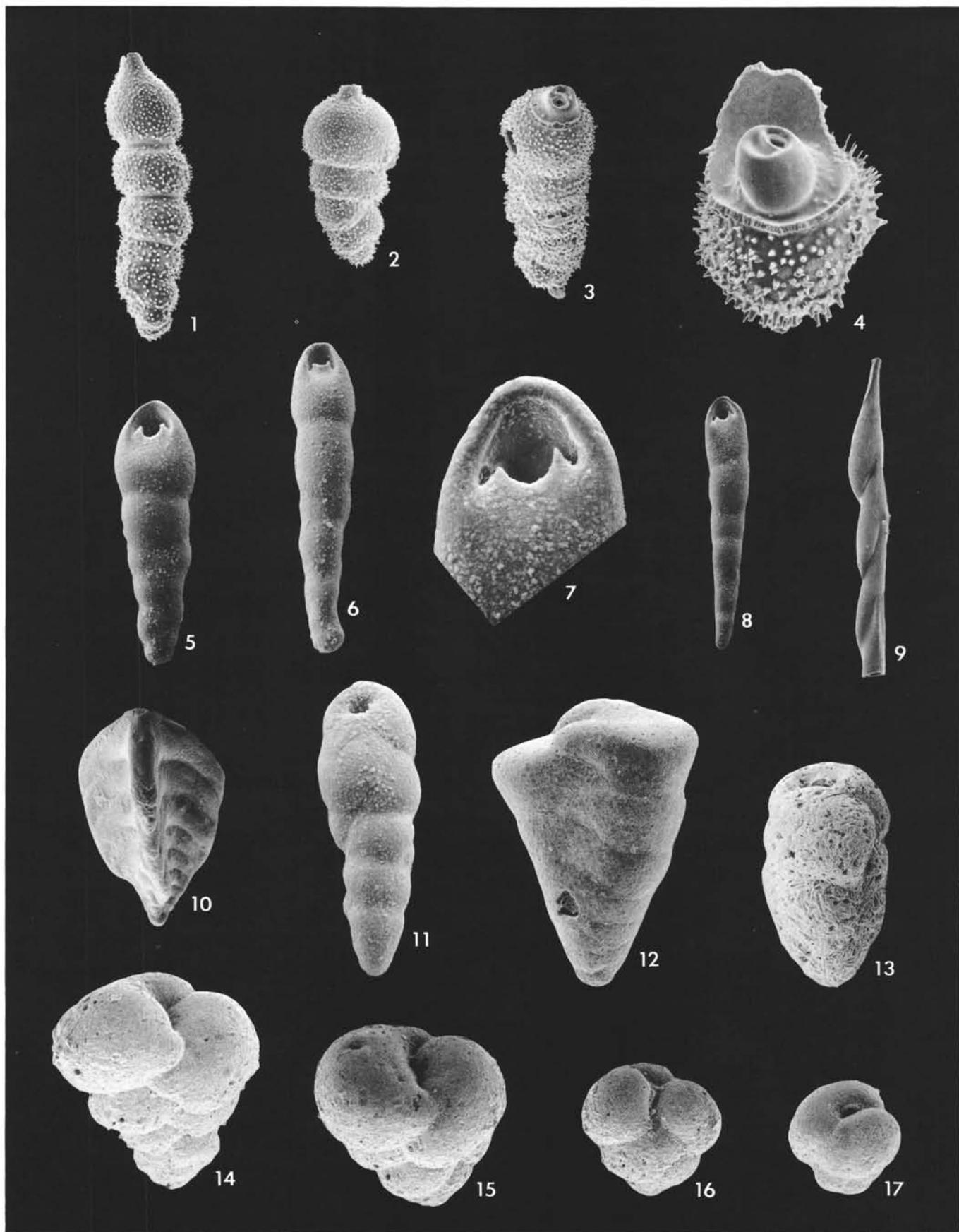


PLATE 4
Sites 390, 392

- Figure 1 *Lenticulina vocontiana* Moullade; 392A-3-3, 50-52 cm; *Globigerinelloides algerianus* Zone. ×90.
- Figure 2 *Lenticulina meridiana* Bartenstein, Bettenstaedt, and Kovatcheva; 392A-4-1, 110-112 cm; *Gavelinella barremiana-Lenticulina (M.) sigali* Zone. ×55.
- Figure 3 *Lenticulina turgidula* (Reuss); 390-3-3, 80-82 cm; *Ticinella primula* Zone. ×75.
- Figure 4 *Lenticulina* ex. gr. *ouachensis* (Sigal); 392A-4-1, 110-112 cm; *Gavelinella barremiana-Lenticulina (M.) sigali* Zone. ×87.
- Figure 5 *Lenticulina (Marginulopsis) sigali* Bartenstein, Bettenstaedt, and Bolli; 390-6, CC, *Gavelinella barremiana-Lenticulina (M.) sigali* Zone. ×100.
- Figure 6 *Lenticulina (Marginulopsis) sigali* Bartenstein, Bettenstaedt, and Bolli; 392A-4-1, 110-112 cm; *Gavelinella barremiana-Lenticulina (M.) sigali* Zone. ×100.
- Figure 7 *Lenticulina (Marginulopsis) sigali* Bartenstein, Bettenstaedt, and Bolli; 392A-4, CC; *Gavelinella barremiana-Lenticulina (M.) sigali* Zone. ×100.
- Figure 8 *Lenticulina* ex. gr. *ouachensis* Sigal; 392A-4-1, 110-112 cm; *Gavelinella barremiana-Lenticulina (M.) sigali* Zone. ×55.
- Figure 9 *Lenticulina crepidularis* (Roemer); 390-6, CC; *Gavelinella barremiana-Lenticulina (M.) sigali* Zone. ×80.
- Figure 10 *Lenticulina* ex. gr. *nodosa* (Reuss); 392A-4, CC; *Gavelinella barremiana-Lenticulina (M.) sigali* Zone. ×80.
- Figure 11 *Epistomina ornata* (Roemer); 390-6, CC; *Gavelinella barremiana-Lenticulina (M.) sigali* Zone. ×80.

PLATE 4

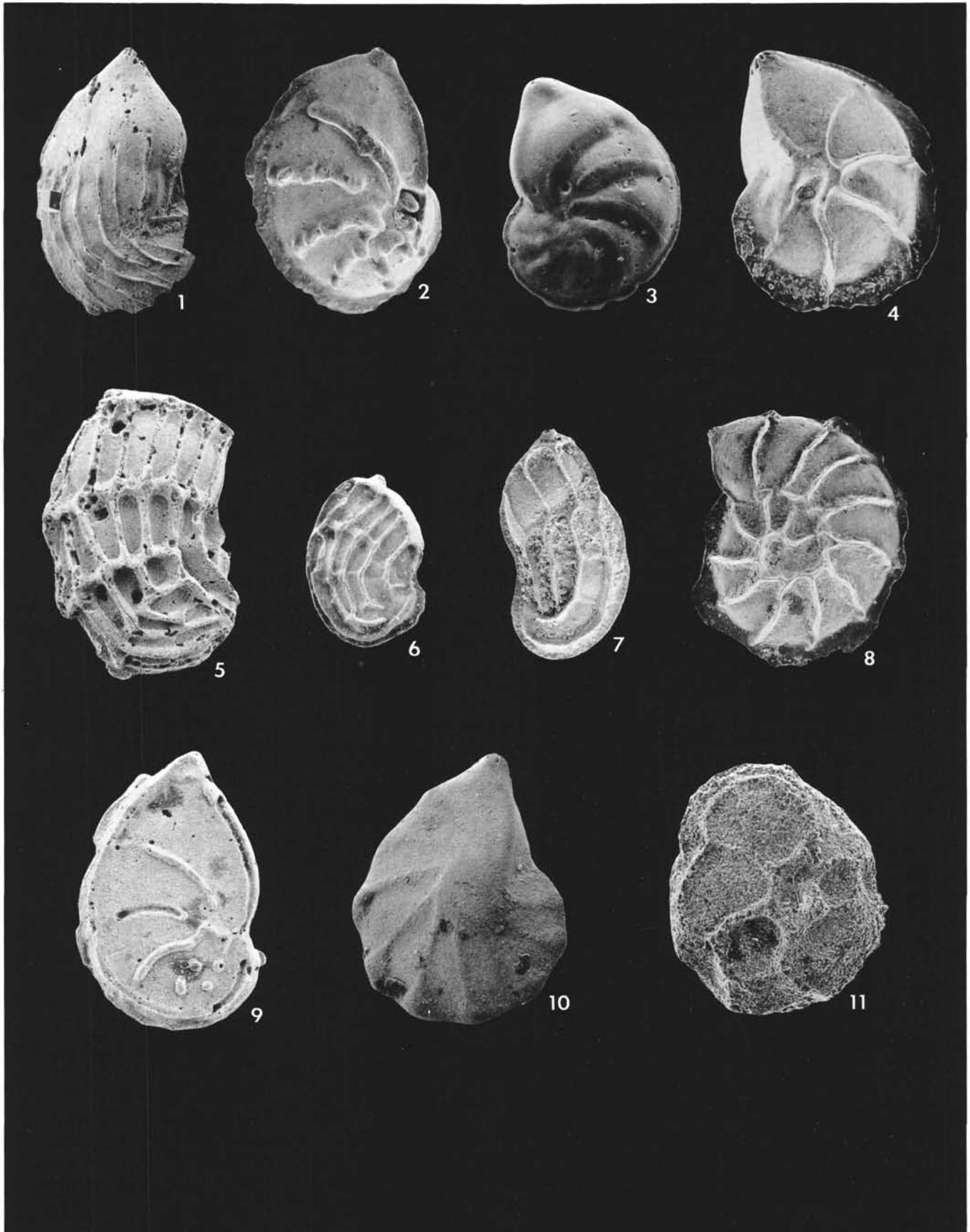


PLATE 5

Gavelinellids at Sites 390, 392

- Figure 1 *Gavelinella* sp. A (spiral view); 390-5-2, 60-62 cm; *Globigerinelloides algerianus* Zone. $\times 90$.
- Figures 2, 3 *Gavelinella* sp. A; 390-5-2, 60-62 cm; *Globigerinelloides algerianus* Zone. $\times 90$.
- Figure 4 Tongue-like flaps which cover the umbilicus in an imbricate manner in *Gavelinella* sp. A. Detail of Figure 3. $\times 350$.
- Figure 5 *Gavelinella* sp. A (small, concavo-convex; reminiscent of *G. barremiana* Bettenstaedt); 392A-2-3, 104-106 cm; *Ticinella breggiensis* Zone. $\times 157$.
- Figures 6, 7 *Gavelinella* sp. A; 392A-2-3, 104-106 cm; *Ticinella breggiensis* Zone. $\times 135$.
- Figure 8 *Gavelinella* sp. B (?*Orithostella*); 390-5-1, 87-89 cm; *Globigerinelloides algerianus* Zone. $\times 110$.
- Figure 9 Tongue-like flaps which form an imbricate umbilical cover in *Lingulogavelinella ciryi* Malapris-Bizouard. Detail of Figure 13. $\times 500$.
- Figures 10, 11 *Gavelinella* sp. A (transitional to *G. intermedia* Berthelin); 392A-2-3, 104-106 cm; *Ticinella breggiensis* Zone. $\times 100$.
- Figure 12 *Gavelinella* sp. A (spiral view); 392A-2-3, 104-106 cm; *Ticinella breggiensis* Zone. $\times 100$.
- Figures 13, 14 *Lingulogavelinella ciryi* Malapris-Bizouard; 392A-2-2, 146-148 cm; *Ticinella breggiensis* Zone. $\times 115$.
- Figure 15 *Lingulogavelinella ciryi* Malapris-Bizouard (note crenulate sutures and vague umbilical flaps); 392A-2-2, 146-148 cm; *Ticinella breggiensis* Zone. $\times 150$.
- Figures 16, 17 *Lingulogavelinella ciryi* Malapris-Bizouard; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 115$.

PLATE 5



PLATE 6

Gavelinellids at Sites 390, 392

- Figures 1, 2 *Gavelinella intermedia* (Berthelin)-*Gavelinella ammonoides* (Reuss); 390-3, CC; *Ticinella primula* Zone. $\times 120$.
- Figure 3 *Gavelinella intermedia* (Berthelin)-*Gavelinella ammonoides* (Reuss); 392A-3, CC; (?*Schackoia cabri*-) *Globigerinelloides algerianus* Zone. $\times 130$.
- Figure 4 *Gavelinella intermedia* (Berthelin)-*Gavelinella ammonoides* (Reuss); 392A-3, CC; (?*Schackoia cabri*-) *Globigerinelloides algerianus* Zone. $\times 150$.
- Figures 5, 6 *Gavelinella intermedia* (Berthelin); 390-5-1, 87-89 cm; *Globigerinelloides algerianus* Zone. $\times 90$.
- Figure 7 *Gavelinella intermedia* (Berthelin); 390A-14, CC; *Ticinella primula* Zone. $\times 135$.
- Figure 8 *Gavelinella intermedia* (Berthelin); 390A-14-5, 119-121 cm; *Ticinella primula* Zone. $\times 112$.
- Figures 9, 10 *Gavelinella intermedia* (Berthelin); 392A-3, CC; (?*Schackoia cabri*-) *Globigerinelloides algerianus* Zone. $\times 135$.
- Figures 11, 12 *Gavelinella intermedia* (Berthelin); 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 75$.
- Figure 13 *Gavelinella intermedia* (Berthelin); 390-5-1, 87-89 cm; *Globigerinelloides algerianus* Zone. $\times 110$.
- Figure 14 *Gavelinella barremiana* (Bettenstaedt) (Note the flap on the last chamber reaching over the umbilicus.); 392A-4, CC; *Gavelinella barremiana*-*Lenticulina* (*M.*) *sigali* Zone. $\times 235$.
- Figure 15 *Gavelinella barremiana* (Bettenstaedt) (spiral view); 390-5, CC; *Globigerinelloides blowi* Zone. $\times 260$.
- Figures 16, 17 *Gavelinella barremiana* (Bettenstaedt); 390-5, CC; *Globigerinelloides blowi* Zone. $\times 260$.

PLATE 6

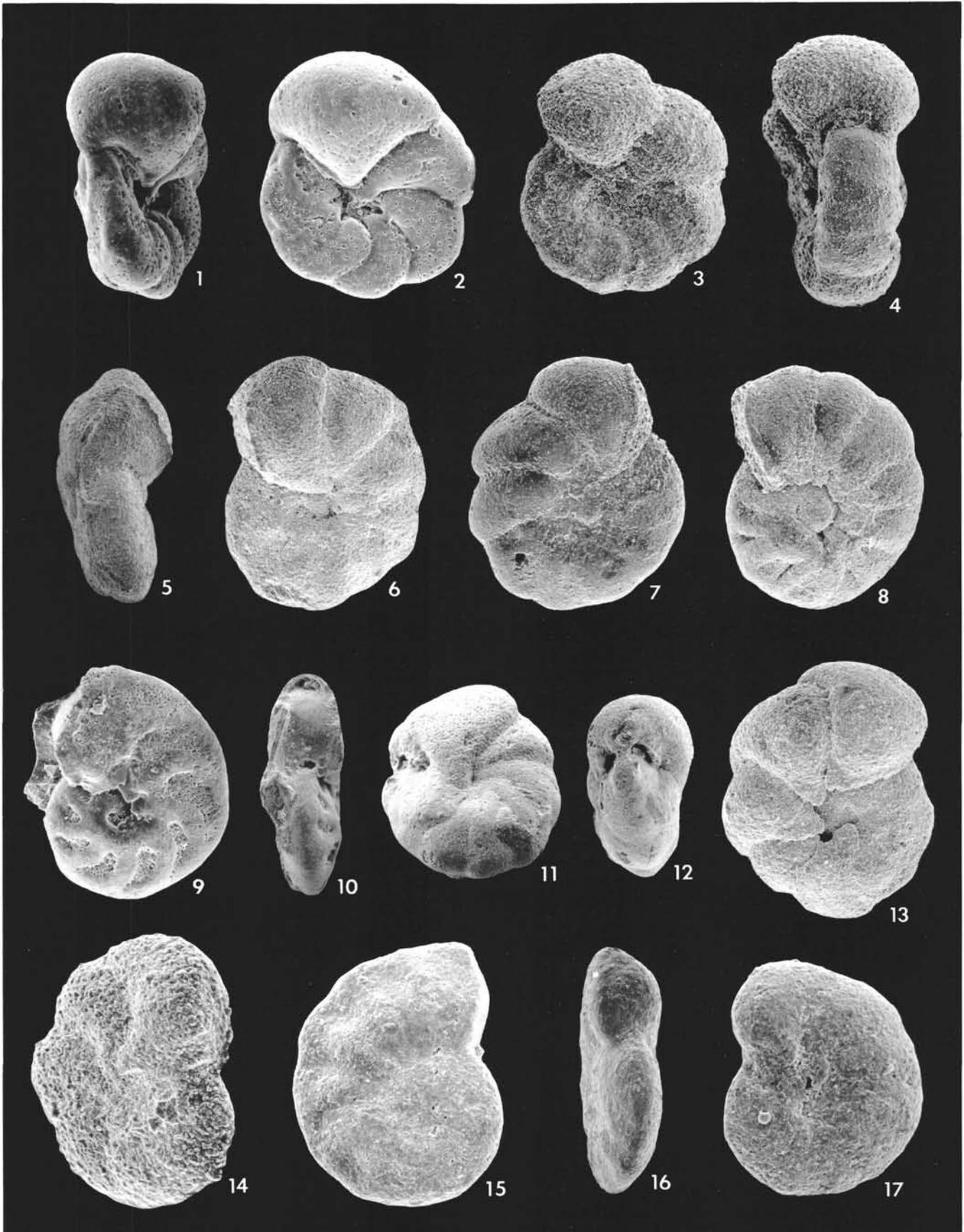


PLATE 7
Sites 390, 392

- Figures 1, 2 *Osangularia insigna* Dailey; 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 125$.
- Figure 3 *Osangularia insigna* Dailey; 392A-2-3, 104-106 cm; *Ticinella breggiensis* Zone. $\times 195$.
- Figure 4 *Osangularia insigna* Dailey; 392A-2-3, 104-106 cm; *Ticinella breggiensis* Zone. $\times 130$.
- Figures 5, 6 *Osangularia utaturensis* (Sastri and Sastry); 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 100$.
- Figures 7, 8 *Osangularia utaturensis* (Sastri and Sastry); 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 90$.
- Figure 9 *Osangularia utaturensis* (Sastri and Sastry); 390-4-2, 75-77 cm; *Ticinella primula* Zone. $\times 100$.
- Figures 10, 11 *Osangularia utaturensis* (Sastri and Sastry); 390-4-2, 75-77 cm; *Ticinella primula* Zone. $\times 112$.
- Figure 12 *Osangularia utaturensis* (Sastri and Sastry); 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 112$.
- Figure 13 *Gavelinella intermedia* (Berthelin); 390A-14-5, 119-121 cm; *Ticinella primula* Zone. $\times 110$.
- Figure 14 *Gavelinella* sp. C; 392A-3-1, 46-48 cm; *Ticinella primula* Zone. $\times 92$.
- Figures 15, 16 *Gavelinella* sp. C; 392A-3-1, 46-48 cm; *Ticinella primula* Zone. $\times 92$.

PLATE 7

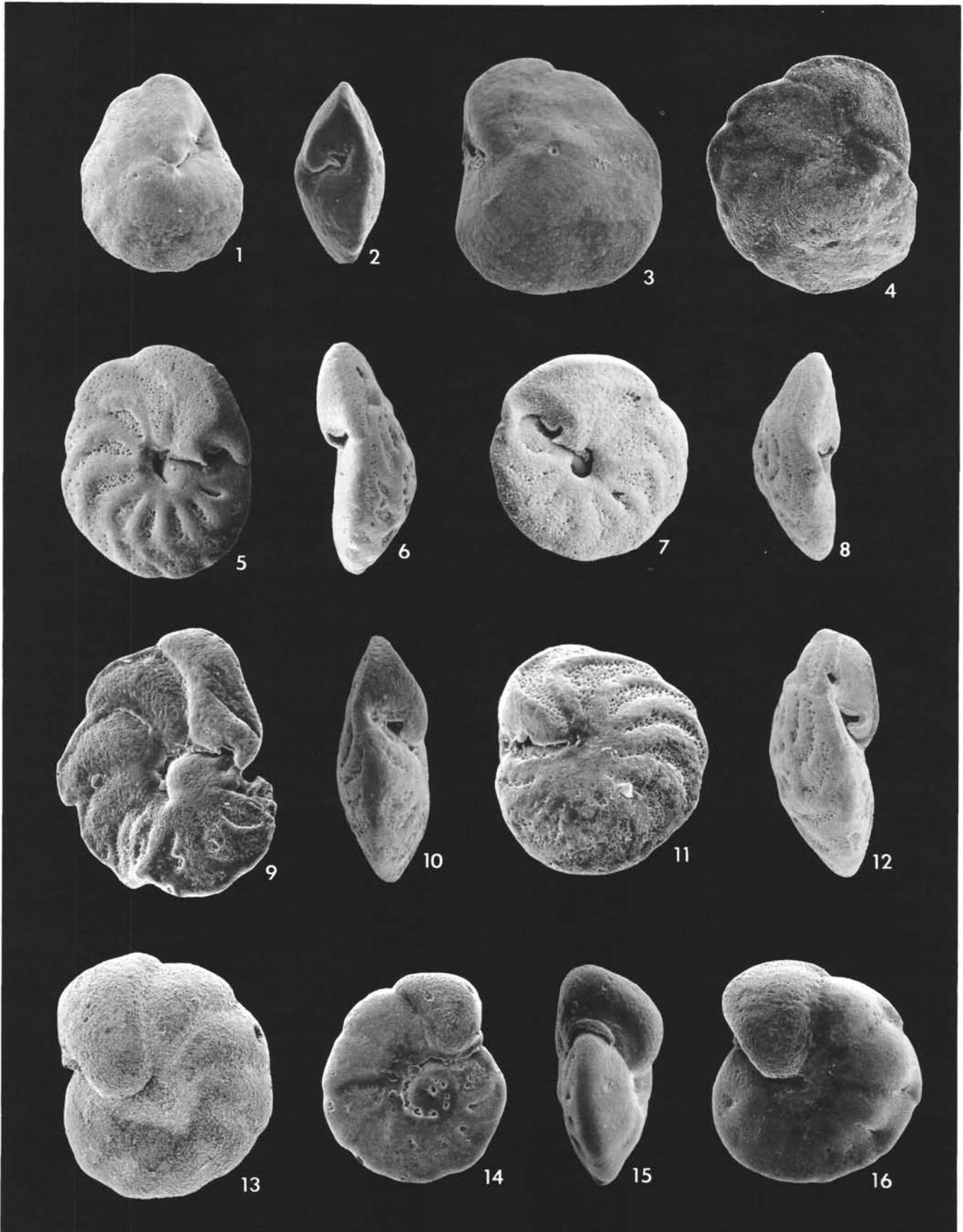


PLATE 8
Sites 390, 392

- Figure 1 *Epistomina* ex. gr. *spinulifera* (Reuss); 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 67$.
- Figure 2 *Epistomina* ex. gr. *spinulifera* (Reuss); 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 27$.
- Figure 3 *Epistomina cretosa* Ten Dam (spiral view); 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 95$.
- Figure 4 *Epistomina cretosa* Ten Dam (umbilical view); 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 95$.
- Figure 5 *Epistomina chapmani* Ten Dam; 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 85$.
- Figure 6 *Ceratolamarckina* sp.; 392A-3-1, 46-48 cm; *Ticinella primula* Zone. $\times 160$.
- Figure 7 *Reinholdella ultima* Dailey (umbilical view); 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 87$.
- Figure 8 *Reinholdella ultima* Dailey (spiral view); 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 87$.
- Figures 9, 10 *Gyroidinoides primitiva* Hofker; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 150$.
- Figure 11 *Valvulineria gracillima* Ten Dam; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 140$.
- Figure 12 *Valvulineria gracillima* Ten Dam; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 200$.
- Figure 13 *Conorotalites aptiensis* (Bettenstaedt); 392A-4-1, 110-112 cm; *G. barremiana-L. sigali* Zone. $\times 115$.
- Figures 14, 15 *Conorotalites aptiensis* (Bettenstaedt); 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 160$.
- Figures 16, 17 *Conorotalites aptiensis* (Bettenstaedt); 392A-4-1, 110-112 cm; *G. barremiana-L. sigali* Zone. $\times 200$.

PLATE 8



PLATE 9
Sites 390, 392

- Figure 1 *Globigerinelloides ferreolensis* (Moullade); 390-5-1, 87-89 cm; *G. algerianus* Zone. $\times 195$.
- Figure 2 *Globigerinelloides ferreolensis* (Moullade); 390-5-1, 87-89 cm; *G. algerianus* Zone. $\times 195$.
- Figures 3, 4 Detail of wall of *G. ferreolensis* (Moullade) in Plate 10, Figure 15, showing coating of test with carbonate particles, including nannoconid (enlarged in Figure 4) and other nannofossils. Respectively, $\times 500$ and $\times 2250$.
- Figure 5 *Globigerinelloides blowi* (Bolli); 390-5, CC; *G. blowi* Zone. $\times 375$.
- Figure 6 *Globigerinelloides blowi* (Bolli); 390-5, CC; *G. blowi* Zone. $\times 275$.
- Figure 7 *Globigerinelloides blowi* (Bolli); 390-5, CC; *G. blowi* Zone. $\times 250$.
- Figure 8 *Globigerinelloides blowi* (Bolli); 390-5, CC; *G. blowi* Zone. $\times 250$.
- Figures 9, 10 "*Globigerina*" *hoterivica* Subbotina; 390-6-1; *Gavelinella barremiana-Lenticulina* (M.) *sigali* Zone. Respectively, $\times 155$ and $\times 135$.
- Figures 11, 12 "*Globigerina*" *hoterivica* Subbotina; 390-6, CC; *Gavelinella barremiana-Lenticulina* (M.) *sigali* Zone. $\times 175$.
- Figure 13 "*Globigerina*" *hoterivica* Subbotina; 390-6, CC; *Gavelinella barremiana-Lenticulina* (M.) *sigali* Zone. $\times 175$.
- Figure 14 "*Globigerina*" *hoterivica* Subbotina; 390-6, CC; *Gavelinella barremiana-Lenticulina* (M.) *sigali* Zone. $\times 175$.
- Figure 15 "*Globigerina*" *hoterivica* Subbotina; 390-6, CC; *Gavelinella barremiana-Lenticulina* (M.) *sigali* Zone. $\times 175$.
- Figure 16 *Praeulimina nannina* (Tappan); 390-5, CC; *Globigerinelloides blowi* Zone. $\times 375$.
- Figure 17 *Praeulimina nannina* (Tappan); 390-5, CC; *Globigerinelloides blowi* Zone. $\times 375$.

PLATE 9

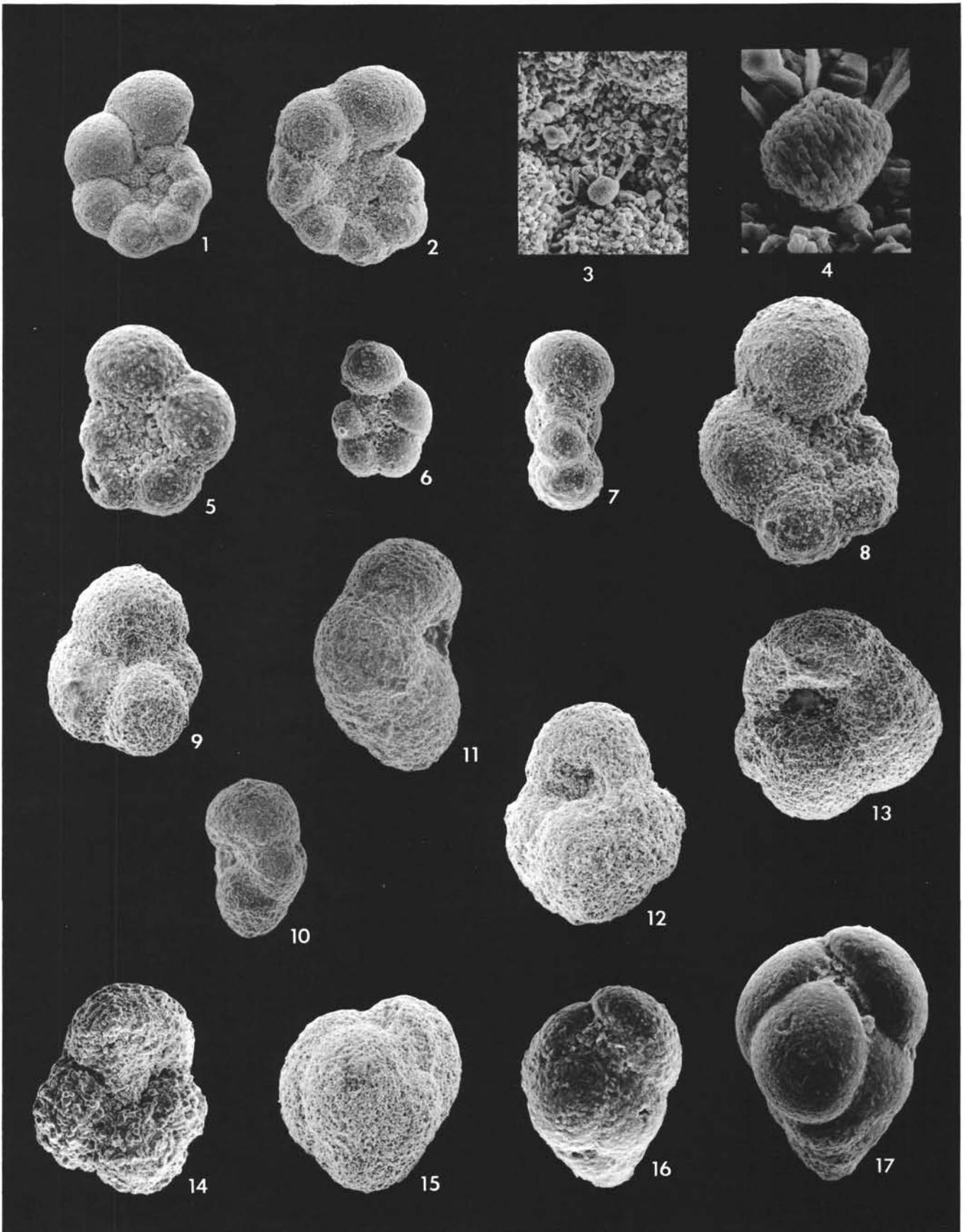


PLATE 10
Sites 390, 392

- Figure 1 *Hedbergella delrioensis* (Carsey); 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 250$.
- Figure 2 *Hedbergella delrioensis* (Carsey); 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 250$.
- Figure 3 *Leupoldina pustulans* (Bolli); 392A-3, CC; (?*Schackoina cabri*-) *Globigerinelloides algerianus* Zone. $\times 120$.
- Figure 4 *Globigerinelloides* aff. *saundersi* (Bolli); 392A-3, CC; (?*Schackoina cabri*-) *Globigerinelloides algerianus* Zone. $\times 120$.
- Figure 5 *Hedbergella trocoidea* (Gandolfi); 390-5-1, 87-89 cm; *Globigerinelloides algerianus* Zone. $\times 75$.
- Figure 6 *Hedbergella trocoidea* (Gandolfi); 390-5-1, 87-89 cm; *Globigerinelloides algerianus* Zone. $\times 75$.
- Figure 7 *Hedbergella* aff. *trocoidea* (Gandolfi); 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 150$.
- Figure 8 *Hedbergella* aff. *trocoidea* (Gandolfi); 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 150$.
- Figures 9, 10 *Globigerinelloides algerianus* Cushman and Ten Dam; 390-5-1, 87-89 cm; *G. algerianus* Zone. $\times 80$.
- Figure 11 *Globigerinelloides algerianus* Cushman and Ten Dam; 390-5-1, 87-89 cm; *G. algerianus* Zone. $\times 80$.
- Figures 12, 13 *Globigerinelloides algerianus* Cushman and Ten Dam; 390-5-1, 87-89 cm; *G. algerianus* Zone. $\times 80$.
- Figure 14 *Globigerinelloides ferreolensis* (Moullade); 390-5-1, 87-89 cm; *G. algerianus* Zone. $\times 155$.
- Figure 15 *Globigerinelloides ferreolensis* (Moullade); 390-5-1, 87-89 cm; *G. algerianus* Zone. $\times 155$.
- Figure 16 *Globigerinelloides ferreolensis* (Moullade); 390-5-1, 87-89 cm; *G. algerianus* Zone. $\times 155$.
- Figure 17 *Globigerinelloides ferreolensis* (Moullade); 390-5-1, 87-89 cm; *G. algerianus* Zone. $\times 155$.

PLATE 10

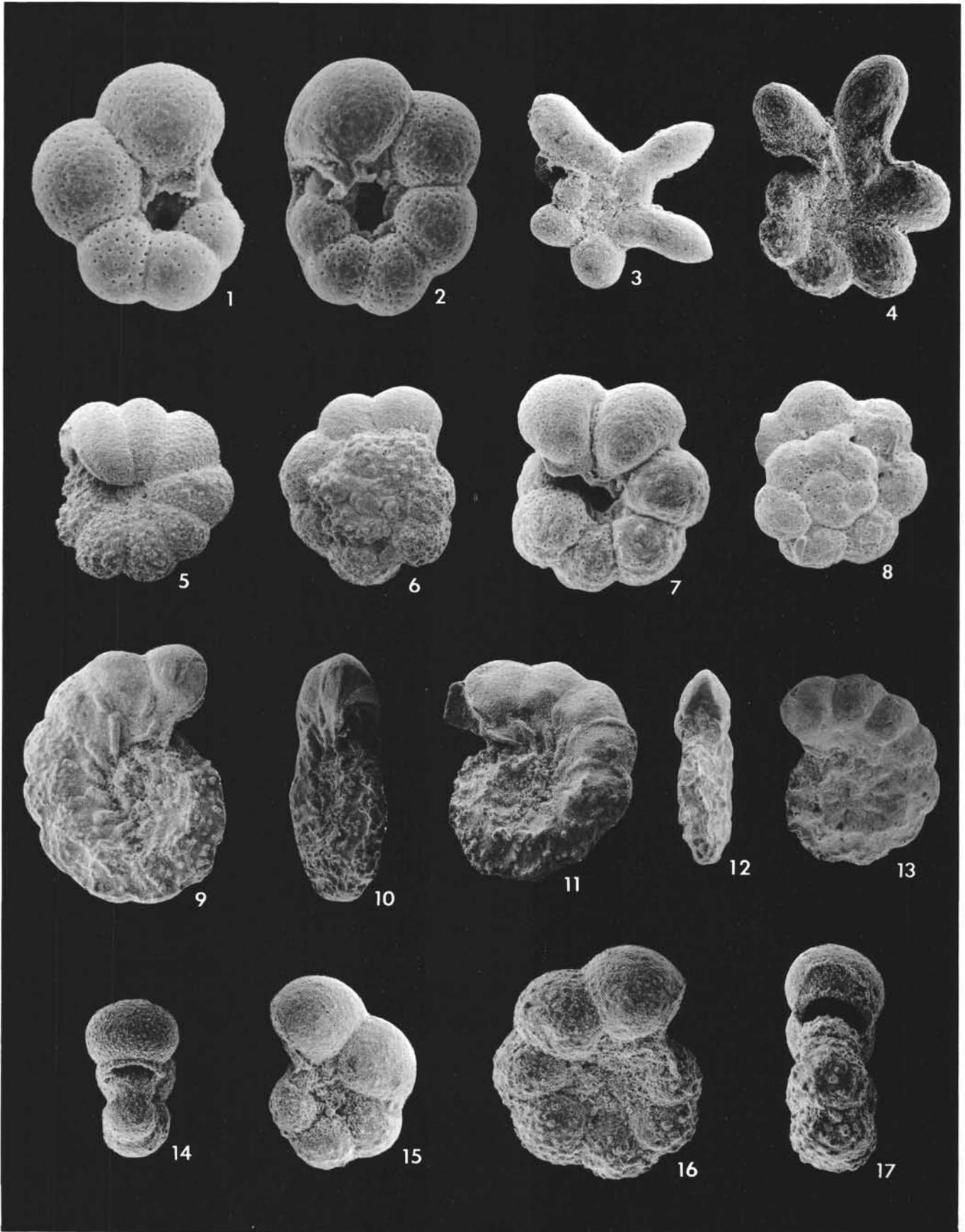


PLATE 11
Sites 390, 392

- Figure 1 *Ticinella breggiensis* (Gandolfi); 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 125$.
- Figure 2 Specimen transitional between *Ticinella primula* Luterbacher and *Ticinella breggiensis* (Gandolfi); 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 125$.
- Figure 3 *Ticinella primula* Luterbacher; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 200$.
- Figure 4 *Ticinella primula* Luterbacher; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 150$.
- Figures 5, 6 *Ticinella primula* Luterbacher; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 150$.
- Figures 7, 8 *Ticinella primula* Luterbacher; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 135$.
- Figures 9, 10 *Ticinella primula* Luterbacher; 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 135$.
- Figure 11 *Hedbergella amabilis* Loeblich and Tappan; 392A-2-1, 84-86; *Ticinella breggiensis* Zone. $\times 135$.
- Figure 12 *Hedbergella amabilis* Loeblich and Tappan; 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 135$.
- Figure 13 *Hedbergella amabilis* Loeblich and Tappan; 392A-2-1, 84-86 cm; *Ticinella breggiensis* Zone. $\times 135$.
- Figures 14, 15 *Hedbergella planispira* (Tappan); 390-3-3, 80-82 cm; *Ticinella primula* Zone. $\times 325$.
- Figure 16 *Hedbergella planispira* (Tappan); 392A-2-2, 146-148 cm; *Ticinella breggiensis* Zone. $\times 230$.

PLATE 11

