10. CRETACEOUS FORAMINIFERS OF HOLE 530A, LEG 75, DEEP SEA DRILLING PROJECT

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ABSTRACT

Hole 530A of Leg 75 is located in the southeastern corner of the Angola Basin of the South Atlantic (19° 11.26' S; 9° 23.15' E), on the abyssal seafloor (4629 m depth), close to the Walvis Ridge and near to its junction with the continental margin. The hole penetrated 503 m of Cretaceous (Maastrichtian to Albian) and bottomed in basalt at 1121 m. No other hole of Leg 75 was drilled below the Neogene.

Most of the 10-cm^3 samples from Hole 530A were barren of foraminifers. Most of the foraminiferal populations recovered were barren of planktonic specimens. Consequently, no correlation with established planktonic biozones was possible, and correlation with European stages was limited to Maastrichtian–Campanian, Santonian–Coniacian, ?lower Turonian, and Albian.

Most of the benthic species were interpreted to be displaced—not reworked nor redrilled cavings. Recognition of the displaced faunas helped in recognizing indigenous benthic faunas and in interpreting their paleodepth and provincial implications. Displaced faunas have temporal and paleogeographical value but not paleobathymetric value.

The principal event of the sedimentary record is a medial Cretaceous lacuna, which includes most of the Turonian–Coniacian, ?lower Turonian, and Albian. Most of the 10-cm^3 samples from Hole 530A were barren of foraminifers. Most of the foraminiferal populations resembled those of other paleoabyssal sites of the South Atlantic and Indian oceans and belong to the Austral Bioprovince. Latitudinal and provincial properties seem to diminish with depth, and the Albian indigenous benthic fauna is cosmopolitan. It is quite different from the Albian planktonic fauna of Hole 530A, which is definitely midlatitudinal and Austral, and from the Albian fauna reported from nearby Sites 363 and 364.

The principal event of the sedimentary record is a medial Cretaceous lacuna, which includes most of the Turonian and Cenomanian and some of the Albian. Such a lacuna is widespread in DSDP sites of the southern hemisphere. Possible hiatuses occur at the base of the Maastrichtian–Campanian and at the base of the Santonian–Coniacian intervals.

INTRODUCTION

Site 530 is located in the southeastern corner of the Angola Basin of the South Atlantic Ocean (19° 11.26' S; 9° 23.15' E), on the abyssal seafloor (4629 m depth), close to the base of the Walvis Ridge and near to its junction with the continental margin (Fig. 1). After one core was taken, the first hole was abandoned because of a mechanical problem. The second hole, Hole 530A, terminated in basalt at 1121 m sub-bottom. Hole 530A penetrated 503 m of Cretaceous, which was divided into four lithologic units (Fig. 2).

The recovery of foraminifers from Cretaceous samples (10 cm^3 volume) of Hole 530A was poor. About 75% of all washed residues yielded few or no specimens. Of the residues with 1% or more foraminiferous specimens, about 75% were totally or dominantly benthic forms, except those approximately from the horizons of Cores 79, 88, and 94. About 75% of the total benthic fauna of a faunule or of a chronostratigraphic interval is not recurrent. In other words, most benthic species occur in one or two samples only. Moreover, they are typically represented by only a few specimens in the sample of occurrence. Such species were considered to be displaced and were excluded from the recurrent and presumably indigenous benthic faunas. They are not included in the faunal lists of the chronostratigraphic intervals discussed below, but are presented separately in Table 1.

In addition to the sparsity of all species and the persistent recurrence of so few species, foraminiferal populations are characterized by conspicuously poor preservation, because of dissolution, abrasion, and distortion. Consequently, it has been impossible to obtain satisfactory photomicrographs, although numerous attempts were made. Camera lucida drawings have been made to supplement photomicrographs of the more important benthic species, but photographic documentation of the dissolved and fragmentary planktonic and displaced benthic species, and of the fragmentary and distorted, quartzose, agglutinated species are not included in this chapter.

Because of the rarity of planktonic species in samples other than those from Cores 79, 88, and 94, established foraminiferal planktonic biozones could not be recognized (Table 2). The chronostratigraphic intervals employed (Fig. 2), namely, Maastrichtian–Campanian, Santonian–Coniacian, ?lower Turonian, and Albian, are based upon both the few, rare, and erratic planktonic species and a small number of long-ranging recurrent benthic species (Tables 3, 4). As a result, the boundaries of intervals are questionable, and their differences from...
those based on nannofossils, as reported elsewhere in this volume, are also questionable.

**MAESTRICHITAN—CAMPANIAN**

This interval extends from Core 50, Section 2, 10–14 cm through Core 80.

Neither the Tertiary/Cretaceous nor the Campanian/Santonian boundary is well documented by foraminifers. Globotrunccanids occur above Sample 50-2, 10–14 cm, and Tertiary planktonic species occur as low as Core 62. Presumably the latter are cavings, although Tertiary specimens are common in residues as low as Core 57. The apparent sharpness of the base of this interval is questionable because of the lack of satisfactory samples immediately below the boundary. The correlation is based for the most part on very poorly preserved, rare, and infrequent globotrunccanids and a restricted, also poorly preserved, but relatively persistent Paleogene to Campanian benthic assemblage.

In the interval from Core 50-2, 10–14 cm to Core 61 (lithologic Units 5a and 5b), one or two broken and eroded specimens of *Abathomphalus mayaroensis* Bolli, *Globotruncana gagnebini* Tlev, *G. contusa* (Cushman), *G. fornicata* Plummer, *G. arca* Cushman, *Pseudoumbelina palpebra* Brönnimann and Brown, *Pseudotextularia diffossis* (Kikoine), and *Rugoglobigerina* sp. were found in residues of four samples. In the interval of Core 61 to Core 71 (Unit 5c), *Globotruncana fornicata*, *G. linneiana* (d’Orbigny), and *Rugoglobigerina* sp. occur with similar rarity. The volcanogenic interval of Core 71 to Core 75 (Unit 6) yielded no planktonic foraminifers, but the interval from Core 76 through Core 80 (upper Unit 7) provided more planktonic species than any other interval of the hole.

The planktonic fauna of Cores 76 through 80 is distinguished by simple and early globotruncanids, such as *G. arca*, *G. fornicata*, *G. linneiana*, and *G. ventricosa* White, by terminal marginotruncanids, including *Marginotruncana* (Dicarinella) asymetrica (Sigal) and *M. sinuosa* Porthault, by *Planoglobulina glabretta* (Cushman), and by rare, infrequent, other species, including *Globigerinellidoides asperus* (Ehrenberg). Reworked specimens of *Hedbergella planispina* (Tappan), *Praeglobotruncana stephani* (Gandolfi), *P. delrioensis* (Plummer), and *Rotalipora apeninnica* (Renz) are common, especially in Core 79. Despite its deficiencies of preservation and diversity, the assemblage is indicative of the lower Campanian and provides this interval with the best correlation in the hole.


**SANTONIAN—CONIACIAN**

The upper part of this interval (Cores 81 through 86) is composed of red and green claystones and vari-colored turbiditic siltstones and sandstones, which appear to be a continuation of and are included in lithologic
Unit 7. However, their foraminiferal content differs from that of the upper part of Unit 7 (Cores 76 through 80). First, the red and green claystones yield a sparse fauna of agglutinated benthic species like those that were reported by Krasheninnikov (1973, 1974) from similar lithology. Second, planktonic specimens are rare, except for one sample from Core 86, Section 3, 47-49 cm, at the bottom of Unit 7, where they are poorly preserved and may be displaced. Third, the benthic fauna changes from upper to lower Senonian forms.
Table 1. Displaced benthic species, Hole 53OA.

Maestrichtian–Campanian

- Allomorphina cretacea Reuss
- Bandyeilla beckeri (Proto Decima and Bolli)
- Bolivina watersi Cushman
- Bulimina reussi Morrow
- Bulimina tripilinensis Cushman and Jarvis
- Buliminaella carseya Plummer
- Charlonella spp.
- Clavulinoides disjuncta (Cushman)
- Clavulinoides trilatera (Cushman)
- Conoribiza spp.
- Conorbinae haidergeri (d’Orbigny)
- Coryphostoma incrustata (Reuss)
- Dorothea retusa (Cushman)
- Ellipsodinodina subtilis Liebus
- Ellipsocollina divergens Storm
- Ellipsopodina velascoensis (Cushman)
- Fissurina sp.
- Foriuniculina striatula Reuss
- Gavelinella cystica mangshlakensis (Vassilenko)
- Globorotalia miceliiniana (d’Orbigny)
- Globorotalia lacrims Cushman
- Globorotalia prsca Reuss
- Marssonella crassa (Marsan)?
- Neoflabellina sp. aff. N. numismalis (Wedekind) Beekmann
- Osangularia velascoensis (Cushman)
- Pleurostomella spp.
- Pseudoclavulina amorph (Cushman)
- Pseudonodosaria manifesta (Reuss)
- Pullenia americana Cushman
- Pullenia cretacea Cushman
- Pullenia puentepiedraensis Galloway and Morrey
- Quadrimorphina velascoensis (Cushman)
- Spiroplectaminna grzybowski Frizzell
- Sternotheca pomerana Broten
- Valvulineria americana (Carsey)?

Santonian–Coniacian

- Allomorphina cretacea Reuss
- Bandyeilla greatvalleysensis (Truillio)
- Dentalina cylindroides Reuss
- Dentalina gracilis d’Orbigny
- Conoribiza cretacea (Franke)?
- Conorbina spp.
- Ellipsodinodina spp.
- Globorotalia lacrims Reuss
- Lagena spp.
- Marginulina spp.
- Nodosarella gracilina Cushman?
- Pseudoclavulina sp.
- Pseudonodosaria manifesta (Reuss)
- Pseudonodosaria mutabilis (Reuss)
- Pullenia cretacea Cushman
- Sternotheca spp.

?lower Turonian

- Dentalina catenula Reuss?
- Dentalina communis d’Orbigny
- Dentalina gracilis d’Orbigny
- Dentalina spp.
- Gyroidina spp.
- Lenticulina circinacea (Berthelin)
- Lenticulina excentrica (Cornuel)?
- Lenticulina macrolithica (Reuss)?
- Lenticulina sternalis (Berthelin)?
- Marginulina calliopsis Reuss?
- Marginulina spp.
- Nodosaria aspera Reuss
- Pleurostomella subnodosa Reuss?

Table 1. (Continued.)

?lower Turonian (Continued.)

- Pseudonodosaria humilis (Reuss)
- Praebuliminina spp.
- Quadrinodina allomorphinoides (Reuss)
- Spiroplectina bettenstaedti Grabert
- Valvulineria spp.

Albian

- Conoribiza broteni Gandolfi
- Dentalina communis Reuss
- Dentalina oligostega Reuss?
- Dentalina soluta Reuss?
- Dentalina spp.
- Gaudryina dividens Grabert
- Globorotalia fornicata (Berthelin)?
- Lagena cidaria Gryzbowski
- Lagena spp.
- Lenticulina circinacea (Berthelin)
- Lenticulina grata Bartenstein, Bettenstaedt, and Bolli
- Lenticulina macrodiscus Reuss
- Lenticulina spp.
- Lenticulina sternalis (Berthelin)
- Marginulina calicopris (Reuss)?
- Marginulina incurvata (Reuss)?
- Marginulina spp.
- Marginulina trunculata (Berthelin)
- Marssonella oxycon (Reuss)
- Nodosaria aspera Reuss
- Nodosaria concinna Reuss
- Nodosaria spp.
- Planularia complanata (Reuss)?
- Pleurostomella subnodosa Reuss?
- Pseudonodosaria humilis (Reuss)
- Pseudonodosaria obtusissima (Reuss)
- Pseudonodosaria pottaf (Marsan)?
- Pseudonodosaria pygmea (Reuss)
- Pseudonodosaria spp.
- Pyrula cirrhosa (Cushman)
- Ramulina aptiensis Bartenstein and Brand
- Saracenaria sp.
- Tribrachia australis Ludbrook?

The lower part of this interval (Cores 87 through 92) is marked by the presence of black shales among the variegated clastics mentioned above. The lithofacies distinguishes Unit 8, which continues to the bottom of the sedimentary section of Hole 530A. Planktonic specimens are common in black shale samples from Core 88, Section 3, 120–122 cm and Core 92, CC but are absent or very rare in other lithofacies. Benthos of an agglutinated fauna were recovered from the red and green claystones, and other benthos are abundant in some residues from light gray turbiditic thin beds.

Whether rare or common, planktonic populations are dominated by Marginotruncana pseudolimneiana Pessagno and M. sinuosa Porthault. The form of the latter species (Robaszynski and Caron, 1979, pl. 74, figs. 2a–c) which is similar to Globotruncana fornicata Plummer (1931, pl. 13, figs. 5a–c) is relatively prominent. Dicarinella concava (Brotzen) and related D. hagni (Scheibenerova), D. primitiva (Dalbiez), and D. sp. are prominent in Core 88, Section 3, 120–122 cm. In frequent, rare, and poorly preserved specimens of M. coronata (Bolli), M. renzi (Gandolfi), and M. marginata (Reuss) are present. Hedbergella flandrina Porthault is
Table 2. Distribution of recurrent planktonic species from Cores 75–105, Hole 53OA, Leg 75.

<table>
<thead>
<tr>
<th>Species</th>
<th>Albian</th>
<th>Turonian</th>
<th>Coniacian-Santonian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hedbergella infracretacea</td>
<td>C</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Hedbergella planispira</td>
<td>R</td>
<td>R</td>
<td>C</td>
</tr>
<tr>
<td>Hedbergella simplex</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Hedbergella delrioensis</td>
<td>F</td>
<td>F</td>
<td>?</td>
</tr>
<tr>
<td>Dicarinella canalicularia?</td>
<td>C</td>
<td>R</td>
<td>?</td>
</tr>
<tr>
<td>Dicarinella imbriata</td>
<td>R</td>
<td>C</td>
<td>R</td>
</tr>
<tr>
<td>Dicarinella concavata</td>
<td>?</td>
<td>C</td>
<td>R</td>
</tr>
<tr>
<td>Hedbergella flandrini</td>
<td>R</td>
<td>F</td>
<td>R</td>
</tr>
<tr>
<td>Marginotruncana corona?</td>
<td>F</td>
<td>R</td>
<td>?</td>
</tr>
<tr>
<td>Marginotruncana pseudolinneiana</td>
<td>C</td>
<td>C</td>
<td>R</td>
</tr>
<tr>
<td>Marginotruncana striata</td>
<td>R</td>
<td>R</td>
<td>A</td>
</tr>
<tr>
<td>Schadobina cenomana bicornis</td>
<td>F</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>Globotruncana fornicata</td>
<td>C</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Dicarinella asymmetrica</td>
<td>R</td>
<td>A</td>
<td>R</td>
</tr>
<tr>
<td>Globotruncana area</td>
<td>C</td>
<td>R</td>
<td>F</td>
</tr>
<tr>
<td>Globotruncana elevata</td>
<td>F</td>
<td>F</td>
<td>C</td>
</tr>
<tr>
<td>Globotruncana lineatissima</td>
<td>C</td>
<td>C</td>
<td>F</td>
</tr>
<tr>
<td>Globotruncana stuartiformis</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Globotruncana ventricosa</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Planopectinella gibbosa</td>
<td>R</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

a. Planktonic occurrences above Core 75 are too infrequent to justify plotting.

Table 3. Distribution of recurrent planktonic species from Cores 81–105, Coniacian-Santonian to Albian, Hole 53OA, Leg 75.

<table>
<thead>
<tr>
<th>Species</th>
<th>Albian</th>
<th>Turonian</th>
<th>Coniacian-Santonian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammosphera sphaeroides sp.</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Arenobulimina sp.</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Dorothia gradata?</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Gavelinella berthelini</td>
<td>F</td>
<td>G</td>
<td>F</td>
</tr>
<tr>
<td>Gyroidina mauretanica</td>
<td>F</td>
<td>F</td>
<td>R</td>
</tr>
<tr>
<td>Lingulogavelinella sp.</td>
<td>F</td>
<td>F</td>
<td>R</td>
</tr>
<tr>
<td>Pleurostomella obtusa</td>
<td>F</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Pseudocalvinia gauldiana carinata</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Textularia sp.</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Valvulinae sp.</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>'Conorbina newtoni</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Dorothia filiformis?</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Gavelinella umbonella</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Gyroidina quadrata</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Spirolectammina chicoana</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Aragonia matena kugleri</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Conorbina sp.</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Gaudryina pulvina</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Nutallinella? sp.</td>
<td>C</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Osangularia popenoei</td>
<td>?</td>
<td>R</td>
<td>F</td>
</tr>
</tbody>
</table>

Table 4. Distribution of recurrent benthic species from the Campanian and Maastrichtian, Hole 53OA.

<table>
<thead>
<tr>
<th>Species</th>
<th>Campanian-Maastrichtian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aragonia ougantensis</td>
<td>R</td>
</tr>
<tr>
<td>Charletonia spp.</td>
<td>R</td>
</tr>
<tr>
<td>Dorothia trochoidea</td>
<td>R</td>
</tr>
<tr>
<td>Gyroidina diversa</td>
<td>F</td>
</tr>
<tr>
<td>Lenticulina munsteri</td>
<td>?</td>
</tr>
<tr>
<td>Nutallid? sp.</td>
<td>R</td>
</tr>
<tr>
<td>Nutallid? trochuza?</td>
<td>?</td>
</tr>
<tr>
<td>Nutallinella? floresl</td>
<td>?</td>
</tr>
<tr>
<td>Nutallinella? spinosa</td>
<td>R</td>
</tr>
<tr>
<td>Nummulites corradi</td>
<td>R</td>
</tr>
<tr>
<td>Roswellia magnocerata</td>
<td>R</td>
</tr>
<tr>
<td>Spirolectammina dentata</td>
<td>R</td>
</tr>
<tr>
<td>Valvulinae? whitei</td>
<td>R</td>
</tr>
</tbody>
</table>

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uncommon but persistent. Typically nodose to costellate globigeriniform specimens are common and may represent a variety of taxa, but the umbilical properties and apertural characters are poorly preserved; consequently, these are presented below as *Hedbergella* ssp.


Benthic species from other lithofacies are more advanced agglutinated or hyaline forms. Only the following species are persistent in the Santonian-Coniacian interval: *Aragonina materna kugleri* Beckmann and Koch, *Gaudryina pulvina* Belford, *Conorboides* sp., *Nuttallinella?* sp. (Globorotalites conicus of authors), *Oasangaria popenoei* (Trujillo), and *Spiroplectammina chicoana* Lalicker. Infrequent and rare species are listed elsewhere.

The Santonian-Coniacian assignment is indicated by the marginotruncanids, particularly the *Dicarinella concavata*, by the sparse but persistent *Hedbergella flan- drini*, and by three of the rare but persistent benthics, namely *Aragonina materna kugleri*, *Oasangaria popenoei*, and *Spiroplectammina chicoana*.

?LOWER TURONIAN

The faunules of this interval, Cores 93 through 95, are marked by a mixing of upper and lower Cretaceous elements. Most of the plankton and some of the benthos are lower Turonian or younger, whereas most of the benthos and a few plankton are typical of, if not limited to, the Albian. In any case, the interval of only 30 m represents a long lacuna for most of the Turonian, the Cenomanian, and possibly some of the Albian.

The simple agglutinated species of the red and green claystones are not as frequent in residues from this interval as in the Santonian-Coniacian, possibly because my sampling concentrated on the turbidites and black shales.

Distorted bicarinate globotruncaniform and spinose, nodose, to partially costellate hedbergelliform planktonic taxa are common to abundant in some black shales but are rare in the red and green claystones. *Dicarinella canaliculata* (Reuss)?, *D. imbricata* (Mornod), *Marginotruncana pseudolinneiana* Pessagno, and *M. coronata* (Boll)? are prominent representatives of the globotruncaniforms. *Hedbergella delrioensis* (Carsey), *H. hoedli* (Scheibnerova)?, *H. planispira* (Tappan), and *H. simplex* (Morrow) are typical hedbergellids.

Most of the hedbergelliform specimens are poorly preserved, and additional species may be present, as well as representatives of other genera, such as *Whiteinella*, but they could not be identified with confidence and are not reported here. *Schackoina cenomana* (Schacko), including *S. cenomana bicornis* Reichel, is prominent in Cores 94 and 95.

The prominent or persistent benthic species include *Dorothy filiformis* (Berthelin)?, *Gavelinella berthelini* Keller?, *Gavelinella umbonella* (Reuss), *Gyroidina quad-rata* (Cushman and Church), *Coronina newtoni* Eicher and Worstell, *Pseudoclavulina gaultina carinata* Neagu, and *Spiroplectammina chicoana* Lalicker.

The apparent temporal contradictions among faunal elements of this interval could have resulted from re-drilling cavings, reworking, a very incomplete section, or some combination of these, and there is evidence for all of them. Some of the prominent, typically older species, such as *Gavelinella berthelini*, *Pseudogaudryina gaultina carinata*, and *Schackoina cenomana bicornis*, have been reported from younger rocks (Keller, 1935; Neagu, 1962; Porthault, 1974), and it is barely possible to accommodate these and the planktonic species of the interval within the lower Turonian; hence that assignment is employed here with question.

ALBIAN

The most persistent and frequent microfossils of this interval (Cores 96 through 105) are silica-filled radiolarian tests. They are most common in the greenish gray siltstones but occur in other lithofacies of the interval, including the black claystones. Where radiolarians are common, foraminifers are typically rare or absent. Inoceramid prisms are common to abundant in three of the eight fossiliferous samples.

A sparse, narrow fauna of primitive agglutinated foraminifers occurs in the red and green claystones of the interval. Most specimens are badly deformed, limiting identifications to *Ammodiscus cretaceus* (Reuss), *Bathyosphon* sp., *Glomospira charoides* (Jones and Park- er), *Haplophragmoides* sp., *Hyperammina* sp., *Labrospra* sp., *Litututuba* sp., *Plectorecurvoides* sp., *Prot- onina* sp., and *Rhabdammina* sp.

The most conspicuous taxa are relatively large and frequent, smoothly finished agglutinated forms, namely *Ammonsphearoniorina* sp., *Arenobulimina* sp., *Dorothy gradata* (Berthelin)?, and *Pseudoclavulina gaultina carinata* Neagu. Also persistent are *Gavelinella berthelini* (Keller) (G. intermedia group), *Gyroidina?* mauretanica Charbonnier, *Lingulogavelinella* sp. (L. albiensis group), *Pleurostomella obtusa* Berthelin, and *P. russell Berthelin*. At least two dozen species of typical lower Cretaceous nodosariids and polymorphinids are represented by one to three broken specimens in one or two occurrences, but they are evidently displaced forms and are not listed here.

Planktonic specimens are absent to rare in all but one sample (104-2, 49-52 cm), in which about 25% of the population is composed of size-graded small hedbergellids, including *Hedbergella infracretacea* (Glaessner), *H. libyca* Barr, *H. planispira* (Tappan), and *H. simplex* (Morrow).

DISPLACED FAUNAS

As mentioned in the introduction, most of the benthic species encountered are represented by rare specimens from one or two samples. They are typically
broken, worn, and etched. Species represented by such specimens were interpreted to have been transported from shallower sites in which they had lived as contemporaries of the indigenous species of Site 530. These displaced species are not to be confused with reworked species from exhumed older sediments and redeposited, nor with redrilled species derived from uphole cavings.

The displaced species are presented in groups in Tables 1 that correspond with the chronostratigraphic intervals, such as Maastrichtian–Campanian. Some of the species occur in more than one group, but most of them occur in one group only, indicating that displaced species can have some temporal significance.

On the other hand, the displaced species of a group show considerable variation in paleoeologic implications. Comparison of the Maastrichtian–Campanian displaced faunal list (Table 1) with generic works, such as Cushman, 1946, and von Morkhoven, 1981, shows that the fauna varies at least from neritic to bathyal, and I would say from middle neritic to middle bathyal. Moreover, the rarity of planktonic species in these samples and the broken, worn, and dissolved condition of the benthic tests combine to require greater paleodepths than the taxonomic composition of the fauna implies. In short, it appears that displaced faunas are not reliable paleodepth indicators.

DEPOSITIONAL ENVIRONMENT

The principal aspects of these foraminiferal populations are sparsity of specimens in the residues, rarity of planktonic specimens, low taxonomic diversity, and prevalence of etched, worn, and broken specimens.

Most of the 148 Cretaceous samples from Hole 530A did not yield foraminifers, and most of those that did so yielded only small numbers of specimens from the 10 cm³ samples. Such low frequency can occur in several foraminiferal habitats, but it is particularly characteristic of the very deep environments.

The relatively few fossiliferous residues were dominated by benthic forms, except for three short intervals centering around Cores 79, 88, and 94. There can be no question that Site 530 was well below the planktonic lysocline during most of the Maastrichtian–Albian and was close to that position during the short intervals of relatively abundant plankton. The position of the lysocline and the CCD vary with time in response to changes in oceanic chemistry; consequently, it might be argued that the planktonic rarity in Hole 530A is the result of an elevated lysocline. However, it could not have been elevated much, because the plankton are common in core-rov sites at nearby paleobathyal Sites 363 (see other interpretation, Scheinbein, 1978) and 364 of Leg 40. Generally the planktonic lysocline is associated with the base of the lower bathyal or deeper realms.

The three short intervals of relative planktonic abundance approximately at Cores 79, 88, and 94 might be interpreted as evidence of shallower seafloors, but there are reasons for doubt. First, the sediment is turbiditic, not truly pelagic. Second, the specimens, both planktonic and benthic, are etched, worn, and broken. Additionally, comments are presented in the Depositional Record below.

The total number of benthic species for an interval of Hole 530A, such as the Maastrichtian–Campanian, is too large for deep realms, such as lower bathyal or abyssal, but recognition of displaced faunas clarifies what the indigenous benthic faunas are, and their taxonomic diversity is very low for all of the Cretaceous encountered in Hole 530A. Like sparsity of numbers, low benthic taxonomic diversity alone is not proof of the deeper realms, but it is pronounced in them.

Most of the species of the indigenous benthic faunas of Hole 530A are well known. They have been reported from samples with abundant plankton or with other evidence of bathyal habitat (e.g., Gandolfi, 1942; von Morkhoven, 1981). However, their occurrence in Hole 530A is marked by the absence of accompanying abundant planktonic species, and that indicates that these indigenous benthic species lived below the planktonic lysocline as well as above it.

The dominance of etched, worn, and broken specimens occurs throughout the Cretaceous of Hole 530A. Its prevalence, even among the indigenous benthos, extends the paleobathymetric implications of the rare plankton to paleodepths very near to the CCD.

The primitive, quartzose, agglutinated faunas of the red and green claystones are strongly suggestive of a paleodepth below the CCD, for they include no calcareous species, not even calcareous agglutinated forms. This kind of fauna has been interpreted as abyssal by Krasheninnikov (1973, 1974) and Beckmann (1978), and as deep abyssal by Sliter (1977a, b). Red and green claystones were first encountered in the basal part of the Maastrichtian–Campanian interval (lithologic Unit 7, Core 75) and continued with increasing prominence to the base of the sedimentary succession. For this lower part of Hole 530A, varicolored claystone is the basic sediment, into which various turbidites were introduced, and upon which the black claystones were superimposed.

The combination of faunal characteristics listed above implies a depositional site well below the planktonic lysocline, below the benthic lysocline, and close to, if not below, the CCD. Such a location should be in the abyssal realm, which is taken here to mean 2500 m or more (see Sliter, 1977b, p. 667). The very similar upper Cretaceous fauna of Site 355 in the Brazil Basin has been reported as paleoabyssal at a paleodepth of 3000–4000 m (Sliter, 1977b, p. 657, 667). This conforms to the paleodepths proposed elsewhere in this volume.

The relative abundance and number of species of the displaced faunas increase from the base to the top of Cretaceous in Hole 530A. This is interpreted to be a result of increasing proximity to a prograding continental margin.

There is no evidence for the nature of the transporting mechanisms within the species or specific associations of the foraminifers, but the sedimentological properties of the cores are interpreted (Stow, this volume) as those of a submarine fan system, which appears to be an
ideal mechanism for production of characteristics of these faunas.

FAUNAL SIMILARITIES

The Cretaceous faunas of Hole 530A conform most closely to those of the Brazil and Argentine basins (Sliter, 1977b), are similar to the abyssal South Atlantic sites (Sliter, 1977a, p. 530, fig. 10), and are a part of the Austral Biogeographic province of the South Atlantic and Indian Oceans (Scheibnerová, 1973, 1974, 1978; Sliter, 1977a, b; Premoli Silva and Boersma, 1977; Beckmann, 1978).

Justification for the first assertion above is based primarily on similarity of faunas (see Sliter, 1977b, Sites 355 and 356), but it is also supported by differences between Site 530 and nearby paleobathyal Sites 363 and 364 of Leg 40 (Beckmann, 1978; Caron, 1978; Scheibnerová, 1978). The faunas of the Leg 40 sites include more plankton, more diverse plankton, and more diverse benthos. Thus Cretaceous faunas of Site 530 are more like other paleobathyal sites of the southern hemisphere than nearby sites of different paleobathymetry.

The evidence for relationship to the Austral Biogeographic province seems to vary with paleodepth of the species concerned. Even the few planktonic specimens of Hole 530A show clear relationship to the well-differentiated midlatitudinal assemblages of the southern hemisphere (Sliter, 1977a, especially p. 534; 1977; Premoli Silva and Boersma, 1977). The upper Cretaceous displaced benthic faunas of Hole 530A are quite like those of coeval nearby paleobathyal Sites 363 and 364, and both are distinguishable from coeval Boreal faunas on the specific level, although it is surprising how many species of the Austral fauna occur in Boreal faunas also. The paleoabyssal Albion of Hole 530A is, however, cosmopolitan, and is illustrated by the distribution of Pseudoclavulina gaultina (also reported as Clavulina gabonica, Triaxia gabonica, etc.), which has a wide geographic and paleolatitudinal range. Taken at face value, the Albion benthic fauna from Hole 530A indicates widespread homogeneity of abyssal water, quite different circulation from shallow water, and absence of dominant and strongly contrasting South Atlantic polar water in the Angola Basin.

DEPOSITIONAL RECORD

The most conspicuous property of the Cretaceous sequence is the brevity of the medial Cretaceous record, which is represented by Cores 93 through 95. There is evidence of redrilled cavings, reworked Albion specimens, and an erratically sequential succession. It is impossible to be certain which species are indigenous and risky to employ the principle of age-dating by the youngest species present. The sequence could be of any age or of any sequence of ages between the Turonian and somewhere in the late Albian.

Regardless of the interpretation, there is a long middle Cretaceous lacuna, or succession of lacunae, in the depositional record of Hole 530A. The same is true and characteristic of other DSDP sites in the southern hemisphere, as has been amply demonstrated (Sliter, 1977a, b; Premoli Silva and Boersma, 1977; Beckmann, 1978; Scheibnerová, 1978). There appears to be no property in the faunas of Hole 530A that would contribute to an explanation for this phenomenon, unless it is the change from cosmopolitan, abyssal faunas of the Albian to latitudinally differentiated abyssal faunas of the Coniacian and younger rocks, suggesting the arrival of colder South Atlantic abyssal water in the Angola Basin.

The brief expansions of the planktonic fauna at the horizons of Cores 88 and 79 are not related to significant shallowing but may reflect reduced sedimentation. The expansion around Core 88 is close to the top of the mid-Cretaceous unconformity, and that around Core 79 is associated with relatively abundant glauconite. However, it seems unlikely that the typical physical properties of an unconformity would occur in the depositional environment of a submarine fan.

It was difficult to determine the exact relationship of foraminiferal samples to black shales. It appeared, however, that my samples came from laminae and thin beds of biogenic calcitic silstone and silty claystone within the black shales. Samples from the well-developed black claystones of Core 98 yielded no foraminifers, yet radiolarians were present. Foraminifers from black claystones of Core 88 are relatively abundant and, by the standards of Hole 530A, well preserved, but the samples came from lighter colored thin beds as has been mentioned. Planktonic foraminifers from the black claystones are less dissolutive than those from other lithofacies, indicating that the environment producing the black claystones favored the preservation of foraminiferal tests. This does not mean that the environment was favorable to living foraminifers.

CONCLUSIONS

Most of the Cretaceous benthic species encountered in Hole 530A are displaced species, represented by specimens transported downslope from their natural habitat. They are not to be confused with reworked species. Displaced faunas have temporal value but do not have paleobathymetric value. Displaced species were recognized by their rarity, infrequency of occurrence, and physical state of dissolution, abrasion, and fragmentation.

Cretaceous foraminiferal populations from Hole 530A are characterized by sparsity of specimens, rarity of planktonic species, low diversity of indigenous benthic species, and prevalent dissolution, abrasion, and fragmentation of specimens. These properties, the primitive, quartzose, agglutinated faunas of abyssal red and green claystones, and the displaced faunas combine to show that the depositional environment at Site 530 was well below the planktonic lysocline, below the benthic lysoline, and close to, if not below, the CCD, and consequently in the abyssal realm in excess of 2500 m. The sum of these properties and the persistence and relative abundance of the displaced, calcitic, benthic faunas suggest deposition on the deep seafloor by an established transport system with access to all paleodepths; hence, perhaps a submarine fan. The relative abundance and diversity of the displaced faunas increase from the Al-
bian into the Maestrichtian, suggesting increasing proximity to a prograding continental margin.

The Cretaceous faunas of Hole 530A are most similar taxonomically to those of the paleobyssal western South Atlantic. They are more like distant paleobyssal sites of the southern hemisphere than like nearby paleobyssal and shallower sites of Leg 40 on the African continental margin.

The planktonic faunas of Hole 530A belong to the middle latitudinal, Austral Biogeozone. The displaced faunas are much like the paleobathymetrically shallow species of Leg 40, which are more definitively Austral. Upper Cretaceous indigenous benthos are also Austral, but the diversity is low and most species also occur in Boreal realms. In contrast, the Albian faunas of Hole 530A is cosmopolitan, including some species with wide geographic and latitudinal range. The contrast between cosmopolitan Albian and latitudinally differentiated upper Cretaceous benthic faunas of Hole 530A could reflect the absence and presence of colder South Atlantic water.

The principal event of the Cretaceous record at Site 530 is the medial Cretaceous break, which includes much, if not all, of the Turonian, the Cenomanian, and part of the Albian. This break is widespread in the southern hemisphere. Nothing in the foraminifers of Hole 530A contributes to an explanation of this phenomenon, with the possible exception of the Albian and upper Cretaceous contrast in indigenous abyssal benthic faunas mentioned above.

There is some indication of hiatuses nearby and related to the brief relative abundances of planktonic specimens around Core 94 (lower Turonian), Core 88 (Cenomanian), and Core 79 (lower Campanian).

There is some evidence that foraminifers from the black claystones actually came from thin beds of turbiditic, biogenic arenites, and silty claystones. Where the arenites and arenitic claystones are intimately mixed with black claystones, the foraminifers are less dissolute than elsewhere, suggesting that the environment of the black claystones was favorable to the preservation of calcitic tests.

SELECTED SYSTEMATIC PALEONTOLOGY

Most of the persistent benthic species are considered here. Because of their poor preservation and architectural simplicity, only a few of the scores of SEM photomicrographs proved informative. Consequently, outline drawings have been made for the majority of species involved.

In this section and elsewhere, genera such as Clavulinoides, Marsipella, and Pseudoclavulina are used with knowledge of current practice otherwise.

Ammosphaeroidina sp.

(Plate 1, Figs. 11–14; Plate 3, Figs. 9–11)

Ammosphaeroidina sp. Cushman, 1918, p. 49, fig. 10.

Charletonia spp.

(Plate 4, Figs. 29–34)

The specimens of this assignment vary from inflated biconvex to rounded plano-convex, from six to eight chambers per whorl, and from completely involuted umbilically to slightly evolute with a small calcite-filled umbilicus. The intercameral umbilical sutures are typically sinusoidal, although also evenly curved; the intercameral spiral sutures are strongly oblique and slightly curved to straight. The low in-
teriomarginal aperture bends posteriorly in proximity to and in the plane of the carinate periphery. As these properties vary, the individual specimens resemble different species, such as *Pulvinulinella ripleysensis* Sandidge, 1932, *Eponides menteriensis* Marie, 1941, *Pseudoparella meeteraeae* Visser, 1950, *P. miniaeae* Visser, 1951, and *Pulvinulinella cretacea*Sacal and Debourle, 1957. Specimens from Hole 530A are small, typically rare, and poorly preserved, making distinctions among them tentative. However, such forms are persistent in the Maestrichtian–Campanian interval and are cited here.

**Gavelinella umbonella** (Reuss)

(Plate 2, Figs. 13; Plate 4, Figs. 26–28)

*G. umbonella* Reuss, 1860, p. 221, pl. 11, fig. 5a–c.

Although these specimens are very similar to Reuss’s form from the Albian of Germany, it has not been reported since Reuss, 1863, and these specimens are much like *Rotaliipora praebalernaensis* evo-
luta Sigal (1969, p. 637, pl. 1, figs. 10–12), except for their appearance of secondary apertures and a definitely *praebalernaensis*-like primary aperture. However, these structures may be present and not demonstrable because of poor preservation of my material. This species also resembles *Discorbus* sp. (see Schelberová, 1978), a widely reported Austr species of the Albian.

The species is abundant in one sample from Core 95, Section 2, 1–10 cm but is rare and infrequent elsewhere in the ?lower Turonian interval.

**Gyroidinoides quadratus martini** Sliter, 1968, p. 397–398 reports similar properties for *G. quadratus* from the Maestrichtian–Campanian part of Hole 530A.

**Gyroidinoides mauretanicae** charbonnier

(Plate 4, Figs. 11–13)

*G. mauretanicae* charbonnier, 1952, p. 113, pl. 5, fig. 5a–c.

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bical fillings, which merge smoothly with the flanks of the coils. White emphasized the low relief of the umbilical fillings and the compressed umbilical profile in peripheral view, but the specimens from Hole 530A show considerable variation in the topography of the umbilical fillings and suggest that his definition be modified to include forms of more varied umbilical topography.

*Lenticulina velascoensis* is similar to some specimens of *L. musseri* (Roemen) as interpreted by Cushman (1946, pl. 17, fig. 5), but the latter has less evolution of coiling, more rapid increase in chamber height, narrower and thicker keel, or some combination of these properties.

Specimens are typically small and rare, but the species is one of the most persistent in the Maestrichtian–Campanian interval of Hole 530A.

*Lingulogavelinella* sp.

(Plate 2, Figs. 14, 15; Plate 4, Figs. 23–25)

The properties of the ventral side (terminology of Malapris, 1965) vary. Generally speaking, the languettes are large, thick, and separated by radial grooves of variable depth along most or all of the final whorl. However, some specimens have a central callus, which may or may not bear a spiral groove. These specimens are similar to *Gavelinella intermedia* (Berthelin). Other specimens have larger languettes that cover the ventral apex and extended meandering grooves between them, suggesting considerable evolution of final coiling on the ventral side. The last condition is proximal to *Gavelinella* (*Lingulogavelinella*) *abinitiens* Malapris, as is the small calcite-filled apical region of the persistently more convex dorsal side. Similar specimens with fewer chambers have been defined from Leg 27 as *Orthistella indica* (Scheibnerová, 1974, p. 715, pl. 7, figs. 4, 8–13; pl. 8, figs. 1–9; pl. 11, fig. 9a–c).

The species is rare to uncommon but is persistent in the Albian.

*Marsnella oxycona* (Reuss)

*Gaudryina oxycona* Reuss, 1860, p. 229, pl. 12, figs. 3a, b.

Suppression of *Marsnella* as a junior synonym of *Dorothia* (Trujillo, 1960, p. 309; Loeblich and Tappan, 1964, p. 275) is sound on the basis of morphologic relations, but the typical shape of *Marsnella*, its stability, and the range of the genus indicate that *Marsnella* is a distinct lineage and a valid genus. Hence it is used here.

Although it seems unlikely that all the reports of *M. oxycona* include one species, its occurrence in Hole 530A is rare and infrequent, and the species could not be divided into more than the usual one.

*Nuttallina?* sp.

(Plate 3, Figs. 29–31)

?Eponides brominanni* Cushman and Renz, 1946, p. 45, pl. 7, fig. 24a–c.

?Eponides florealis* (White) Sacal and Debourle, 1957, p. 38, pl. 13, fig. 50.

Nuttallinda brominanni* (Cushman and Renz) Beckmann, 1978, p. 768, pl. 3, figs. 1, 2.

This species is very similar to *Nuttallinda treumpyi* (Nuttall), from which it differs mainly in having a more protruding, yet flattened, and typically wider umbonal plug. This species seems to be the same as the forms reported by Beckmann (1978), but none of my specimens definitely showed the intracamer al structure of *Nuttallinda*. The width of the plug and the sinusity of the umbilical intercameral sutures vary; consequently, specimens close to *Eponides brominanni* Cushman and Renz (= *E. florealis* Sacal and Debourle, 1957) occur, but the preservation of this small species is poor without exception and assignment to that species is questionable.

*Nuttallinda* sp. is persistent and is common in the Maestrichtian–Campanian interval.

*Nuttallinda treumpyi* (Nuttall)

(Plate 3, Figs. 32–34)

Eponides treumpyi* Nuttall, 1930, p. 287, pl. 24, figs. 9, 13, 14.

Very small, rare specimens occur at a few horizons within the Maestrichtian–Campanian interval.

*Nuttallinda? florealis* (Cushman)

*Gyroidina florealis* White, 1928, p. 293, pl. 40, fig. 3a–c.

The few and infrequent specimens are poorly preserved but seem to differ from *Nuttallinda? spinea* (Cushman) only in the lack of spines along the peripheral flange and of a secondary deposit of granular calcite on the spiral surface. They are rare in the Maestrichtian–Campanian.

*Nuttallinda?* sp.

(Plate 2, Figs. 7, 8; Plate 4, Figs. 1–4)

The spiral surface varies from markedly concave, suggesting attachment, to slightly convex but is typically planar. The relative diameter of the final whorl and the flare of its periphery also vary widely. However, the blunt, almost truncate summit of the cone with its deep umbilicus and incised, converging sutures gives a distinctive planocovexy to the species. The low interiomarginal aperture is bent posteriorly near the peripheral margin in the manner of *Nuttallinda*, but the internal profile of that genus was not seen.

This species appears to be the same as *Globorotalites conicus* (Carsey) Beckmann (1978, pl. 4, figs. 22, 23) but not the same as *Globorotalites conicus* (Cushman) Sliter (1977b, pl. 9, figs. 7, 8). None of the three above is *Globorotalites conicus* (Carsey), which is a large, stable, smooth-surfaced, deeply umbilicate, bullet-shaped form, of exactly the properties illustrated by Plummer (1931, pl. 14, fig. 11a, b). *Nuttallinda?* sp. is similar to *Globorotalia subconica* Morrow, which may be gravitational into *Globorotalia umbilicata* Loetterle, but the presence of a nuttalline apertural bend remains to be demonstrated for those two species.

*Nuttallinda?* sp. is persistent and at some horizons is common in the Santonian–Coniacian.

*Nuttallinda? spinea* (Cushman)

(Plate 4, Figs. 5–7)

Truncatulina spinea* Cushman, 1926, p. 22, fig. 10a–c.

Globorotalites spinea* (Cushman) Sliter, 1968, p. 119, pl. 22, fig. 4a–c; 1977b, p. 692, pl. 11, fig. 8; Beckmann, 1978, p. 766, pl. 4, fig. 21, 27.

The spines are located opposite the intercameral sutures in the interperipheral flange. The spiral surface is usually covered by a minutely granular deposit of secondary calcite. A definite umbilicus is usually covered by an extension of the final chamber. The interiomarginal aperture is very low in proximity to the peripheral keel, where it bends posteriorly in accordance with a bend in the aperture face. The slit-like aperture continues into the umbilicus along the edge of the extension of the final chamber.

The general form and the external aspect of the aperture are like those of *Nuttallinda*, but the internal plate was not observed. Except for the spines and the secondary deposit on the spiral surface, this species seems identical to *N. florealis* (Cushman).

This distinctive species is few but relatively persistent in the Maestrichtian–Campanian interval.

*Osangularia popenoei* (Trujillo)

(Plate 2, Fig. 9; Plate 4, Figs. 17–19)

Anomalina popenoei* Trujillo, 1960, p. 335, pl. 48, fig. 9a–c.

It is difficult to understand the differences between *O. popenoei*, *O. californica* Dailey, *O. insigna* Dailey, and *O. utaurensis* (Sastri and Sastry). Scheiherová (1974) has reported that *O. californica* is a junior synonym of *O. utaurensis* and noted variation in the periphery and umbonal plug of *O. utaurensis* from Leg 27 that would include Dailey’s diagnostic properties of *O. insigna*.

Specimens from the Maestrichtian–Campanian of Hole 530A have a wall structure, or preservation, in which the camerae are very finely perforate and white in color; the periphery, sutures, and umbilical boss are nonperforate and translucently gray; and the apertures are clearly osangularine. Specimens from the Santonian–Coniacian are composed of light gray, translucent material entirely (possibly internal moulds); the intercameral sutures are broad and elevated, and the apertures are not clearly osangularine; in fact, it appears on some specimens to be an arched, interiomarginal opening near the periphery, possibly with a slight lip. These specimens have been assigned to *O. popenoei* but seem closer to *O. utaurensis* as it has been presented by Scheiherová.

The first morphotype described above is extremely rare in a few residues from the lower part of the Maestrichtian–Campanian, and
the second type occurs at several horizons of the Santonian-Coniacian in rare to few frequency.

### Pleurostomella obtusa Berthelin

**(Plate 3, Figs. 14-17)**

**Pleurostomella obtusa** Berthelin, 1880, p. 29, pl. 1, fig. 9.

**Pleurostomella reussi** Berthelin, 1880, p. 28, pl. 1, figs. 11, 12, not fig. 10.

**Pleurostomella obtusa** has been reported to be the senior synonym and megalospheric form of **P. reussi** Berthelin (Bartenstein, 1954, p. 41; Moullade, 1966, p. 63). Specimens of **P. obtusa** from Hole 530A are broken or only partially developed. They are rare to few, but persistent in the Albian.

### Pseudoclavulina gautina carinata (Neagu)

**(Plate 1, Fig. 8)**

**Clavulinoides gautinus carinata** Neagu, 1962, pp. 420, 421, pl. 40, figs. 14-20.

Most specimens of **Pseudoclavulina gautina** (Morozova) encountered in Hole 530A belong to the carinata variety, which has been confused with **Clavulina gabonica** Le Calvez et al. The latter lacks the prominent suture depression and chamber shape of the uniseriial stage that marks carinata, but *C. gabonica* is similar to and may be a junior synonym of **P. gautina intermedius** (Neagu).

**Pseudoclavulina gautina carinata**, which is one of the most persistent, widespread, deep-water benthic forms of the medial Cretaceous, is a distinctive, conspicuous, and recurrent species of the lower Turonian and Albian intervals of Hole 530A.

### Pullicaoryella White

**Pullicaoryella** White, 1929, p. 56, pl. 5, fig. 22a, b.

Specimens are rare and erratic in occurrence in the Maestrichtian-Campanian interval. The interpretation of them as indigenious forms herein may be erroneous.

### Reussella scarnochae (Grzybowski)

**(Plate 2, Fig. 1)**

**Verneuilina scarnochae** Grzybowski, 1896, p. 287, pl. 9, fig. 19.

This distinctive species is, like *Aragonia owezzanensis*, a rare but persistent member of the Maestrichtian-Campanian fauna.

### Spiroplectammina chicoana Lalicker

**(Plate 1, Figs. 3, 4)**

**Spiroplectammina chicoana** Lalicker, 1935, p. 7, pl. 1, figs. 8, 9; Beckmann, 1978, p. 769, pl. 1, fig. 3.

Uncommon to rare but persistent in the Santonian-Coniacian interval.

### Spiroplectammina dentata (Alth)

**(Plate 1, Fig. 5)**

**Textularia dentata** Alth, 1850, p. 262, pl. 13, fig. 13.

Rare to uncommon but persistent in the Maestrichtian-Campanian interval. Often well preserved.

### Spiroplectammina grzybowski Frizzell

**(Plate 1, Fig. 6)**

**Spiroplectammina grzybowski** Frizzell, 1943, p. 339, pl. 12, fig. 12a-b, 13.

Having seen specimens of *Bolivinopsis rosula* (Ehrenberg) Cushman (1946, p. 44, figs. 5-8) from the Gulf Coastal Plain, I am impressed with the difference between its test and that of **Spiroplectammina grzybowski** Frizzell from Hole 530A. The latter is finely but definitely agglutinated and seemingly identical to Frizzell's holotype, whereas the former is much more calcitic, glassy, and similar to *B. capitata* Yakelov, the holotype of *Bolivinopsis*. Consequently, utilization of Spiroplectammina seems advisable herein.

The form of Frizzell's holotype and paratype appears to be identical with that of *Spiroplectella spectabilis* Grzybowski 1896 and *S. clotho* Grzybowski 1901 respectively, and it is evident that he considered the relative size of the planispiral portion of these tests an intraspecific variant, as does Hanzliková (1972, p. 48), who has synonymized spectabilis and clotho. Hanzliková has also placed grzybowski in synonymy with these two, but her assignment of them to *Bolivinopsis* reopens the question of the composition of Grzybowski's species. If it is that of *Bolivinopsis*, they are not synonymous with Frizzell's species. **Spiroplectammina grzybowski** Frizzell occurs as rare and broken specimens in several samples from the Maestrichtian of Hole 530A. They may be displaced.

### Textularia sp.

**(Plate 1, Figs. 1, 2; Plate 3, Figs. 1, 2)**

This species is similar to *Spiroplectammina roemer* Lalicker (Textularia laevis Roemer), except for greater curvature of chambers and a distinct proloculum instead of a coil. It has the shape and chamber curvature of *S. senonian* Lalicker but again lacks the spiral stage.

**Textularia sp.** is rare in the Albian interval.

### Valvulineria spp.

**(Plate 3, Figs. 21-23)**

Tiny, variable, poorly preserved *Valvulineria* of the *V. parvus* Khan to *V. praestans* Magnezi-Jannin morphic group are rare in the Albian but could not be identified specifically.

### Valvulineria? vombsensis (Broten)

**(Plate 2, Fig. 6; Plate 3, Figs. 24-26)**

**Pseudovalvulineria vombsensis** Broten, 1945, p. 50, pl. 1, figs. 12, 13.

**Gavelinella whitei** (Martin) Sllter, 1968, p. 126, pl. 24, fig. 1a-c;

Hanzliková, 1972, p. 133, pl. 38, figs. 5a-c; pi. 39, fig. 9a-c.

The rare specimens of this assignment differ from the primary definition of the species by having in the circumumbilical area very thick and raised but relatively straight sutures (see Broten, 1945, p. 51, text-fig. 9), and coarsened, closely packed, coalesced mural pores and large depressions in the intersutural areas, and a large umbilical flap.

Extremely rare in the lower Campanian of Hole 530A.

### Valvulineria? whitei (Martin)

**(Plate 3, Figs. 27, 28)**

**Anomalina whitei** Martin, 1964, p. 106, pl. 16, figs. 4a-c.

**Rotalia beccariiformis** White, 1928, p. 287, pl. 39, figs. 3a-c.

**Rotalia beccariiformis**, var. White, 1928, p. 287, pl. 39, figs. 3a-c.

**Gavelinella whitei** (Martin) Sllter, 1977, p. 695, pl. 13, figs. 2-5.

**Gavelinella beccariiformis** (White) Beckmann, 1978, p. 766, pl. 5, figs. 1, 2.

**Gavelinella beccariiformis** (White), conical variety Beckmann, pl. 5, fig. 3.

The distinctive properties of this species occur in the umbilical region, where the sutures become widened, elevated, and irregular in outline and topography; where the mural pores become large, irregular in shape, and coalesced; where, in consequence of the last, irregular depressions and meandering, branching grooves occur between the sutures and may connect with the umbilicus. The aperture is a low, interiomarginal opening that extends along the umbilical half of the apertural face and continues along the umbilical margin of the final, if not other, chambers. Some specimens appear to have the remnant of an umbilical flap. It appears that the apertural function was concentrated in the umbilicus and extended into the adjacent area of pits, grooves, etc. The shape varies considerably, with the result that highly vaulted forms occur, as Beckmann has noted (see above), but the prevalent form is rounded biconvex, trochospiral with a very low angle of coiling. The combination of typical form and apertural properties have led to the assignment to *Valvulineria* employed herein.

In addition to the question of generic affinities, there are problems of nomenclature which involve priority, synonymy, and consanguinity. First, there is the question of whether White's variations are of one species. It would seem that they are, but he did distinguish *R. beccariiformis* by beaded sutures, which have not been specifically mentioned since and do not occur in material from Hole 530A; and he did, by his wording, imply that the "thread-like lines" are sutural in position, rather than interstural. The second question is the status of *Pseudovalvulineria vombsensis* Broten and *Anomalina whitei* Martin, both of which were specifically synonymized with and do appear to be the same as White's varieties of *R. beccariiformis*. White's material was from what would seem to have been a tropic realm, in contrast to
the evidently higher latitudinal position of the Brotenz and Martin taxa; consequently, it seems prudent to retain one or both of them. Of these two, Brotenz’s species has priority, but there are some peculiarities of definition, particularly the nontypical illustrations (Brotenz, 1945, text figs. 9, 1-4, p. 51), wherein the circumbivalar topography includes a very thick and raised base rather straight sutures and intersticial areas without meandering depressions. Brotenz noted that his specimens from the Maestrichtian and Campanian are closer to White’s varieties than his specimens from the Santonian and Coniacian; perhaps the specimens of text-figure 9 are older.

Without arguing the case, I shall maintain R. beccariformis White, P. yombensis Brotenz (for forms of his text-fig. 9), and A. whitlei. Until typic or topotypic material can be compared, change in nomenclature is as likely to be wrong as to be right.

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