16. UPPER CRETACEOUS-PALEOCENE FORAMINIFERA FROM SITE 208 (LORD HOWE RISE, TASMAN SEA), DSDP, LEG 21

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INTRODUCTION

The lowermost 55 meters penetrated at Site 208, Lord Howe Rise, Tasman Sea (Figure 1), consisted of 18 meters of Maestrichtian sediments overlain by 37 meters of Paleocene sediments. The Paleocene sediments are disconformably overlain by Middle Eocene sediments. The Maestrichtian sediments consist of light gray chalk and occasional chert. Bioturbation structures are common. A 0.5-meter black chert with ghosts of lamination and burrows marks the Maestrichtian-Paleocene boundary. Paleocene sediments consist of pale gray to green gray chalks in which radiolarians, diatoms, and sponge fragments are common. Sediments are mottled and silicified with lenses of chalk, or predominantly chalk with silicified streaks. Foraminifera and nannoplankton are present in both Maestrichtian and Paleocene sediments. Foraminifera tend to be more abundant and best preserved in the Maestrichtian. Planktonic foraminifera dominate Maestrichtian assemblages and calcareous benthic foraminifera the Paleocene assemblages. The present study is based on the examination of forty-two 10-cc samples. Preliminary comments on these faunas were provided by Webb (1973).

BIOSTRATIGRAPHY

Abathomphalus mayaroensis Zone

The occurrence of *G.* (*A.*) *mayaroensis* Bolli in Samples 33-3 (26-28 cm) and 33-2 (112-114 cm) allows confident correlation with the *A. mayaroensis* Zone of Trinidad. This species occurs in very small numbers at Site 208 and exhaustive picking failed to provide specimens lower in this succession. The interval 33-3 (95-97 cm) down to 34-3 (124-126 cm) (the lowermost core) also failed to provide *Globorotruncana gansseri* Bolli leaving open the question of whether this lower interval should be assigned to the *G. mayaroensis* or *G. gansseri* Zones. That this interval is certainly no older than the *G. gansseri* Zone is supported by the presence of *Heterohelix glabrans* (Cushman), *Pseudotextularia deformis* (Kikoine), *Planoglobulina carseyae* (Plummer), *Rugoglobigerina rotundata* Bronnimann, *G.* (*Rugotruncana*) *circumnodifer* (Finlay), *Globotruncanella petaloidea* (Gandolfi), and *Hedbergella monmouthensis* (Olsson). The occurrence of *G.* (*Rugotruncana*) *circumnodifer* (Finlay) allows correlation with the *G. circumnodifer* Zone of New Zealand (Webb, 1966, 1971).

Globoconcusa daubjergensis-Globorotalia pseudobulloides Zone (Figure 2)

The interval 30-4 (29-31 cm) to 31-3 (111-113 cm) contains quite abundant planktonics including *Globigerina triloculinoides* Plummer, *Globorotalia pseudobulloides* (Plummer), and *Globorotalia compressa* (Plummer). This interval is tentatively correlated with the *Globoconcusa daubjergensis-Globorotalia pseudobulloides* Zone.

Globorotalia uncinata Zone (Figure 2)

The interval 30-1 (34-36 cm) to 30-3 (112-114 cm) contains *Globorotalia uncinata* Bolli, *Globorotalia pseudobulloides* (Plummer), *Globorotalia ehrenbergi* Bolli, *Chiloguembelina crinata* (Glaessner), and *Zeauvigerina teuria* Finlay. The interval is correlated with the *G. uncinata* Zone.

Globorotalia pusilla pusilla-G. angulata Zone (Figure 2)

Globorotalia angulata(White) appears in 29-6 (53-55 cm) and ranges up to 29-2 (118-120 cm). Accompanying taxa include *Globorotalia pusilla pusilla* Bolli, *Globorotalia pseudobulloides* (Plummer), *Globorotalia ehrenbergi* Bolli, *Globigerina triloculinoides* Plummer, *Globorotalia acarinata* (*Subbotina*), *G. mckannai* (White), and *Chiloguembelina crinata* (Glaessner).

Globorotalia pseudomenardii Zone (Figure 2)

Taxa present in this zone include *Globorotalia pseudomenardii* Bolli, *Globorotalia pusilla pusilla* Bolli, *Globorotalia pusilla laevigata* Bolli, *Globorotalia pseudobulloides* (Plummer), *Globigerina triloculinoides* Plummer, *Globorotalia acarinata* (*Subbotina*), and *Globorotalia mckannai* (White).

New Zealand Paleocene Zones (Figure 2)

The Paleocene succession at Site 208 appears to provide a better Lower-Middle Paleocene planktonic succession than currently available in New Zealand. The interval correlated here with the *G. daubjergensis-G. pseudobulloides* is about equivalent to Jenkin's (1971) *Globigerina pauciloculata* Zone. The interval correlated here with the *G. uncinata* Zone, *G. pusilla pusilla-G. angulata* Zone, and *G. pseudomenardii* Zone correlates with part of Jenkin's (1971) *Globigerina* (*Subbotina*) *triloculinoides* Zone.

NEW ZEALAND AND EUROPEAN STAGES

New Zealand late Cretaceous and early Tertiary stages are defined principally on benthic taxa (Webb, 1970, 1971). Benthic taxa present in the *Abathomphalus mayaroensis* Zone sediments at Site 208 allow correlation with the uppermost Haumurian Stage of New Zealand (Figure 3). Diagnostic taxa include *Gaudryina healyi* Finlay, *Dorothia elongata* Finlay, and *Frondicularia rakauroana* (Finlay). The presence of *Bolivinoides draco* Marsson throughout the Cretaceous part of the succession confirms correlation with the Maestrichtian.

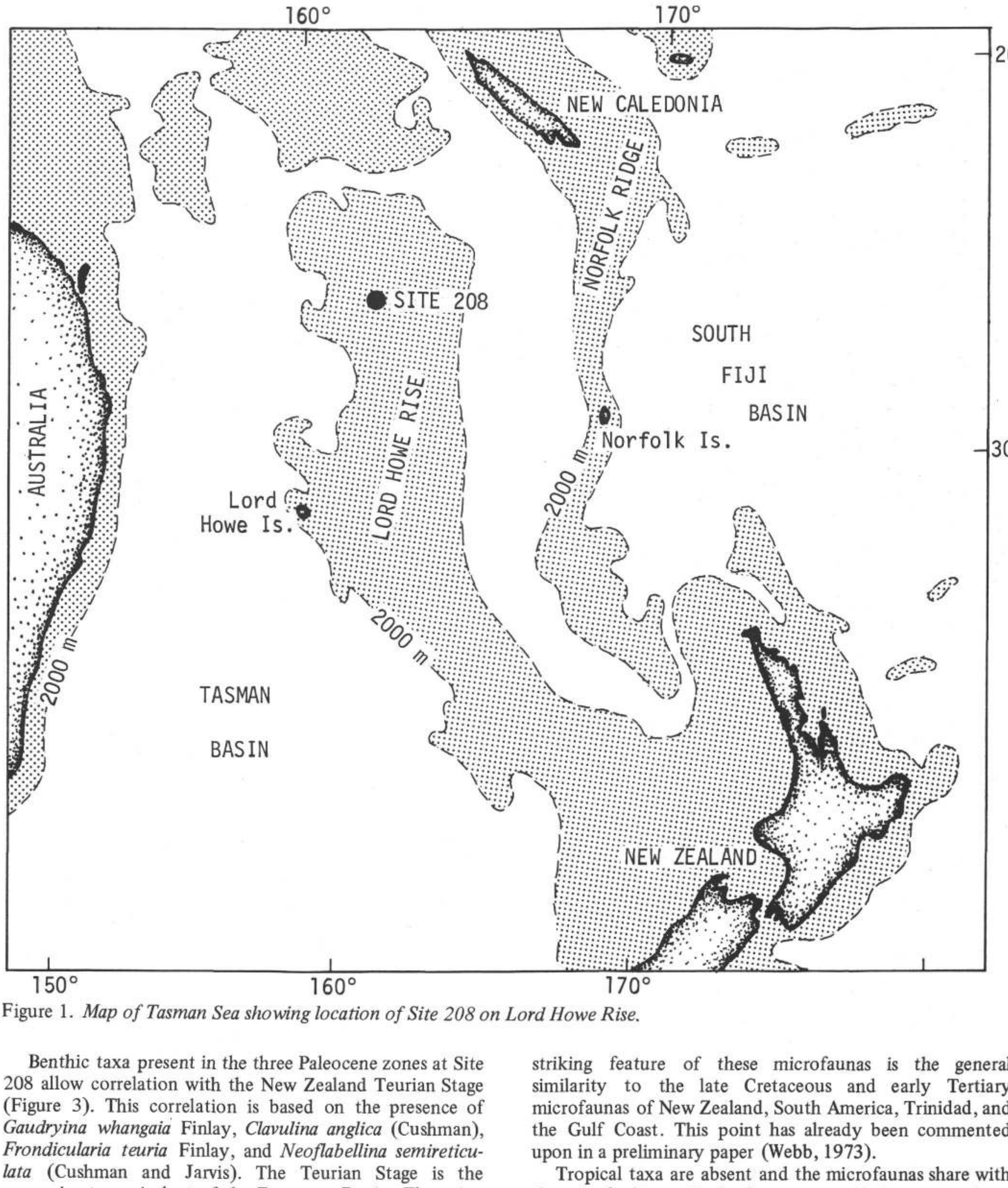

Figure 1. *Map of Tasman Sea showing location of Site 208 on Lord Howe Rise.*

Benthic taxa present in the three Paleocene zones at Site 208 allow correlation with the New Zealand Teurian Stage (Figure 3). This correlation is based on the presence of *Gaudryina whangaia* Finlay, *Clavulina anglica* (Cushman), *Frondicularia teuria* Finlay, and *Neoflabellina semireticulata* (Cushman and Jarvis). The Teurian Stage is the approximate equivalent of the European Danian-Thanetian Stage interval.

GENERAL COMMENTS ON FORAMINIFERA

A detailed list of all planktonic and benthic foraminifera is given in Figures 2 and 3, and some of the more significant planktonic taxa are shown in Plates 1 to 6. The most striking feature of these microfaunas is the general similarity to the late Cretaceous and early Tertiary microfaunas of New Zealand, South America, Trinidad, and the Gulf Coast. This point has already been commented upon in a preliminary paper (Webb, 1973).

Tropical taxa are absent and the microfaunas share with those of New Zealand an extra-Tethyan southern high-latitude or Austral composition. Almost all the taxa encountered in Site 208 are also present in correlative New Zealand sediments. *Planoglobulina carseyae* (Plummer), *Globigerinelloides subcarinatus* (Bronnimann), *Globotruncanella petaloidea* (Gandolfi), *Spiroplectammina ripleyensis* Berry, *Nodosaria gracilitatus* Cushman, *Pseudouvigerina* *cristata* Marsson, *Eouvigerina americana* Cushman, *Stensioina* sp. and *Bulimina* sp. (reticulate ornament) are unknown in the New Zealand late Cretaceous. The latter taxon may be a new species. The main differences between the Maestrichtian of the two areas lies in their species diversity and proportions of planktonic to benthic taxa. The Lord Howe Rise material displays a much higher proportion of planktonics, but, conversely, a much lower species diversity. The Whangai Formation of southern Hawke's Bay is probably the nearest, facies-wise, to the Lord Howe Rise Maestrichtian. Webb (1971) reports a total of 164 species from the former area whereas only 85 occur in the latter. Planktonic diversity is the same at both localities, i.e., 12 species. The Hawke's Bay faunas contain 46 species of agglutinated benthics as against 11 in the Lord Howe Rise material and 106 species of calcareous benthics compared with 62 species. Much the same situation exists between the Paleocene foraminifera of the two areas. Planktonic diversity is similar at about 15 species but numbers of agglutinated and calcareous benthic taxa are again much higher in the New Zealand faunas. Notes on some of the more significant taxa are provided below.

Gaudryina healyi Finlay

This is an index species for the New Zealand Haumurian Stage where it occurs as quite large tests with a well-developed series of biserial chambers. Triserial early forms are present in small numbers. Test wall components are usually of medium sand size. Site 208 specimens never develop beyond the initial triserial stage and test components are extremely fine grained. The stratigraphic range of this important benthic is the same at both localities, the upper limit being the Maestrichtian-Paleocene boundary.

Gaudryina whangaia Finlay

This species appears in Sample 31-3 (111-113 cm) low in the Paleocene and persists in low numbers to the uppermost sample. Its range appears to be the same as in New Zealand where it is an index for the Teurian Stage.

Dorothia elongata Finlay

D. elongata is restricted to the Maestrichtian at Site 208 and its range therefore conforms to that known in New Zealand where it is an index species for the Haumurian Stage.

Dorothia biformis Finlay

D. biformis is restricted to the Maestrichtian at Site 208 but ranges into the Paleocene (Teurian) in New Zealand. New Zealand material develops to a large size with a well-developed series of biserial chambers. The Lord Howe Rise material seldom develops past the initial polyserial growth stage.

Conotrochammina whangaia Finlay

A single specimen occurs in Sample 30-6(116-118 cm) (Paleocene). This is an index species for Teurian in New Zealand. A single specimen is also present low in the Maestrichtian at Site 208 and is attributed to downhole reworking.

Clavulina anglica (Cushman)

Common throughout the Paleocene succession. An index for Teurian in the New Zealand Paleocene. Site 208 specimens are confined mostly to the initial triserial portion whereas a long uniserial series of chambers is common in New Zealand material. Wall components in the Site 208 specimens are generally finer grained than their New Zealand counterparts.

Frondicularia teuria Finlay

Fragments of this large species are restricted to the Paleocene sediments at Site 208. The stratigraphic range is the same as that in New Zealand where this is an index species for the Teurian Stage.

Neoflabellina semireticulata (Cushman)

A few specimens, mostly early growth forms, are restricted to the Paleocene. A junior synonym, *Neoflabellina thalmanni* (Finlay), is a Teurian index (Webb, 1970).

Gavelinella beccariiformis (White)

This is the dominant benthic species in all Maestrichtian samples and in a number of those from the Paleocene. This species is also a common Maestrichtian-Paleocene benthic in New Zealand (Webb, 1970). It constitutes up to 12% of Maestrichtian faunas and up to 33% of Early Paleocene faunas at Site 208.

Heterohelix striata (Ehrenberg)
(Plate 1, Figures 1-3).

H. striata is the dominant taxon in all but the uppermost Maestrichtian sample. Nonstriate heterohelicids equivalent to *H. globulosa* were not encountered.

Heterohelix glabrans (Cushman)
(Plate 1, Figure 4)

Present in most samples but always completely subordinate to *Heterohelix striata* (Ehrenberg).

Chiloguembelina crinata (Glaessner)

Isolated specimens occur in several Paleocene samples. The genus is, on the whole, very poorly represented at Site 208.

Chiloguembelina wilcoxensis (Cushman & Ponton)
(Plate 2, Figures 1-2).

Quite common in the uppermost Paleocene sample, 29-1(45-47 cm), which is correlated with the *G. pseudomenardii* Zone. It enters the record at about the same level as proposed by Beckmann (1957) in Trinidad but somewhat earlier than in New Zealand (Jenkins, 1971).

Zeauvigerina teuria Finlay
(Plate 2, Figures 3-4).

Restricted to the *G. uncinata* Zone and lower part of the *G. pusilla pusilla-G. angulata* Zone. Occurs in some abundance in Sample 30-4(29-31 cm). A few poorly preserved specimens occur in the *G. daubjergensis-G. pseudobulloides* Zone, but it is thought that these may result from downhole reworking.

	Sample																				
	34-3, 124-126	34-3, 34-36	34-2, 127-129	34-2, 36-38	33-5, 94-96	33-5, 20-22	33-4, 128-130	33-4, 32-34	33-3, 95-97	33-3, 26-28	33-2, 112-114	33-2, 30-32	33-1, 91-93	33-1, 21-23	32	31-3, 111-113	31-3, 33-35	31-2, 119-121	31-2, 33-35	31-1, 113-115	30-6, 116-118
Heterohelix striata (Ehrenberg)	●	●	●	●	●	●	●	●	●	●	●	●	●								
Heterohelix glabrons (Cushman)	●	●		●		●	●	●		●	●	●									
Globigerinelloides volutus (White)	●	●	●	●	●	●	●	●	●	●	●	●									
Globigerinelloides subcarinatus (Bronnimann)	●		●				●	●													
Hedbergella monmouthonsis (Olsson)	●	●	●	●	●	●	●	●	●	●	●										
Rugoglobigèrina rugosa (Plummer)	●	●	●	●	●	●	●	●	●	●	●	●	●								
Rugoglobigerina rotundata Bronnimann	●	●	●		●	●	●					●									
G. (Rugotruncana) circumnodifer (Finlay)	●	●	●		●																
Globotruncanella petaloidea (Gandolfi)					●																
Pseudotextularia deformis (Kikoine)								●	●	●	●	●	●								
Planoglobulina carseyae (Plummer)										●	●	●									
Abathompholus mayaroensis										●	●										
Globorotalia pseudobulloides (Plummer)																●	●	●	●		●
Globorotalia compressa (Plummer)																●		●			●
Globigerina triloculinoides Plummer																			●		
Zeauvigerina feuria Finlay																					
Globorotalia uncinata Bolli																					
Globorotalia ehrenbergi Bolli																					
Chiloguembelina crinata Glaessner																					
Globorotalia pusilla pusilla Bolli																					
Globorotalia angulata (White)																					
Globorotalia acarinata (Subbotina)																					
Globorotalia McKannai (White)																					
Chiloguembelina wilcoxensis (Cushman & Ponton)																					
Globorotalia pusilla laeuigata Bolli																					
Globorotalia pseudomenardii Bolli																					
New Zealand Zones	*Globotruncana (Rugotruncana) circumnodifer* Zone													*Globigerina pauciloculata* Zone							
New Zealand Stages	Haumurian													Teurian							
Trinidad Zones	?									*Abathomphalus mayaroensis* Zone				?		*Globoconcusa daubjergensis Globorotalia pseudobulloides* Zone					
	Upper Cretaceous (Maastrichtian)													Early to Middle Paleocene							

Figure 2. *Stratigraphic distribution of planktonic foraminifera.*

Sample: 30-6, 38-40	30-5, 112-114	30-5, 37-39	30-4, 112-114	30-4, 29-31	30-3, 112-114	30-3, 39-41	30-2, 112-114	30-2, 40-42	30-1, 112-114	30-1, 34-36	29-6, 53-55	29-5, 110-112	29-5, 35-37	29-4, 108-110	29-4, 31-33	29-3, 118-120	29-3, 75-77	29-2, 118-120	29-2, 36-38	29-1, 45-47
	●	●			●				●							●				●
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Samples	Zone
30-6, 38-40 to 30-4, 29-31	*Globigerina pauciloculata* Zone
30-3, 112-114 to 29-1, 45-47	***Globigerina triloculinoides* Zone**
All samples	Teurian
30-6, 38-40 to 30-4, 29-31	*Globoconcusa daubjergensis Globorotalia pseudobulloides* Zone
30-3, 112-114 to 30-1, 34-36	***Globorotalia uncinata* Zone**
29-6, 53-55 to 29-2, 36-38	***Globorotalia pusilla pusilla–G. angulata* Zone**
29-1, 45-47	***G. pseudomenardii* Zone**
All samples	Early to Middle Paleocene

Figure 2. *(Continued).*

	Sample															
	34-3, 124-126	34-3, 34-36	34-2, 127-129	34-2, 36-38	33-5, 94-96	33-5, 20-22	33-4, 128-130	33-4, 32-34	33-3, 95-97	33-3, 26-28	33-2, 112-114	33-2, 30-32	33-1, 91-93	33-1, 21-23	31-3, 111-113	31-3, 33-35
Dorothia biformis Finlay	●	●			●							●	●			
Dorothia elongata Finlay	●	●			●			●	●	●		●				
Lenticulina (L.) *insulsis* (Cushman)	●			●	●	●	●	●		●	●	●	●			
Lenticulina (L.) *macrodisca* (Reuss)	●	●	●	●	●	●	●	●	●				●		●	●
Dentalina basiplanata Cushman	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
Nodosaria velascoensis Cushman	●		●	●		●		●		●	●				●	
Nodosaria affinis Reuss	●	●	●	●	●	●	●	●		●		●	●	●	●	●
Pseudonodosaria cylindracea (Reuss)	●															
Globulina lacrima Reuss	●	●	●	●	●	●		●				●	●		●	
Buliminella carseyae Plummer	●	●				●	●	●	●	●	●	●	●			
Bolivina incrassata Reuss	●		●	●	●	●	●	●	●	●	●	●	●		●	
Bolivinoides draco Marsson	●	●	●	●	●	●	●	●	●	●	●	●	●			
Bolivinoides delicatulus Cushman	●											●	●			
Bulimina rakauroana Finlay	●	●	●	●	●	●	●	●		●		●	●			
Nuttallides florealis (White)	●	●	●		●	●	●	●		●		●	●			
Eponides bollii Cushman & Renz	●	●		●				●				●				
Pleurostomella subnodosa Reuss	●															
Pullenia coryelli White	●		●	●	●	●	●	●	●	●	●	●	●		●	●
Alabamina creta (Finlay)	●	●	●	●	●	●	●	●		●		●	●		●	●
Osangularia navarroana Cushman	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●
Gyroidinoides globosus (Hagenow)	●		●			●									●	●
Globorotalites sp.	●	●	●	●	●			●			●	●				
Anomalinoides piripaua (Finlay)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Anomalinoides rubiginosus (Cushman)	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●
Gavelinella beccariiformis (White)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Gavelinella sp.	●			●				●				●	●			
Cibicides stephensoni (Cushman)	●		●	●	●	●	●	●	●	●	●	●	●			
Ammodiscus cretaceus (Reuss)		●											●		●	
Glomaspira charoides (Jones & Parker)		●			●		●		●					●		
Bolivinopsis spectobilis (Grzybowski)		●			●	●	●	●		●						
Gaudryina healyi Finlay		●			●	●					●	●	●			
n. sp and gen. cf *Rzehakina*		●	●		●	●	●									
L. (Astacolus) cretacea (Cushman)		●	●				●		●	●			●			
Nodosaria aspera Reuss		●														
Nodosaria limbata d'Orbgny		●						●								
Nodosaria gracilitatis Cushman		●														
New Zealand Zones	*Globotruncana (Rugotruncona) circumnodifer* Zone															
New Zealand Stages	Haumurian															
Trinidad Zones	?									*Abathomphalus mayaroensis* Zone						
	Upper Cretaceous (Maastrichtian)															

Figure 3. ***Stratigraphic distribution of benthic foraminifera.***

Sample

31-2, 119-121	31-2, 33-35	31-1, 113-115	30-6, 116-118	30-6, 38-40	30-5, 112-114	30-5, 37-39	30-4, 112-114	30-4, 29-31	30-3, 112-114	30-3, 39-41	30-2, 112-114	30-2, 40-42	30-1, 112-114	30-1, 34-36	29-6, 53-55	29-5, 110-112	29-5, 35-37	29-4, 108-110	29-4, 31-33	29-3, 118-120	29-3, 75-77	29-2, 118-120	29-2, 36-38	29-1, 45-47
	●	●						●	●	●		●				●			●		●	●		
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Globigerina pauciloculata Zone (31-2, 119-121 to 30-4, 29-31) | *Globigerina triloculinoides* Zone (30-3, 112-114 to 29-1, 45-47)

Teurian

Globoconcusa daubjergensis – *Globorotalia pseudobulloides* Zone | *Globorotalia unimata* Zone | *Globorotalia pusilla pusilla* Zone | *G. pseudomenardii* Z. →

Early to Middle Paleocene

Figure 3. *(Continued).*

	Sample															
	34-3, 124-126	34-3, 34-36	34-2, 127-129	34-2, 36-38	33-5, 94-96	33-5, 20-22	33-4, 128-130	33-4, 32-34	33-3, 95-97	33-3, 26-28	33-2, 112-114	33-2, 30-32	33-1, 91-93	33-1, 21-23	31-3, 111-113	31-3, 33-35
Frondicularia rakauroana (Finlay)		●		●			●	●			●		●			
Valvalineria teuriensis Loeblich & Tappan		●					●									
Ellipsoidina ellipsoides Seguenza		●														
Cibicides beaumontianus (d'Orbigny)		●										●				
Gyroidensides nitidus (Reuss)		●		●	●				●			●	●			
Nuttallides cretatruempyi Finlay			●	●	●	●	●	●	●							
Angulogauelinella rakauroana (Finlay)			●	●	●		●	●	●							
Lagena sulcata (Walker & Jacob)				●	●	●		●							●	
Lagena vulgaris Williamson				●	●	●	●		●						●	
Gyroidinoides quadratus Cushman & Church				●	●											
Pyramidina prolixa (Cushman & Parker)				●	●	●	●									
Gyroidinoides depressus Alth				●												
Spiroplectammina piripaua Finlay					●	●		●								
Dentalina solvata Cushman					●		●				●		●			
Frondicularia sp					●	●										
Fissurina marginata (Walker & Boys)					●	●	●	●		●						
Guttulina trigonula (Reuss)					●			●							●	
Ellipsoglandulina manifesta Franke					●											
Bulimina sp. (reticulate)					●	●	●									
Buliminidae gen. et sp. indet.					●	●	●				●					
Allomorphina whangaia Finlay					●											
L. (Saracenaria) triangularis (d'Orbigny)						●									●	
Fissurina orbignyana Seguenza						●										
Pseudouvigerina cristata (Marsson)						●	●	●	●	●	●	●				
Ellipsopdymorphina velascoensis (Cush.)						●										
Lagena apiculata Reuss							●									
Spiroplectammina ripleyensis Berry								●								
Dentalina catenula Reuss								●							●	
Nodosarella gracillima Cushman								●				●	●		●	
Gaudryina sp.								●			●					
Eouvigerina americana Cushman										●						
Stensioina sp.										●						
Pullenia jarvisi Cushman										●	●				●	
Citharina rakauroana (Finlay)											●				●	
Globorotalites michelinianus (d'Orbigny)											●					
New Zealand Zones	*Globotruncana (Rugotruncona) circumnodifer* Zone															
New Zealand Stages	Haumurian															
Trinidad Zones	?									*Abathomphalus mayaroensis* Zone				?		
	Upper Cretaceous (Maastrichtian)															

Figure 3. *(Continued)*.

Sample

31-2, 119-121	31-2, 33-35	31-1, 113-115	30-6, 116-118	30-6, 38-40	30-5, 112-114	30-5, 37-39	30-4, 112-114	30-4, 29-31	30-3, 112-114	30-3, 39-41	30-2, 112-114	30-2, 40-42	30-1, 112-114	30-1, 34-36	29-6, 53-55	29-5, 110-112	29-5, 35-37	29-4, 108-110	29-4, 31-33	29-3, 118-120	29-3, 75-77	29-2, 118-120	29-2, 36-38	29-1, 45-47
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Globigerina pauciloculata Zone	*Globigerina triloculinoides* Zone	
Teurian		
Globoconcusa daubjergensis – *Globorotalia pseudobulloides* Zone	*Globorotalia unimata* Zone	*Globorotalia pusilla pusilla* Zone; *G. pseudomenardii* Z.→
Early to Middle Paleocene		

Figure 3. *(Continued).*

	Sample															
	34-3, 124-126	34-3, 34-36	34-2, 127-129	34-2, 36-38	33-5, 94-96	33-5, 20-22	33-4, 128-130	33-4, 32-34	33-3, 95-97	33-3, 26-28	33-2, 112-114	33-2, 30-32	33-1, 91-93	33-1, 21-23	31-3, 111-113	31-3, 33-35
Marssonella oxycona (Reuss)												●				
Gyroidenoides subangulatus (Plummer)												●	●		●	
Bolivinopsis compta Finlay															●	●
Verneuilina sp.															●	
Gaudryina whangaia Finlay															●	
Frondicularia zeuria Finlay															●	
Nodosaria callosa Stache															●	●
Citharina plumoides (Plummer)															●	
Ramulina aculeata (d'Orbigny)															●	
Bulimina midusayensis Plummer															●	
Bulimina subbortonica Finlay - *quadrata* Plummer															●	●
Cibicides sp.															●	●
Neoflabellina semireticulata (Cushman & Jarvis)															●	●
Nuttallides aff. *truemyi* (Nuttall)															●	●
Bulimina seratospina Finlay																●
Anomalinoides nobilis Brotzen																
Rzehakina epigona (Rzehak)																
Nodosaria orfhopleura Reuss																
Clavulina anglica (Cushman)																
Conotrochammina whangaia Finlay																
L. (Marginulina) armata Reuss																
L. (Marginulina) jarvisi Cushman																
Dentalina legumen Reuss																
Pleurostomella naranjoensis Cushman & Bermudez																
Bulimina spinata Cushman & Hanna																
Neoflabellina rugosa (d'Orbigny)																
Frondicularia mucronata Reuss																
Nuttallides sp. (wide flange)																
Tappanina selmensis (Cushman)																
Nanionella soldadoensis Cushman & Renz																
Quadrimorphina allamorphinoides (Reuss)																
L. (Lenticulina) sp.																
Alabamino midwayensis Brotzen																
Guttulina caudita d'Orbigny																
Guttulina hantkeni Cushman & Ozawa																
New Zealand Zones	*Globotruncana (Rugotruncona) circumnodifer* Zone															
New Zealand Stages	Haumurian															
Trinidad Zones	?									*Abathomphalus mayaroensis* Zone				?		
	Upper Cretaceous (Maastrichtian)															

Figure 3. *(Continued).*

Sample																								
31-2, 119-121	31-2, 33-35	31-1, 113-115	30-6, 116-118	30-6, 38-40	30-5, 112-114	30-5, 37-39	30-4, 112-114	30-4, 29-31	30-3, 112-114	30-3, 39-41	30-2, 112-114	30-2, 40-42	30-1, 112-114	30-1, 34-36	29-6, 53-55	29-5, 110-112	29-5, 35-37	29-4, 108-110	29-4, 31-33	29-3, 118-120	29-3, 75-77	29-2, 118-120	29-2, 36-38	29-1, 45-47
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Globigerina pauciloculata Zone									*Globigerina triloculinoides* Zone															
Teurian																								
Globoconcusa daubjergensis – *Globorotalia pseudobulloides* Zone									*Globorotalia unimata* Zone						*Globorotalia pusilla pusilla* Zone									*G. pseudomenardii* Z. →
Early to Middle Paleocene																								

Figure 3. *(Continued).*

Pseudotextularia deformis (Kikoine)
(Plate 1, Figures 5-8).

Enters in Sample 33-4(32-34 cm) and continues in abundance to the top of the Maestrichtian. Becomes the dominant taxon in the uppermost of the Maestrichtian samples. Tests are quite large with a robust widely spaced elongate ornament. Most tests have lost the last chamber. Its considerable abundance at Site 208 is in marked contrast to its record in New Zealand where only a single locality in Raukumara Peninsula is known.

Planoglobulina carseyae (Plummer)
(Plate 1, Figure 9).

Present in low numbers in three samples in the uppermost part of the Maestrichtian succession where it occurs with *Pseudotextularia deformis*. Not known in the New Zealand Maestrichtian.

Globigerinelloides volutus (White)
(Plate 2, Figure 5-7).

This is the second most abundant taxon in most Maestrichtian samples. The writer follows Pessagno (1967) in accepting *G. volutus* as a senior synonym of *G. messinae* Bronnimann. These specimens closely resemble New Zealand counterparts although the double end chambers and apertures were not encountered.

Globigerinelloides subcarinatus (Bronnimann)
(Plate 2, Figures 8-9).

This tiny and distinctive species occurs sparsely in only four Maestrichtian sample. The end chambers normally are broken away.

Hedbergella monmouthensis (Olsson)
(Plate 3, Figures 1-2).

Present in low numbers in most samples. Reaches a peak in Sample 33-4(32-34 cm) where it constitutes 2% of the fauna. The stratigraphically lower occurrences show no transition to *Hedbergella holmdelensis* Olsson, a species characteristic of the Middle and Lower Maestrichtian.

Rugoglobigerina rugosa (Plummer)
(Plate 3, Figures 3-8).

Normally the third or fourth most abundant taxon in most samples. Specimens show a considerable variation in the degree of ornamentation. Most show the typical heavy rugose ornament while a few are semi-rugose or even thin walled and pustulate. The latter resemble *Rugoglobigerina pustulata* Bronnimann.

Rugoglobigerina rotundata Bronnimann
(Plate 3, Figure 9).

Present in much smaller numbers than *R. rugosa*. It is debatable whether this is a distinct species or a variant of *R. rugosa*. Certainly at Site 208, there is a distinct difference between the two species in chamber arrangement and size.

Globotruncana (Rugotruncana) circumnodifer (Finlay)
(Plate 4, Figures 1-4).

Present in the four lowermost samples. This species has a distinctive four- to five-chambered test with heavy rugose ornament and strong paired keels. There is similarity to *R. rugosa* but the presence of strong paired keels make the distinction easy. First described from New Zealand where it occurs with *G. (A.) mayaroensis* Bolli. It is interesting to note, however, that at Site 208, the range of *G. (R.) circumnodifer* terminates prior to the appearance of *G. (A.) mayaroensis*. *G. (R.) circumnodifer* is obviously related to *G. (R.) subcircumnodifier* (Gandolfi) and other occurrences of *Rugotruncana*. A study of this group is currently under way.

Globotruncanella petaloidea (Gandolfi)

A single specimen is present in Sample 33-5(94-96 cm). This is the first record of the species from the southwest Pacific area.

Globotruncana (Abathomphalus) mayaroensis Bolli
(Plate 4, Figures 7-9).

Occurrs only near the top of the Maestrichtian succession in Samples 33-2(112-114 cm) and 33-3(26-28 cm). Extremely rare with only about fifteen tests being recovered from these two samples. Identical in size and morphology to specimens in the Whangai and Rakauroa Formations (Webb, 1971). The related *G. (A.) intermedia* Bolli is present in Northland, New Zealand (Webb, 1971), but has not been seen in the Lord Howe Rise material.

Globigerina triloculinoides Plummer
(Plate 5, Figures 4-5).

This species is not particularly common but tends to increase in abundance towards the upper part of the Paleocene succession.

Globorotalia pseudobulloides (Plummer)
(Plate 5, Figures 1-2).

Most common in the lower part of the Paleocene, particularly in Sample 30-5(112-114 cm) where it makes up 18% of the total fauna.

Globorotalia uncinata Bolli
(Plate 6, Figures 1-3)

Appears first in Sample 30-3(112-114 cm) but further sampling might extend its entry slightly lower. This species exhibits some variation in outline but satisfies the diagnosis in possessing a flat or slightly convex spiral side with curved and slightly depressed sutures and a more strongly convex umbilical side with radial and more depressed sutures. Umbilicus narrow, deep, and open. Outline subacute in side view. Aperture elongate interio-marginal extra-umbilical to umbilical. Final chamber frequently broken away. Reticulate ornament, slightly coarser than for *G. pseudobulloides* and *G. triloculinoides*. Also present in *G. pusilla pusilla-G. angulata* Zone. Not reported as yet from New Zealand.

Globorotalia angulata (White)
(Plate 6, Figures 4, 7).

Appears first in Sample 29-6(53-55 cm) and present in low numbers throughout the *G. pusilla pusilla-G. angulata* Zone. Not continuing into *G. pseudomenardii* Zone. Transitional forms between *G. uncinata* and *G. angulata* are present (Plate 6, Figure 4). *Globorotalia angulata* is never as acutely angled as in Bolli (1957, pl. 17, figs. 7-9), but is closer to those shown in his plate 17, figures 10-12. Spiral side flat with strongly recurved, slightly depressed sutures, ubilical side strongly convex with radial strongly depressed sutures. Umbilicus narrow and deep. The occurrence at Site 208 appears earlier than in New Zealand where Jenkins (1971) reports it in Late Paleocene post-Teurian (i.e. Waipawan) sediments.

Globorotalia compressa (Plummer)

Restricted to the lower part of the Paleocene succession (*G. daubjergensis-G. pseudobulloides* Zone). Tests very small and final chamber frequently broken away.

Globorotalia ehrenbergi Bolli
(Plate 5, Figure 6).

Appears first in *G. uncinata* Zone, Sample 30-3(39-41 cm), and ranges up to the top of the *G. pusilla pusilla-G. angulata* Zone. Test larger than the preceding *Globorotalia compressa*. The two species do not overlap at Site 208. It precedes *G. pseudomenardii* and again the two species do not overlap. Periphery acute but not keeled. Final chamber often broken away. Not reported by Jenkins (1971) from New Zealand.

Globorotalia pseudomenardii Bolli
(Plate 5, Figures 7-9).

Occurs abundantly in the uppermost of the Paleocene samples, 29-1(45-47 cm). Periphery strongly acute and with a distinct keel. Chambers strongly compressed. Final chamber frequently broken away.

Globorotalia acarinata (Subbotina)
(Plate 6, Figure 9).

Appears high in the *G. pusilla pusilla-G. angulata* Zone in Sample 29-3(118-120 cm) and continues into the *G. pseudomenardii* Zone where it is the dominant taxon.

Globorotalia mckannai (White)

Appears at the same level as *G. acarinata* and ranges up into the *G. pseudomenardii* Zone.

Globorotalia pusilla pusilla Bolli

Appears first in Sample 29-6(53-55 cm) with *G. angulata* and ranges up into the *G. pseudomenardii* Zone. Uncommon. Small, early circular tests with a subacute outline in side view. Strongly curved sutures on the spiral side with sutures slightly depressed, particularly in the final whorl. A small narrow umbilicus.

Globorotalia pusilla laevigata Bolli

A few tests enter along with *G. pseudomenardii* in Sample 29-1(45-47 cm).

STRUCTURE OF FORAMINIFERAL POPULATIONS

An attempt is made to record the structure of individual populations by census counts and species diversity determinations. As pointed out in the introductory section, bioturbation structures are common throughout this Maestrichtian-Paleocene section and populations have probably been reorganized to some unknown degree. This factor has been ignored in the present study.

Census Studies

The residue resulting from the washing to 10 cc of core was reduced to a much smaller quantity by microsplitter. This residue was spread on a squared counting tray and species determinations made for 300 randomly selected specimens. Only species with counts of five or more were recorded in the histograms shown in Figures 4 and 5. Information from each sample is summarized in Figure 6 where data is reduced to percentage form and portrayed in stratigraphic order. The first column shows the proportion of planktonic to benthic taxa, while the second and third columns provide the percentages for the dominant benthic and planktonic taxa. Maestrichtian samples are particularly rich and lend themselves readily to this treatment. Only five of the Paleocene samples were rich enough to be subjected to census studies.

Maestrichtian samples reveal that, in almost every case, planktonic taxa constitute more than 75 to 80% of the faunas (Figure 4). *Heterohelix striata* (Ehrenberg) is by far the most dominant taxon, making up between 31% and 53% of the faunas. (Figure 6). Low in the Maestrichtian succession, *Globigerinelloides volutus* (White) and *Rugoglobigerina rugosa* (Plummer) are the next most abundant taxa. Towards the top of the Maestrichtian, *Pseudotextularia deformis* (Kikoine) becomes increasingly prolific and, in the uppermost sample (33-2, 30-32 cm), it is the dominant species. *Gavelinella beccariiformis* (White) is the dominant benthic taxon throughout the Maestrichtian but never achieves an abundance greater than 12%. It may be significant that low in the Maestrichtian succession, the percentage occurrence of *G. beccariiformis* increases slightly while the percentage for *H. striata* is slightly lower (Figure 6). Census data on Maestrichtian sediments indicate the existence of a high degree of population stability.

Much greater variability characterizes the Paleocene succession. A sample from the *G. daubjergensis-G. pseudobulloides* Zone (31-2, 33-35 cm) contains no planktonic taxa but a rich assemblage of benthic taxa. *Gavelinella beccariiformis* (White) attains its greatest abundance for the entire section at 33% of the fauna (Figures 5 and 6). Other prominent taxa include *Cibicides* sp., *Anomalinoides piripaua* (Finlay), *Nodosaria velascoensis* Cushman, *Gyroidinoides subangulatus* (Plummer), *G. globosus* (Hagenow), and *Nuttallides* aff. *truempyi* (Nuttall), in that order.

Slightly higher in the same zone (Sample 31-2, 33-35 cm), planktonics are present but the most abundant, *G. pseudobulloides* (Plummer), constitutes only 5% of the fauna. Here, *Nuttallides* aff. *truempyi* (Nuttall) is the dominant taxon, making up 19% of the fauna (Figures 5 and 6), and is closely followed by *Bulimina serratospina* Finlay, *Cibicides* sp., *Bolivinopsis compta* Finlay, *Gavelinella beccariiformis* (White), *Anomalinoides piripaura* (Finlay), *Bulimina subbortonica* Finlay–*quadrata* Plummer, *Gyroidinoides subangulatus* (Plummer), *G. globosus* (Hagenow), and *Pullenia coryelli* White.

Higher in the *G. daubjergensis-G. pseudobulloides* Zone (Sample 30-5, 112-114 cm), planktonic taxa increase markedly to constitute 52% of the fauna, with *Globorotalia pseudobulloides* (Plummer) dominant at 18%, followed by *Globorotalia compressa* (Plummer) at 13%. Here, the dominant benthic is *Nuttallides* aff. *truempyi* (Nuttall), also

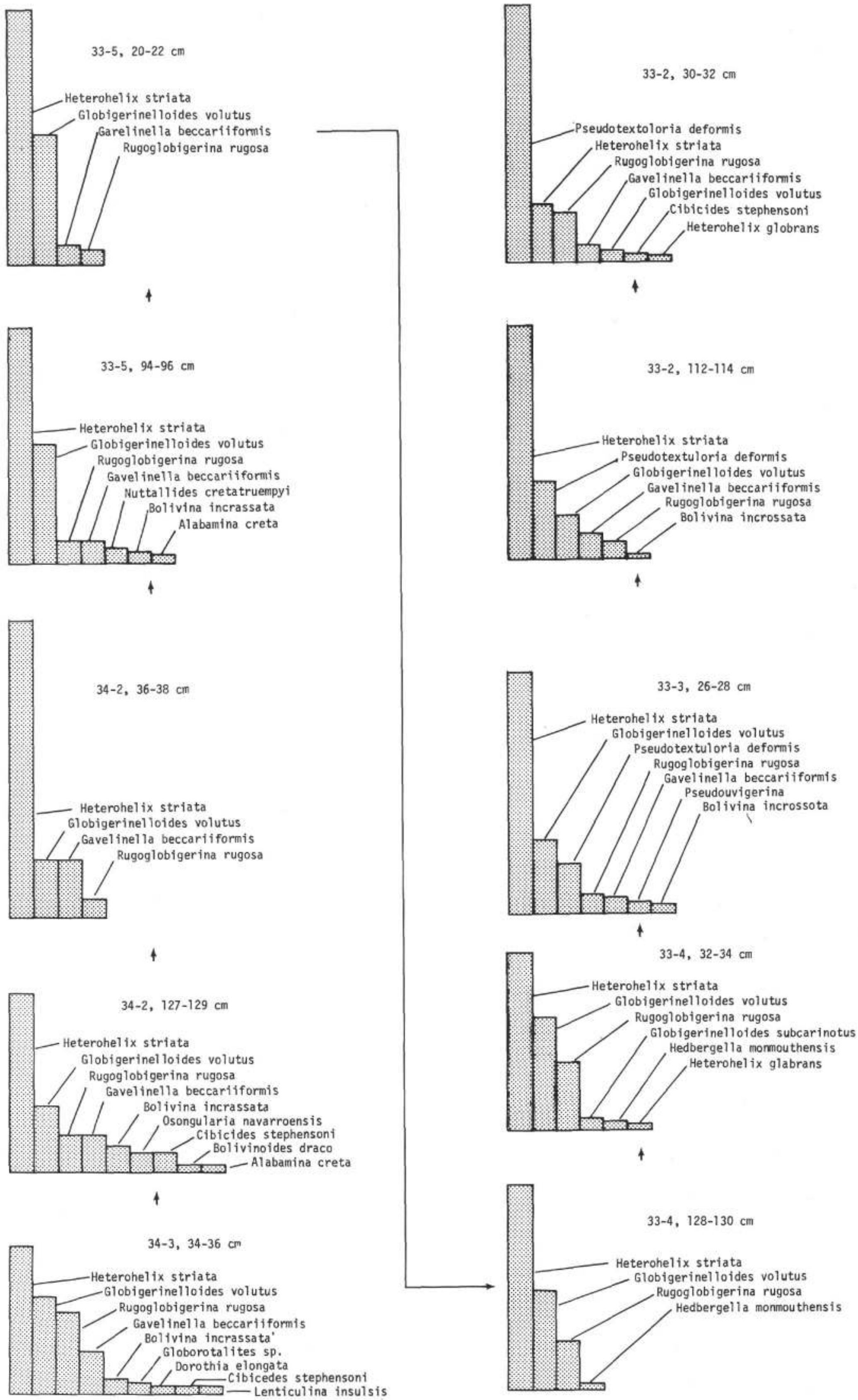

Figure 4. *Census histograms of ten Maestrichtian faunas. Based on 300 counts of randomly selected foraminifera. Species with counts of less than five are excluded.*

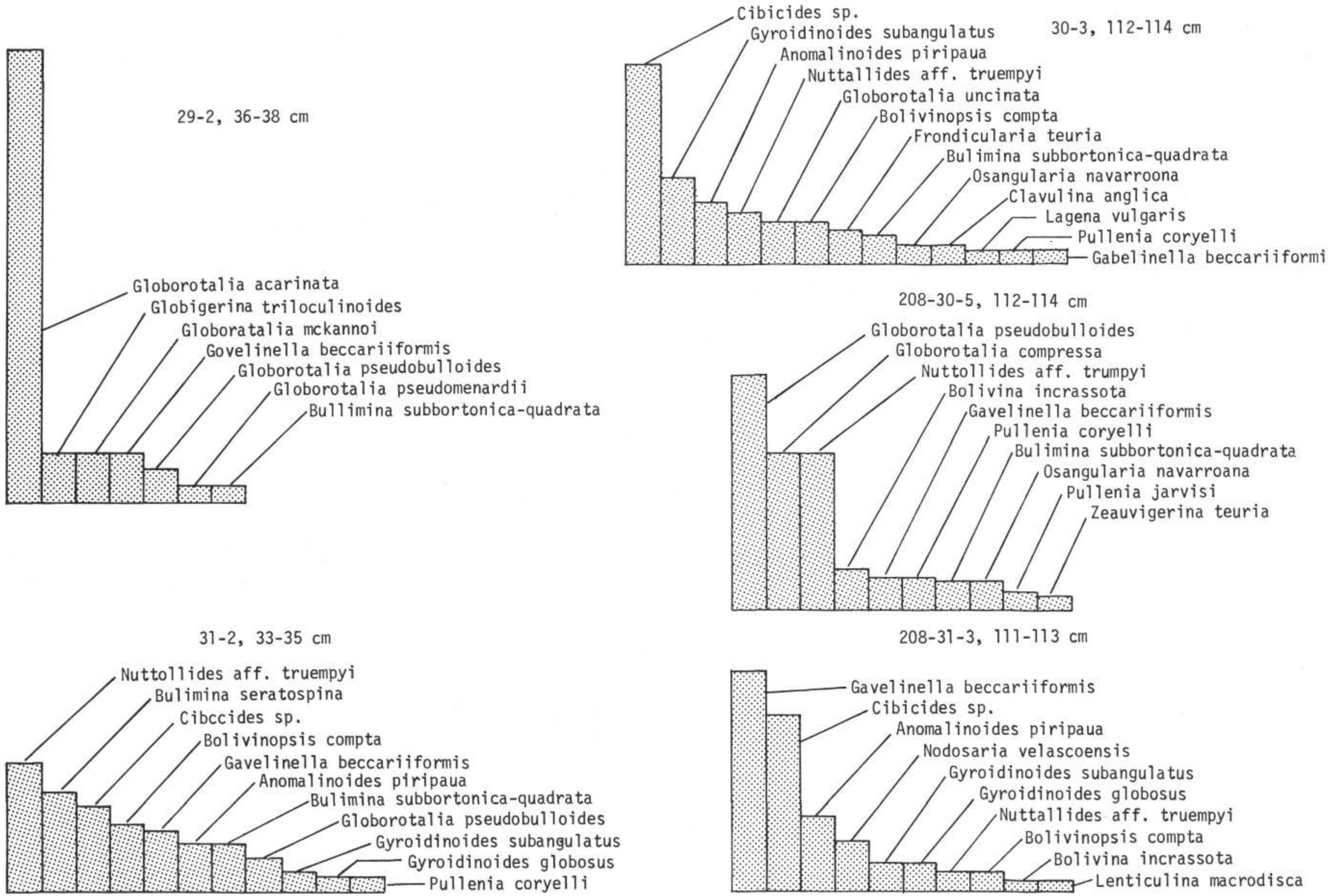

Figure 5. *Census histograms of five Paleocene faunas. Based on 300 counts of randomly selected foraminifera. Species with counts of less than five are excluded.*

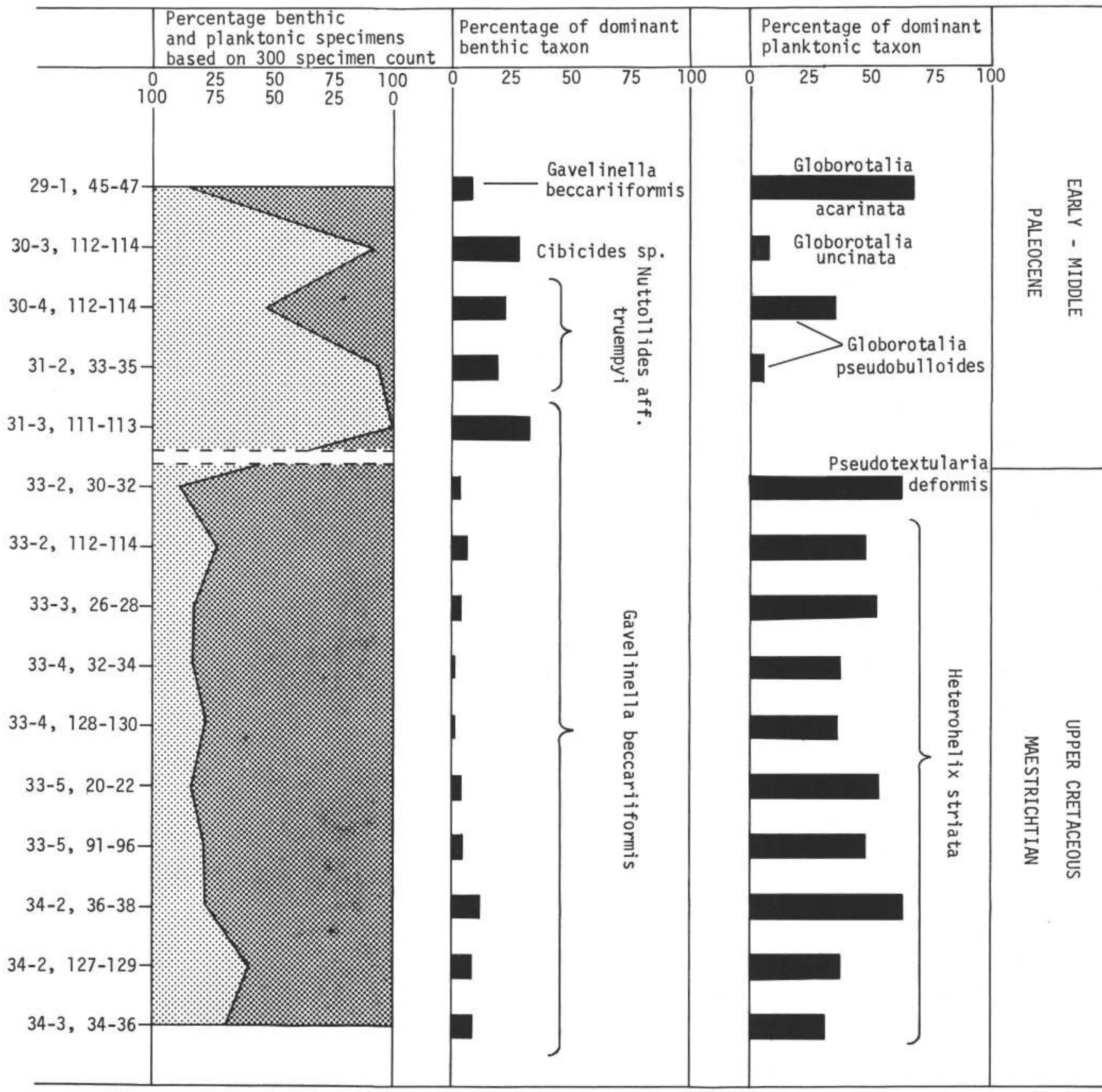

Figure 6. *Information shown is based on census histograms (Figures 4 and 5). Data is based on 300 counts and reduced to percentage form. First column shows proportion of benthic to planktonic taxa. Center and right hand columns show the dominant benthic and planktonic taxa and their percentage occurrence.*

at 13%. Benthic species making up between 2% and 6% of the fauna included *Bolivina incrassata* (Reuss), *Gavelinella beccariiformis* (White), *Pullenia coryelli* White, *Bulimina subbortonica* Finlay–*quadrata* Plummer, *Osangularia navarroana* (Cushman), and *Pullenia jarvisi* Cushman, in that order.

Sample 30-3, 112-114 cm, from low in the *G. uncinata* Zone, is dominated by benthics (94%) (Figures 5 and 6). *Cibicides* sp. is clearly the most dominant taxon (22%) with *Gyroidinoides subangulatus* (Plummer), *Anomalinoides piripaua* (Finlay), *Nuttallides* aff. *truempyi* (Nuttall), *Bolivinopsis compta* Finlay, *Frondicularia teuria* Finlay, *Bulimina subbortonica* Finlay–*quadrata* Plummer, *Osangularia navarroana* Cushman, *Clavulina anglica* (Cushman), *Lagena vulgaris* Williamson, *Pullenia coryelli* White, and *Gavelinella beccariiformis,* in that order, constituting between 12% and 2% of the total fauna. *G. uncinata* Bolli is the dominant planktonic taxon but makes up only 5% of the fauna.

The uppermost sample (29-1, 45-47 cm) (lowermost *G. pseudomenardii* Zone) shows a major shift in the proportions of planktonic and benthic taxa. Planktonic taxa constitute 85% of the total fauna, a figure common to the Maestrichtian faunas below (Figures 5 and 6).

Globorotalia acarinata (Subbotina) is the dominant taxon at 68% with *Globigerina triloculinoides* Plummer and *Globorotalia mckannai* (White) both constituting 7% of the fauna. The important zone fossil *Globorotalia pseudomenardii* Bolli makes up only 2% of the fauna. The dominant benthic taxon is *Gavelinella beccariiformis* (White) at 7%.

In conclusion, two further points emerge from this census study. First, agglutinated taxa play almost no part in the histograms of Maestrichtian and Paleocene faunas (Figures 4 and 5). In the Maestrichtian, no agglutinated benthic constitutes more than 2% of the total fauna, while in the Paleocene only *Bolivinopsis compta* Finlay and *Clavulina anglica* (Cushman) appear in the histograms (Figure 5). The former makes up 10% of one population and the latter only 3% of another population. The second point is that important stage and zone taxa exhibit very low abundances, often less than 2% of the total fauna. These include such important taxa as *Gaudryina healyi* Finlay, *Dorothia elongata* Finlay, *Frondicularia rakauroana* (Finlay), *Bolvinoides draco* Marsson, *Globotruncana (Rugotruncana) circumnodifer* (Finlay), and *Globotruncana (Abathomphalus) mayaroensis* Bolli in the Maestrichtian and *Gaudryina whangaia* Finlay, *Clavulina anglica* (Cushman), *Conotrochammina whangaia* Finlay, *Frondicularia teuria* Finlay, *Neoflabellina semireticulata* (Cushman and Jarvis), *N. rugosa* (d'Orbigny), *Globorotalia angulata* Bolli, and *G. pseudomenardii* Bolli in the Paleocene.

The benthic taxa named here are much more abundant in the New Zealand Maestrichtian and Paleocene. In most cases, the diagnostic planktonic taxa occur with about the same rarity as their counterparts in New Zealand. Davids (1966) has provided census counts on Maestrichtian planktonics in Trinidad and other areas which indicate that important taxa such as *Globotruncana (Abathomphalus) mayaroensis* Bolli are also rare in low-latitude areas. His studies of similar Maestrichtian sediments from the Gulf-Caribbean-eastern North America area also show that planktonics are dominant and that Heterohelicidae dominate the planktonic taxa, followed by *Globigerinelloides* and *Rugoglobigerina*. Unfortunately, such census data is not available for low-latitude Paleocene populations and it would be interesting to know if the diagnostic Paleocene planktonics named above are also present in such low quantities as in the Site 208 populations. Another point, as yet unexplained, is the extreme rarity of *Chiloguembelina* in the Paleocene at Site 208, in sharp contrast to the overwhelming abundance of *Heterohelix* in the underlying Maestrichtian.

Species Diversity Studies

Counts of the total number of species per sample (in 10 cc washed samples) reinforces the rule that low diversity is generally accompanied by high dominance. For the Maestrichtian, it may be seen (Figures 6 and 7) that although there are only 12 species of planktonic foraminifera present, they commonly make up 75 to 80% of the fauna in terms of test counts. The calcareous benthic species are relatively diverse at 62 species yet constitute only 15 to 20% of the fauna. None of the 11 species of Maestrichtian agglutinated foraminifera constitute more than 1 to 2% of the fauna. Species diversity for agglutinated taxa is very stable through the Maestrichtian and Paleocene and seldom rises above three or four for any one sample (Figure 7). There is a tendency for one or two samples low in the Maestrichtian succession to have as many as eight agglutinated taxa. The number of calcareous benthic taxa shows a slight decrease towards the top of the Maestrichtian, followed by a sharp increase at the base of the Paleocene succession and a further slight decrease higher in the section. One characteristic of the Paleocene calcareous benthic taxa is the considerable fluctuation in species numbers, perhaps reflecting instability in the bottom environment. Planktonic diversity shows a steady increase up the Paleocene succession. The marked contrast in diversity of planktonics across the Maestrichtian-Paleocene boundary is striking (Figure 7).

CRETACEOUS-TERTIARY BOUNDARY

The major change occurring across the Maestrichtian-Paleocene boundary at Site 208 is already apparent from the foregoing discussion and is obvious in Figures 6 and 7. Census studies have shown a major shift in the proportions of planktonic and benthic groups across this boundary, i.e., 12% benthic content in Maestrichtian Sample 33-2, 30-32 cm to 100% in the Early Paleocene Sample 31-2, 111-113 cm. Ecological changes occurring across this boundary involved a massive increase in productivity among the benthic groups whereas planktonic groups suffered total destruction followed by progressive revival. Calcareous benthics in some lower samples, particularly 33-1, 21-23 cm, are poorly preserved and commonly broken. They are accompanied by abundant fish teeth and sponge spicules. There is no indication of Maestrichtian taxa reworked into the Paleocene. The importance of this particular boundary is made clearer when we consider the level of extinction of the three main foraminiferal groups. This information is provided in Figures 2 and 3 and has been summarized in Figure 8. These figures show that there has been extinction of 100% of planktonics, 52% of calcareous benthics, and 73% of agglutinated benthics across the Maestrichtian-Paleocene boundary at Site 208. This provides an average of 62% extinction for the entire fauna. Extinction figures for Trinidad, extracted from several sources, are also shown in Figure 8. Here the extinction for all groups is only 27%. This difference is striking and could be explained in two ways. First, Maestrichtian-Paleocene faunas of Trinidad might represent shallower inshore sites of deposition. Under such conditions, benthic taxa would have a higher tolerance to environmental changes brought about by hydrological or tectonic influences and tend to range through the Maestrichtian-Paleocene boundary. Second, the low-latitude and warmer-water Trinidad faunas may have experienced little climatic fluctuation across the boundary and a resulting low incidence of extinction among the benthic community. In the southwest Pacific (Site 208), the transition from Maestrichtian to Paleocene may have been marked by a distinct drop in temperature and so account for the very high extinction rate among benthic taxa. These suggestions do not explain the one hundred percent extinction common to planktonic taxa in both the

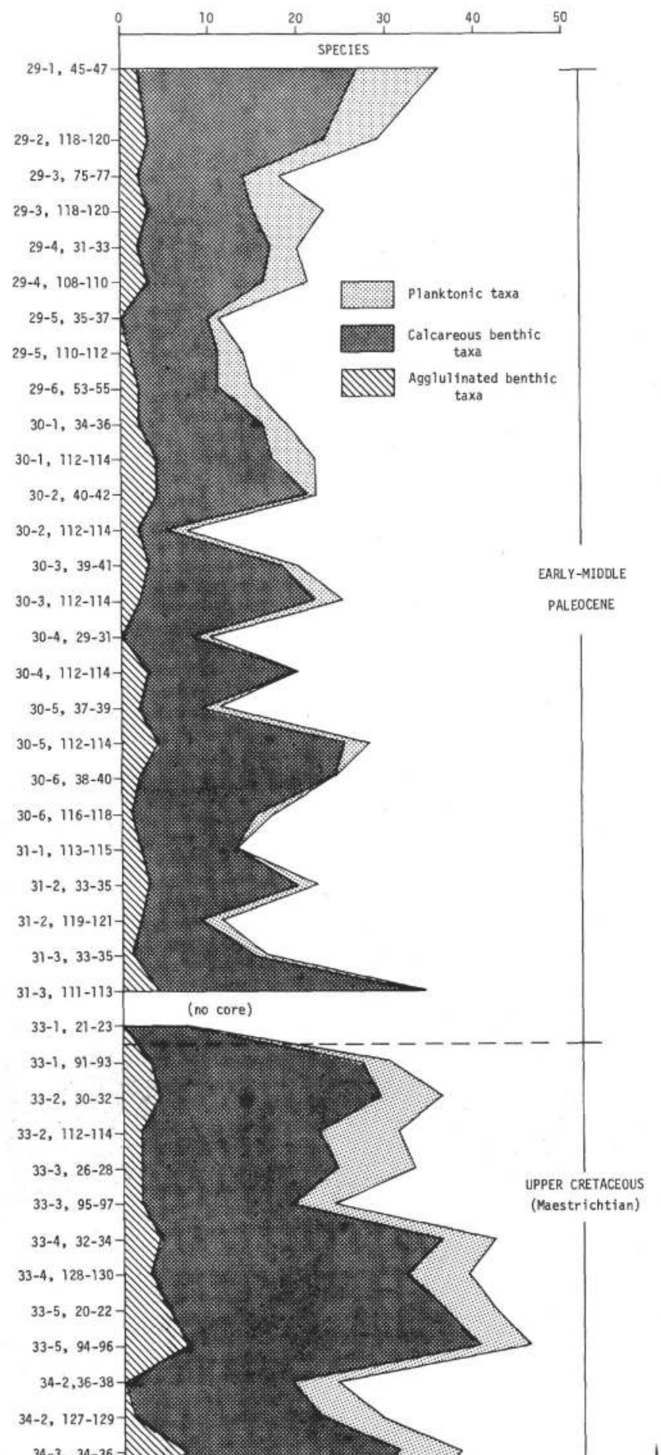

Figure 7. *Species diversity for all Maestrichtian and Paleocene samples, showing numbers of agglutinated and calcareous benthic and planktonic taxa extracted after exhaustive picking of a 10-cc sample retained on screen of 200 mesh.*

low-latitude Trinidad and higher-latitude Lord Howe Rise faunas.

A disconformity, or at least a hiatus, separates the Maestrichtian and Paleocene at Site 208. The writer suggests that, following warm to temperate, relatively deep water conditions in the Maestrichtian, there was an elevation of Maestrichtian sediments or a drop in sea level, or both, before the onset of Paleocene sedimentation. Early Paleocene faunas suggest shallower and perhaps cooler conditions. By the mid-Paleocene, water depths had increased and the abundance of planktonic taxa suggests a return to warmer conditions similar to those prevailing during the Maestrichtian.

CONCLUDING REMARKS

From the present study, it may be seen that drilling at Site 208 terminated in Maestrichtian pelagic chalks. The age of the oldest marine sediments in this part of the Lord Howe Rise remains unanswered. Population census counts and diversity counts show that Maestrichtian foraminiferal faunas maintain a high degree of stability to the base of the cored section. There is, therefore, no suggestion that environments of deposition are shallowing downward and it seems reasonable to predict that Campanian, or even older marine sediments, are present lower in the sedimentary column of the Lord Howe Rise. This can only be tested by further drilling.

ACKNOWLEDGMENTS

The writer wishes to thank the Deep Sea Drilling Project and especially the paleontologists of Leg 21 for making this material available for study. Miss Mary Jennings prepared SEM prints and Mr. R. C. Brazier and Mr. B. J. Burt assisted with the preparation of the plates. Scanning Electron Microscope photographs were made by the author on a Cambridge Mark II instrument at the Physics and Engineering Laboratory, Department of Scientific and Industrial Research, Gracefield, Lower Hutt.

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	Lord Howe Rise – Site 208		Trinidad (after Beckmann, 1960, 1957; Bolli, 1957; and Davids, 1966)	
Total number of species in the Paleocene	Agglutinated benthic species	9	Agglutinated benthic species	91
	Calcareous benthic species	7	Calcareous benthic species	172
	Planktonic species	14	Planktonic species	22
	Total	30	Total	285
Total number of species in the uppermost Cretaceous	Agglutinated benthic species	11	Agglutinated benthic species	66
	Calcareous benthic species	62	Calcareous benthic species	149
	Planktonic species	12	Planktonic species	27
	Total	85	Total	242
Number of species entering in the Paleocene	Agglutinated benthic species	6	Agglutinated benthic species	31
	Calcareous benthic species	27	Calcareous benthic species	56
	Planktonic species	14	Planktonic species	22
	Total	47	Total	109
Number of species ranging from Cretaceous to Paleocene	Agglutinated benthic species	3	Agglutinated benthic species	60
	Calcareous benthic species	30	Calcareous benthic species	116
	Planktonic species	0	Planktonic species	0
	Total	33	Total	176
Number of species becoming extinct at Cretaceous-Tertiary boundary	Agglutinated benthic species	8	Agglutinated benthic species	6
	Calcareous benthic species	32	Calcareous benthic species	33
	Planktonic species	12	Planktonic species	27
	Total	52	Total	66
Extinction of species at Cretaceous-Tertiary boundary expressed as a percentage	Agglutinated benthic species	73%	Agglutinated benthic species	9%
	Calcareous benthic species	52%	Calcareous benthic species	22%
	Combined benthic species	54%	Combined benthic species	18%
	Planktonic species	100%	Planktonic species	100%
	Extinction for all elements microfauna combined	62%	Extinction for all elements of microfauna combined	27%

Figure 8. *Table showing numbers of species of the various major groups restricted to the Maastrichtian or Paleocene, or present in both the Maastrichtian and Paleocene. Figures for Trinidad are also shown for comparison.*

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PLATE 1

All specimens from Site 208

Figure 1	*Heterohelix striata* (Ehrenberg) 33-4(32-34 cm), ×180.
Figure 2	*Heterohelix striata* (Ehrenberg) 33-4(32-34 cm), ×140.
Figure 3	*Heterohelix striata* (Ehrenberg) 33-4(32-34 cm), ×180.
Figure 4	*Heterohelix glabrans* (Cushman) 33-4(128-130 cm), ×280.
Figure 5	*Pseudotextularia deformis* (Kikoine) 33-2(114-116 cm), ×200.
Figure 6	*Pseudotextularia deformis* (Kikoine) 33-2(30-32 cm), ×187.
Figure 7	*Pseudotextularia deformis* (Kikoine) 33-2(112-114 cm), ×187.
Figure 8	*Pseudotextularia deformis* (Kikoine) 33-2(112-114 cm), ×175.
Figure 9	*Planoglobulina carseyae* (Plummer) 33-2(30-32 cm), ×175.

PLATE 1

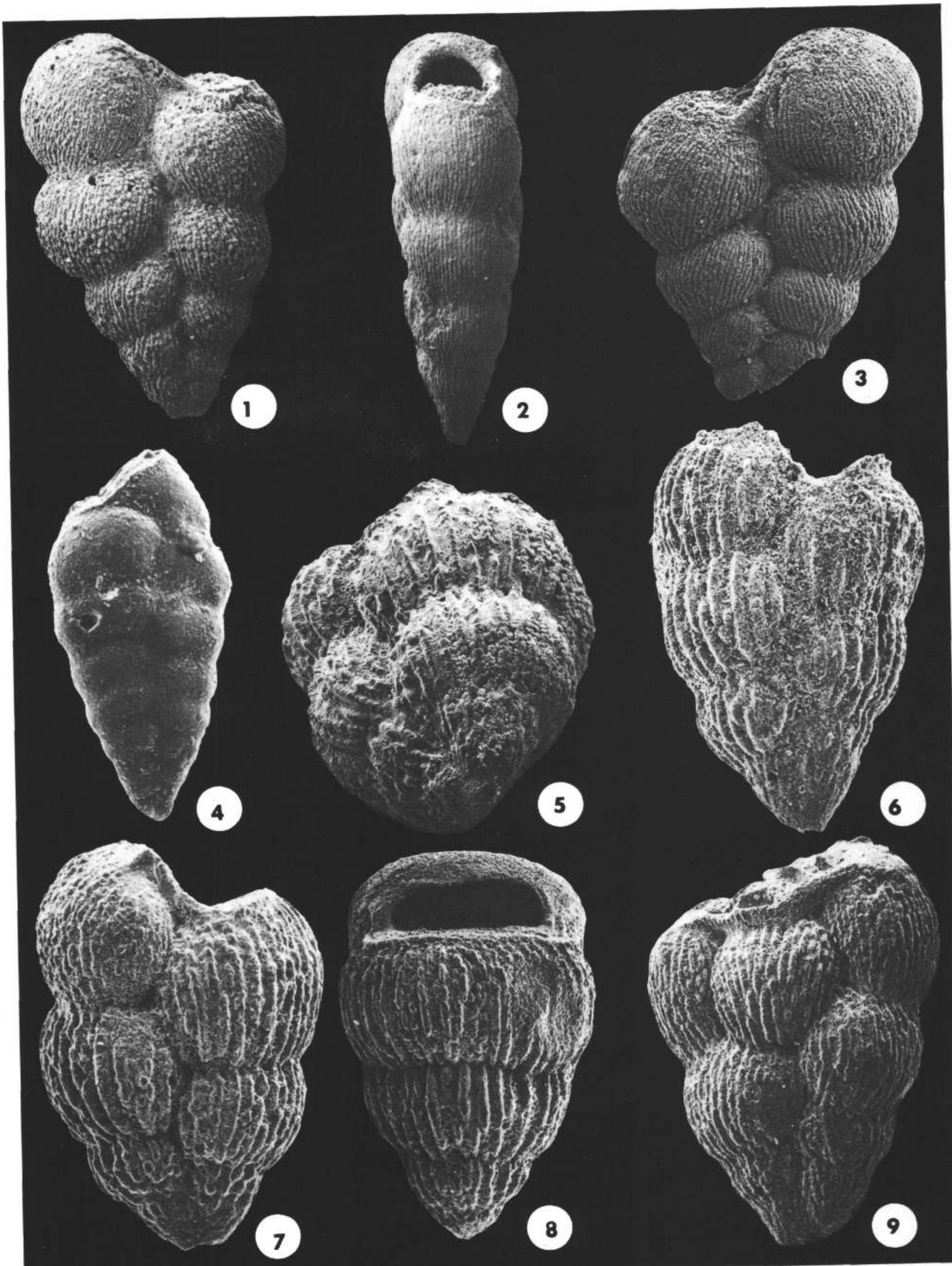

PLATE 2
All specimens from Site 208

Figure 1	*Chiloguembelina wilcoxensis* (Cushman and Ponton) 29-1(45-47 cm), X280.
Figure 2	*Chiloguembelina wilcoxensis* (Cushman and Ponton) 29-1(45-47 cm), X325.
Figure 3	*Zeauvigerina teuria* Finlay 30-1(112-114 cm), X375.
Figure 4	*Zeauvigerina teuria* Finlay 30-1(112-114 cm) X375.
Figure 5	*Globigerinelloides volutus* (White) 33-2(112-114 cm), X375.
Figure 6	*Globigerinelloides volutus* (White) 33-5(20-22 cm), X325.
Figure 7	*Globigerinelloides volutus* (White) 33-4(128-130 cm), X325.
Figure 8	*Globigerinelloides subcarinatus* (Bronnimann) 33-5(94-96 cm), X300.
Figure 9	*Globigerinelloides subcarinatus* (Bronnimann) 33-4(128-130 cm), X260.

PLATE 2

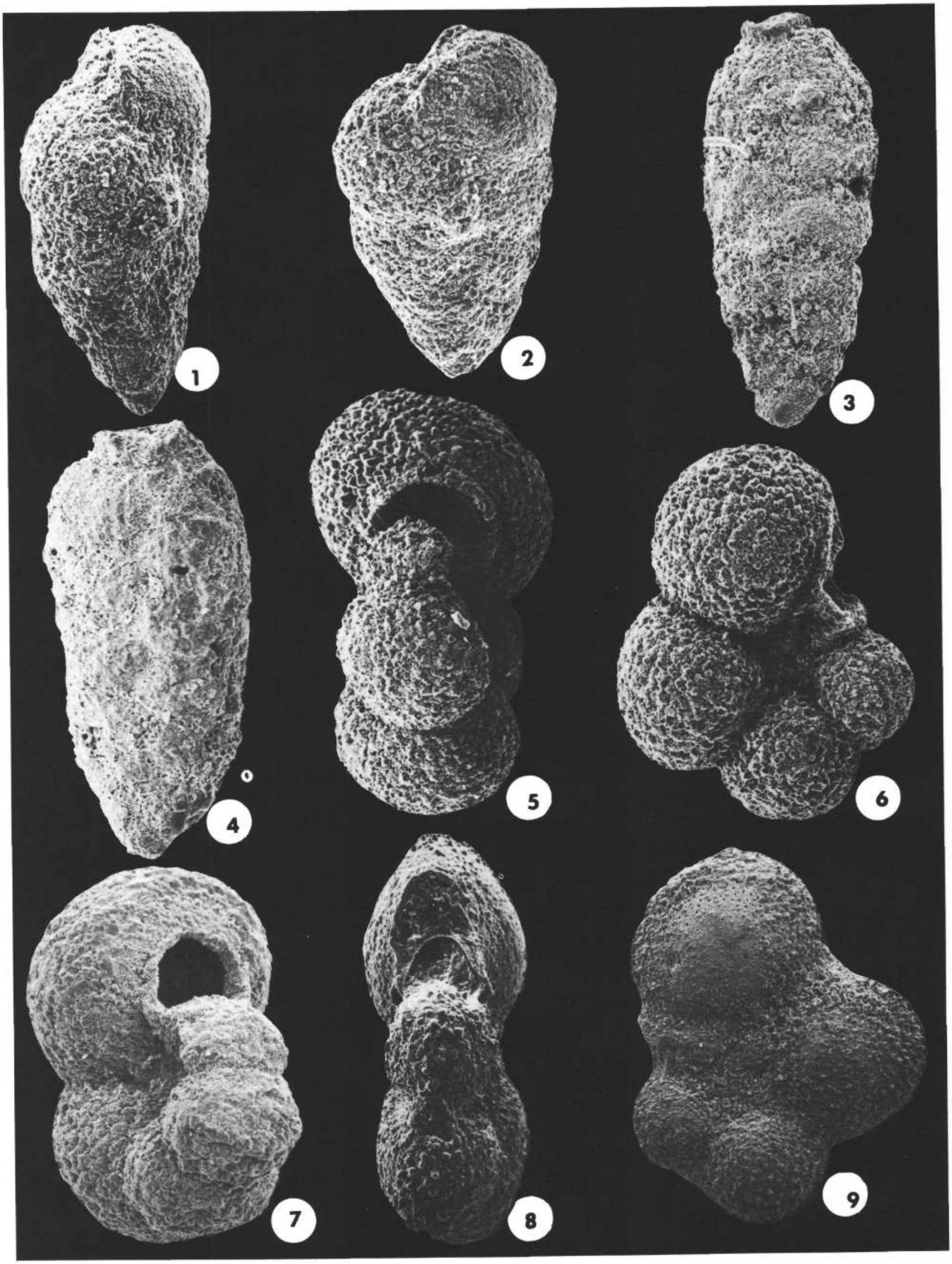

PLATE 3

All specimens from Site 208

Figure 1	*Hedbergella monmouthensis* (Olsson) 33-4(32-34 cm), X200.
Figure 2	*Hedbergella monmouthensis* (Olsson) 33-4(32-34 cm), X175.
Figure 3	*Rugoglobigerina rugosa* (Plummer) 33-5(20-22 cm), X220.
Figure 4	*Rugoglobigerina rugosa* (Plummer) 33-5(20-22 cm), X220.
Figure 5	*Rugoglobigerina rugosa* (Plummer) 33-4(32-34 cm), X220.
Figure 6	*Rugoglobigerina rugosa* (Plummer) 33-4(128-130 cm), X220.
Figure 7	*Rugoglobigerina rugosa* (Plummer) 33-2(30-32 cm), X220.
Figure 8	*Rugoglobigerina rugosa* (Plummer) 33-5(20-22 cm), X200.
Figure 9	*Rugoglobigerina rotundata* Bronnimann 33-5(20-22 cm), X150.

PLATE 3

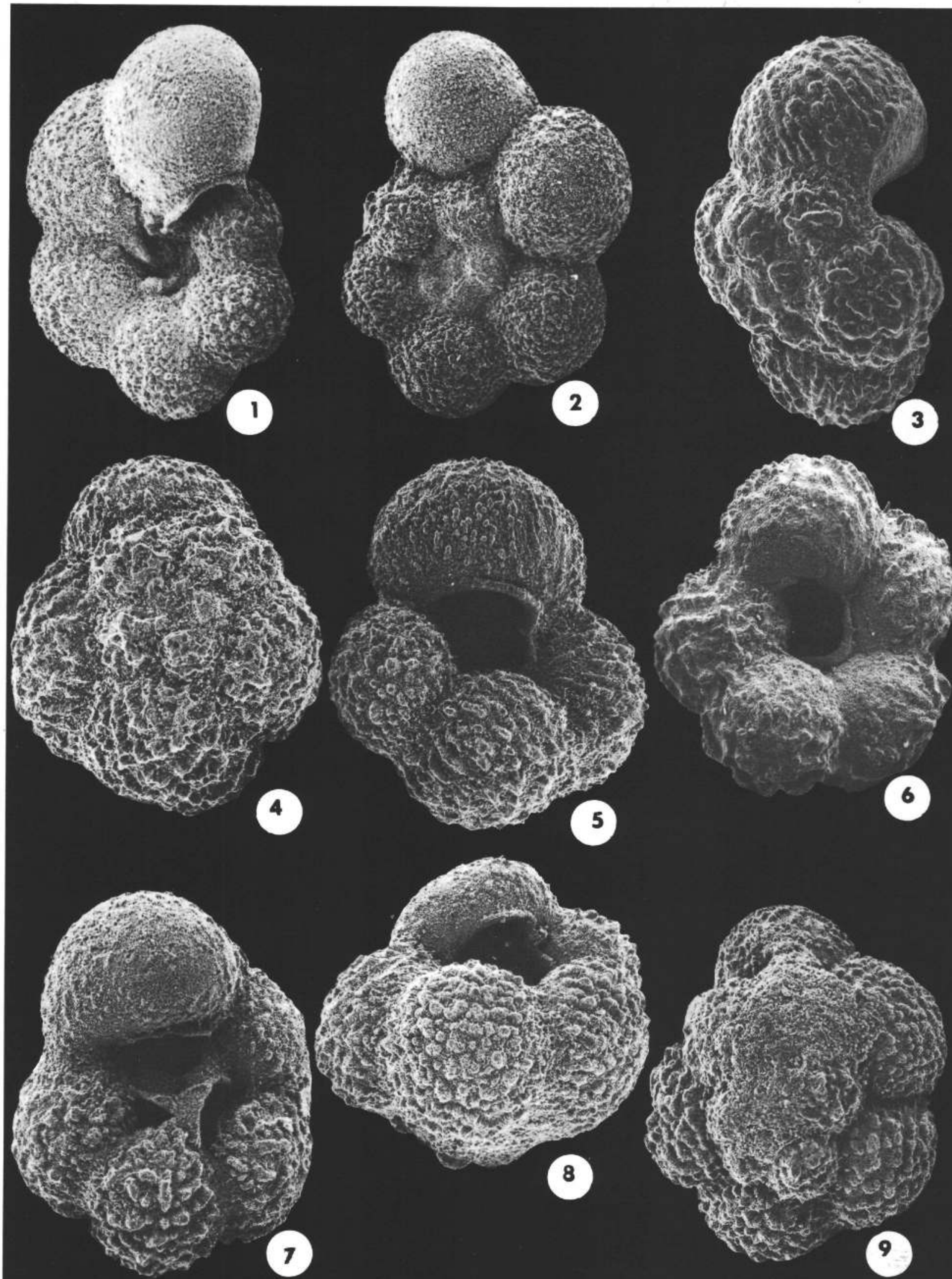

PLATE 4

All specimens from Site 208

Figure 1	*Globotruncana (Rugotruncana) circumnodifer* (Finlay) 33-5(94-96 cm), X145.
Figure 2	*Globotruncana (Rugotruncana) circumnodifer* (Finlay) 34-2(127-129 cm), X145.
Figure 3	*Globotruncana (Rugotruncana) circumnodifer* (Finlay) 33-5(94-96 cm), X145.
Figure 4	*Globotruncana (Rugotruncana) circumnodifer* (Finlay) 34-2(127-129 cm), X145.
Figure 5	*Globotruncana (Abathomphalus) mayaroensis* Bolli 33-3(26-28 cm), X185.
Figure 6	*Globotruncana (Abathomphalus) mayaroensis* Bolli 33-3(26-28 cm), X185.
Figure 7	*Globotruncana (Abathomphalus) mayaroensis* Bolli 33-2(112-114 cm), X185.
Figure 8	*Globotruncana (Abathomphalus) mayaroensis* Bolli 33-2(112-114 cm), X130.
Figure 9	*Globotruncana (Abathomphalus) mayaroensis* Bolli 33-2(112-114 cm), X120.

PLATE 4

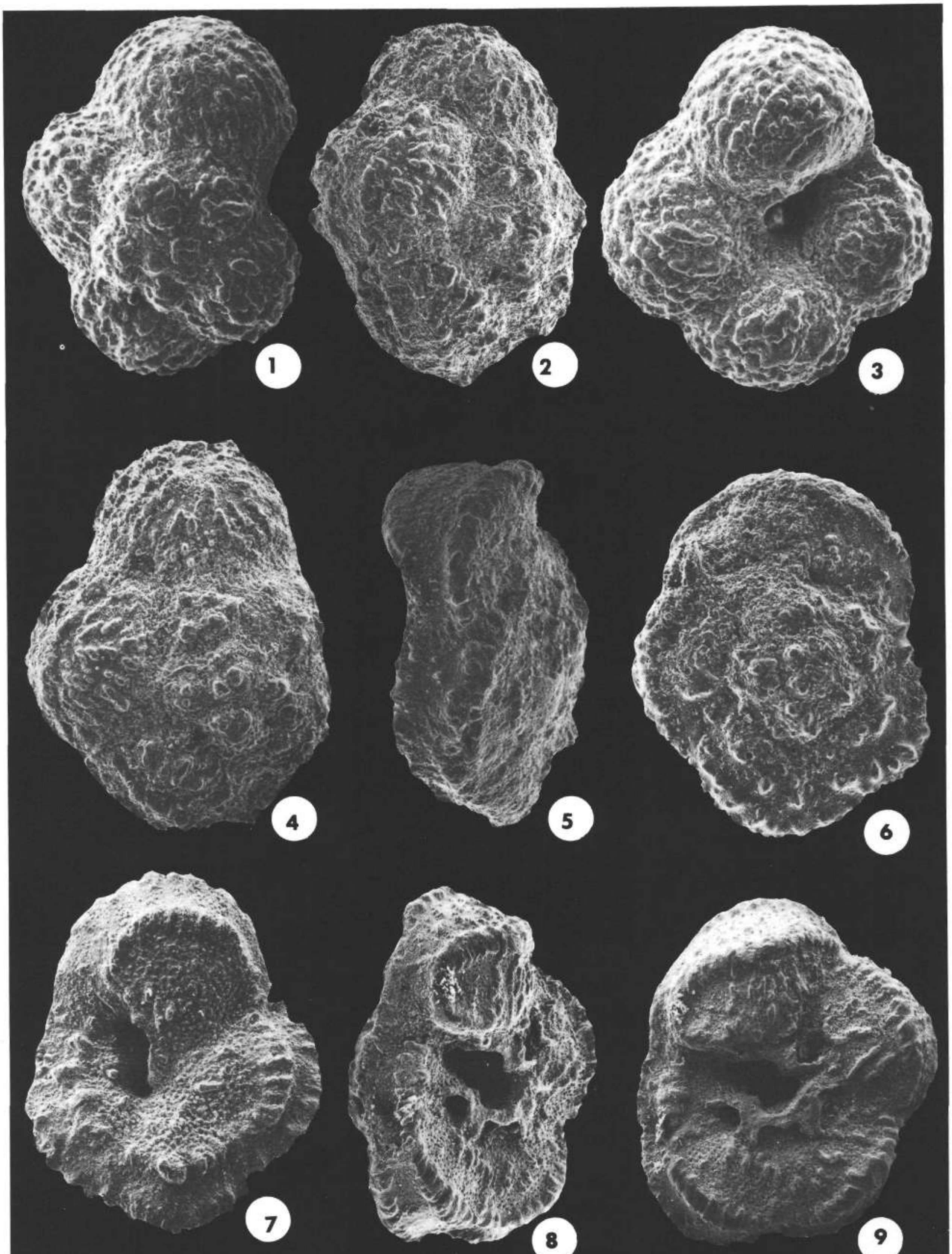

PLATE 5

All specimens from Site 208

Figure 1	*Globorotalia pseudobulloides* (Plummer) 30-5(112-114 cm), X220.
Figure 2	*Globorotalia pseudobulloides* (Plummer) 30-5(112-114 cm), X220.
Figure 3	*Globorotalia pseudobulloides* (Plummer) 30-5(112-114 cm), X200.
Figure 4	*Globigerina triloculinoides* Plummer 29-3(118-120 cm), X260.
Figure 5	*Globigerina triloculinoides* Plummer 29-3(118-120 cm), X240.
Figure 6	*Globorotalia ehrenbergi* Bolli 29-3(118-120 cm), X220.
Figure 7	*Globorotalia pseudomenardii* Bolli 29-1(45-47 cm), X280.
Figure 8	*Globorotalia pseudomenardii* Bolli 29-1(45-47 cm), X185.
Figure 9	*Globorotalia pseudomenardii* Bolli 29-1(45-47 cm), X260.

PLATE 5

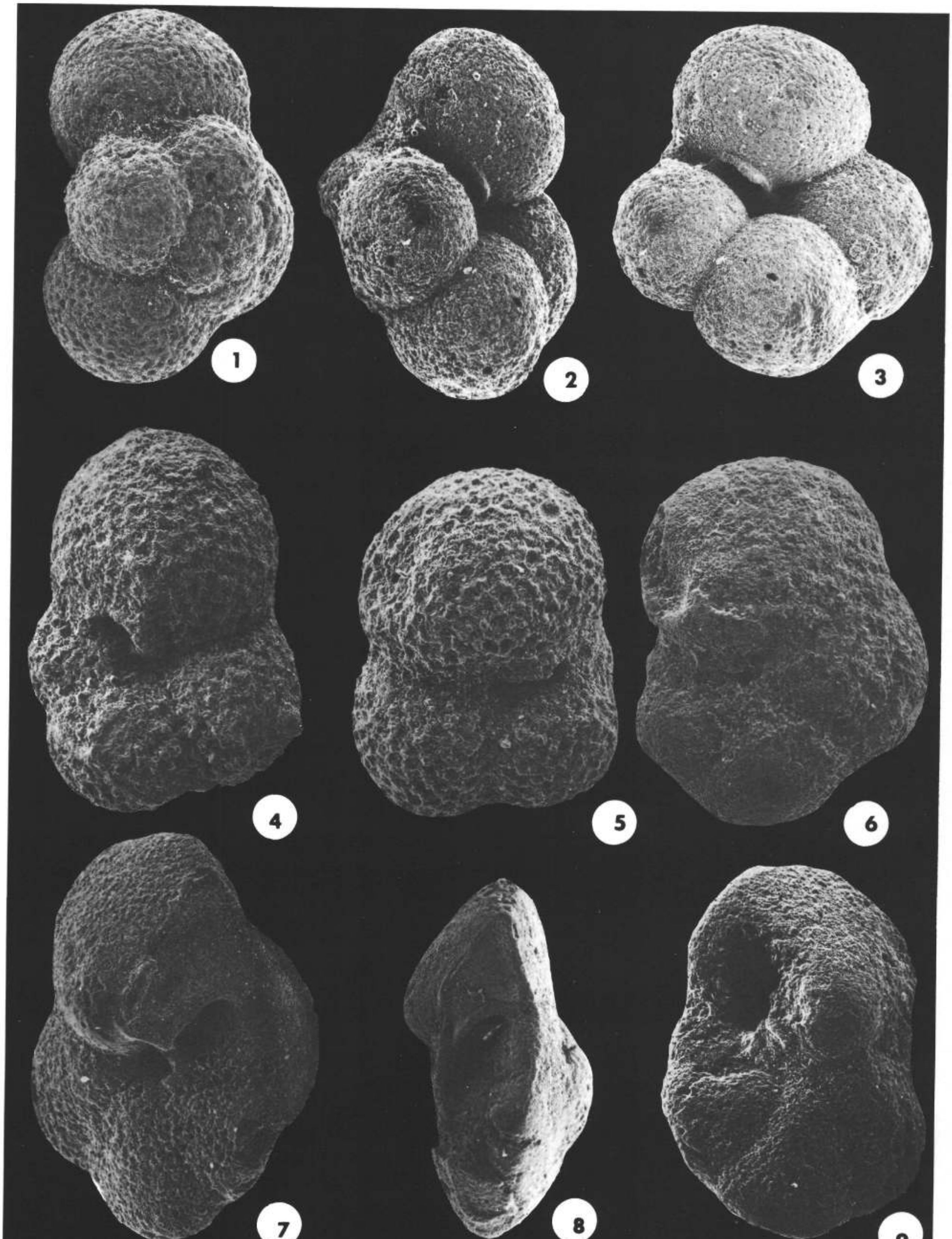

PLATE 6

All specimens from Site 208

Figure 1	*Globorotalia uncinata* Bolli 29-4(31-33 cm), X220.
Figure 2	*Globorotalia uncinata* Bolli 29-4(31-33 cm), X220.
Figure 3	*Globorotalia uncinata* Bolli 29-5(108-110 cm), X220.
Figure 4	*Globorotalia uncinata* Bolli-*angulata* (White) 39-6(53-55 cm), X220.
Figure 5	*Globorotalia mckannai* (White) 29-2(118-120 cm), X220.
Figure 6	*Globorotalia mckannai* (White) 29-2(118-120 cm), X220.
Figure 7	*Globorotalia angulata* (White) 29-6(53-55 cm), X220.
Figure 8	*Globorotalia mckannai* (White) 29-2(118-120 cm), X220.
Figure 9	*Globorotalia acarinata* (Subbotina) 29-1(45-47 cm), X220.

PLATE 6