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Lower Cretaceous benthic foraminifera from DSDP Site 263: micropalaeontological constraints for the early evolution of the Indian Ocean

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Ann E.L. Holbourn, Michael A. Kaminski

Research School of Geological and Geophysical Sciences, Birkbeck College and University College London, Gower Street, London WC1E 6BT, UK

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Abstract

Analysis of 66 samples from DSDP Site 263 (Cores 263-4R-4 to 263-29R-4) reveals a unique faunal composition with a predominance of agglutinated taxa, many of them previously unrecorded from any other DSDP and ODP Indian Ocean sites. A total of 66 agglutinated and 31 calcareous taxa are documented and five new species are described: *Hippocrepina gracilis* n.sp., "*Textulariopsis*" *elegans* n.sp., *Aaptotoichus challengeri* n.sp., "*Gaudryinopsis*" *pseudobettenstaedti* n.sp. and "*Gaudryina*" *cuvierensis* n.sp. Three assemblages are recognized based on changes in the composition of dominant taxa and occurrences of stratigraphically important species: (1) a high-diversity Valanginian to Barremian *Bulbobaculites–Recurvoides* Assemblage (Cores 263-29R to -18R), comprised of numerous elongate agglutinated forms, rare nodosariids, and variable numbers of tubes and ammodiscids; (2) a moderately diverse Aptian to Albian *Rhizammina–Ammodiscus–Glomospira* Assemblage (Cores 263-18R to -7R) with highly fluctuating numbers of the nominate taxa and *Haplophragmoides*, *Trochammina*, *Verneuilinoides* spp., and *Verneuilina howchini*; (3) a very low diversity Albian or younger Assemblage (Cores 263-6R to -4R) containing sparse agglutinated foraminifera, rare nodosariids and rotaliids. We interpret the assemblages as shelf to lower slope and consider them to reflect a deepening palaeobathymetry as the Cuvier margin subsided after the initial breakup of East Gondwana during the Valanginian. Our interpretation is in sharp contrast with initial palaeodepth estimates of less than 100 m, as well as with original chronostratigraphic interpretations based on foraminifera and nannofossils which correlated the base of the recovered interval with the Aptian. The absence of many cosmoplitan forms, despite high diversity, suggests strong faunal differentiation in the Austral realm or endemisn within the Cuvier Basin during the Early Cretaceous.

1. Introduction

The Deep Sea Drilling Program (DSDP) and the Ocean Drilling Program (ODP) have recovered extensive Lower Cretaceous sedimentary sequences at 12 sites in the Indian Ocean. The Indian Ocean cores contain some of the most diverse benthic foraminiferal assemblages ever recorded from the Lower Cretaceous of the DSDP and ODP sites (e.g. Kaminski et al., 1992; Holbourn and Kaminski, in press). The systematics of Lower Cretaceous foraminifera from high southern latitudes in the Indian Ocean are, however, still not well defined. Indeed, most previous studies of Indian Ocean DSDP material were completed during the first phase of drilling in the early 1970s and were either preliminary reports or isolated studies of individual holes. Even some of the subsequent reports of Lower Cretaceous benthic foraminifera from the Indian Ocean do

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not provide a consistent taxonomic data base. There is an urgent need for taxonomic reappraisal to ensure the validity of stratigraphic correlations and to enable us to use the foraminiferal records for constraining the palaeoenvironment, subsidence history, and palaeoceanography of the Early Cretaceous Tethyan seaways of eastern Gondwana.

The main aims of this study are to fully document the Lower Cretaceous benthic foraminifera from DSDP Site 263 and to provide a data base for understanding the chronostratigraphy and palaeoenvironment of the Cuvier Abyssal Plain. This study is a step towards a comprehensive account of the Lower Cretaceous deep-water benthic foraminiferal assemblages from this region.

2. Previous work

The original description of Lower Cretaceous benthic foraminifera from DSDP Site 263 was carried out by Scheibnerová (1974), who documented selected taxa from several Leg 27 sites in the DSDP Leg 27 *Report* (Veevers et al., 1974). Scheibnerová listed a total of 33 agglutinated taxa from DSDP Site 263 (22 were illustrated with SEM photographs and/or drawings) and 28 calcareous taxa. Scheibnerová (1974) assigned an "Aptian or older" age to Cores 263-11R to -29R and a late Albian age to Cores 263-5R to -10R. However, the ages attributed to the same cores on the basis of other microfossils differed markedly. Pollen and spores suggested a late Neocomian to late Aptian age for Cores 263-11R to -28R and a Neocomian age for Core 263-29R (Veevers et al., 1974). Cores 263-22R to -27R were determined as upper Albian, Core 263-28R as middle Albian, and Core 263-29R as "undifferentiated Lower Cretaceous" on the basis of original nannofossil studies (Veevers et al., 1974). By contrast, a recent re-examination of nannofossils from Cores 263-4R to -29R failed to confirm any Albian index species and suggested a Valanginian to early Hauterivian age for Cores 263-22R to-29R and a Hauterivian–Albian age for Cores 263-4R to -21R (P.R. Bown, pers. commun., 1994). This was based on the occurrence of *Eiffelithus striatum*, the marker for the *T. striatum* zone of Mutterlose, 1992 (Valanginian–early Hauterivian). This species also occurs in a similar stratigraphic position at nearby ODP Sites 765 and 766.

A revision and extension of Scheibnerová's foraminiferal studies have become essential, as considerable changes in the taxonomy and palaeoenvironmental interpretation of agglutinated foraminifera have taken place since her work was completed. Scheibnerová (1974, 1977) interpreted the palaeoenvironment of the foraminiferal assemblages at DSDP Site 263 as shallow to very shallow, with estimated water depths not exceeding 100 m. Scheibnerová considered the assemblages to closely resemble those of the Canning and Great Artesian Basins and attributed the scarcity of calcareous tests to diagenetic solution in a shallow, stagnant, dysaerobic environment.

3. Location and geological setting

3.1. Location

DSDP Site 263 is situated at the eastern edge of the Cuvier Abyssal Plain in the Indian Ocean, at 23°19.43'S and 110°58.81'E (Fig. 1). The Cuvier Abyssal Plain is a small oceanic basin (about 200 km by 400 km), bounded by the Wallaby Plateau to the south, the Exmouth Plateau to the north and the Sonne and Sonja Ridges to the west. Recent seismic reflection data have revealed that the Cuvier and Exmouth Plateau margins had very different rifting and magmatic developments during the Early Cretaceous despite contemporaneous break-up. Rapid rifting associated with emplacement of exceptionally large volumes of magma occurred in the Cuvier Basin, whereas the Exmouth Plateau underwent slow extensional deformation through faulting with moderate magmatism (Fullerton et al., 1989; Hopper et al., 1992; Colwell et al., 1994).

DSDP Site 263 is an abyssal site drilled on oceanic crust close to the base of the western Australian continental rise, in a water depth of 5048 m. Drilling at DSDP Site 263 was terminated before reaching basement, leaving the basal 100–200 m of the sedimentary sequence unrecovered (Veevers et al., 1974). The magnetic anomaly pattern in the Cuvier Abyssal Plain and in the adjacent Gascoyne Abyssal Plain to the north has been identified as encompassing anomalies M10–M5 (Larson, 1977; Fullerton et al., 1989). Continental breakup in this sector of eastern Gondwana, therefore, occurred in Chron M10 (Fullerton et al., 1989) or perhaps in Chron M11 (Veevers and Li, 1991), during

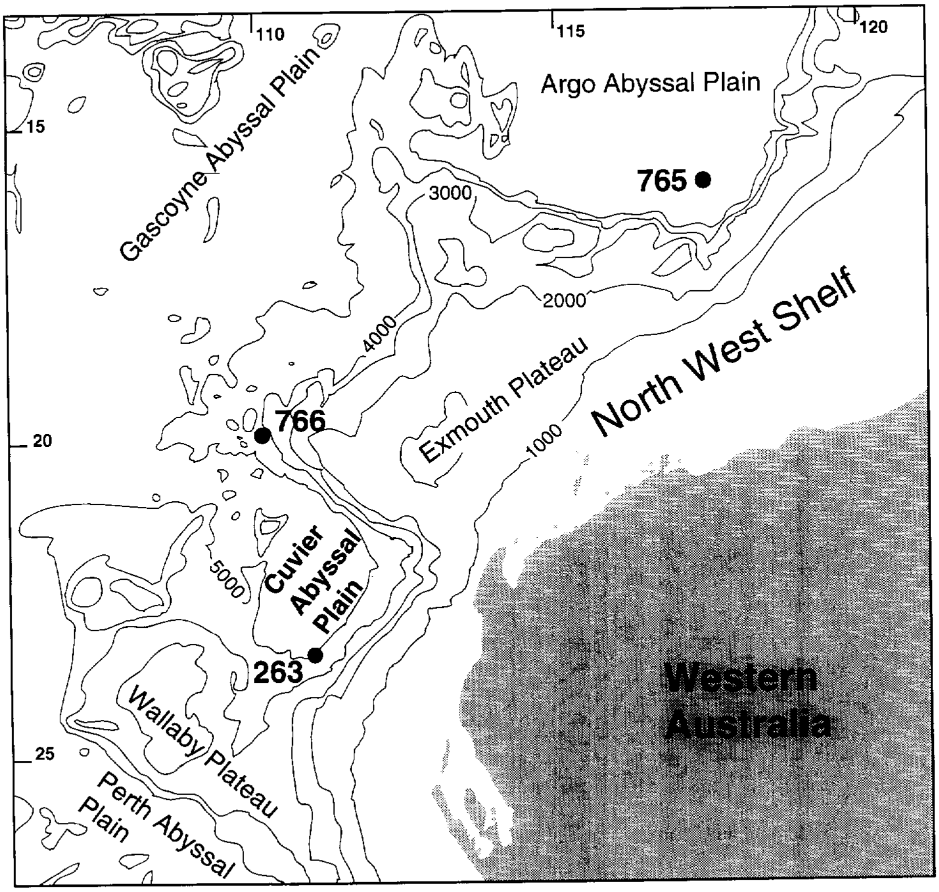

Fig. 1. Location map showing DSDP Site 263, ODP Sites 765 and 766 and bathymetric contours (m).

the Valanginian. As DSDP Site 263 is located just landwards of anomaly M10 (Fig. 2), it is reasonable to assume that the base of the sediment column is the age equivalent of the basal sediments recovered at ODP Site 766 on the northern flank of the Cuvier Abyssal Plain, which has been dated as late Valanginian (Kaminski et al., 1992). This interpretation is at odds with the Leg 27 shipboard work as well as the work of Veevers and Johnstone (1974) who correlated the Lower Cretaceous oceanic sequences from DSDP Site 263 with the Aptian–Albian Winning Group sequences of the Carnarvon Basin (Fig. 3).

3.2. *Lithology*

Approximately 615 m of Lower Cretaceous sediments were recovered at this site. They were subdivided by the Shipboard Scientific Party into three main lithological units.

Unit 2: The base of unit 2 (Cores 263-5R to -6R) consists of dark greenish nannofossil-bearing clay (proportion of nannos is small in the lower part of the unit: ca. 5–10%).

Unit 3: This unit (Cores 263-7R to -18R) consists of a greenish-black claystone with a thickness of about 275 m. Montmorillonite is the dominant clay mineral with some minor quartz, feldspar, pyrite, kaolinite and muscovite, more abundant in the coarser fractions. The sediment has poorly defined bedding of contorted laminae and lenses, up to 1 cm thick. A gradational boundary is observed (Cores 263-16R to -19R) between the clays of unit 3 and the silty layers of unit 4.

Unit 4: This unit (Cores 263-19R to -29R) is an olive black silty claystone, approximately 276 m thick.

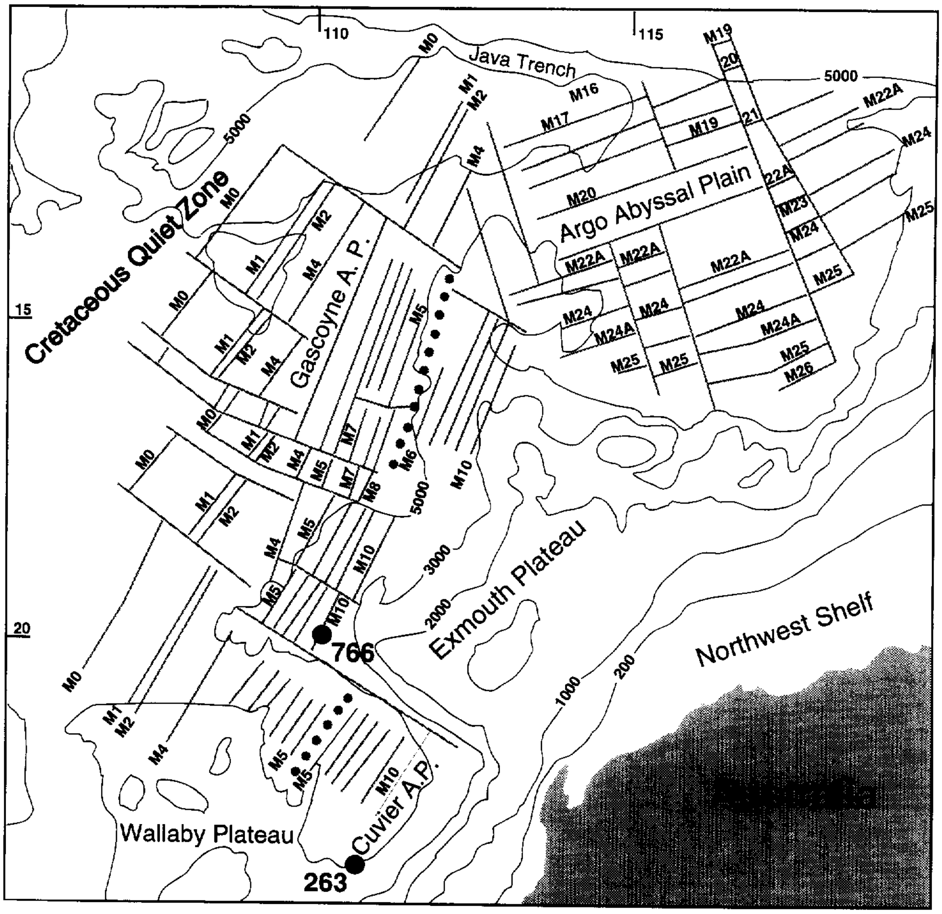

Fig. 2. Magnetic anomalies along the northwest Australian continental margin, showing bathymetric contours (m), fossil spreading ridges (dotted) and location of DSDP Site 263 and ODP Site 766 (after Fullerton et al., 1989).

It consists of about 70–80% kaolinitic clay and 10–30% silt-size quartz with minor silt-size feldspar, pyrite, muscovite, heavy minerals and zeolite. Calcite and dolomite nodules are frequent throughout the unit. Cross-bedding is evident in the coarser sandstones at the bottom of the unit while laminae are found in the claystone, higher up in the sequence. This change in lithology probably reflects a decrease in depositional energy from the base to the top of the unit. Alternance of black layers with lighter calcitic bioturbated intervals suggests that there were also significant changes in oxygenation and/or TOC. Bioturbation is evident in the lighter, calcitic mudstones.

4. Methods

Sixty-six samples from Cores 263-4R-4 to 263-29R-4 were processed by repeated drying and washing in 1% Calgon solution. The washed residues were randomly divided into fractions with the help of a sample splitter and picked for microfossils. When fossil abundance allowed, at least 300 foraminifera were picked from each sample. The specimens were mounted onto slides and sorted for identification. Scanning Electron micrographs were made on a Zeiss-DSM-940 SEM at the Micropalaeontology Unit of University College London.

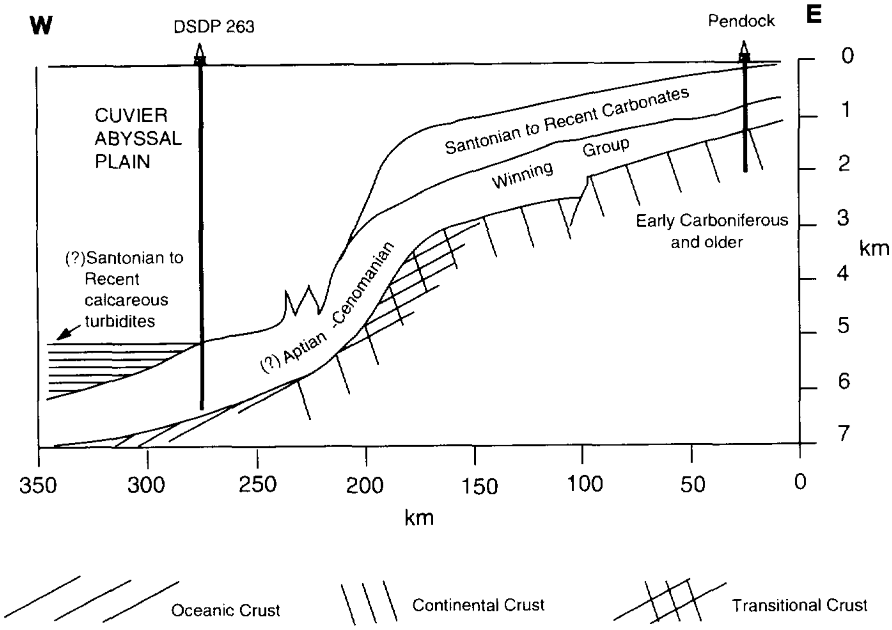

Fig. 3. Tentative correlation of Lower Cretaceous sedimentary sequences at DSDP Site 263 with Aptian–Albian Winning Group sequences (after Veevers and Johnstone, 1974).

5. Results and discussion

5.1. Taxonomy

The benthic foraminiferal data are given in Tables 1 and 2. A total of 66 agglutinated taxa and 31 calcareous taxa were recorded (the samples examined contained no planktic foraminifera, except in Cores 263-5R to -4R). The assemblages in lithological units 3 and 4 exhibit high diversity and consist predominantly of agglutinated species with organic cement that is now preserved as silica. Most common genera are *Rhizammina*, *Rhabdammina*, *Ammodiscus*, *Glomospira*, *Reophax*, *Bulbobaculites*, *Recurvoides*, *Paratrochamminoides*, *Haplophragmoides*, *Trochammina* and *Verneuilinoides*. Some nodosariid tests were found in 12 samples from lithological units 3 and 4 (Table 2); these were often corroded near the base of the sequence. The sparse assemblages in lithological unit 2 contain rare calcareous taxa (mainly rotaliids) as well as a few agglutinated species with calcareous cement.

Five new species are described: *Hippocrepina gracilis* n.sp., "*Textulariopsis*" *elegans* n.sp., *Aaptotoichus challengeri* n.sp., "*Gaudryinopsis*" *pseudobettenstaedti* n.sp. and "*Gaudryina*" *cuvierensis* n.sp. The generic affiliation to the genera *Textularia*, *Textulariopsis*, *Gaudryinopsis* and *Gaudryina* remains tentative because differences in wall composition and mode of coiling have suggested that the present classification is inadequate and needs to be revised.

The assemblages from DSDP Site 263 contain a number of cosmopolitan species that have been widely recorded in areas of the USA, Canada, Siberia, and Europe where environmental conditions favoured agglutinated assemblages during the Early Cretaceous. However, an even greater proportion of taxa remain in open nomenclature or are here described as new. Further taxonomic studies of taxa described under open nomenclature and local names may extend the cosmopolitan affiliations of these assemblages.

5.2. Biostratigraphy

The stratigraphic ranges of selected benthic foraminifera are plotted in Fig. 4. First and last occurrences are shown on Fig. 5. The foraminiferal assemblages are divided into three assemblages (Fig. 4), based on changes in the composition of dominant taxa and occurrences of stratigraphically important species:

Table 1
Agglutinated foraminifera at DSDP Site 263

Samples (core, section, interval)	Ammobaculites crespinae	Bulbobaculites humei	Haplophragmoides spp.	Hyperammina gaultina	Lagenammina spp.	Psammosphaera sp. 1	Recurvoides obskiensis	Recurvoides spp.	Trochammina abrupta	Trochammina spp.	Pseudoreophax sp. 1	Cribrostomoides nonioninoides	"Textulariopsis" elegans n.sp.	Verneuilinoides neocomiensis	Verneuilinulla sp. 1	Ammodiscus infimus	Spiroplectammina sp. 1	Bathysiphon brosgei	Ammodiscus cretaceus	Evolutinella perturbans	Haplophragmoides concavus	Ammobaculites sp. 1	Reophax cf. geniculatus	Trochammina subinflata	Verneuilinoides spp.	Ammodiscus tenuissimus	"Gaudryina" cuvierensis n.sp.	Rhabdammina spp.	Rhizammina spp.	Hippocrepina depressa	Trochammina depressa	"Gaudryinopsis" pseudobettenstaedti n.sp.	Aschemocella sp.	Verneuilinoides aff. crespinae	Lituotuba sp.	Caudammina crassa	Saccammina lagenoides	Saccammina spp.
4-4; 63-67																			3									7	6									
4-5; 64-68																			3									6	5									
4-6; 46-50			1																10									10	2									
5-1; 131-135																			1							1		3										
6-2; 24-28			1																1							2												
6-4; 67-71			3																3									1	3									
6-6; 135-139			3							2									6									2	1									
7-2; 14-18			15							3								3	1					8	3				11					1		3		
7-3; 91-95			3	1															1					12	1				6					2				
8-1; 83-87			3		1																			3	1			4	28									
9-1; 96-100			8	1														1	4					7	6			1	15	1						1		
9-3; 45-49			6																4					5	4			3	20	2								1
9-4; 105-109			24	5						15									7						1	1		9	57					12				
10-1; 131-135			8		4													4	5					7	4				31	4				7		6		3
10-2; 84-89			10	3						3						1		1	5					10	3	2		20	70					4		1		
10-3; 67-71			15	1	1					1						2		3	5						3	1		19	71					3		1		
11-2; 92-96			14															2	4		9				4	4		10	30	1				9				2
11-3;105-109			11	1				8		1	1			7		3								1		7		12	55	5				1				
11-4; 67-71			11	3				3		1						3									3	1		10	50					2				
12-1; 124-128			8					2			1					1			7						2	9		7	21									
12-3; 79-83			6	3				9		1	2							5							1	6		18	49					3				
12-4; 70-74			8		1			4			2					2			1							5		9	23									
13-1; 99-103			25	1	4			11			2					2										2		15	68					27				
13-3; 34-38			13	8												1		3	1						1	6		4	31					13				
13-6; 111-115			6	2							1							3							3	1		7	24					2				
14-1; 41-45			3	1				3								1		5							2	2		13	44	2								
14-3; 72-76			3																									2	18	1								
14-5; 127-131			2		1																							4	51							3		
15-1; 106-110			26	1				10		1						2		1								13			41					2				
15-2; 113-117			10	2				19								2			2							8		11	46							12		
15-3; 71-75			6					18																	9	14										1		
16-1; 93-97			16	2	1	4		10						9				1								15		10	64	6					2	3		
17-1; 118-122			19			1							12											2	3	4			32					6		1		
17-3; 9-13			11								1		3													2			7							1		
17-5; 76-80			8					3			1		12	5		6			10							7			9					2				
18-2; 85-89			13		6	2					8		12			18		12	1							2		14	74	2				5		6		
18-4; 92-96			2		1			1					2	4					1					1				2	16					1				1
18-5; 101-105			2		1			5					25	2					2								2	1	4					1				
19-2; 86-90			1	1				42			9		2					6	1					4			1	3	8	8				6				
19-4; 102-106					2	1		65					2	2		1		10	2									1	8	6						1		
19-6; 61-65			3					58								1		2								2			7					13				
20-2; 15-19					9			24										8					14				2	7	81	1				4		2		
20-4; 127-131			1		10			40		1				3		1		5	7				4			2	1		52	4				11		3	2	2
20-6; 132-136				1	1			11					2					1							1			3	9					3				
21-2; 36-40								20						4							2													5				
21-3; 90-94			3			1		71						3		1		3	5		1				6	15		14	26					13		1		
21-4; 120-124			2	6				43		1				3					1					1		34		8	5	2				66		2		1
22-1; 66-70			1	2				18					15	26		5		3									7	11	23	8				20				
22-2; 91-95		21	7	7	5	1		43		1	4	4	39					4									13	18	62	4				11		3		2
22-3; 117-121			5	2				37					6	3				9	1							8	30	26	15	3				4				1
23-2; 139-143			9	1		1		39				6	2							1					1			15				16		4				
23-4; 74-78	63		9	1	6	3		66				6	4			1		1		3			2					25	6			45	3	2		1		1
23-5; 130-134	15		13		9			64		2		6	2			3		4	1	12			1					16	19			18						
24-2; 30-34	23	2	6	1	28	4		54		1		6	25		15	4				1			14	2				6	16		1	5		12				8
24-4; 62-68				1	1			54		2					6	1						3			2				6			6						
24-6; 102-106			1		3			20										2											1					1				2
25-2; 36-40	25	2	4	1	15	1		28		23	1		2		4			1				3	19	10	1	1	1		21	2		12	2	5		2		3
25-4; 100-103	10	5			3				1	8	1				4			4			2		6	11					27	3	5	7		3	1	1	1	2
26-2; 60-64	6	2	4		14		8	39		4		4	1		2				12	3		8	7	4	2				1	3		17	1					
26-4; 31-35	24	4	4		11	3		3				4	2			1			1	3			2	3		1	1	4										
26-5; 126-130	9	39	10		12	3		5		11		16				2						17	2					1	4		3							
28-1; 36-40	2	2		4	9	2		5		1	1	2	2			13	1	2				2		6			2	2	34	1								
28-3; 103-107			1	2	2	1		4					2		1		1	4	1						1	1	1											
29-2; 76-80	21	15	4		11			13		10		4			3			1	1	2	1	2	6	5														
29-3; 71-75	19		5		3	4		5		6	1	1	6	1	1	2	4																					
29-4; 140-144	14	2	1	1	10	1	2	3	2																													

Samples (core, section, interval)	Glomospira gordialis	Aaptotoichus clavellatus	Reophax sp. 1	Aaptotoichus challengeri n.sp.	Ammodiscus spp.	Glomospira gaultina	Glomospira charoides	Subreophax sp. 1	Paratrochamminoides spp.	Ammosphaeroidina sp.	?Arenobulimina sp.	Reophax spp.	Thalmannammina spp.	"Gaudryina" spp.	Verneuilinulla sp. 2	Kalamopsis grzybowkii	Bimonilina cf. variana	"Textularia" spp.	Bulbobaculites spp.	Hippocrepina gracilis n. sp.	Caudammina spp.	Bulbobaculites cf. inconstans	Spiroplectammina spp.	Glomospira irregularis	Reophax sp. 2	Nothia robusta	Trochammina ribstonensis	Haplophragmoides hagni	Verneuilina howchini	Marssonella sp.	Ammolagena clavata	Remesella sp.	Pseudogaudryinella sp. 1	Diversity (s)	Number of specimens
4-4; 63-67							3																										4	5	23
4-5; 64-68						1	4									1																	1	7	21
4-6; 46-50	5																																	5	28
5-1; 131-135						2	10														1						1					1		8	20
6-2; 24-28							1																				2			2				6	9
6-4; 67-71	3					1																												6	14
6-6; 135-139	7						19																				7		4	9		6		11	66
7-2; 14-18	4					2	5																				31		12	1				16	104
7-3; 91-95						1																	1				14	6	18					12	66
8-1; 83-87					4	1	2										1			3			1				7		11			1		15	71
9-1; 96-100	5					2	10					1					2											5	21					16	90
9-3; 45-49						2	2					5						13										3	14			1		15	85
9-4; 105-109	3				1		29					2						9		1								18	8					17	202
10-1; 131-135	6				1	2	10					2				1		10										24	23					20	162
10-2; 84-89					1	2	59					4				1		14	6	4				1			1	13	53					25	292
10-3; 67-71	3				1	4	58			1					1				2	19	4						2		9	19	3	2			27	254
11-2; 92-96	5				1	2	25					2							30	4						1		34	20					21	213
11-3; 105-109	7					2	33									1		10		7						3			15					21	191
11-4; 67-71	12				2	4	44											18	2	3						2		2	16					20	192
12-1; 124-128	5						11											8		3						2			9					15	96
12-3; 79-83	17					2	2											1								1	1	1	9					19	137
12-4; 70-74	2						10											6											5					13	78
13-1; 99-103	3					2	12					2								5									40					16	221
13-3; 34-38						6	51												6							3			33					15	180
13-6; 111-115						1	8					1						6								3		9	13					16	90
14-1; 41-45							7					8						1	1	5								1	12	1				18	112
14-3; 72-76	1				2		4					1								5						1			6					11	44
14-5; 127-131						1	3					1								3						3			3					11	75
15-1; 106-110							14													4						3	19		3					14	140
15-2; 113-117						3	37					6						5									2		24	1				16	190
15-3; 71-75							28					1		2			10	7	2	3		1					3	1	44					16	150
16-1; 93-97				4		2	34					18						2		1								5	39	1				22	249
17-1; 118-122							4	1				3						10	2			1						5						16	106
17-3; 9-13							1					1						12										4						10	43
17-5; 76-80					16		6					11				3		2		8		1	2					12						19	124
18-2; 85-89							3					7		5				6		3		4						4						21	207
18-4; 92-96																		2										2						13	36
18-5; 101-105				1								1							8															13	55
19-2; 86-90							4		16			7						3	3								2						19	127
19-4; 102-106				1			4		33			6					2	2		3		20												20	172
19-6; 61-65							2		7			2							4			9				1								13	111
20-2; 15-19				3		1			11			5				1																		15	173
20-4; 127-131						7	4		19			12																						21	191
20-6; 132-136				2					2									2							6									13	44
21-2; 36-40							6		5			3						3				1												9	49
21-3; 90-94					6	7	35		27			6		2				2							18									22	266
21-4; 120-124				11		6	51		9			11							23			126		1	35									23	448
22-1; 66-70				12		5	8					10							4		7		3											19	188
22-2; 91-95	3			6		3	15					5				5	1		18	7	2	17												29	331
22-3; 117-121				21		14	79		14	1		7	6	1		1	2	6	6															26	308
23-2; 139-143															1																			12	96
23-4; 74-78			11	1					1					1																				23	262
23-5; 130-134									4			4	1																					18	194
24-2; 30-34				1				2	8	1	2																							26	248
24-4; 62-68									6																									11	88
24-6; 102-106				4			1	2	2																									11	39
25-2; 36-40				2	1	1	2	1																										30	196
25-4; 100-103	6	6	1																															23	118
26-2; 60-64																																		20	142
26-4; 31-35																																		16	71
26-5; 126-130																																		14	134
28-1; 36-40																																		19	93
28-3; 103-107																																		13	22
29-2; 76-80																																		15	99
29-3; 71-75																																		13	58
29-4; 140-144																																		9	36

Table 2
Calcareous benthic foraminifera at DSDP Site 263

Samples (core, section, interval)	*Lenticulina* spp.	*Laevidentalina* spp.	*Globulina prisca*	*Vaginulinopsis excentrica*	*Pyramidulina sceptrum*	Polymorphinids	*Oolina* cf. *caudata*	*Lenticulina subangulata*	*Saracenaria forticosta*	*Saracenaria* spp.	*Bullopora* sp.	*Frondicularia hastata*	*Saracenaria erlita*	*Astacolus calliopsis*	*Lenticulina muensteri*	*Lenticulina heiermanni*	*Dentalina communis*	*Citharina harpa*	*Vaginulina recta*	*Marginulina bullata*	*Planularia complanata*	*Pyrulina* sp.	*Ramulina* sp.	*Pseudonodosaria* sp.	*Pleurostomella* sp.	*Gyroidina infracretacea*	*Globorotalites* sp.	*Scheibnerova* sp.	*Dentalina debilis*	*Lingulina* sp.	*Frondicularia* sp.	*Gavellinella* sp.	*Oolina* sp.	Diversity (s)	Number of specimens
4-4; 63-67																									1				1	1	1	1	1	6	6
4-6; 46-50																										2		1						2	3
5-1; 131-135	2													1												1	1							4	5
6-4; 67-71																									1									1	1
18-5; 101-105	20	22	7	4	2	17		1	5	3				12	1	4	1	1	2	1	1	2	3	1										20	110
19-6; 61-65	1					2																												2	3
21-3; 90-94	1			1											1																			3	3
22-1; 66-70		1																																1	1
23-4; 74-78		1	1										1	1																				4	4
24-4; 62-68	1																																	1	1
25-2; 36-40	1																																	1	1
26-2; 60-64				2		7			1			2																						4	12
26-4; 31-35				1		1				1	2																							4	5
26-5; 126-130		2	1						1																									3	4
29-2; 76-80	2	1		1	1	16	1	1																										7	23
29-3; 71-75	1	1	1																															3	3

(1) A high-diversity Valanginian to Barremian *Bulbobaculites–Recurvoides* assemblage (Cores 263-29R-18R) is characterised by *Ammobaculites crespinae*, *Bulbobaculites humei*, *Lagenammina* aff. *alexandrei*, *Aaptotoichus challengeri* n.sp., "*Textulariopsis*" *elegans*. n.sp., "*Gaudryina*" *cuvierensis* n.sp., *Paratrochamminoides*, *Recurvoides*, *Reophax* and *Verneuilinoides* spp. with rare nodosariids and variable numbers of *Rhabdammina*, *Rhizammina*, *Ammodiscus* and *Glomospira* spp. This assemblage can be subdivided into two sub-assemblages (1A and 1B), based on the disappearance of *Cribrostomoides nonioninoides*, *Bulbobaculites humei*, "*Gaudryinopsis*" *pseudobettenstaedti* n.sp. and *Verneuilinulla* sp. 1 above Core 263-22R and on the occurrence of *Bulbobaculites* cf. *inconstans* and *Bimonilina* cf. *variana* in Core 263-22R.

The calcareous species, found intermittently between Cores 263-29R-3 and 263-18R-5, indicate a Valanginian–Barremian age (*Oolina* cf. *caudata*, *Lenticulina subangulata*, *Citharina harpa*, *Frondicularia hastata*, *Lenticulina heiermanni*, abundant polymorphinids).

(2) A moderately diverse Aptian to Albian *Rhizammina–Ammodiscus–Glomospira* assemblage (Cores 263-18R-7R) is characterized by highly fluctuating numbers of the nominate taxa and by *Rhabdammina*, *Haplophragmoides*, *Verneuilinoides* spp., *Trochammina ribstonensis* and *Verneuilina howchini*.

There are few stratigraphically significant species among the agglutinated taxa in lithological units 3 and 4. The main diagnostic species are: *Verneuilina howchini* in Cores 263-16R-1 to 263-6R-6, which has a reported range from the Aptian to the Albian in Australia and the Indian Ocean (Haig, 1980), *Cribrostomoides nonioninoides* in Cores 263-29R-3 to 263-22R-2, which was recorded in the Hauterivian–Barremian of the Carnarvon Basin (McLoughlin et al., in press) and is cosmopolitan in the Barremian–Aptian (Haig, 1980) and *Aaptotoichus challengeri* n.sp. in Cores 263-25R-2 to 263-16R-1, which is also found in the Berriasian–Valanginian and Valanginian–Hauterivian at ODP Sites 765 and 766, respectively (Kaminski et al., 1992; Holbourn and Kaminski, in press).

(3) A very low diversity assemblage (Cores 263-6R-4R) contains rare specimens of *Rhizammina*, *Rhabdammina*, *Glomospira* and *Ammodiscus* spp. with scarce *Gyroidina infracretacea*, *Lingulina* sp., *Pleurostomella* sp. and *Gavelinella* spp., indicative of an Albian or younger age.

Although the agglutinated foraminiferal assemblages from DSDP Site 263 are diverse, many of the index taxa that are used in the foraminiferal assemblages of the Boreal Lower Cretaceous are absent. The

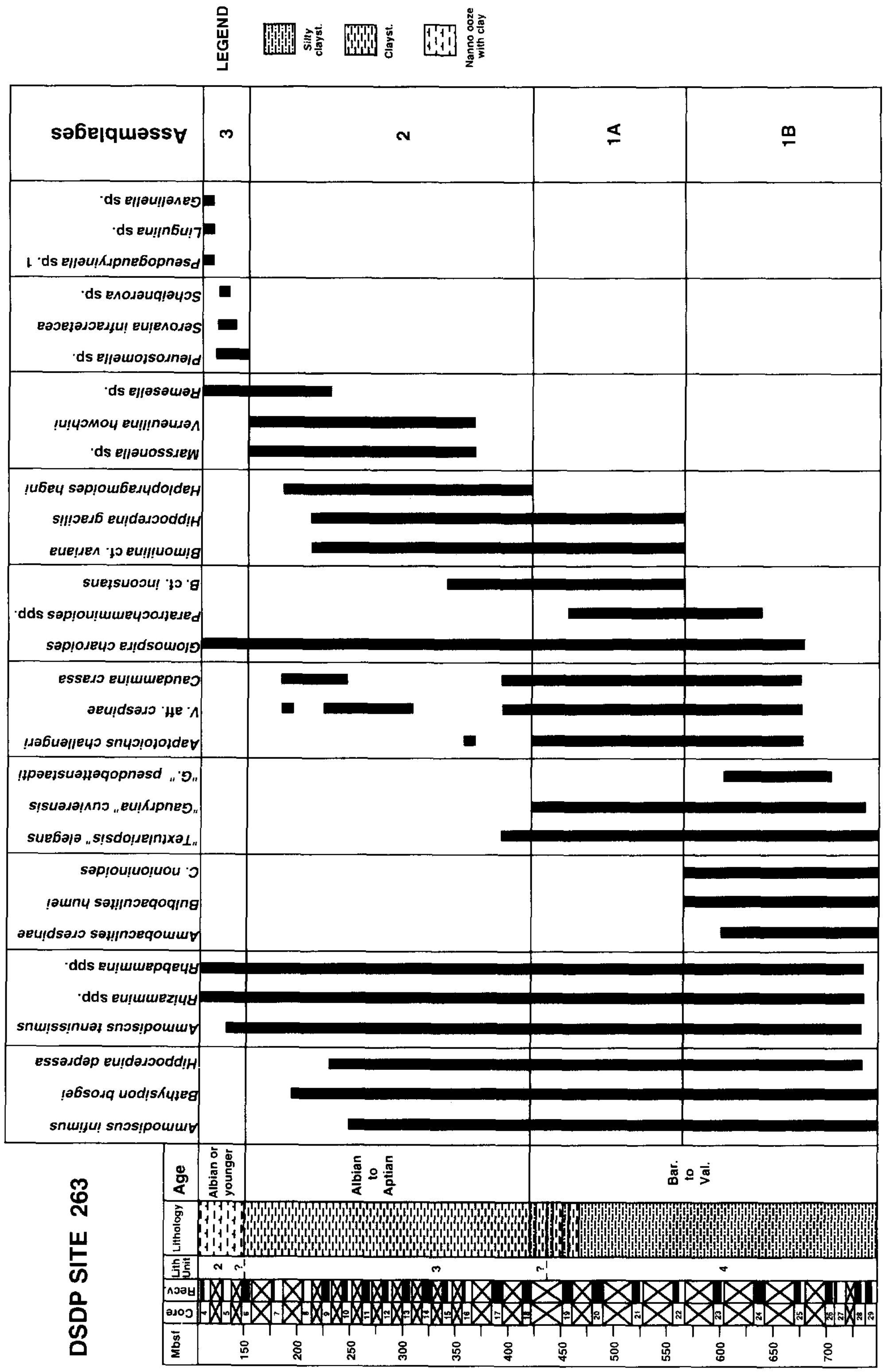

Fig. 4. Stratigraphic ranges of selected benthic foraminifera at DSDP Site 263 (percentage core recovery shaded black, lithological units with gradational boundaries).

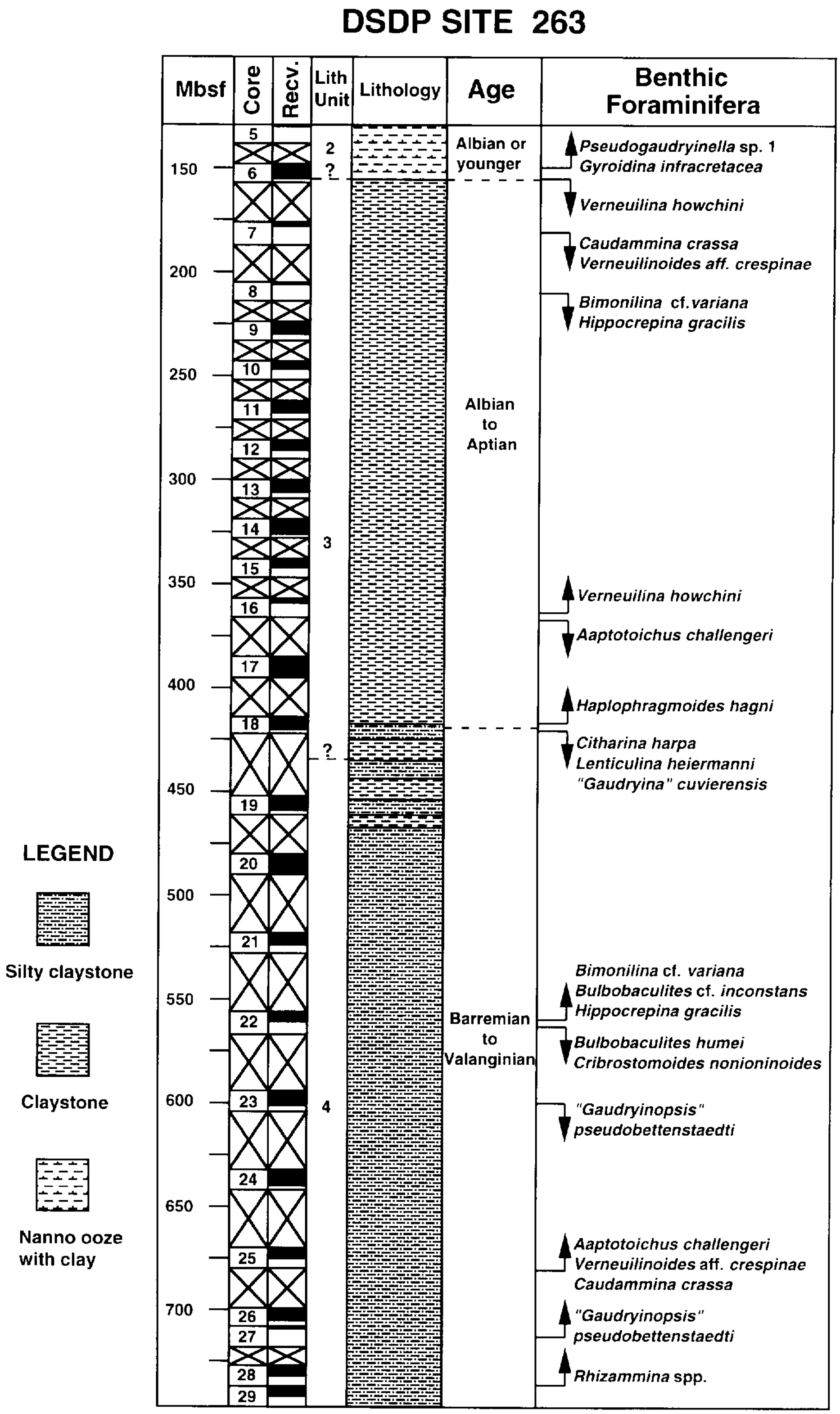

Fig. 5. First and Last Occurrences of benthic foraminifera at DSDP Site 263 (percentage core recovery shaded black).

stratigraphically important *Falsogaudryinella* and *Praedorothia* lineages are not present, even though the index species *P. praehauteriviana* has been observed at other Indian Ocean sites (Riegraf and Luterbacher, 1989a; Kaminski et al., 1992). Of the seven Lower Cretaceous Deep Water Agglutinated Foraminifera (DWAF) zonal markers in the scheme of Geroch and Nowak (1984) only *Cribrostomoides nonioninoides* [= *Haplophragmoides nonioninoides* of Geroch and Nowak (1984)] and an atypical species of *Pseudoreophax*, differing from *P. cisownicensis* Geroch, have been observed. Among the 24 index species used in the Boreal Lower Cretaceous zonations of King et al. (1989), only one species tentatively identified as *Bulbobaculites* cf. *inconstans* (Bartenstein and Brand, 1951) was found at DSDP Site 263.

5.3. Palaeoecology

Taxa with organic and siliceous cement and tapered (presumably infaunal) morphologies dominate the assemblages of lithological units 3 and 4, suggesting that dysaerobic environmental conditions were prevalent during the deposition of these units. Mineralogical evidence indicates that sediments from DSDP Site 263 were predominantly terrestrially derived with minor pelagic input (Compton et al., 1992) and the lithologies of dark claystones also point to high organic influx and oxygen depletion. However, a very restricted, stagnant environment is excluded by the high faunal diversity. Conditions appear, nevertheless, to have remained more restricted at DSDP Site 263 than at ODP Sites 765 and 766 during the Early Cretaceous, which may explain the paucity of calcareous benthic taxa and the absence of some cosmopolitan DWAF.

The Valanginian–Barremian assemblages contain several species of foraminifera that are here described as new, as well as others that we have provisionally left in open nomenclature. This may due to endemism in the Cuvier Basin or may be a reflection of the generally strong faunal provinciality between the Boreal, Tethyan and Austral realms during the Neocomian. A high degree of provincialism has been observed among Valanginian–Barremian ammonites in the Boreal realm (Rawson, 1980), whereas provinciality became less marked in the Aptian–Albian owing to generally warmer climates and rising sea levels, leading to increased opportunities for faunal dispersal. Although such a pattern has not yet been observed among Tethyan–Austral invertebrate faunas owing to a lack of published data (P. Rawson, pers. commun., 1994), we do observe this pattern in the benthic foraminiferal assemblages at DSDP Site 263 and ODP Site 766. At both sites, many of the well-known Tethyan Neocomian index forms are missing. However, the Valanginian–Barremian assemblages from ODP Site 766 contain a much higher proportion of cosmopolitan calcareous taxa in comparison with those from DSDP Site 263. This probably reflects distinct sedimentation and circulation regimes at these two sites, which may be linked to their different rifting histories (Colwell et al., 1994).

The overall decrease in coarsely agglutinated species and corresponding increase in finely agglutinated deeper-water forms indicate that although the sediments from DSDP Site 263 were originally deposited in a neritic environment (possibly under deltaic influence), gradual deepening occurred as the rifted Indian Ocean margin subsided. The occurrence of deep-water species such as *Caudammina crassa* from Cores 263-25R-4 to 263-7R-2, the marked upward increase of *Rhabdammina*, *Rhizammina*, *Ammodiscus* and *Glomospira* spp. in lithological units 3 and 4, as well as the scarcity of shallow-water taxa such as *Hyperammina* spp. also point to increasing water depth. Evidence of a deepening palaeobathymetry is reflected in the lithology by an upward decrease in grain size and a change to lower energy bedforms in the lower part of the sequence. Our interpretation contrasts markedly with the views presented by Scheibnerová in her syntheses of Leg 27 (1974, 1977), in which she concluded that water depth did not exceed 100 m at DSDP Site 263 during the Early Cretaceous, and that there was no evidence for deep-water environments before the Santonian at any of the Indian Ocean sites.

6. Summary

DSDP Site 263 is an important taxonomic reference site for the still poorly-known Lower Cretaceous benthic foraminifera of the Indian Ocean: 66 agglutinated and 31 calcareous taxa have been documented in this study. We have been able to confirm 22 of the taxa originally reported by Scheibnerová, and 5 taxa are here described as new.

Although the base of the sedimentary column was not drilled at DSDP Site 263, our findings of sparse Valanginian–Barremian calcareous benthic foraminifera in lithological unit 4 is in general agreement with a Valanginian age for the opening of the Cuvier Basin, as suggested by geophysical evidence. The assemblages at DSDP Site 263 reflect a deepening palaeobathymetry, from shelf to middle or lower slope. Our interpretation contrasts sharply with the views expressed by Scheibnerová (1974), Scheibnerová (1977) who interpreted the foraminiferal assemblages as diagnostic of shallow-water conditions (less than 100 m) in the Indian Ocean, throughout the Early Cretaceous.

The nature of the sediments and the composition of the assemblages indicate that circulation within the Cuvier Basin was relatively restricted during the Early Cretaceous. Except for brief intervals of time, DSDP Site 263 remained below the CCD until the Albian and experienced a much greater influence of clastic deposition than ODP Site 766 on the northern margin of the basin. As a result, the foraminiferal assemblages of these two sites are not comparable. The palaeocirculation reconstruction of Baumgartner et al. (1992) also suggested that DSDP Site 263 was influenced by cooler water from higher latitudes than ODP Site 765 where a cosmopolitan agglutinated fauna was established since the Tithonian. The combination of cooler waters, shallower depths, clastic sedimentation and restricted circulation have conspired to produce a unique faunal composition at DSDP Site 263 during the Valanginian–Barremian in contrast to that of the more pelagic, oceanic ODP Sites 765 and 766.

Our study provides time constraints for the rifting in the Cuvier Basin that are in agreement with recent geophysical evidence and gives new insight into the palaeoenvironments of the Indian Ocean during early opening stage.

7. Systematic taxonomy

Taxa are arranged according to the systematics of Loeblich and Tappan (1988).

Agglutinated foraminifera

Superfamily ASTRORHIZACEA, Brady, 1881

Bathysiphon brosgei Tappan, 1957 (Plate I, 11)

Bathysiphon brosgei Tappan 1957, pl. 65, figs. 1–5.—Tappan 1962, pl. 29, figs. 1–5.—Haig and Lynch, 1993, pl. 1, fig. 1.

Range and occurrence: A cosmopolitan species, widely recorded in the Aptian–Albian (Haig, 1980).

Plate I

1. *Rhabdammina* sp., (×40), Sample 263-15-6; 111–115 cm.
2. *Rhabdammina* sp., (×35), Sample 263-13-1; 99–103 cm.
3. *Rhabdammina* sp., (×17), Sample 263-10-3; 67–71 cm.
4. *Rhizammina* sp., (×45), Sample 263-23-3; 130–134 cm.
5. *Rhizammina* sp., (×55), Sample 263-11-2; 92–46 cm.
6. *Rhizammina* sp., (×45), Sample 263-23-3; 130–134 cm.
7. *Rhizammina* sp., (×45), Sample 263-21-3; 90–94 cm.
8. *Rhizammina* sp., (×90), Sample 263-20-2; 15–19 cm.
9. *Rhizammina* sp., (×40), Sample 263-25-4; 100–103 cm.
10. *Rhizammina* sp., (×40), Sample 263-22-2; 91–95 cm.
11. *Bathysiphon brosgei* Tappan, (×35), Sample 263-15-1; 106–110 cm.
12. *Nothia robusta* (Grzybowski), (×25), Sample 263-15-1; 106–110 cm.
13. *Nothia robusta* (Grzybowski), (×18), Sample 263-15-1; 106–110 cm.
14. *Hippocrepina depressa* Vašiček, (×40), Sample 263-25-4; 100–103 cm.
15. *Hippocrepina gracilis* n.sp., (holotype), (×45), Sample 263-19-2; 86–90 cm.
16. *Hippocrepina gracilis* n.sp., (×20), Sample 263-17-5; 76–80 cm.
17. *Hyperammina gaultina* Dam, (×100), Sample 263-10-3; 67–71 cm.
18. *Hyperammina gaultina* Dam, (×40), Sample 263-22-2; 91–95 cm.
19. *Kalamopsis grzybowskii* (Dylążanka), (×70), Sample 263-21-3; 90–94 cm.
20. *Kalamopsis grzybowskii* (Dylążanka), (×45), Sample 263-10-2; 84–89 cm.

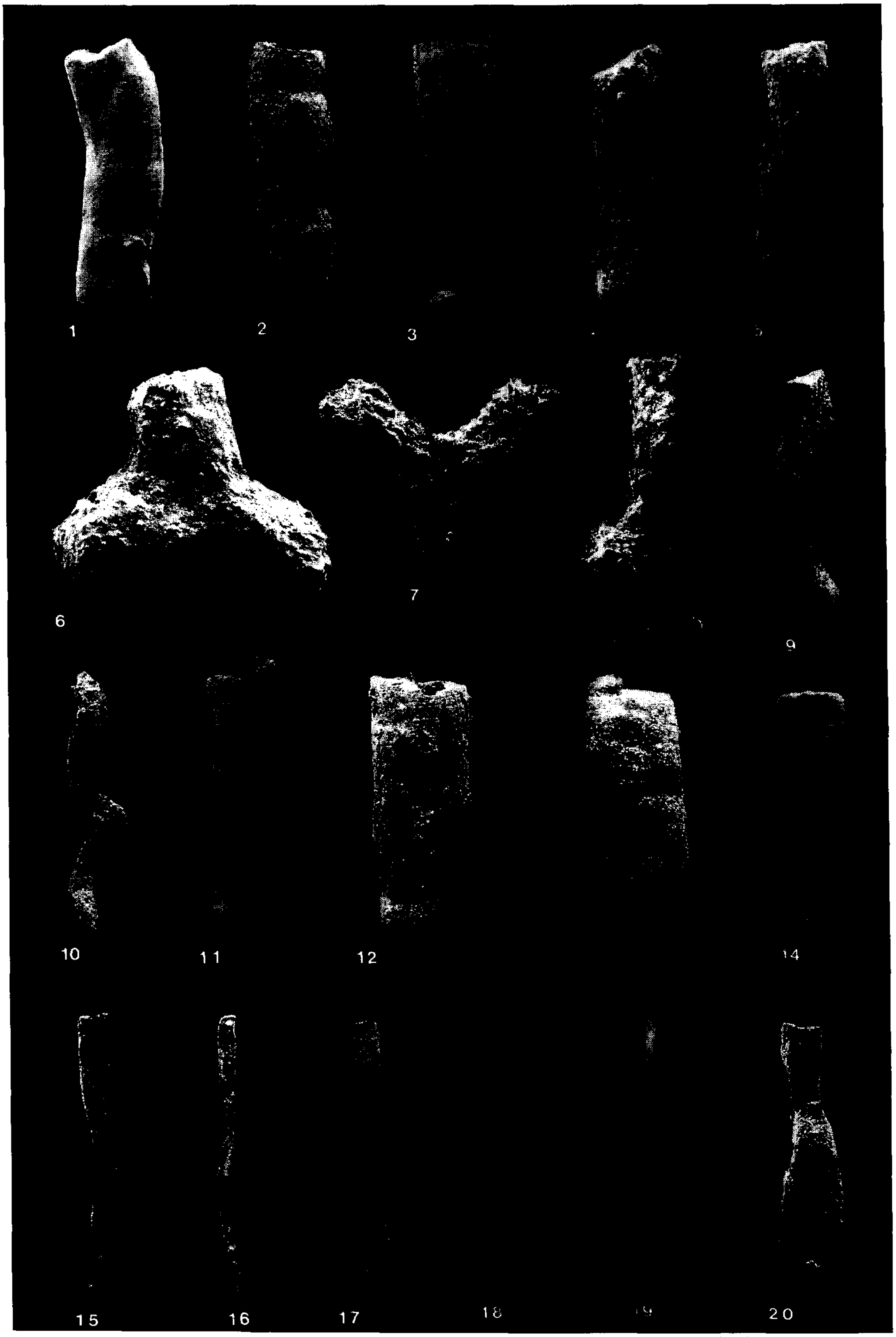

Plate I

Rhizammina spp. (Plate I, 4–10)

Remarks: We included in this group all finely-medium agglutinated branched or unbranched tubes.

Rhabdammina spp. (Plate I, 1–3)

Remarks: We included in this group all thick-walled, unbranched tubular forms.

Nothia robusta (Grzybowski, 1898) (Plate I, 12–13)

Dendrophyra robusta Grzybowski, 1898, pl. 10, fig. 7.

Rhabdammina robusta (Grzybowski).—Weidich, 1990, pl. 33, fig. 1.

Psammosphaera sp. 1 (Plate II, 4)

Description: Spherical to sub-spherical, well-cemented test with medium to coarse agglutinated particles giving the external wall of the test a rough texture. Aperture indistinct.

Remarks: Differs from *Psammosphaera fusca* Schulze, illustrated by Bartenstein and Brand, 1951 (pl. 1, fig. 2), by the smaller size of agglutinated particles.

Saccammina lagenoides (Crespin, 1953) (Plate II, 9)

Pelosina lagenoides Crespin, 1953, pl. 1, figs. 19–20.

Saccammina lagenoides (Crespin).—Haig, 1980, pl. 1, figs. 18–21.

Range and occurrence: Recorded in the Aptian–Albian of Australia and India (Haig, 1980).

Saccammina scruposa (Berthelin, 1880) (Plate II, 8)

Haplophragmium scruposum Berthelin, 1880, pl. 1, fig. 1.

Description: Sub-globular test with a short, narrow neck. Well-cemented wall with coarser particles.

Lagenammina aff. ***alexanderi*** (Loeblich and Tappan, 1950) (Plate II, 5–7)

Proteonina alexanderi Loeblich and Tappan, 1950, pl. 1, figs. 1–2.

Lagenammina alexanderi (Loeblich and Tappan).—Haig, 1980, pl. 1, figs. 14–17.

Remarks: Differs from *Lagenammina alexanderi* by the more spherical shape of the test, without tapering into apertural neck.

Range and occurrence: A cosmopolitan species, widely recorded from the Aptian to the Cenomanian (Haig, 1980).

Superfamily HORMOSINACEA Haeckel, 1894

Aschemocella sp. (Plate VIII, 13)

Remarks: Only a few specimens were found at DSDP Site 263.

Kalamopsis grzybowskii (Dylążanka, 1923) (Plate I, 19–20)

Hyperammina grzybowskii Dylążanka, 1923, pp. 65–66.

Plate II

1. *Caudammina crassa* (Geroch), (×100), Sample 263-10-2; 84–89 cm.
2. *Caudammina crassa* (Geroch), (×40), Sample 263-22-2; 91–95 cm.
3. *Caudammina crassa* (Geroch), (×50), Sample 263-21-3; 90–94 cm.
4. *Psammosphaera* sp. 1, (×75), Sample 263-29-4; 140–144 cm.
5. *Lagenammina* aff. *alexanderi* (Loeblich and Tappan), (×70), Sample 263-29-4; 140–144 cm.
6. *Lagenammina* aff. *alexanderi* (Loeblich and Tappan), (×65), Sample 263-10-1; 131–135 cm.
7. *Lagenammina* aff. *alexanderi* (Loeblich and Tappan), (×105), Sample 263-22-2; 91–95 cm.
8. *Lagenammina scruposa* Berthelin, (×65), Sample 263-21-4; 120–124 cm.
9. *Saccammina lagenoides* (Crespin), (×60), Sample 263-21-4; 120–124 cm.
10. *Reophax* cf. *geniculatus*, (×50), Sample 263-29-3; 71–75 cm.
11. *Reophax* cf. *geniculatus*, (×45), Sample 263-29-2; 76–80 cm.
12. *Reophax* sp. 1, (×35), Sample 263-29-2; 76–80 cm.
13. *Reophax* sp. 2, (×75), Sample 263-22-3; 117–121 cm.
14. *Pseudoreophax* sp. 1, (×65), Sample 263-19-2; 86–90 cm.
15. *Pseudoreophax* sp. 1, (×85), Sample 263-19-2; 86–90 cm.
16. *Subreophax* sp. 1, (×45), Sample 263-25-2; 36–40 cm.
17. *Ammolagena clavata* (Jones and Parker), (×60), Sample 263-21-3; 90–94 cm.
18. *Lituotuba* sp., (×50), Sample 263-25-4; 100–103 cm.

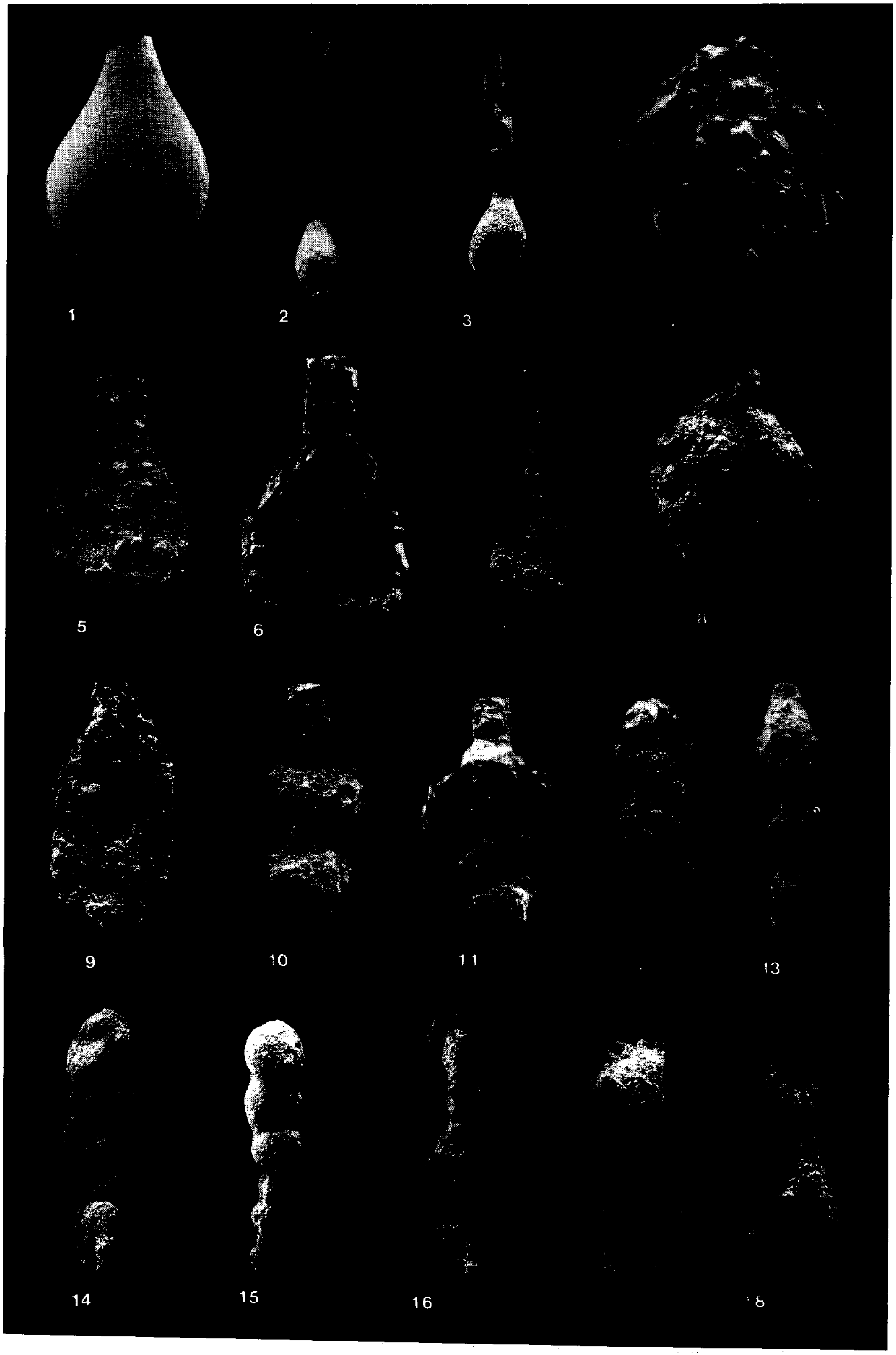

Plate 2.

Kalamopsis grzybowskii (Dylążanka).—Riegraf and Luterbacher 1989b, pl. 1, figs. 4–5.

Remarks: The Lower Cretaceous specimens of *K. grzybowskii* typically have shorter chambers than the type specimens in the Grzybowski Collection, which can be up to 1 mm in length (Kaminski and Geroch, 1993).

Caudammina crassa (Geroch, 1966) (Plate II, 1–3)

Hormosina ovulum crassa Geroch, 1966, p. 439, fig. 6.

Hormosina crassa Geroch.—Kaminski et al., 1992, pl. 3, figs. 7–8.

Remarks: We transfer this species to the genus *Caudammina* Montanaro-Gallitelli, 1955, because of the presence of stolons between chambers. We regard the genus *Carpathiella* Myatlyuk, 1966 to be fully synonymous with *Caudammina*. The specimens of *C. crassa* from DSDP Site 263 include ones with extremely long stolons (e.g. Plate II, 2,3), suggesting some link to "more primitive" tubular genera such as *Kalamopsis* or *Hyperammina*. Such a feature has not been observed in specimens from the Carpathians, where the species was first described.

Range and occurrence: Tithonian to Valanginian at ODP Site 765 (Kaminski et al., 1992). Reported by Riegraf and Luterbacher (1989a) as a cosmopolitan species from the Hauterivian to the Campanian.

Reophax cf. **geniculatus** (Ludbrook, 1966) (Plate II, 10–11)

Reophax geniculatus Ludbrook, 1966, pl. 1, figs. 3–4.

Reophax deckeri Tappan.—Haig, 1982, pl. 1, fig. 6.

Description: Elongate test with few flattened chambers and coarsely agglutinated wall. Terminal aperture, at the end of a long, broad neck.

Remarks: Close to *Hormosinella* because of the presence of stolons between the chambers. Differs from *Reophax geniculatus* Ludbrook by the presence of these short stolons.

Reophax sp. 1 (Plate II, 12)

Description: Elongate test with flattened chambers increasing slowly in size and coarsely agglutinated wall. Simple aperture is at the end of the last chamber.

Remarks: This species resembles *Scherochorella minuta* (Tappan, 1940) in that it has horizontal sutures and lacks an apertural neck. It differs, however, in having fewer chambers and a coarser wall.

Reophax sp. 2 (Plate II, 13)

Description: Elongate test with initially rounded chambers increasing gradually in size and becoming fusiform. Wall thick, coarsely agglutinated. Terminal aperture at the end of the last chamber which is slightly drawn-out.

Remarks: Close to *Reophax* sp. A (pl. 4, fig. 8 in Crespin, 1963) but has wider, depressed sutures.

Subreophax sp. 1 (Plate II, 16)

Description: Test elongate and irregularly constricted, without distinct chambers. Terminal aperture.

Superfamily HIPPOCREPINACEA Rhumbler, 1895

Hippocrepina depressa Vašiček, 1947 (Plate I, 14)

Hippocrepina depressa Vašiček, 1947, pl. 1, figs. 1–2.—Kaminski et al., 1992, pl. 1, figs. 7–8.

Plate III

1. *Ammodiscus tenuissimus* (Gümbel), (×85), Sample 263-21-3; 90–94 cm.
2. *Ammodiscus cretaceus* (Reuss), (×140), Sample 263-21-4; 120–124 cm.
3. *Ammodiscus cretaceus* (Reuss), (×130), Sample 263-22-3; 117–121 cm.
4. *Ammodiscus infimus* Franke, (×90), Sample 263-21-3; 90–94 cm.
5. *Ammodiscus infimus* Franke, (×35), Sample 263-10-3; 67–71 cm.
6. *Ammodiscus* sp. 1, (×105), Sample 263-26-2; 60–64 cm.
7. *Ammodiscus* sp., (×105), Sample 263-21-4; 120–124 cm.
8. *Glomospira* sp., (×105), Sample 263-21-4; 120–124 cm.
9. *Glomospira gordialis* (Jones and Parker), (×130), Sample 263-22-3; 117–121 cm.
10. *Glomospira charoides* (Jones and Parker), (×110), Sample 263-10-2; 84–89 cm.
11. *Glomospira charoides* (Jones and Parker), (×130), Sample 263-21-4; 120–124 cm.
12. *Glomospirella gaultina* (Berthelin), (×70), Sample 263-10-2; 84–89 cm.

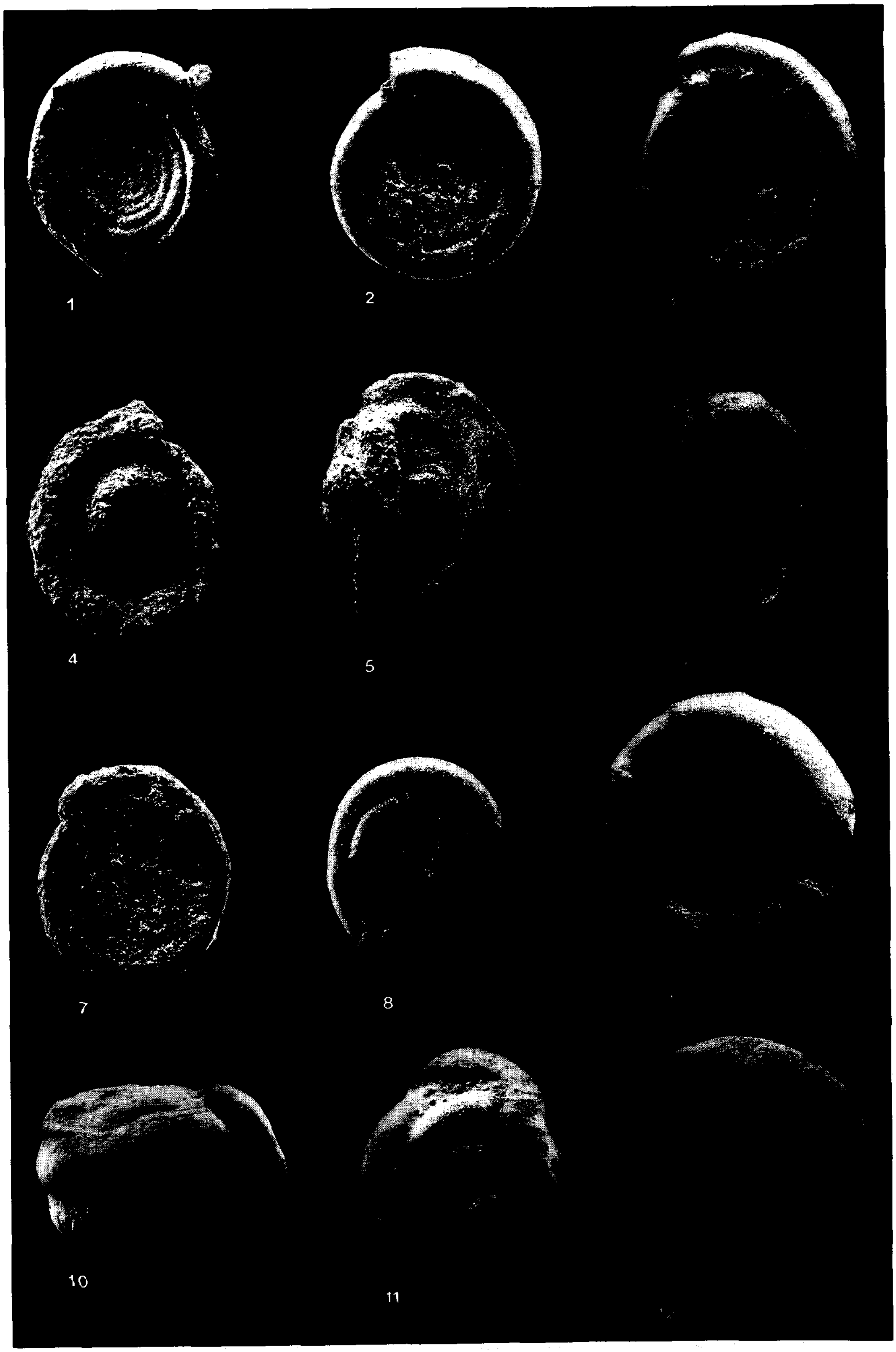

Plate 3.

Remarks: A cosmopolitan species from the Oxfordian to the Cenomanian (Riegraf and Luterbacher, 1989a).

Hippocrepina gracilis n.sp. (Plate I, 15–16)
Derivation of name: latin, meaning thin.
Holotype: Specimen figured in Plate I, fig. 15. Deposited in the micropalaeontological collections of the British Museum (Natural History), catalog no. PF 53004.
Material: 76 specimens.
Locality and horizon: Sample 263-19R-2, 86–90 cm.
Age: Valanginian–Barremian.
Description: Test a narrow, elongated, compressed tube, very gently arched, and gently tapered towards the base, with a median furrow. Wall finely agglutinated and smoothly finished. Aperture is the open end of the tube.
Dimensions: Length of Holotype: 0.97 mm.
Remarks: Differs from *H. depressa* by its longer, narrower, more gently arched test and thinner agglutinated wall. Closely resembles *Hyperammina* sp. C figured in pl. 2, fig. 4 by Crespin (1963). The Albian species *Hippocrepina vermicula* Bulatova described from the Albian of Siberia is a much broader, stouter form.

Hyperammina gaultina Ten Dam, 1950
Hyperammina gaultina Ten Dam, 1950, pl. 1, fig. 2.—Haig, 1980, pl. 1, figs. 4–5.
Remarks: Very common in the shallow-water *Ammobaculites* Association of Queensland (D. Haig, pers. commun., 1994). Few specimens are found at DSDP Site 263.
Range and occurrence: A cosmopolitan species in the Aptian–Albian (Haig, 1980).

Superfamily AMMODISCACEA Reuss, 1862

Ammodiscus cretaceus (Reuss, 1845) (Plate III, 2–3)
Operculina cretacea Reuss 1845, pl. 13, figs. 64–65.
Ammodiscus cretaceus (Reuss).—Riegraf and Luterbacher 1989a, pl. 1, fig. 7.

Ammodiscus infimus Franke, 1936 (Plate III, 4–5)
Ammodiscus infimus Franke, 1936, pl. 1, fig. 14.—Weidich, 1990, pl. 34, fig. 1–3.

Ammodiscus tenuissimus (Gümbel, 1862) (Plate III, 1)
Spirillina tenuissima Gümbel, 1862, pl. 4, fig. 12.
Ammodiscus tenuissimus (Gümbel, 1862).—Kaminski et al., 1992, pl. 2, fig. 3.
Remarks: Close to *Ammodiscus glabratus* Cushman and Jarvis, 1928, except for its smaller size.

Ammodiscus sp. 1 (Plate III, 6)
Description: Tubular test with globular proloculus and very wide, planispirally coiled second chamber which is occasionally constricted. Aperture at end of open tube.

Ammolagena clavata (Jones and Parker, 1860) (Plate II, 17)
Trochammina irregularis var. *clavata* Jones and Parker, 1860, p. 304.
Ammolagena clavata (Jones and Parker).—Loeblich and Tappan, 1988, pl. 36, fig. 16.

Plate IV
1. *Recurvoides obskiensis* Romanova, (×140), Sample 263-21-4; 120–124 cm.
2. *Recurvoides* sp., (×110), Sample 263-20-4; 127–131 cm.
3. *Recurvoides* sp., (×140), Sample 263-22-3; 117–121 cm.
4. *Recurvoides* sp., (×140), Sample 263-20-4; 127–131 cm.
5. *Recurvoides* sp., (×140), Sample 263-19-6; 61–65 cm.
6. *Recurvoides* sp., (×130), Sample 263-22-3; 117–121 cm.
7. *Thalmannammina* sp., (×100), Sample 263-10-2; 84–89 cm.
8. *Thalmannammina* sp., (×180), Sample 263-21-4; 120–124 cm.
9. *Thalmannammina* sp., (×150), Sample 263-22-3; 117–121 cm.
10. *Paratrochamminoides* sp., (×130), Sample 263-22-3; 117–121 cm.
11. *Paratrochamminoides* sp., (×120), Sample 263-19-6; 61–65 cm.
12. *Ammosphaeroidina* sp., (×160), Sample 263-22-3; 117–121 cm.

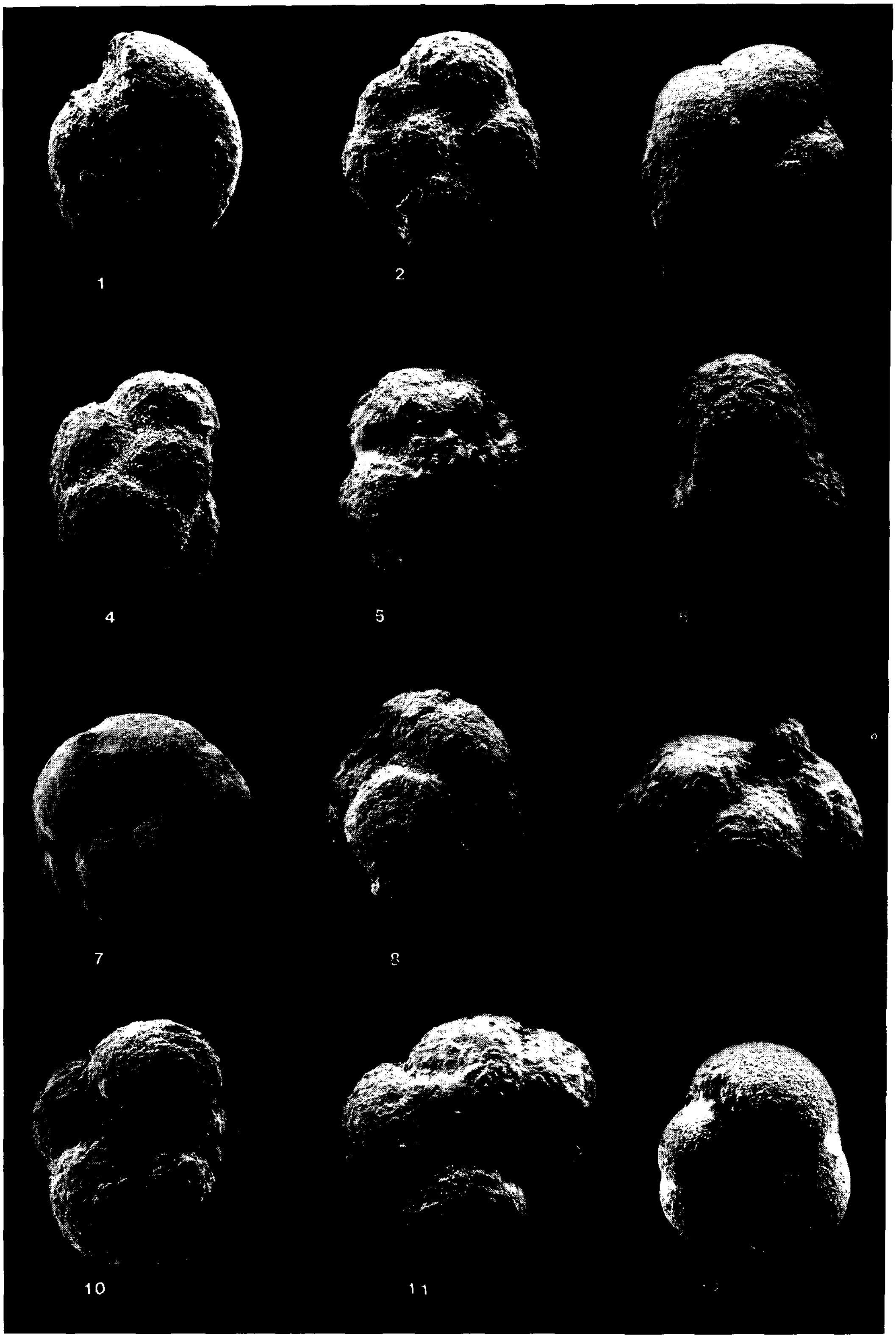

Plate 4.

Glomospira charoides (Jones and Parker, 1860) (Plate III, 10–11)

Trochammina squamata var. *charoides* Jones and Parker, 1860, p. 304.

Glomospira charoides (Jones and Parker).—Berggren and Kaminski, 1990, pl. 1, fig. 2.

Glomospira gordialis (Jones and Parker, 1860) (Plate III, 9)

Trochammina squamata var. *gordialis* Jones and Parker, 1860, p. 304.

Glomospira gordialis (Jones and Parker).—Berggren and Kaminski, 1990, pl. 1, fig. 1.

Glomospira irregularis (Grzybowski, 1896)

Ammodiscus irregularis Grzybowski, 1896, pl. 11, figs. 2–3.

Glomospira irregularis (Grzybowski, 1896).—Kaminski et al., 1992, pl. 2, figs. 11–12.

Glomospirella gaultina (Berthelin, 1880) (Plate III, 12)

Ammodiscus gaultinus Berthelin, 1880, pl. 1, fig. 3.

Glomospirella gaultina (Berthelin).—Kaminski et al., 1992, pl. 2, fig. 15.

Superfamily SPIROPLECTAMMINACEA Cushman, 1927

Ammobaculoides sp. (Plate VI, 13)

Remarks: Rare at Site 263.

Spiroplectammina sp. 1 (Plate VI, 11)

Description: Elongate, compressed test with small initial coil. Sutures oblique in biserial part; well-cemented wall, coarsely agglutinated.

Aaptotoichus clavellatus (Loeblich and Tappan, 1946) (Plate VI, 16)

Bigenerina clavellata Loeblich and Tappan, 1946, pl. 35, figs. 7–8.

Bigenerina clavellata (Loeblich and Tappan).—Bartenstein and Brand, 1951, pl. 4, figs. 75–76.

Bigenerina clavellata (Loeblich and Tappan).—Sliter, 1977, pl. 3, figs. 6–7.

Aaptotoichus challengeri n.sp. (Plate VII, 1–6)

Bigenerina loeblichae Crespin.—Scheibnerová, 1974, pl. 9, fig. 7.

cf. *Bigenerina jurassica* Haeusler.—Riegraf and Luterbacher, 1989b, pl. 2, figs. 15–20.

Bigenerina sp. Kaminski et al., 1992, pl. 7, fig. 1.

Derivation of name: after the drilling vessel *Glomar Challenger*.

Holotype: Specimen figured in Plate I, fig. 1. Deposited in the micropalaeontological collections of the British Museum (Natural History), catalog no. PF 53005.

Material: 69 specimens from Site 263, and several specimens from ODP Sites 765 and 766.

Locality and horizon: Sample 263-22R-3, 117–121 cm. *Age*: Valanginian–Barremian.

Description: Elongate, narrow test with short, biserial stage followed by longer, uniserial portion of up to seven chambers. Chambers in the uniserial portion are inflated, with sutures that are horizontal or slightly oblique. Wall finely agglutinated, finely finished. Aperture terminal, a small round opening at the end of a

Plate V

1. *Cribrostomoides nonioninoides* (Reuss), (×100), Sample 263-26-5; 126–130 cm.
2. *Evolutinella perturbans* Ludbrook, (×55), Sample 263-26-5; 126–130 cm.
3. *Haplophragmoides concavus* (Chapman), (×115), Sample 263-29-3; 71–75 cm.
4. *Haplophragmoides* sp., (×70), Sample 263-26-5; 126–130 cm.
5. *Trochammina depressa* Lozo, (×85), Sample 263-21-4; 120–124 cm.
6. *Trochammina* sp., (×90), Sample 263-21-4; 120–124 cm.
7. *Trochammina subinflata*, (×130), Sample 263-21-4; 120–124 cm.
8. *Trochammina abrupta* Geroch, (×100), Sample 263-29-4; 140–144 cm.
9. *Trochammina ribstonensis* Wickenden, (×170), Sample 263-19-2; 86–90 cm.
10. *Trochammina ribstonensis* Wickenden, (×150), Sample 263-19-2; 86–90 cm.
11. *Trochammina ribstonensis* Wickenden, (×200), Sample 263-19-2; 86–90 cm.
12. *Trochammina ribstonensis* Wickenden, (×170), Sample 263-19-2; 86–90 cm.

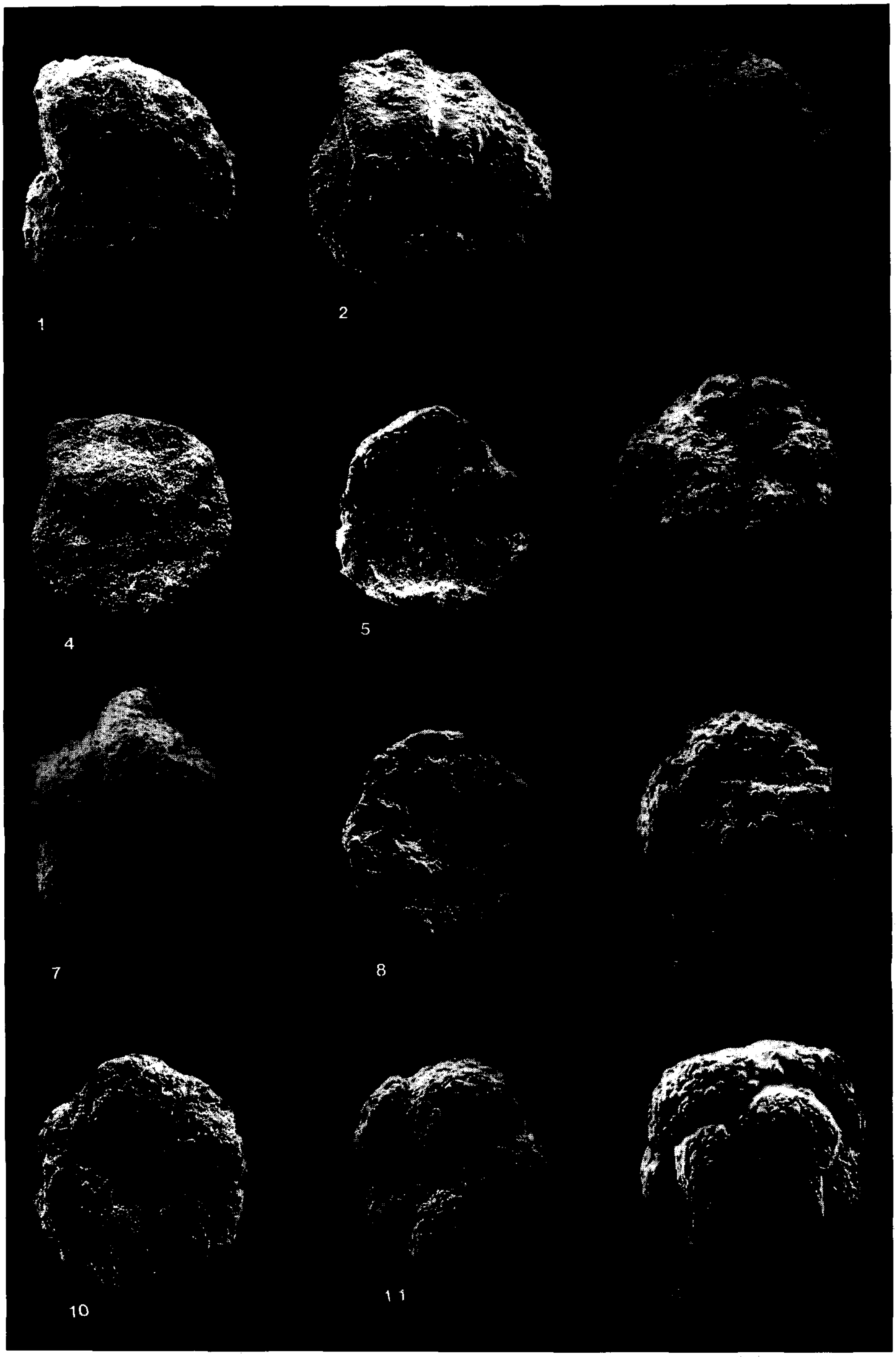

Plate 5.

short neck. This species is distinctly dimorphic: the microsphere has a pointed, rapidly expanding biserial stage composed of numerous small chambers, whereas the megalosphere has only a few large round biserial chambers in the initial part of the test.

Dimensions: Length of Holotype: 0.46 mm.

Remarks: The definition of the genus *Aaptotoichus* given by Loeblich and Tappan (1988) makes no mention of a neck. This species differs from the type species *A. clavellatus* (Loeblich and Tappan) in possessing fewer number of uniserial chambers separated by slightly oblique sutures, and in its short neck. The species *Bigenerina pitmani* (Crespin) of Haig (1980) (which also includes the subjective synonyms *Ammobaculoides romaensis* Crespin, 1953 and *Bigenerina loeblichae* Crespin, 1953), differs from it by its straighter axis and much longer uniserial stage with horizontal sutures, and by the absence of an apertural neck.

Aaptotoichus challengeri n.sp. appears to be the intermediate form between the Upper Jurassic "*Bigenerina*" *jurassica* (Haeusler, 1890) and the Aptian species *Aaptotoichus pitmani* (Crespin, 1953) (= *Bigenerina pitmani*). Evolution in this suspected lineage progresses by a reduction in the relative proportions of the biserial part with respect to the uniserial part, and the addition of numerous low uniserial chambers with horizontal sutures. The typical *B. jurassica* as emended by Oesterle (1968) has a terminal part that is still loosely biserial, with high chambers. In the intermediate stage represented by *A. challengeri*, the biserial part is followed by a more loosely biserial stage, and the terminal chambers may still have slightly oblique sutures. Similar specimens have been illustrated as *Bigenerina jurassica* by Riegraf and Luterbacher (1989a) from the Valanginian of western North Atlantic. In the younger species *Aaptotoichus pitmani*, as well as in *Aaptotoichus clavatellus* (Bartenstein and Brand, 1951), there is no sign of a loosely biserial portion—the initial chambers of the uniserial part are immediately low, with horizontal sutures.

Range and occurrence: This species was found in Cores 60R and 61R at ODP Site 765 and in Cores 49R-43R at ODP Site 766, which have been correlated with the Berriasian–Valanginian and the Valanginian–Hauterivian, respectively.

Bimonilina sp. (Plate VI, 17–18)

Bimonilina cf. ***variana*** Eicher, 1960 (Plate VI, 14–15)

Bimonilina variana Eicher, 1960, pl. 4, figs. 15–19.

Pseudobolivina variana (Eicher).—Haig, 1980, pl. 5, figs. 23–26.

Pseudobolivina parvula Ludbrook, 1966, pl. 4, figs. 18–20.

Range and occurrence: *Bimonilina variana* is widely recorded in North America from the Albian to

Plate VI

1. *Ammobaculites* sp. 1, (×45), Sample 263-26-5; 126–130 cm.
2. *Ammobaculites* sp. 1, (×45), Sample 263-26-5; 126–130 cm.
3. *Bulbobaculites* cf. *inconstans* (Bartenstein and Brand), (×140), Sample 263-22-2; 91–95 cm.
4. *Bulbobaculites* cf. *inconstans* (Bartenstein and Brand), (×100), Sample 263-21-4; 120–124 cm.
5. *Ammobaculites* sp. 1, (×35), Sample 263-25-2; 60–64 cm.
6. *Bulbobaculites humei* Nauss, (×70), Sample 263-22-3; 117–121 cm.
7. *Bulbobaculites humei* Nauss, (×45), Sample 263-19-4; 102–106 cm.

8a. *Bulbobaculites humei* Nauss, (×70), Sample 263-11-2; 92–96 cm.

8b. *Bulbobaculites humei* Nauss, (×200), Sample 263-19-4; 102–106 cm.

9. *Ammobaculites crespinae* Bhalla, (×45), Sample 263-25-4; 100–104 cm.
10. *Ammobaculites crespinae* Bhalla, (×40), Sample 263-25-2; 60–64 cm.
11. *Spiroplectammina* sp. 1, (×80), Sample 263-19-4; 102–106 cm.
12. *Spiroplectammina* sp., (×45), Sample 263-13-6; 111–115 cm.
13. *Ammobaculoides* sp., (×55), Sample 263-25-4; 100–104 cm.
14. *Bimonilina* cf. *variana* Eicher, (×130), Sample 263-19-4; 102–106 cm.
15. *Bimonilina* cf. *variana* Eicher, (×85), Sample 263-16-1; 93–97 cm.
16. *Aaptotoichus clavellatus* (Loeblich and Tappan), (×95), Sample 263-25-4; 100–104 cm.
17. *Bimonilina* sp., (×95), Sample 263-16-1; 93–97 cm.
18. *Bimonilina* sp., (×55), Sample 263-16-1; 93–97 cm.

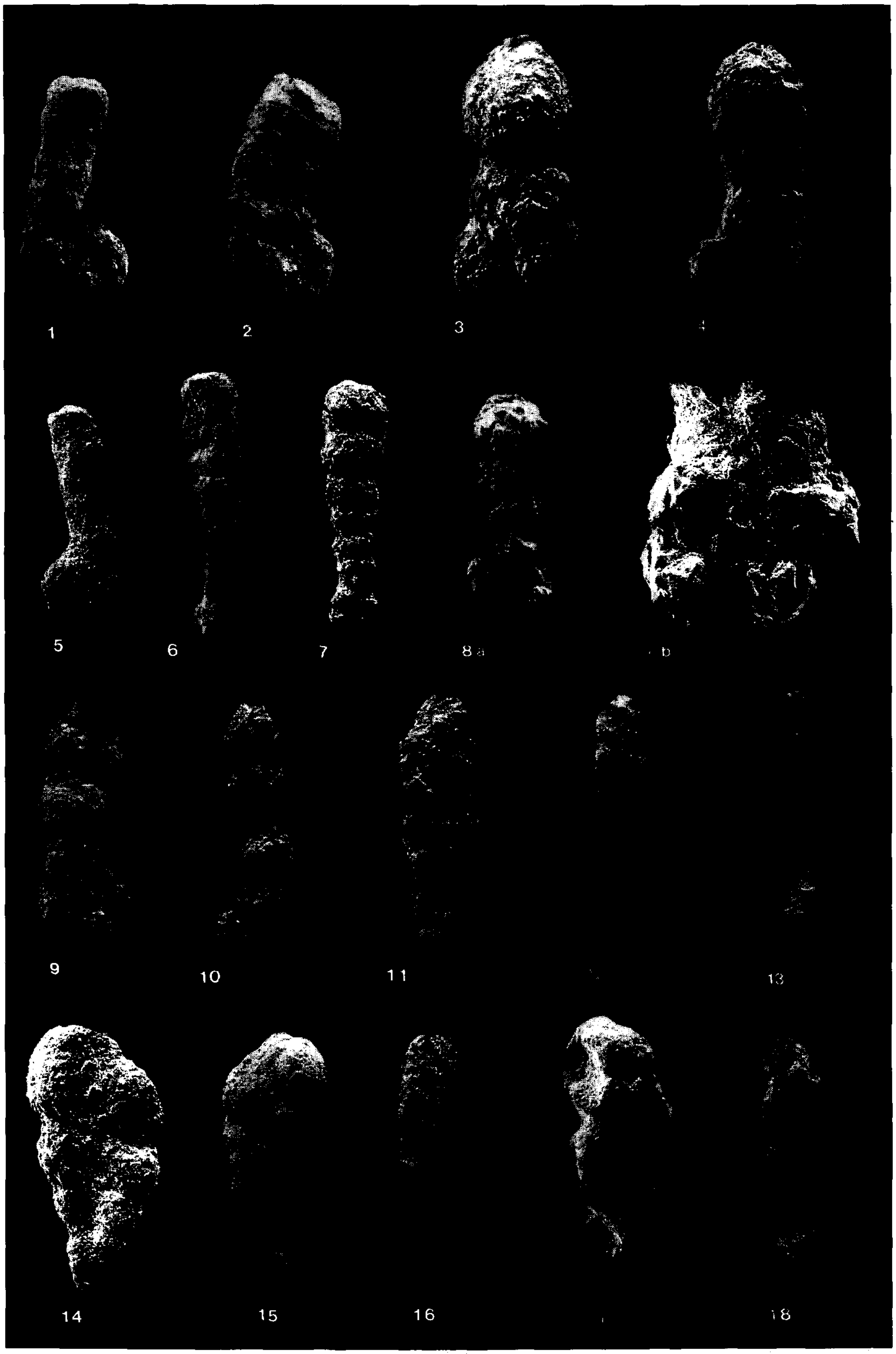

Plate 6.

the Cenomanian. *Pseudobolivina parvula* is found in the Aptian–Albian of South Australia (Ludbrook, 1966).

Remarks: The test does not display the tendency to become uniserial of *B. variana* and *B. parvula*: the last chamber is not so markedly elongated and does not overlap the preceeding pair of chambers.

"Textulariopsis" elegans n.sp. (Plate VIII, 1–2)

Derivation of name: because of its slender "elegant" shape.

Holotype: Specimen figured in Plate VIII, fig. 2. Deposited in the micropalaeontological collections of the British Museum (Natural History), catalog no. PF 53006.

Material: 128 specimens from Site 263.

Locality and horizon: Sample 263-22R-2, 91–95 cm.
Age: Valanginian–Barremian.

Description: Test biserial with an adventitious chamber in the initial portion of the test; elongate, narrow, very gently flaring, with numerous chambers gradually increasing in size (usually 17 pairs or more). The test is sub-rounded in cross-section with well-defined, sutures that are oblique in the centre and becoming horizontal towards the periphery, forming a distinctive herring-bone pattern down the centre of the test. Wall is solid, noncalcareous, finely agglutinated with a smooth finish. Aperture is a slit at the base of the last chamber.

Dimensions: Length of Holotype: 0.42 mm.

Remarks: The wall is not calcareous. This species cannot, therefore, be placed in *Textularia* as currently defined by Loeblich and Tappan (1988). It differs from *T. anacooraensis* Crespin (Ludbrook, 1966, pl. 4, fig. 6) by its more numerous chambers and by the presence of an adventitious chamber. The wall appears to be thin and tests are often distorted.

Superfamily LITUOLACEA de Blainville, 1827

Cribrostomoides nonioninoides (Reuss, 1863) (Plate V, 1)

Haplophragmium nonioninoides Reuss, 1863, pl. 1, fig. 8.

Labrospira nonioninoides (Reuss).—Haig, 1980, pl. 3, fig. 12–19.

Haplophragmoides nonioninoides (Reuss).—Meyn and Vespermann, 1994, pl. 1, figs. 1–8.

Remarks: Haig (1980) suggested that many of the Australian forms described under *Haplophragmoides* by Crespin (1963) and Ludbrook (1966) closely resemble *C. nonioninoides*, but the poor preservation state prevented precise determination. In most specimens from Site 263 the aperture is indeterminate, but the best-preserved specimens appear to have a small areal aperture in the centre of the apertural face. Meyn and Vespermann (1994) assigned this species to the genus *Haplophragmoides* despite the fact that their plates show a distinctly areal aperture. These authors considered the genus *Labrospira* to be a Holocene taxon, following the age reported by Loeblich and Tappan (1988), with no known counterparts in the Cretaceous. This species has now been assigned to the genus *Cribrostomoides* on account of the areal aperture and slightly streptospiral early stage, observed in some specimens (D. Haig, pers. commun., 1994; McLoughlin et al., in press).

Range and occurrence: A cosmopolitan species in the Barremian–Aptian (Haig, 1980), it was recorded in the Hauterivian–Barremian of the Carnarvon Basin (McLoughlin et al., in press).

Evolutinella perturbans (Ludbrook, 1966) (Plate V, fig. 2)

Haplophragmoides perturbans Ludbrook, 1966, pl. 3, figs. 1–4.

Haplophragmoides audax Ludbrook, 1966, pl. 2, figs. 1–4.

Remarks: This species resembles *H. gigas* Cushman, except for its more rounded periphery and straighter sutures.

Range and occurrence: This species ranges from the Aptian to the base of the Albian in South Austalia (Ludbrook, 1966).

Haplophragmoides concavus (Chapman, 1892) (Plate V, fig. 3)

Trochammina concava Chapman, 1892, pl. 6, fig. 14.

Haplophragmoides concavus (Chapman).—Bartenstein and Brand, 1951, pl. 1, figs. 24–25.

Haplophragmoides concavus (Chapman).—Weidich, 1990, pl. 7, figs. 2, 11, 19 and pl. 36, figs. 5–6.

Range and occurrence: A cosmopolitan species throughout the Early Cretaceous (Weidich, 1990).

Haplophragmoides hagni Bhalla, 1965

Haplophragmoides hagni Bhalla, 1965.—Bhalla, 1969, pl. 1, figs. 6–7, text-fig. 3.

Remarks: This species shows close similarity to *Haplophragmoides euryraptum* Fowler and Braun (1993, pl. 3, figs. 11–13).

Haplophragmoides sp. (Plate V, 4)

Remarks: Many tests, are distorted and poorly preserved and can only be tentatively identified.

Lituotuba sp. (Plate II, 18)

Remarks: Only three specimens were found at DSDP Site 263.

Paratrochamminoides spp. (Plate IV, 10–11)

Remarks: Specimens classified under this generic name have a planispiral last whorl. These forms also display affinity to specimens included here as *Recurvoides*.

Ammobaculites crespinae Bhalla, 1969 (Plate VI, 9–10)

Ammobaculites crespinae Bhalla, 1969, pl. 2, figs. 1–3.

Ammobaculites crespinae Bhalla.—Scheibnerová, 1974, pl. 1, fig. 11 and pl. 9, fig. 4.

Remarks: The specimens from DSDP Site 263 have a characteristic dome-shaped last chamber which often bears a very short neck. They show considerable variation in size, number and width of chambers and wall texture.

Ammobaculites sp. 1 (Plate VI, 1–2,5)

Description: Test with large initial planispiral coil, slightly evolute, composed of 6–11 chambers in the last whorl (in presumed megalospheric forms the coil is larger and contains up to 11 chambers). Uniserial portion extends tangentially, is straight or slightly curved, usually narrower than the coil, with as many as 10 (normally four or five) broad, low chambers separated by thin, depressed, horizontal sutures. Aperture indistinct, probably simple and terminal in the uncoiled part. Wall noncalcareous, thick and firmly cemented, medium to finely agglutinated.

Remarks: The size of initial coil and width of uniserial portion vary considerably in our specimens from DSDP Site 263. The specimen from the Muderong Shale illustrated as *Ammobaculites laevigatus* Lozo by Crespin (1963) differs by its curved axis, finer grained wall and more involute, broader initial coil. This species also resembles the Siberian species *Acruliammina pseudolonga* Subbotina, 1964, (Subbotina, 1964, pl. 14, fig. 4), from which it differs in having a single aperture and a greater number of chambers in its coiled part.

Superfamily HAPLOPHRAGMIACEA Eimer and Fickert, 1899

Ammosphaeroidina sp. (Plate IV, 12)

Remarks: Coiling is involute and slightly streptospiral, with four chambers visible from the exterior. The aperture is not visible in our specimens, but it is probably interiomarginal.

Recurvoides* cf. *obskiensis Romanova, 1960 (Plate IV, 1)

Recurvoides obskiensis Romanova (in Glazunova et al., 1960), pl. 4, figs. 1–8.

Recurvoides cf. *obskiensis* Romanova.—Weidich, 1990, pl. 4, figs. 13–17.

Remarks: Our specimens display the characteristic oval outline, recurvoidiform coiling, and thick sutures of this distinctive Siberian species, but differ in their generally smaller dimensions, and in having a fewer number of chambers in the final whorl. *Recurvoides obskiensis* was described as possessing 9–13 chambers, but our specimens generally have 9–10, rarely 11 chambers.

Range and occurrence: *Recurvoides obskiensis* was first described from the Valanginian to Hauterivian of western Siberia (Subbotina, 1964). It has been reported from the Volgian to Ryazenian of Spitsbergen (Nagy et al., 1990).

Recurvoides spp. (Plate IV, 2–6)

Remarks: Specimens from DSDP Site 263 show considerable variability with many transitional forms to *Thalmannammina* and *Paratrochamminoides* spp. A detailed taxonomic study of specimens belonging to all three groups is necessary before speciation can be attempted.

Thalmannammina spp. (Plate IV, 7–9)

Remarks: Specimens grouped under this generic name are typically coiled in a U-shaped manner.

Bulbobaculites humei (Nauss, 1947) (Plate VI, 6–8)

Ammobaculites humei Nauss, 1947, pl. 48, fig. 1.

Ammobaculites humei Nauss.—Haig, 1980, pl. 4, figs. 4–10. [with synonymy]

Remarks: Included under this designation are all the slender forms with numerous chambers. This is a very variable species which has been described under a large number of specific names (Haig, 1980). Haig's synonymy includes the specimens illustrated by Scheibnerová (1974) as *Ammobaculites fisheri* Crespin, 1953 from DSDP Site 263.

Range and occurrence: A cosmopolitan species in the Aptian–Albian (Haig, 1980).

Bulbobaculites cf. ***inconstans*** (Bartenstein and Brand, 1951) (Plate VI, 3–4)

Haplophragmium inconstans erectum Bartenstein and Brand, 1951, pl. 3, figs. 50–55.

Bulbobaculites cf. *inconstans* Bartenstein and Brand.—Kaminski et al., 1992, pl. 4, figs. 9–10.

Remarks: Specimens from DSDP Site 263 have a shorter uniserial portion (usually two or three chambers) than the Valanginian species described by Bartenstein and Brand (1951).

Superfamily TROCHAMMINACEA Schwager, 1877

Trochammina abrupta Geroch, 1959 (Plate V, 8)

Trochammina abrupta Geroch, 1959, pl. 12, figs. 1–3.

Trochammina abrupta Geroch.—Kaminski et al., 1992, pl. 5, figs. 14–15 and pl. 6, figs. 1–2.

Range and occurrence: This species was found in the Tithonian to Valanginian at Site 765 (Kaminski et al., 1992). It was described from the Hauterivian to Albian in the Polish Carpathians (Geroch and Nowak, 1984).

Trochammina depressa Lozo, 1944 (Plate V, 5)

Trochammina depressa Lozo, 1944, pl. 2, figs. 4–5.

Trochammina depressa Lozo.—McNeil and Caldwell, 1981, pl. 13, fig. 8.

Remarks: Haig (1980) regarded the species *T. flosculus*, described by Ludbrook (1966, pl. 5, figs. 7–10) as a synonym of *T. depressa.*

Range and occurrence: A cosmopolitan species in the Aptian–Albian (Haig, 1980).

Trochammina ribstonensis Wickenden, 1932 (Plate V, 9–12)

Trochammina ribstonensis Wickenden, 1932, pl. 1, fig. 12.

Trochammina ribstonensis Wickenden.—Tappan, 1962, pl. 39, fig. 15–17.

Trochammina minuta Crespin.—Scheibnerová, 1974, pl. 1, figs. 18–20 and pl. 9, figs. 19–20.

Remarks: This is a small species, described as *T. ribstonensis* by Tappan (1962) and as *T. minuta* by Scheibnerová (1974). It differs from *T. ribstonensis*,

Plate VII

1a. *Aaptotoichus challengeri* n.sp., (holotype), (×85), Sample 263-22-3; 117–121 cm.
1b. *Aaptotoichus challengeri* n.sp., (holotype), (×350), Sample 263-22-3; 117–121 cm.
2a. *Aaptotoichus challengeri* n.sp., (×95), Sample 263-22-3; 117–121 cm.
2b. *Aaptotoichus challengeri* n.sp., (×350), Sample 263-22-3; 117–121 cm.
3a. *Aaptotoichus challengeri* n.sp., (×75), Sample 263-22-3; 117–121 cm.
3b. *Aaptotoichus challengeri* n.sp., (×275), Sample 263-22-3; 117–121 cm.
4a. *Aaptotoichus challengeri* n.sp., (×75), Sample 263-22-3; 117–121 cm.
4b. *Aaptotoichus challengeri* n.sp., (×325), Sample 263-22-3; 117–121 cm.
5. *Aaptotoichus challengeri* sp.n., (×75), Sample 263-21-4; 120–124 cm.
6. *Aaptotoichus challengeri* n.sp., (×80), Sample 263-21-4; 120–124 cm.
7. "*Gaudryina*" sp., (×80), Sample 263-26-2; 60–64 cm.
8. "*Gaudryina*" sp., (×100), Sample 263-21-4; 120–124 cm.
9a. "*Gaudryinopsis*" *pseudobettenstaedti* n.sp., (holotype), (×95), Sample 263-25-4; 100–104 cm.
9b. "*Gaudryinopsis*" *pseudobettenstaedti* n.sp., (holotype), (×275), Sample 263-25-4; 100–104 cm.
10a. "*Gaudryinopsis*" *pseudobettenstaedti* n.sp., (×110), Sample 263-24-2; 30–34 cm.
10b. "*Gaudryinopsis*" *pseudobettenstaedti* sp.n., (×425), Sample 263-24-2; 30–34 cm.

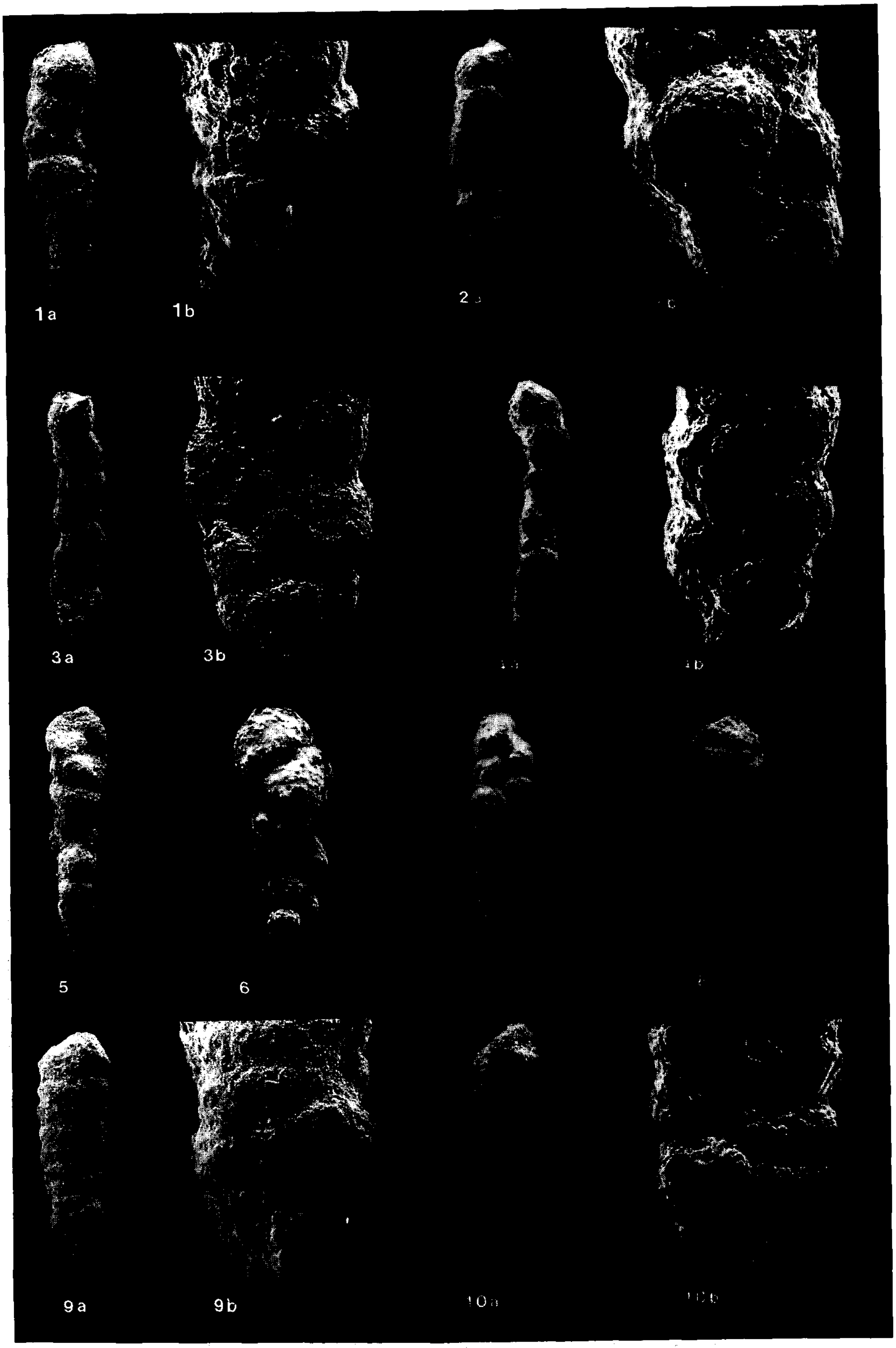

Plate 7.

illustrated by McNeil and Caldwell (1981, pl. 13, fig. 1), by having fewer chambers in the last whorl (four to six) and in its more conical shape.

Range and occurrence: *Trochammina ribstonensis* has been widely recorded from the Turonian to Campanian of North America (McNeil and Caldwell, 1981). *Trochammina minuta* is common in the Aptian of the Great Artesian and Canning Basins, also, in the lower Albian of the Great Artesian Basin (Scheibnerová, 1974).

Trochammina subinflata (Plate V, 7)

Trochammina subinflata Crespin, 1963, pl. 18, figs. 11–19.

Trochammina subinflata Crespin.—Ludbrook, 1966, pl. 5, figs. 11–14.

Trochammina subinflata Crespin.—Haig, 1980, pl. 6, figs. 17–18 and pl. 7, figs. 1–2.

Superfamily VERNEUILINACEA Cushman, 1911

"Gaudryinopsis" pseudobettenstaedti n.sp. (Plate VII, 9–10)

Derivation of name: because of its resemblance to *Textularia bettenstaedti* Bartenstein and Oertli, 1977.

Holotype: Specimen illustrated in Plate VII, fig. 9. Deposited in the micropalaeontological collections of the British Museum (Natural History), catalog no. PF 53007.

Material: 126 specimens from Site 263.

Locality and horizon: Sample 263-25R-4, 100–104 cm. *Age*: Valanginian–Barremian.

Description: Elongate test with a short triserial stage, becoming biserial with near parallel sides (9–14 pairs of chambers) and a sub-circular cross-section. Sutures curved and slightly depressed. Wall noncalcareous, finely agglutinated with distinctive mafic grains along the sutures. Aperture, a low arch at the base of the last chamber.

Dimensions: Length of Holotype: 0.44 mm.

Remarks: The biserial part of the test strongly resembles *Textularia bettenstaedti* because of the mafic grains along the sutures. It differs in the presence of an initial triserial part.

Pseudoreophax sp. 1 (Plate II, 14–15)

Description: Elongate test, initially trochospiral, then uniserial with asymmetric chambers along a twisting axis. Megalosphere is uniserial throughout. Chambers are inflated, wall finely agglutinated, aperture rounded and terminal.

Remarks: Differs from *Pseudoreophax cisownicensis* Geroch, 1966, by its longer size, greater number of chambers and thinner wall.

Verneuilinoides aff. ***crespinae*** Ludbrook, 1966 (Plate IX, 6)

Verneuilinoides crespinae Ludbrook, 1966, pl. 7, figs. 13–14.

Verneuilinoides crespinae Ludbrook—Scheibnerová, 1974, pl. 1, figs. 25–26 and pl. 9, fig. 14.

Remarks: Scheibnerová described this species as *V. crespinae*. However, examination of type material

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Plate VIII

1a. "*Textulariopsis*" *elegans* n.sp., (×75), Sample 263-22-2; 91–95 cm.
1b. "*Textulariopsis*" *elegans* n.sp., (×450), Sample 263-22-2; 91–95 cm.
2. "*Textulariopsis*" *elegans* n.sp., (holotype), (×100), Sample 263-22-2; 91–85 cm.
3. "*Textularia*" sp. 1, (×100), Sample 263-22-2; 91–95 cm.
4. "*Textularia*" sp. 1, (×105), Sample 263-22-3; 117–121 cm.
5. "*Textularia*" sp. 1, (×140), Sample 263-19-4; 102–106 cm.
6. "*Gaudryina*" *cuvierensis* n.sp., (×85), Sample 263-24-2; 30–34 cm.
7a. "*Gaudryina*" *cuvierensis* n.sp., (×75), Sample 263-22-3; 117–121 cm.
7b. "*Gaudryina*" *cuvierensis* n.sp., (×85), Sample 263-22-3; 117–121 cm.
8a. "*Gaudryina*" *cuvierensis* n.sp., (×75), Sample 263-22-3; 117–121 cm.
8b. "*Gaudryina*" *cuvierensis* n.sp., (×275), Sample 263-22-3; 117–121 cm.
9a. "*Gaudryina*" *cuvierensis* n.sp., (×50), Sample 263-22-2; 91–95 cm.
9b. "*Gaudryina*" *cuvierensis* n.sp., (×210), Sample 263-22-2; 91–95 cm.
10. "*Gaudryina*" *cuvierensis* n.sp., (×70), Sample 263-22-2; 91–95 cm.
11. "*Gaudryina*" *cuvierensis* n.sp., (×85), Sample 263-22-2; 91–95 cm.
12. "*Gaudryina*" *cuvierensis* n.sp., (×95), Sample 263-22-2; 91–95 cm.
13. *Aschemocella* sp., (×60), Sample 263-23-4; 74–78 cm.

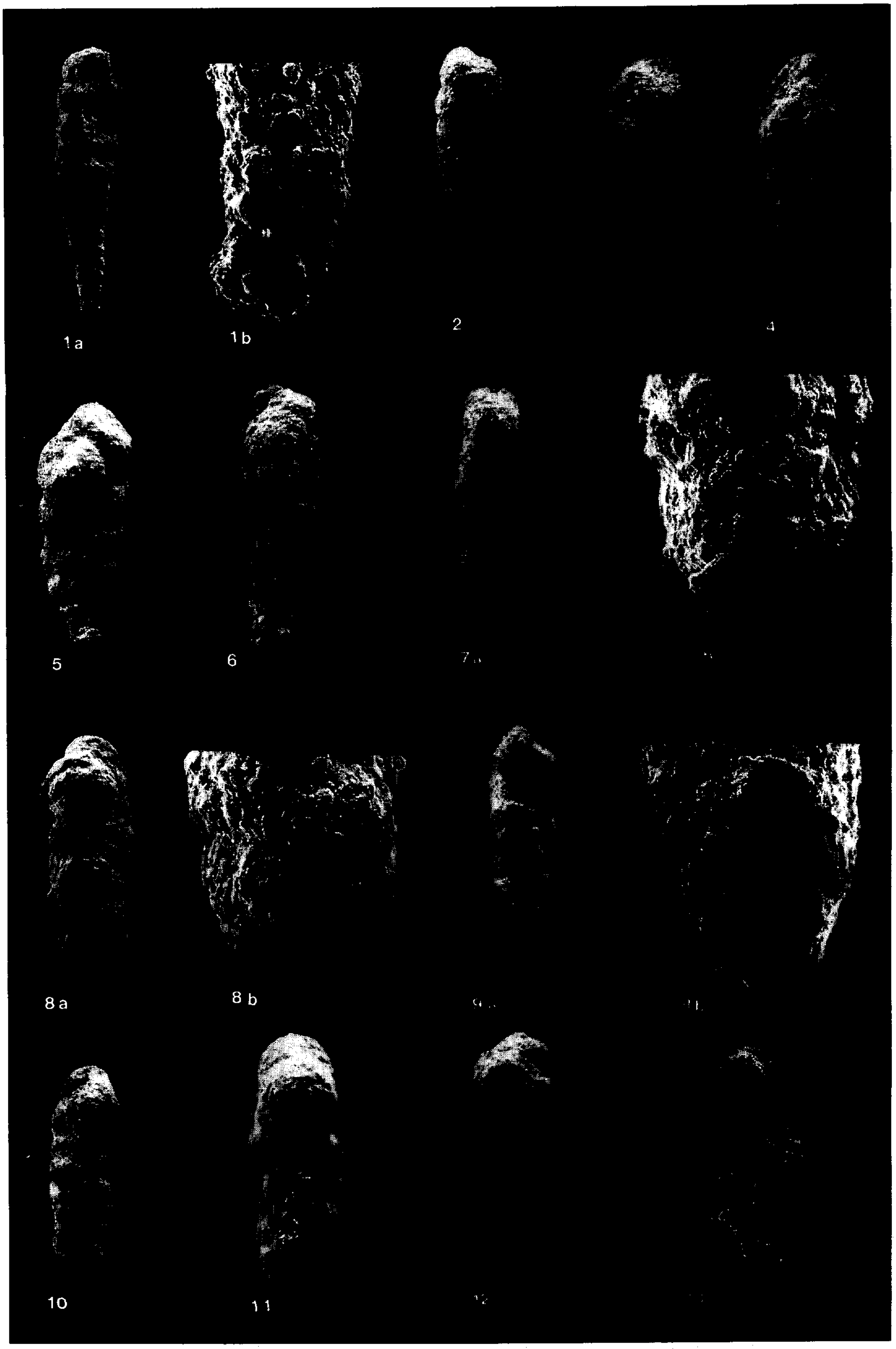

Plate 8.

showed that the specimens from DSDP Site 263 differed from *V. crespinae* by their uniform triserial coiling, greater number of whorls and more pronounced flare. The holotype, redescribed by Haig (1980) as *Riyadhella crespinae* (now referred to as *Eomarssonella crespinae* by Haig and Lynch, 1993), and the paratypes, have a distinct trochospire at the beginning of the test, consisting of one to two whorls of four chambers; the remainder of the test is triserial with three to four whorls of chambers. The species from DSDP Site 263 shows some resemblance to *Verneuilinoides implexus* Fowler and Braun, 1993, (pl. 5, figs. 17–19).

Range and occurrence: *Eomarssonella crespinae* was found in the Albian of Queensland, Australia. *V. implexus* was recorded from the upper Barremian by Fowler and Braun (1993) in Arctic Canada.

Verneuilinoides neocomiensis (Myatlyuk, 1939) (Plate IX, 5)

Verneuilina neocomiensis Myatlyuk, 1939, pl. 1, figs. 12–13.

Verneuilinoides asperulus Crespin 1963, pl. 15, figs. 8–12.

Verneuilinoides neocomiensis (Myatlyuk).—Kaminski et al., 1992, pl. 7, fig. 15.

Range and occurrence: Cosmopolitan during the Early Cretaceous (Haig, 1980).

Remarks: *Verneuilinoides asperulus* appears to be a coarse-grained morphotype of *V. neocomiensis.*

''Gaudryina''cuvierensis n.sp. (Plate VIII, 6–12)

Derivation of name: after the Cuvier Abyssal Plain.

Holotype: Specimen figured in Plate VIII, fig. 9. Deposited in the micropalaeontological collections of the British Museum (Natural History), catalog no. PF 53008.

Material: 61 specimens from Site 263.

Locality and horizon: Sample 263–22R-3, 117–121 cm. *Age*: Valanginian–Barremian.

Description: Elongate test with circular cross-section, sub-parallel sides and well-developed triserial initial stage, becoming fully biserial in adult tests. The test often has a slightly twisted axis, so that the chambers are not uniformely aligned above each another. The triserial part consists of six to eight whorls of chambers which increase rapidly in size initially. The length of the biserial part varies considerably (from one to five whorls of chambers). Wall finely agglutinated. Aperture, a low arch at the base of the last chamber.

Dimensions: Length of Holotype: 0.77 mm.

Remarks: The wall is not calcareous and therefore, this species cannot be assigned to *Gaudryina* as currently reported by Loeblich and Tappan (1988).

Pseudogaudryinella sp. 1

Pseudogaudryinella sp. B Haig and Lynch, 1993, pl. 1, fig. 25–26.

Verneuilina howchini Crespin, 1953 (Plate IX, 3)

Verneuilina howchini Crespin, 1953, pl. 5, fig. 16.

Verneuilina howchini Crespin.—Scheibnerová, 1974, pl. 10, fig. 12.

Plate IX

1. *Marssonella* sp., (× 100), Sample 263-26-5; 126–130 cm.
2. *Verneuilinulla* sp. 2, (× 55), Sample 263-23-2; 139–143 cm.
3. *Verneuilina howchini* Crespin, (× 85), Sample 263-15-2; 113–117 cm.
4. *Verneuilinoides* sp., (× 80), Sample 263-12-3; 79–83 cm.
5. *Verneuilinoides neocomiensis* (Myatlyuk), (× 80), Sample 263-21-4; 120–124 cm.
6. *Verneuilinoides* aff. *crespinae* Loeblich and Tappan, (× 120), Sample 263-21-4; 120–124 cm.
7. *Verneuilinulla* sp. 1, (× 160), Sample 263-29-2; 76–80 cm.
8. *Bullopora* sp., (× 45), Sample 263-26-4; 31–35 cm.
9. *Citharina harpa* Roemer, (× 70), Sample 263-18-5; 101–105 cm.
10. *Vaginulinopsis excentrica* (Cornuel), (× 60), Sample 263-18-5; 101–105 cm.
11. *Oolina* cf. *caudata* (Walker and Jacob), (× 100), Sample 263-29-2; 76–80 cm.
12. *Lenticulina subangulata* (Reuss), (× 70), Sample 263-29-2; 76–80 cm.
13. *Lingulina* sp. 1, (× 105), Sample 263-4-4; 63–67 cm.
14. *Gyroidina infracretacea* Morozova (× 100), Sample 263-4-6; 46–50 cm.
15. *Gavelinella* sp., (× 110), Sample 263-4-4; 63–67 cm.
16. *Schreibnerova* sp., (× 100), Sample 263-4-6; 46–50 cm.

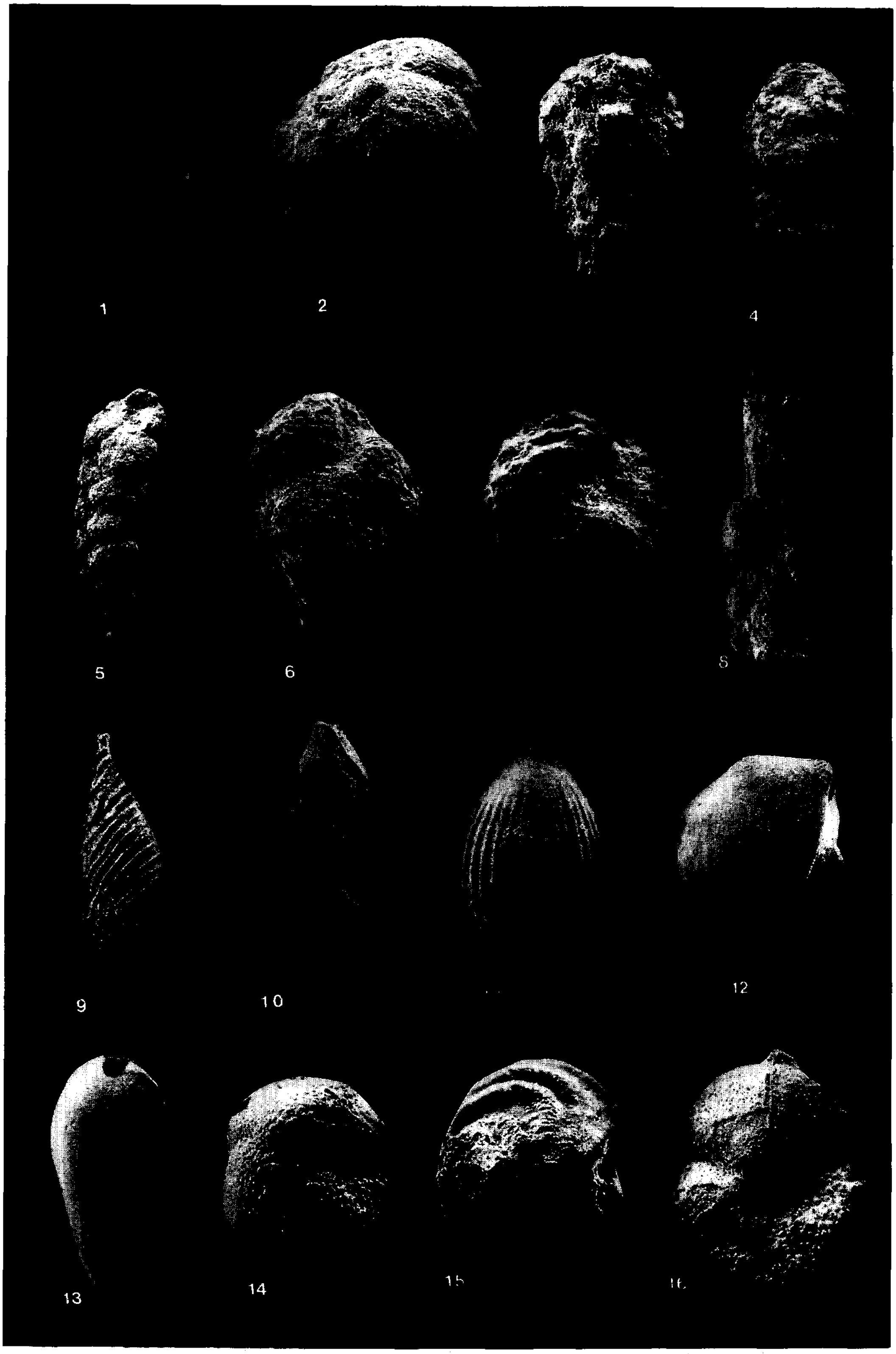

Plate 9.

Verneuilina howchini Crespin.—Haig, 1980, pl. 7, figs. 5–17.
Verneuilina canadensis Cushman.—McNeil and Caldwell, 1981, pl. 14, fig. 3.

Superfamily ATAXOPHRAGMIACEA Schwager, 1877

?Arenobulimina sp.
Description: Subconical, trochospiral test with five chambers per whorl. The chambers are inflated and separated by depressed sutures. Aperture, an interiomarginal arch; wall finely agglutinated.
Remarks: This species was only tentatively identified as the wall structure is unknown. Only two specimens were found.

Verneuilinulla sp. 1 (Plate IX, 7)
Description: Short, conical test, trochospirally coiled with four chambers per whorl. In some specimens the number of chambers reduces to three in the last whorls. Slit aperture at the base of the last chamber.
Remarks: A relatively rare species, occurring at the base of Hole 263.

Verneuilinulla sp. 2 (Plate IX, 2)
Description: Subconical test, initially trochospiral, becoming triserial. Chambers are very inflated and separated by markedly depressed sutures (with supporting pillars). Aperture is an interiomarginal arch at the base of the last chamber. Wall finely agglutinated.
Remarks: Only one specimen was found. Scheibnerová (1974) tentatively identified one similar specimen in Core 263-19CC as *Jarvisella* sp.

Remesella sp.
Remarks: This species occurs rarely in Cores 263-9R-3 to -4-R4.

Superfamily TEXTULARIACEA Ehrenberg, 1838

Marssonella sp. (Plate IX, 1)

"Textularia" sp. 1 (Plate VIII, 3–5)
Textularia wilgunyaensis Crespin.—Scheibnerová, 1974.
Description: Elongate, tapering, biserial test with 8–11 pairs of chambers increasing gradually in size. Wall finely agglutinated, sutures depressed and slightly oblique. Slit aperture at the base of the last chamber.
Remarks: The wall is not calcareous and this species cannot be assigned to *Textularia* as currently defined by Loeblich and Tappan (1988).

Calcareous benthic foraminifera

Superfamily NODOSARIACEA Ehrenberg, 1838

Laevidentalina communis (d'Orbigny, 1826)
Nodosaria communis d'Orbigny, 1826, p. 254.
Dentalina communis (d'Orbigny).—Bartenstein and Bolli, 1986; pl. 2, figs. 36–37.

Laevidentalina debilis (Berthelin, 1880)
Marginulina debilis Berthelin, 1880, pl. 3, fig. 28.
Lenticulina (*Vaginulina*) *debilis* (Berthelin). Moullade, 1984, pl. 3, fig. 13.

Frondicularia hastata Roemer, 1842
Frondicularia hastata Roemer 1842, pl. 7B, fig. 5.—Weidich, 1990, pl. 25, fig. 21.

Citharina harpa Roemer, 1841 (Plate IX, 9)
Citharina harpa Roemer, 1841, pl. 15, fig. 13.
Citharina harpa Roemer.—Riegraf, 1989, pl. 2, figs. 23–24.
Citharina pseudostriatula.—Bartenstein and Brand, 1951, pl. 7, fig. 182.
Range and occurrence: Valanginian–Barremian in Germany and western Indian Ocean.

Pyramidulina sceptrum (Reuss, 1863)
Nodosaria sceptrum Reuss, 1863, pl. 2, fig. 3.—Haig, 1982, pl. 2, figs. 29–32.

Lenticulina heiermanni Bettenstaedt, 1952
Lenticulina heiermanni Bettenstaedt, 1952, pl. 1, figs. 9–10.—Weidich 1990, pl. 20, figs. 15–16.

Lenticulina muensteri (Roemer, 1839)
Robulina muensteri Roemer, 1839, pl. 20, fig. 29a,b.
Lenticulina muensteri (Roemer).—Meyn and Vespermann, 1994, pl. 23, figs. 12–17 and pl. 24, figs. 1–17.

Lenticulina subangulata (Reuss, 1863) (Plate IX, 12)

Cristellaria subangulata Reuss, 1863; pl. 8, fig. 7.

Lenticulina subangulata (Reuss).—Moullade, 1984, pl. 3, fig. 3.

Saracenaria erlita Ludbrook, 1966

Saracenaria erlita Ludbrook, 1966, pl. 8, fig. 10.—Scheibnerová, 1976, text-figs. 84–85.

Saracenaria forticosta Bettenstaedt, 1952

Saracenaria forticosta Bettenstaedt, 1952, pl. 1, fig. 12 and pl. 2, fig. 13.

Saracenaria crassicosta Eichenberg.—Riegraf, 1989, pl. 1, fig. 18.

Astacolus calliopsis (Reuss, 1863)

Marginulina linearis Reuss, 1863, pl. 5, fig. 15.

Astacolus calliopsis (Reuss).—Meyn and Vespermann, 1994, pl. 10, figs. 15–16 and pl. 41, figs. 1–15.

Marginulina bullata Reuss, 1860

Marginulina bullata Reuss 1860, pl. 6, figs. 4–6.—Scheibnerová, 1976, pl. 29, fig. 1.

Vaginulinopsis excentrica (Cornuel, 1848) (Plate IX, 10)

Cristellaria excentrica Cornuel, 1848, pl. 2, figs. 11–13.

Vaginulinopsis excentrica (Cornuel).—Sliter, 1980, pl. 12, figs. 21–22 and pl. 13, fig. 1.

Planularia complanata (Reuss, 1845)

Cristellaria complanata Reuss, 1845, pl. 13, fig. 54a,b.

Planularia madagascariensis Espitalié and Sigal, 1963, pl. 6, figs. 8–11 and pl. 24.

Planularia complanata (Reuss).—Weidich, 1990, pl. 40, figs. 13–14.

Psilocytharella recta (Reuss, 1863)

Vaginulina recta Reuss, 1863, pl. 2, figs. 14–15.

Citharina recta (Reuss).—Haig, 1982, pl. 6, figs. 31–34.

Psilocytharella recta (Reuss). — Meyn and Vespermann, 1994, pl. 59, figs. 1–10.

Ramulina tappanae Bartenstein and Brand, 1951

Ramulina tappanae Bartenstein and Brand, 1951, pl. 11, figs. 305–307.—Riegraf, 1989, pl. 2, figs. 21–22.

Globulina prisca (Reuss, 1863)

Polymorphina prisca Reuss, 1863, pl. 8, fig. 8.

Globulina prisca (Reuss).—Bartenstein and Brand, 1951, pl. 10, fig. 286.

Oolina cf. ***caudata*** d'Orbigny, 1840 (Plate IX, 11)

Oolina caudata d'Orbigny, 1840, pl. 5, fig. 6.

Lagena cf. *caudata* (d'Orbigny).—Bartenstein and Brand, 1951, pl. 10, fig. 282 and pl. 13, fig. 352.

Superfamily DISCORBACEA Ehrenberg, 1838

Gyroidina infracretacea (Morozova, 1948) (Plate IX, 14)

Gyroidina nitida Reuss var. *infracretacea* Morozova, 1948, pl. 2, figs. 12–14.

Serovaina infracretacea (Morozova).—Haig, 1992, pl. 3, figs. 8–9.

Remarks: The genus *Serovaina* is considered to be a junior synonym of *Gyroidina* (S. Revets, pers. commun., 1994).

Some poorly preserved or single specimens of the genera *Laevidentalina, Frondicularia, Pyramidulina, Lenticulina, Lingulina* (Plate IX, 13), *Oolina, Bullopora* (Plate IX, 8), *Pleurostomella, Gavelinella* (Plate IX, 15), *Schreibnerova* (Plate IX, 16), *Globorotalites* and some *Polymorphinids* were recorded in open nomenclature.

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For further information the senior author can also be contacted via INTERNET, her e-mail address is aholbourn@ucl.ac.uk.

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