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FLYSCH-TYPE AGGLUTINATED FORAMINIFERAL ASSEMBLAGES FROM TRINIDAD: TAXONOMY, STRATIGRAPHY AND PALEOBATHYMETRY

by

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With 8 figures, 10 plates and 4 tables

ZUSAMMENFASSUNG

Aus dem Bereich Maastricht bis Untereozän der Guayaguayare und Lizard Springs Formation von Trinidad wurden verschiedene „Flyschtyp" Assoziationen agglutinierter Foraminiferen (45 Gattungen mit 105 Arten) bestimmt. Diese wurden mit Vergesellschaftungen sogenannter „Flyschfaunen" von Labrador, Polen, Westgrönland und der Nordsee verglichen. Dreizehn der von CUSHMAN & RENZ (1946) beschriebenen Arten sind synonym mit solchen aus der Grzybowski-Kollektion der Flyschfaunen Polens. Die Systematik von CUSHMAN & RENZ wurde entsprechend revidiert und mit zusätzlichen Arten ergänzt.

Mit Hilfe der Faktoranalyse konnten in der Bohrung G-287 drei verschiedene Vergesellschaftungen im Danien festgestellt werden. Der erste Faunentyp ist durch die epibenthische, röhrenförmige Art *Dendrophrya excelsa* dominiert und korreliert mit einer relativen Häufigkeit von *Nuttallides truempyi*. Sedimentologische Kriterien weisen auf Sortierung und Umlagerung aus einem tiefen, distalen Ursprungsgebiet hin. Die zweite Vergesellschaftung besteht vorwiegend aus kleinen, fein agglutinierten Arten und findet sich in bioturbaten, kalkfreien Tonen. Sie wird als *in situ* interpretiert. Eine dritte Gruppe wird vorwiegend von Ataxophragmien und Lituoliden gebildet und korreliert mit Häufigkeiten von *Stensioeina beccariiformis*. Eine Umlagerung aus einem seichteren, proximaleren Ursprungsgebiet als das der *D. excelsa* Assoziation wird angenommen. Die Artenverteilung in den drei Faktorenvergesellschaftungen wird dazu benützt, ein paläobathymetrisches Modell für die agglutinierten Vergesellschaftungen der „Flyschfaunen" von Süd-Trinidad zu konstruieren. Dieses Modell wird mit der paläobathymetrischen Verteilung der Flyscharten in den polnischen Karpaten verglichen.

Die stratigraphischen Reichweiten von 81 häufigen Arten in Süd-Trinidad wurden zusammengestellt. Bei sieben Arten konnten isochrone Zeitebenen in anderen Becken gefunden werden.

ABSTRACT

Diverse flysch-type agglutinated foraminiferal assemblages (105 species belonging to 45 genera) have been identified in Maastrichtian to lower Eocene sediments of the Guayaguayare and Lizard Springs Formations of Trinidad.These assemblages are compared with flysch-type assemblages from Labrador, Poland, West Greenland, and the North Sea. Thirteen species documented by Cushman and Renz (1946) are synonymized

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with species in the Grzybowski collection of flysch-type foraminifera from Poland. The systematics of Cushman and Renz are accordingly revised and supplemented with additional species.

Factor analysis delineated three assemblages in Danian sediments of well G-287. The first assemblage is dominated by the epibenthic tubular species *Dendrophrya excelsa* and correlates with the relative abundance of *Nuttallides truempyi* and sedimentological criteria suggesting redeposition and sorting from a deep, distal source. A second assemblage consists largely of small, finely agglutinated species, and is associated with bioturbated noncalcareous shales interpreted as being *in situ*. A third assemblage is comprised mainly of ataxophragmiids and lituolids and correlates with the abundance of *Stensioeina beccariiformis*. This is interpreted as indicating redeposition from a shallower, more proximal source than the *D. excelsa* assemblage. The distribution of species in the three factor assemblages is used to construct a paleobathymetric model of flysch-type agglutinated foraminifera in southern Trinidad, and this model is compared with the paleobathymetric distribution of flysch-type species in the Polish Carpathians.

Stratigraphic ranges of 81 common taxa are compiled in southern Trinidad. Seven species were found to possess isochronous datum levels in other basins.

INTRODUCTION

Studies of flysch-type agglutinated foraminiferal assemblages from pelitic intervals of flysch sediments (Brouwer 1965; Gradstein and Berggren 1981) and from DSDP Sites throughout the world (Miller *et al.* 1982) have revealed the cosmopolitan nature of many deep-water agglutinated species. Gradstein and Berggren (1981) recognized two main types of flysch-type assemblages, probably reflecting faunistic trends. The "Type-A" assemblage is comprised of large, coarsely agglutinated simple forms, and corresponds to the *Rhabdammina*-fauna of Brouwer (1965). This fauna is found in slope basins and rapidly subsiding troughs where restricted bottom water circulation leads to sedimentary conditions that may limit the occurrence of normal marine taxa and favor the development and preservation of agglutinated forms. Cretaceous and Early Paleogene type-A assemblages have also been recovered from DSDP Sites with paleodepths between 2.5 and 4.5 km (Miller *et al.* 1982). The "Type-B" agglutinated assemblage is comprised of minute, smooth-walled varieties and was apparently restricted to deep Cretaceous paleodepths (>4 km), such as Sites 196, 198A, 260, 261, 263 (Krasheninnikov 1973, 1974) and at selected sites in the North Atlantic. This fauna is generally restricted to zeolitic clays, and thus probably lived beneath the CCD.

In southeastern Trinidad, a wholly agglutinated "Type-A" assemblage is found in the subsurface lower Paleocene of the Lizard Springs Formation. This interval is equivalent to the "*Rzehakina epigona*" zonule of Bolli (1957b), which contains intervals devoid of calcareous foraminifera. The type locality of the Lizard Springs Formation described by Cushman and Renz (1946), however, represents only the upper Paleocene portion of the formation.

Cushman and Renz (1946) recorded 54 species of agglutinated foraminifera from the Lizard Springs Formation, but our examination of core samples from two Texaco Trinidad exploration wells has revealed a considerably more diverse assemblage than originally described by Cushman and co-workers. Abrupt changes in faunal composition were also noticed that are apparently related to redeposition and mixing of faunal assemblages. We have therefore undertaken the present study with three main goals in mind:

A) to perform a thorough revision of the taxonomy of Cushman and Renz (1946) by comparing the Lizard Springs assemblages with those described half a century earlier by Jozef Grzybowski from the upper Cretaceous and lower Paleogene of Poland;

B) to distinguish redeposited and autochthonous assemblages based on sedimentological and microfaunal evidence, and produce a paleoslope model for Lizard Springs based on the composition and relative abundance of agglutinated foraminiferal species;

C) to compare our assemblages from Trinidad with contemporaneous flysch-type agglutinated faunas from Poland, Labrador, and the North Sea to determine if consistent paleobathymetric and distributional patterns exist among these regions.

PREVIOUS STUDIES

Foraminifera from the Lizard Springs Formation were initially studied by Cushman and Jarvis (1928, 1932) and Cushman and Renz (1946, 1947), who subdivided the formation into a lower and upper unit based on benthic foraminifera. These authors regarded the assemblages from Lizard Springs as

indicative of open-marine, deep-water conditions. Samples with *Rzehakina epigona* were designated as lower Lizard Springs. Both zones were originally regarded as Cretaceous (late Maastrichtian to Danian) in age, but were later assigned a Paleocene age by Bolli (1952) and Bronnimann (1952) based on studies of planktonic foraminifera. Beckmann (1960) tabulated the ranges of benthic foraminifera from the Guayaguayare and Lizard Springs Formations and was able to show that at least some of Cushman's samples from the upper Lizard Springs contain a mixture of Paleocene species and reworked elements from the Cretaceous. Ranges of some additional species of benthic foraminifera from the Guayaguayare and Naparima Hill Formations were given by Beckmann (in Kugler and Bolli 1967).

The planktonic zonation of southeast Trinidad was developed by Bolli (1957a,b, 1959, 1966) and Kugler and Bolli (1967), who divided the Guayaguayare Formation into 3 zones, and the Lizard Springs Formation into 9 zones. Bolli (1957b) assigned a Paleocene to early Eocene age to the Lizard Springs Formation. The wholly arenaceous *R. epigona* facies of the basal Lizard Springs was given zonule rank, although this facies may also occur higher in the formation if only agglutinated foraminifera constitute the assemblage (Bolli 1957b). The "*Rzehakina epigona* Zonule" is approximately equivalent to the *Subbotina pseudobulloides* Zone. Both Hillebrandt (1962) and Tjalsma and Lohmann (1983) incorporated samples from Lizard Springs into their respective studies of early Paleogene foraminiferal faunas.

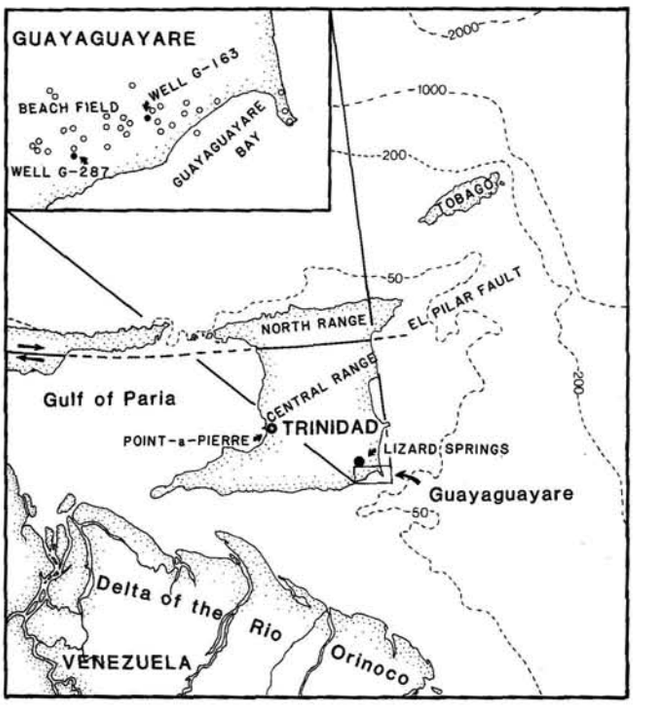


Fig. 1.
Location of samples from the Lizard Springs formation of Trinidad and surrounding areas.
Base map adopted from DMA Chart 2408, bathymetry in fathoms. Insert map by courtesy of R.D. LISKA.

GEOLOGIC SETTING

The island of Trinidad has a complex geologic history owing to its location at the boundary between the South American and Caribbean plates. The geodynamic evolution of the Caribbean plate has been reconstructed by Bouysse (1984) and Mattson (1984). North of the island, the Lesser Antilles Arc is an area of active subduction and accretion (Moore *et al.* 1984). To the south, the geomorphology of NE Venezuela is influenced by the delta of the Rio Orinoco, where along the coast sediment thickness exceeds 20,000 ft (Feo-Codecido *et al.* 1984).

Trinidad is divided into two structural provinces by the El Pilar fault system (fig. 1), which extends from a point east of the island westward through the Gulf of Paria and northern Venezuela to the Cariaco Trench. This is the major structure which terminates the subduction zone east of the Lesser Antilles Arc and accommodates the right lateral motion between the Caribbean and South American plates (Vierbuchen 1984). The El Pilar fault forms the boundary between the uplifted metasedimentary, volcanic and ultramafic rocks of the North Range of Trinidad and the Cordillera de la Costa of Venezuela, and the Cenozoic foreland thrust and fold belt of the Serrana del Interior and South Trinidad Provinces. North of the El Pilar Fault, the Araya-Tobago metamorphic terrain is probably displaced with respect to both the Caribbean plate and the South American continent (Speed and Westbrook 1984).

In Late Cretaceous time, the Caribbean plate began moving eastward, underthrusting South America (Mattson 1984). The Laramide uplift and deformation of the Northern Range resulted in thrusting and folding in Central Trinidad along NE trending axes. This tectonic activity led to the development of a foredeep environment and deposition of flysch and wildflysch facies in central Trinidad. The Chaudiere Formation of central Trinidad is an 800 m thick unit of wildflysch of Paleocene age containing slipmasses of Cretaceous sediments (Kugler 1953; 1956). In Trinidad, south of the El Pilar Fault, Cretaceous and Cenozoic strata are laterally continuous with those of the thrust belt of eastern Venezuela, and autochthonous strata are developed in the subsurface of South Trinidad and in the Orinoco delta cover (Speed and Westbrook 1984). Gravity models (Bonini 1978, Westbrook and

Jackson 1984) suggest that as much as 12 km of sediment is present in the eastern Venezuela Trinidad basin, whose axis lies in the gulf separating Trinidad from the mainland. In Trinidad, Upper Cretaceous and lower Paleogene sediments of the Guayaguayare, Lizard Springs and Navet Formations are developed in a distal, deep water turbidite facies, reflecting even deeper conditions than shown in Venezuela (Speed and Westbrook 1984). The deposition of these sediments was followed by uplift and deformation in the Middle to Late Eocene which was associated with the commencement of subduction in the Outer Arc of the Lesser Antilles and strike-slip motion along the north coast of Venezuela (Bouysse 1984, Vierbuchen 1984, Mattson 1984).

Towards the north, the Lizard Springs Formation grades laterally into the Chaudiere Formation (fig. 2). In the south, these formations have been correlated with the Santa Anita Group of Venezuela (Hedberg 1950, Kugler 1956).

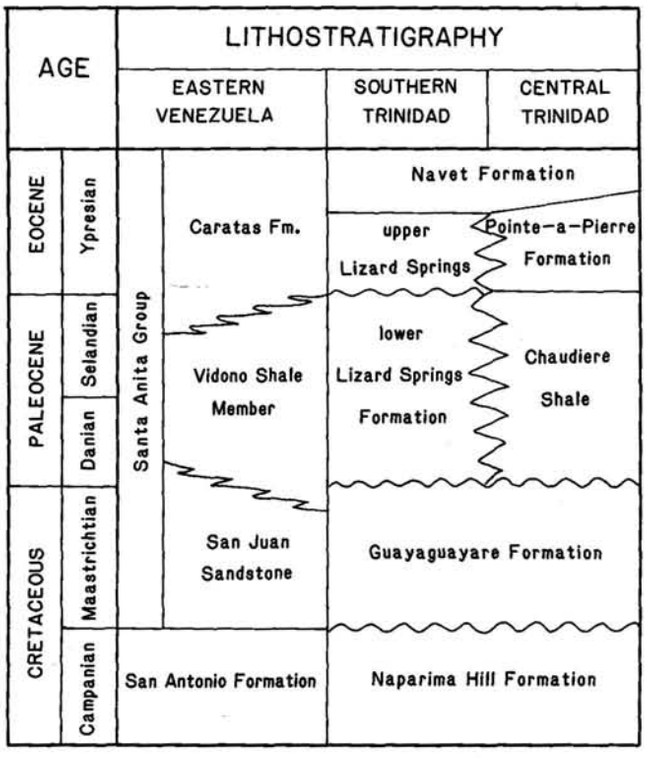


Fig. 2.
Stratigraphic correlation of lithologic units in Trinidad and eastern Venezuela (from BARR & SAUNDERS, 1968, and SALVADOR & STAINFORTH, 1968). The positions of probable hiatuses are indicated by wavey lines.

STRATIGRAPHY

The Guayaguayare Formation has been described from exploration wells in southern Trinidad and from isolated slump blocks in Tertiary strata in the Central Range (Bolli 1950, 1957a, Kugler and Bolli 1967). It overlies the Turonian-Campanian Naparima Formation, and consists of mottled gray calcareous shale. The type locality of the Guayaguayare Formation is in the Texaco Trinidad G-163 well (Guayaguayare field) between 5588 and 6000 ft. This well is the type locality for the Maastrichtian *Abathomphalus mayaroensis*, *Globotruncana gansseri*, and *G. lapparenti tricarinata* Zones of Bolli (1957a).

The Paleocene to lower Eocene Lizard Springs Formation is best developed in the subsurface of the Guayaguayare field where it lies unconformably on the Guayaguayare Formation and attains a thickness of 400 m (Kugler 1956, Bolli 1957b). It consists of dark gray calcareous or noncalcareous foraminiferal shales. Gamma ray and Sp logs from wells G-163 and G-287 suggest a predominantly argillaceous facies. In surface outcrops, the Lizard Springs Formation is strongly disturbed and incomplete. Very dark gray claystones of the *Morozovella uncinata* to *Planorotalites pseudomenardii* Zones crop out in the Lizard Springs area. The type locality described by Cushman and Renz (1946), which is the type locality of the *Morozovella velascoensis* Zone, consists of a slip mass within a clay boulder bed of Miocene age (Bolli 1957a). The lowermost Eocene *Morozovella edgari* Zone has not been recognised in Trinidad (Stainforth *et al.* 1975), indicating a possible hiatus of at least 1 m.y. duration. The upper Lizard Springs Formation differs lithologically from underlying sediments and consists of light tan to cream-colored slightly siliceous marly clay (R.D. Liska personal communication 1986). Bolli (1959) placed the contact of the Lizard Springs Formation with the overlying Navet Formation at the top of the *Morozovella aragonensis* Zone.

MATERIALS and METHODS

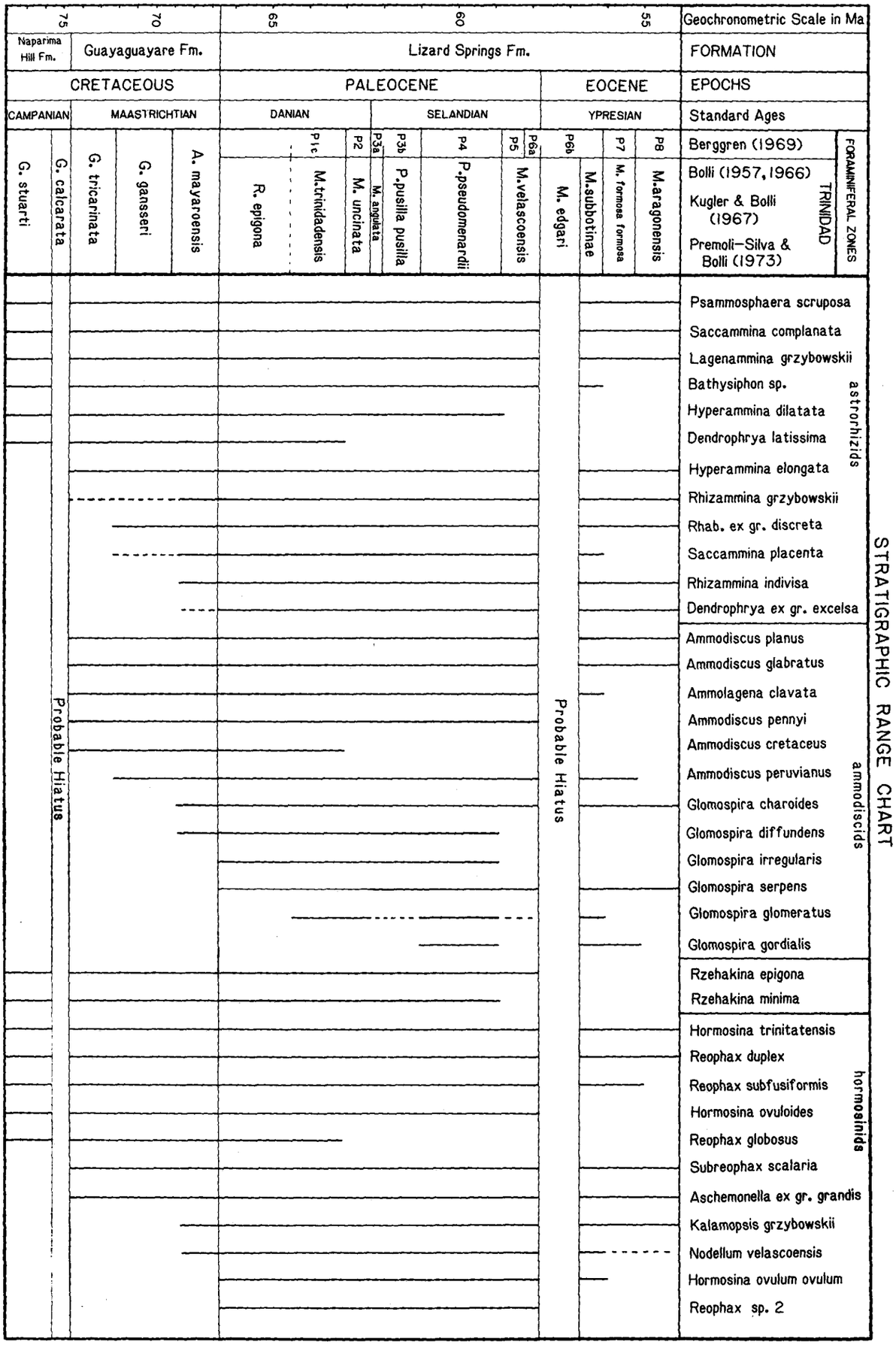
The majority of the samples investigated in this study were kindly provided by R.D. Liska, Texaco Trinidad, and consist of 34 washed residues and petrographic slides from three-inch diameter conventional core samples from Guayaguayare wells 163 and 287, and washed residue from two outcrop samples collected by James Terry Christian from the "Tank Site Olistostrome" at Pointe-a-Pierre (Christian 1979). Thirty core samples from the *S. pseudobulloides* and *S. trinidadensis* Zones of the Lizard Springs Formation (3205'- 3364' interval in well G-287), and four samples from the "*R. epigona*" zone of well G-163 were picked for benthic foraminifera. An outcrop sample from the type locality of the Lizard Springs Formation in Ravine Ampelu, and three samples from the Guayaguayare Formation in the G-163 well were provided by J. Van Couvering from archived material deposited in

the American Museum of Natural History by H.M. Bolli, H.H. Renz, and B. Stone. We also examined the original samples from the Lizard Springs Formation collected by P.W. Jarvis and H.H. Renz. These samples consist of picked assemblage slides sent to Joseph A. Cushman for taxonomic purposes and are housed at the U.S. Natural History Museum in Washington, D.C.. Renz's samples from the upper Lizard Springs Formation contain planktonic foraminifera which allow zonal age assignments (table 1), but none of Jarvis' eight samples in the Cushman collection contain enough planktonic foraminifera to make precise age determinations. The stratigraphic range chart (fig. 3) is based on the material mentioned above and is supplemented by information contained in unpublished reports on Trinidad type localities (see Bolli 1957a,b).

Splits of samples for quantitative analyses were sieved through a 212 µm screen and all agglutinated foraminifera were picked, mounted on a reference slide, identified and counted. The <212 µm fraction was examined for species not present in the larger size fraction, but was not treated quantitatively.

Table 1.
Samples from the Lizard Springs and Guayaguayare Formations of Trinidad examined in this study.

SAMPLE NUMBER	TYPE	AGE	COMMENTS
SAMPLES COLLECTED BY P.W. JARVIS:			
BON ACCORD 2	1 SLIDE	?	
LS CALEX 116'	2 SLIDES	?	"MARL LENS IN VELASCO BEDS"
LS PIT 70	1 SLIDE	?	
LS PIT 82	1 SLIDE	?	"NEAR TRINIDAD CENTRAL
LS PIT 96	1 SLIDE	?	OILFIELDS WELL # 1.
LS PIT 102	MISC. SLIDES	?	
TCO WELL #1, 720'	1 SLIDE	?	
RAVINE AMPELU	MISC. SLIDES	?	
SAMPLES COLLECTED BY H.H. RENZ:			
RENZ 378	SEDIMENT	P8	TYPE LOCALITY OF LIZARD SPRINGS FM.
RENZ 283; 286-291	5 SLIDES	?	MIXED PLANKTON ASSEMBLAGES
HGK 3463	2 SLIDES	?	NO PLANKTON
HGK 3465	2 SLIDES	P3b	
MAERKY 102A	3 SLIDES	M. velascoensis Zone	
HGK 4006	1 SLIDE	P7 or P8	
HGK 3460B	1 SLIDE	M. subbotinae Zone	
MAERKY 102B, I	2 SLIDES	P8	
MAERKY 102B, II	2 SLIDES	P8	
MAERKY 102B, III	2 SLIDES	M. subbotinae Zone	
MAERKY 102B, IV	2 SLIDES	P6	
SAMPLES SUPPLIED BY R.D. LISKA:			
GUAYAGUAYARE WELL G-287, 3205' TO 3364'	30 WASHED RESIDUES & PETROGRAPHIC SLIDES	P1b-P1c	CORE SAMPLES
GUAYAGUAYARE WELL G-163, 4452', 4456', 4566', 4569'	4 WASHED RESIDUES & PETROGRAPHIC SLIDES	"Rzehakina epigona Zonule"	CORE SAMPLES
SAMPLES COLLECTED BY J.T. CHRISTIAN:			
TC-145	WASHED RESIDUE	P4	Tank Site at
TC-174	WASHED RESIDUE	Upper P2	Point-a-Pierre
SAMPLES COLLECTED BY H.M. BOLLI:			
Sample 1006	WASHED RESIDUE	P. pseudomenardii Zone	Well G-163
Sample 1007	WASHED RESIDUE	P2	"South of Point-a-Pierre Railroad Station"
Sample 1008	WASHED RESIDUE	A. mayaroensis Zone	Well G-163, 5588-5598'
Sample 1110	WASHED RESIDUE	G. tricarinata Zone	Well G-163, 5882-5902'



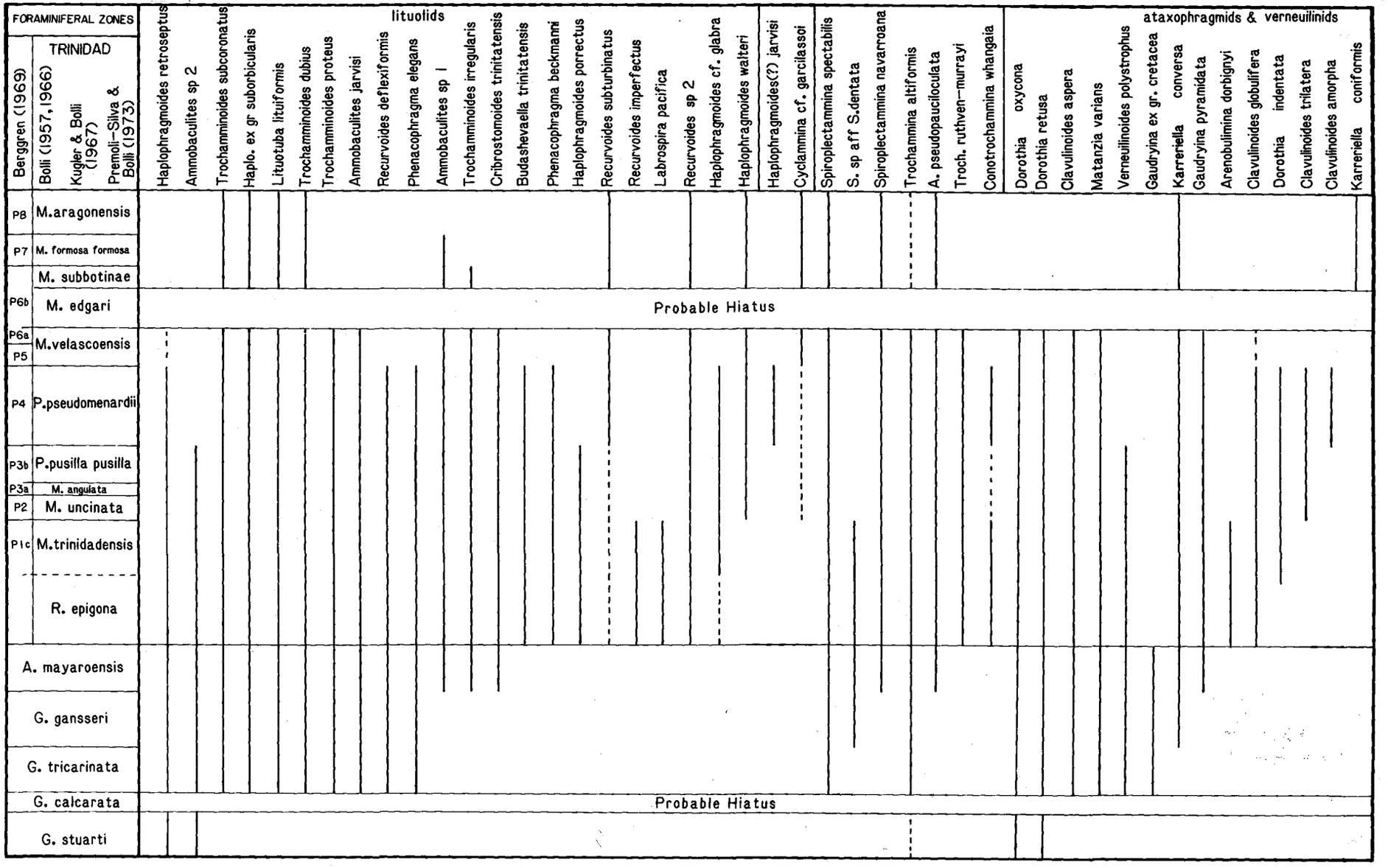


Fig. 3.
Campanian to Early Eocene stratigraphic distribution of agglutinated foraminifera in Trinidad (data compiled by J.P. BECKMANN and M.A. KAMINSKI). Possible occurrences are marked by dashed line. Time scales used are from BERGGREN et al. (1985) and KENT & GRADSTEIN (1985). Note change of scale across the Cretaceous/Tertiary boundary. The type locality of the *"Rzehakina epigona* Zonule" is approximately equivalent to zones P1a–P1b of BERGGREN (1969). The absence of the *Globotruncana calcarata* zone between the Naparima Hill and Guayaguayare Formations may indicate a hiatus of at least 0.5 m.y. duration.

Counts of agglutinated foraminifera are tabulated in appendix 1. The relative proportions of agglutinated, calcareous benthic, planktonic foraminifera and nonbiogenic particles were estimated from counts of 500 specimens on a strewn slide. Similarly, the relative proportions of important calcareous benthic species were estimated using a laboratory counter to obtain a count of 500 individuals on a strewn slide. We used Q-mode principal components and Varimax factor analysis to summarize meaningful patterns of variation in our percentage data and delineate faunal assemblages. Percentage data was calculated from raw counts (appendix 1) without further data transformation, thus giving each species equal weight in the subsequent analyses. Programs used are listed and described by Lohmann (1980). Shannon-Wiener diversity was also calculated for the abundance data in well G-287. Selected specimens were photographed on a JEOL U-3 SEM, a Zeiss petrographic microscope, or sketched using camera lucida.

RESULTS

PETROLOGY. Thin sections from each core sample in wells G-287 and G-163 were examined to distinguish hemipelagic silts and clays from those of turbiditic origin. Studies of Alpine flysch (Hesse 1975) have revealed differences in bioturbation, grain size, microfossil content, color, bed thickness, and carbonate content between the two facies. O'Brian *et al.* (1980) have also found differences in clay fabric and carbon/nitrogen ratios between turbidite and hemipelagic sediments.

Sedimentary structures observed in thin section can be used to interpret the sedimentary environment. Sand and silt grains occurring as thin laminae commonly imply a weak traction current, whereas dispersed grains suggest rapid deposition, bioturbation, or introduction of wind-blown silt (Potter *et al.* 1980). Hemipelagic sediments are generally mottled owing to bioturbation, whereas parallel laminae are preserved in turbidites. Turbidite muds are often darker in color due to a greater amount of organic matter present (Piper 1973, Hesse 1977, O'Brian *et al.* 1980) Despite the discontinuous nature of our sampling, inferences can be made about the depositional environment of the intervals studied in well G-287. A brief description of the sediments encountered follows, and is summarized in figure 4.

The uppermost interval (3205-3210 ft) consists of a uniform, noncalcareous clay with discontinuous organic-rich laminae. The next lower interval (3232-3248 ft) also contains a uniform clay with organic-rich burrows and streaks, but calcareous particles are present. A single lamina containing silt-sized calcareous grains was found at 3237 ft. The interval from 3266 to 3276 ft again contains calcareous mottled clay with organic-rich burrows. Silt laminae containing calcareous particles were encountered at 3270 and 3274 ft. The presence of these sedimentary structures implies deposition by traction currents.

Uniform bioturbated noncalcareous clay was found from 3306-3320 ft. No sedimentary laminations were observed in this interval, suggesting hemipelagic deposition beneath a local CCD.

The basal interval from 3348 to 3364 ft contains rather coarse silty shales that are darker in color due to the presence of pyrite and siderite. Calcareous particles are common, and silt laminae were found at 3362 ft, suggesting redeposition. Organic-rich burrows were found at 3351, 3362, and 3364 ft.

COMPOSITION OF SAND FRACTION. The relative proportion of calcareous benthic, agglutinated, planktonic foraminifera, and nonbiogenic constituents (quartz, siderite and pyrite) was estimated for each washed sample (fig. 4). Of the five intervals studied, the basal interval displays the largest proportion of nonbiogenic sand and the largest ratio of calcareous/agglutinated foraminifera. Quartz and siderite predominate, and echinoderm fragments are common, supporting the sedimentological evidence suggesting redeposition. The bioturbated noncalcareous interval from 3306-3320 ft contains exclusively agglutinated foraminifera and quartz grains, with only minor authigenic minerals. Laminated sediments higher in the well contain greater proportions of calcareous benthics, but the amount of nonbiogenic grains does not differ greatly from the noncalcareous interval.

FAUNAL COMPOSITION. Benthic foraminiferal assemblages of the Lizard Springs Formation are more diverse than in the underlying Guayaguayare Formation, display generally poorer preservation of calcareous forms, and are not as diluted by nonbiogenic sand particles. Table 2 summarizes our revision of the agglutinated taxonomy of Cushman and Renz (1946) supplemented by additional species. The stratigraphic ranges of agglutinated species from the Lizard Springs and Guayaguayare Formations are presented in figure 3. Although the principal goal of this study was to describe the agglutinated component of the assemblage, the relative abundance of important calcareous taxa was also estimated for well G-287.

(A) GUAYAGUAYARE FORMATION. The agglutinated assemblages from the Cretaceous

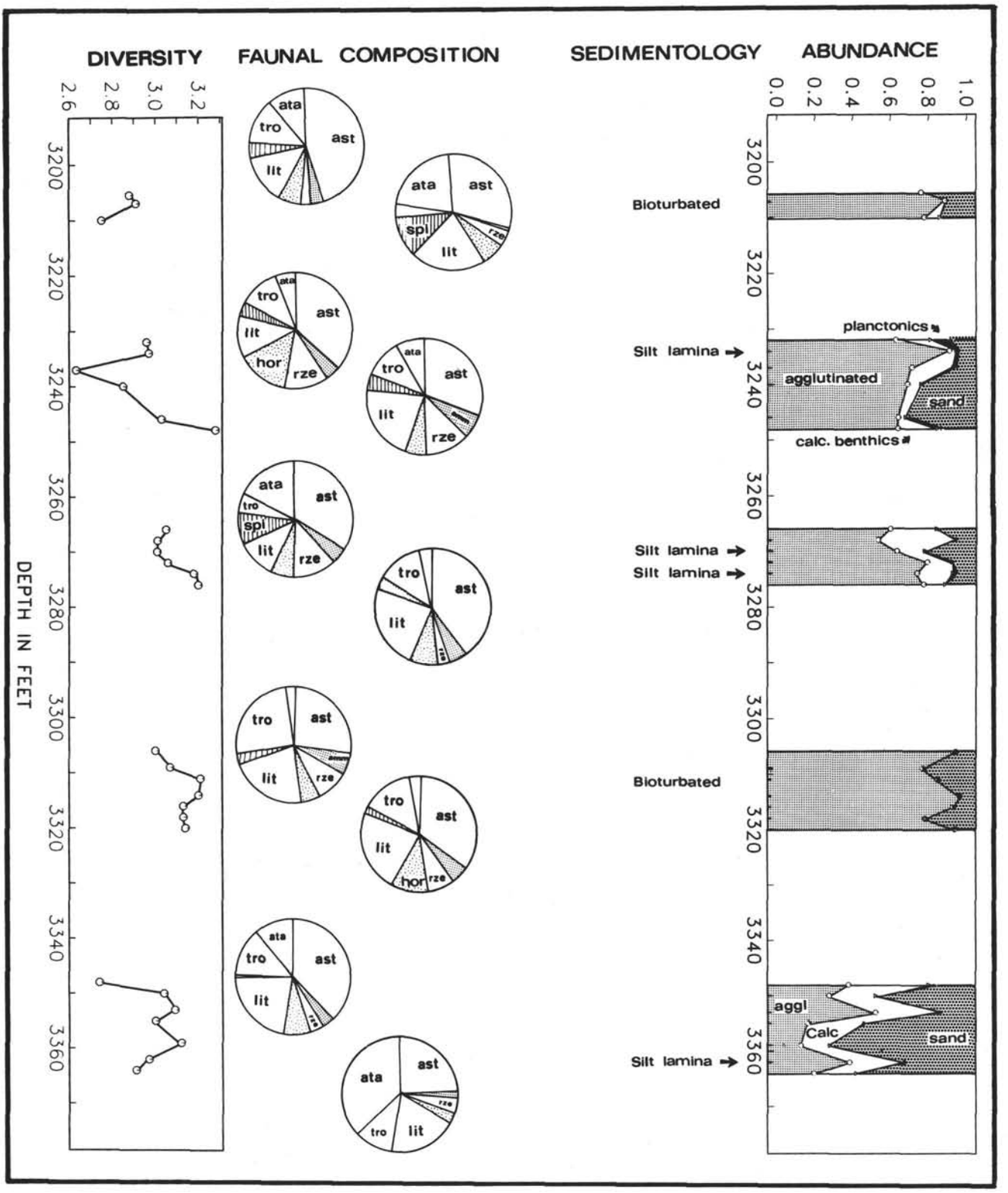


Fig. 4.
Plot of Shannon-Wiener diversity, faunal composition, sedimentology, and composition of the sand fraction for samples from well G-287. Pie diagrams represent faunal composition by superfamily for the top and bottom samples of each interval. Also shown are sedimentary structures observed from thin sections.

Guayaguayare Formation display moderate to good preservation, and specimens are generally not as compressed as often seen in the overlying Lizard Springs Formation. In the lower part of the Guayaguayare Formation (the *Globotruncana tricarinata* Zone of Bolli 1957a), the agglutinated assemblage is dominated by simple, coarse grained species of astrorhizids, saccamminids and hormosinids. The most common species are *Dendrophrya* ex gr. *excelsa, Rzehakina epigona,*

Table 2.
Taxonomy of agglutinated foraminifera from the Lizard Springs Formation.

THIS STUDY	CUSHMAN & RENZ (1946)
ASTRORHIZACEA BRADY, 1881	
Bathysiphon microrhaphidus Samuel	--
Bathysiphon sp.	*Bathysiphon? dubia* (White) pars
Dendrophrya ex gr. *excelsa* Grzybowski	--
Dendrophrya latissima Grzybowski	--
Lagenammina grzybowskii (Schubert)	--
Rhabdammina ex gr. *discreta* Brady	*Rhabdammina discreta* Brady
	Rhabdammina discreta Brady, var.
Rhizammina indivisa Brady	--
Rhizammina grzybowskii Liszka & Liszkowa	--
Psammosphaera scruposa (Berthelin)	--
Psammosphaera testacea Flint	--
Saccammina complanata (Franke)	*Pelosina complanata* Franke
Saccammina placenta (Grzybowski)	*Saccammina rhumbleri* (Franke)
Thurammina sp.	--
HYPERAMMINACEA Eimer & Fickert, 1899	
Hyperammina dilatata Grzybowski	--
Hyperammina elongata Brady	*Hyperammina elongata* Brady
Hyperammina ex gr. *subnodosiformis* Grzybowski	*Hyperammina?* sp.
AMMODISCACEA Reuss, 1862	
Ammodiscus cretaceus (Reuss)	--
Ammodiscus glabratus Cushman & Jarvis	*Ammodiscus glabratus* Cushman & Jarvis
Ammodiscus pennyi Cushman & Jarvis	*Ammodiscus pennyi* Cushman & Jarvis
Ammodiscus peruvianus Berry	--
Ammodiscus planus Loeblich	--
Ammolagena clavata (Jones & Parker)	*Ammolagena clavata* (Jones & Parker)
Glomospira charoides (Jones & Parker)	*G. charoides* var. *corona* Cushman & Jarvis
Glomospira diffundens (Cushman & Renz)	*G. gordialis* var. *diffundens* Cushman & Renz
Glomospira glomerata (Grzybowski)	--
Glomospira gordialis (Jones & Parker)	*Glomospira gordialis* (Jones & Parker) [1]
Glomospira irregularis (Grzybowski)	--
Glomospira serpens (Grzybowski)	*Glomospira* sp. A [2]
RZEHAKINACEA Cushman, 1933	
Rzehakina epigona (Rzehak)	*R. epigona* var. *lata* Cushman & Jarvis
Rzehakina minima Cushman & Renz	*R. epigona* var. *minima* Cushman & Renz
HORMOSINACEA Haeckel, 1894	
Aschemonella ex gr. *grandis* (Grzybowski)	--
Hormosina ovuloides (Grzybowski)	--
Hormosina ovulum ovulum (Grzybowski)	--
Hormosina trinitatensis Cushman & Renz	*H. globulifera* var. *trinitatensis* Cushman & Renz
Kalamopsis grzybowskii (Dylazanka)	*Bathysiphon dubia* White (pars)
Nodellum velascoensis (Cushman)	*Nodellum velascoense* (Cushman)
Reophax duplex Grzybowski	--
Reophax globosus Sliter	--
Reophax subfusiformis Earland emend. Höglund	--
Reophax sp. 2	--
Subreophax pseudoscalaria (Samuel)	--
Subreophax scalaria (Grzybowski)	*Reophax?* sp
LITUOLACEA de Blainville, 1827	
Ammobaculites jarvisi Cushman & Renz	*Ammobaculites jarvisi* Cushman & Renz
Ammobaculites sp. 1	--
Ammobaculites sp. 2	*Ammobaculites coprolithiformis* (Schwager)
Ammobaculites sp. 3	
Budashevaella cf. *multicameratus* (Voloshinova & Budasheva)	--
Budashevaella trinitatensis (Cushman & Renz)	*Haplophragmoides flagleri* var. *trinitatensis*
Cribrostomoides trinitatensis Cushman & Jarvis	*Cribrostomoides trinitatensis* Cushman & Jarvis (pars)
Haphragmoides cf. *glabra* Cushman & Waters	*Haplophragmoides glabra* Cushman & Waters [1]
Haplophragmoides horridus (Grzybowski)	--
Haplophragmoides lamella (Grzybowski)	--
Haplophragmoides porrectus Maslakova	--
Haplophragmoides retroseptus (Grzybowski)	--

Table 2 (continued).

THIS STUDY	CUSHMAN & RENZ (1946)
Haplophragmoides ex gr. *suborbicularis* (Grzybowski)	*Cribrostomoides trinitatensis* Cushman & Jarvis (pars)
Haplophragmoides walteri (Grzybowski)	*Haplophragmoides excavata* Cushman
Haplophragmoides(?) jarvisi (Thalmann)	*Nonion jarvisi* Thalmann
Labrospira pacifica Krashenninikov	--
Lituotuba lituiformis (Brady)	*Lituotuba lituiformis* (Brady)
Phenacophragma beckmanni Kaminski & Geroch	*Ammomarginulina* sp. A
Phenacophragma elegans Kaminski	--
Recurvoides deflexiformis (Noth)	--
Recurvoides gerochi Pflaumann	--
Recurvoides imperfectus Hanzliková	--
Recurvoides cf. *subturbinatus* (Grzybowski)	--
Recurvoides sp. 1	--
Recurvoides sp. 2	*Cribrostomoides trinitatensis* (pars)
Sphaerammina gerochi Hanzliková	--
Trochamminoides dubius (Grzybowski)	--
Trochamminoides irregularis White	*Haplophragmoides coronata* (Brady)
Trochamminoides proteus (Karrer)	--
Trochamminoides subcoronatus (Grzybowski)	--
LOFTUSIACEA Brady, 1884	
Reticulophragmium cf. *garcilassoi* (Frizzel)	*Cyclammina* cf. *garcilassoi* Frizzel
SPIROPLECTAMMINACEA Cushman, 1927	
Spiroplectammina aff. *S. dentata* (Alth)	*S. dentata* (Alth), *S. anceps* (Reuss) var., *S. jarvisi* Cushman.
Spiroplectammina excolata (Cushman)	*Spiroplectammina excolata* (Cushman)
Spiroplectammina navarroana Cushman	*Gaudryina foeda* (Reuss)
Spiroplectammina spectabilis (Grzybowski)	*Spiroplectammina grzybowskii* Frizzel
TROCHAMMINACEA Schwager, 1877	
Ammosphaeroidina pseudopauciloculata (Mjatliuk)	*Trochammina globigeriniformis* var. *altiformis* (pars)
Conotrochammina whangaia Finley	--
Trochammina altiformis Cushman & Renz	*T. globigeriniformis* var. *altiformis* Cushman & Renz
Trochammina ruthven-murrayi Cushman & Renz	*Trochammina ruthven-murrayi* Cushman & Renz
VERNEUILINACEA Cushman, 1911	
Gaudryina ex gr. *cretacea* (Karrer)	--
Gaudryina pyramidata Cushman	*Gaudryina (Pseudogaudryina) pyramidata* Cushman
Verneuilinoides polystrophus (Reuss)	*Verneuilina polystropha* (Reuss)
ATAXOPHRAGMIACEA Schwager, 1877	
Arenobulimina dorbignyi (Reuss)	--
Arenobulimina truncata (Reuss)	--
Clavulinoides amorpha (Cushman)	*Pseudoclavulina amorpha* (Cushman)
Clavulinoides aspera (Cushman)	*Clavulinoides aspera* (Cushman)
Clavulinoides globulifera (ten Dam & Sigal)	*Clavulinoides aspera* var. *whitei* (Cushman & Jarvis)
Clavulinoides paleocenica (Tjalsma & Lohmann)	--
Clavulinoides trilatera (Cushman)	*Clavulinoides trilatera* (Cushman)
Dorothia beloides Hillebrandt	--
Dorothia indentata (Cushman & Jarvis)	*Marssonella indentata* Cushman & Jarvis
Dorothia oxycona (Reuss)	*M. oxycona* var. *trinitatensis* Cushman & Renz
Dorothia retusa (Cushman)	*Gaudryina retusa* Cushman [1]
Dorothia cf. *trochoides* (Reuss)	--
Eggerella trochoides (Reuss)	*Eggerella trochoides* (Reuss)
Karreriella coniformis (Grzybowski)	--
Karreriella conversa	*Gaudryina filiformis* Berthelin; *G. bentonensis* (Carmen)
Karreriella horrida Mjatliuk	--
Karreriella tenuis (Grzybowski)	--
Karreriella sp. 2	--
Matanzia varians (Glaessner)	*Textulariella trinitatensis* Cushman & Renz
	T. trinitatensis var. *subcylindrica* Cushman & Renz
TEXTULARACEA Eherenberg, 1839	
Textularia sp.	*Textularia* sp.

-- not reported [1] from Cushman & Jarvis (1932) [2] from Beckmann (1960)

Saccammina complanata, Hormosina trinitatensis, Karreriella conversa, Ammobaculites sp. 2, and *Spiroplectammina spectabilis*. Distinctive species in this zone are *Rhizammina grzybowskii*, a robust, coarse species with a thick wall, and *Gaudryina* ex gr. *cretacea*.

Higher in the Guayaguayare Formation the agglutinated assemblage is more similar in composition to the fauna from the overlying Lizard Springs Formation. Sample G-163-1108, which is the type sample of the *Abathomphalus mayaroensis* Zone of Bolli (1957a) contains diverse agglutinated and calcareous foraminifera. The agglutinated assemblage is dominated by astrorhizids. *D.* ex gr. *excelsa, Rhizammina indivisa, Bathysiphon* sp., *S. complanata*. and *H. trinitatensis* are the most abundant species. A variety of *R. indivisa* which agglutinates small planktonic foraminifera is common in this sample, and there are numerous ataxophragmiids which are usually associated with calcareous facies, such as *Gaudryina pyramidata* and *Matanzia varians*. Compared with the underlying assemblage, there is a greater abundance of species with finely agglutinated tests, such as *Ammodiscus* spp., *Trochamminoides* spp., *Bathysiphon* sp. and *Ammosphaeroidina*, which are more common elements of a "Type-B" fauna.

(B) LIZARD SPRINGS FORMATION. The agglutinated component of well G-287 is dominated by astrorhizids. Ataxophragmiids are common in the basal interval, whereas spiroplectamminids, rzehakinids, ammodiscids and hormosinids increase in abundance in the upper section of the well. Figure 4 presents the faunal composition by superfamily of Loeblich and Tappan (1984) for the top and bottom sample in each interval. The relative abundance of agglutinated genera in well G-287 is shown in figure 5. This data was subjected to Q-mode Varimax factor analysis and three faunal factors were associated with eigen-values greater than unity, explaining 87% of the variance. A plot of factor scores showing the composition of each faunal factor is given in figure 6.

The first factor, which reflects the "average" fauna, explains 40% of the variance and consists primarily of *Dendrophrya* ex gr. *excelsa*, with *Rzehakina epigona, Spiroplectammina spectabilis, Saccammina placenta*, and *Bathysiphon* sp. of lesser importance. Shannon-Wiener faunal diversity is variable in this interval. Faunal factor 2, which describes the principal axis of variation about the "average" explains 28% of the variance. This factor is made up of forms with finely agglutinated tests such as *Ammosphaeroidina pseudopauciloculata*,

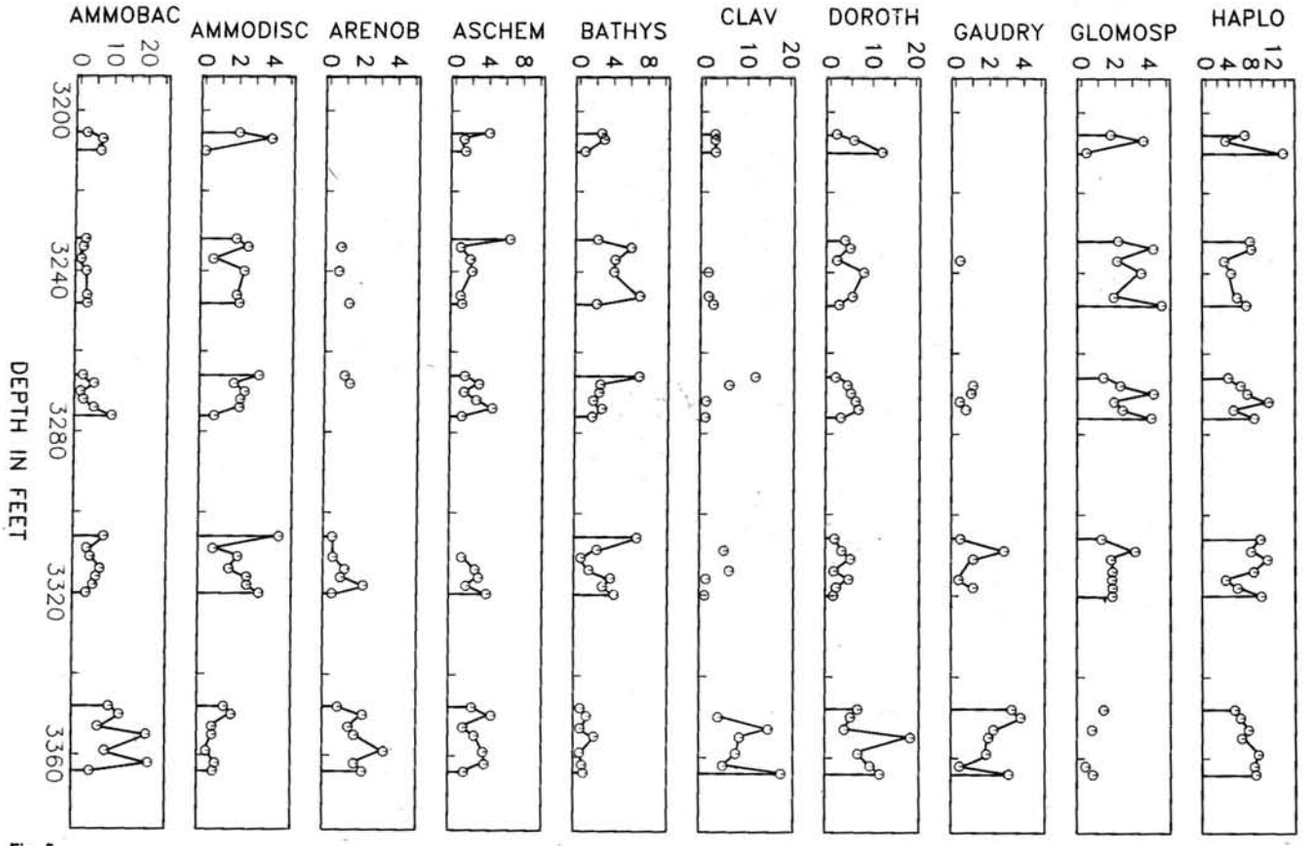


Fig. 5.
Relative abundance in percent of agglutinated genera between 3200' and 3360 ' in well G-287.
Plot of *Ammobaculites* also includes *Phenacophragma*. The *Rhabdammina* plot also includes *Dendrophyra*. Counts of *Budahevaella* are included in *Haplophragmoides*. The *Subreophax* data were combined with *Reophax*.

Rhizammina indivisa, Recurvoides gerochi, and *Rzehakina epigona,* and has highest loadings in the noncalcareous interval from 3306-3318 ft. The third significant faunal factor accounts for 18% of the variance and is strongly associated with the basal interval. This assemblage exhibits a relatively low diversity of agglutinated forms, and species awarded highest factor scores are robust coarse forms such as *Clavulinoides globulifera, Dorothia retusa, Phenacophragma beckmanni,* and *Haplophragmoides* ex gr. *suborbicularis*. The paleobathymetric and depositional significance of the three factors will be discussed in the following section.

Benthic foraminiferal assemblages from Zone P2 and younger contain a mixture of calcareous and agglutinated species. Samples from the *Morozovella uncinata* Zone contain markedly fewer astrorhizids than early Danian assemblages, and many specimens are green in color. The assemblage is dominated by *Saccammina placenta, Rzehakina epigona, Haplophragmoides* spp., *Clavulinoides aspera, Dorothia retusa, Trochammina altiformis,* and *Conotrochammina whangaia* (with closed umbilicus). The first probable occurrence of *Reticulophragmium* has been found in the upper part of Zone P2.

Samples from the Selandian similarly contain few astrorhizids, and are dominated by *Saccammina placenta, Dendrophrya* ex gr. *excelsa, Karreriella conversa, Trochammina altiformis,* and *Glomospira* spp. (*G. charoides, G. diffundens, G. glomeratus, G. gordialis, G. irregularis*). The ataxophragmiids are well represented, and include *Dorothia beloides, Karreriella horrida,* and five species of *Clavulinoides* (*C. amorpha, C. aspera, C. globulifera, C. paleocenica,* and *C. trilatera*). Distinctive forms include *Haplophragmoides*(?) *jarvisi,* large typical specimens of *H. walteri* and *Recurvoides subturbinatus* (in contrast with small Danian specimens), *C. whangaia* with an open umbilicus, and one of the first species of *Reticulophragmium* (*R.* cf *garcilassoi* s.l.).

Foraminiferal assemblages from the upper Lizard Springs Formation at the type locality in Ravine Ampelu display good preservation, and contain an approximately equal proportion of agglutinated and calcareous benthics. The agglutinated assemblage is less diverse, as noted by Cushman and Renz (1946), and is dominated by astrorhizids and lituolids. The most abundant genera are *Dendrophrya, Rhizammina, Rhabdammina, Saccammina, Hormosina, Trochamminoides, Haplophragmoides* and *Spiroplectammina.* The dominant lituolids are

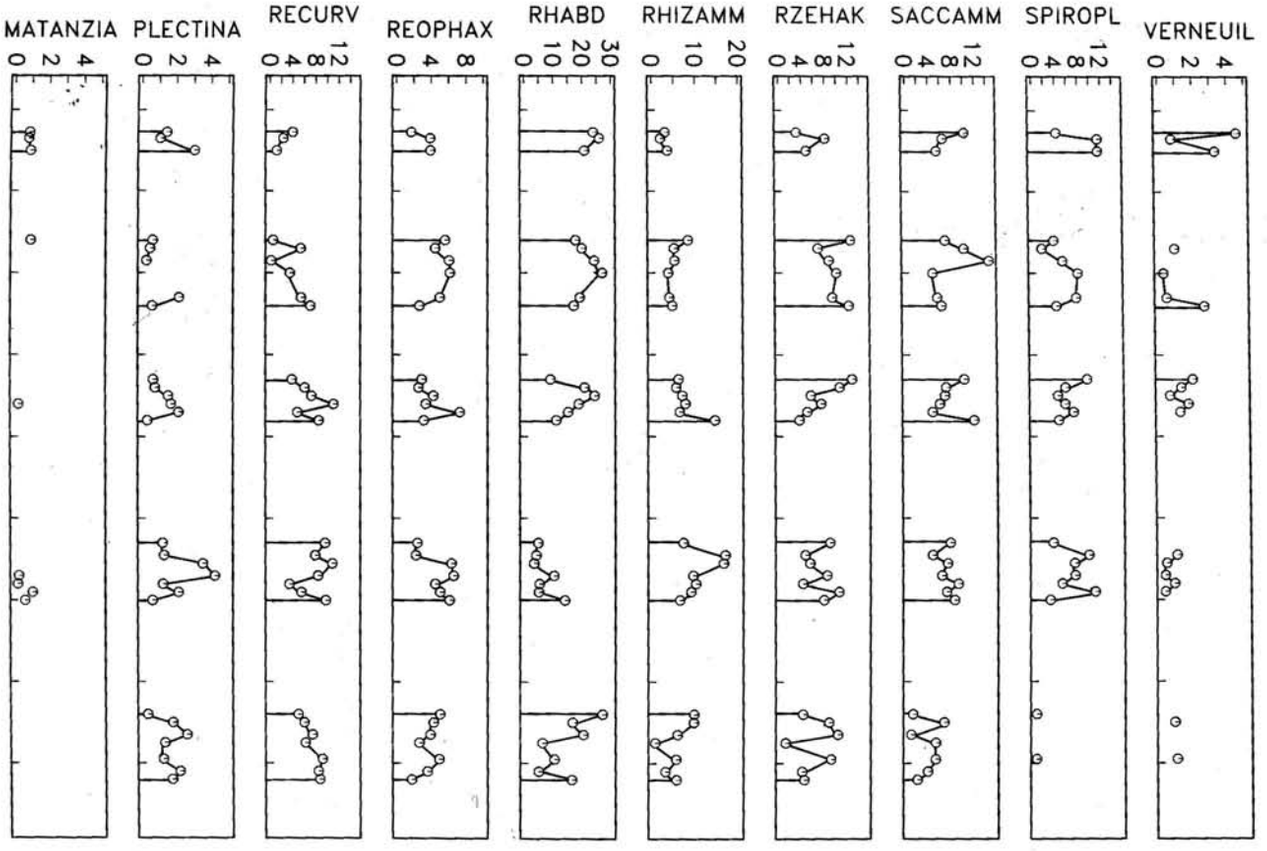


Fig. 5 (continued).

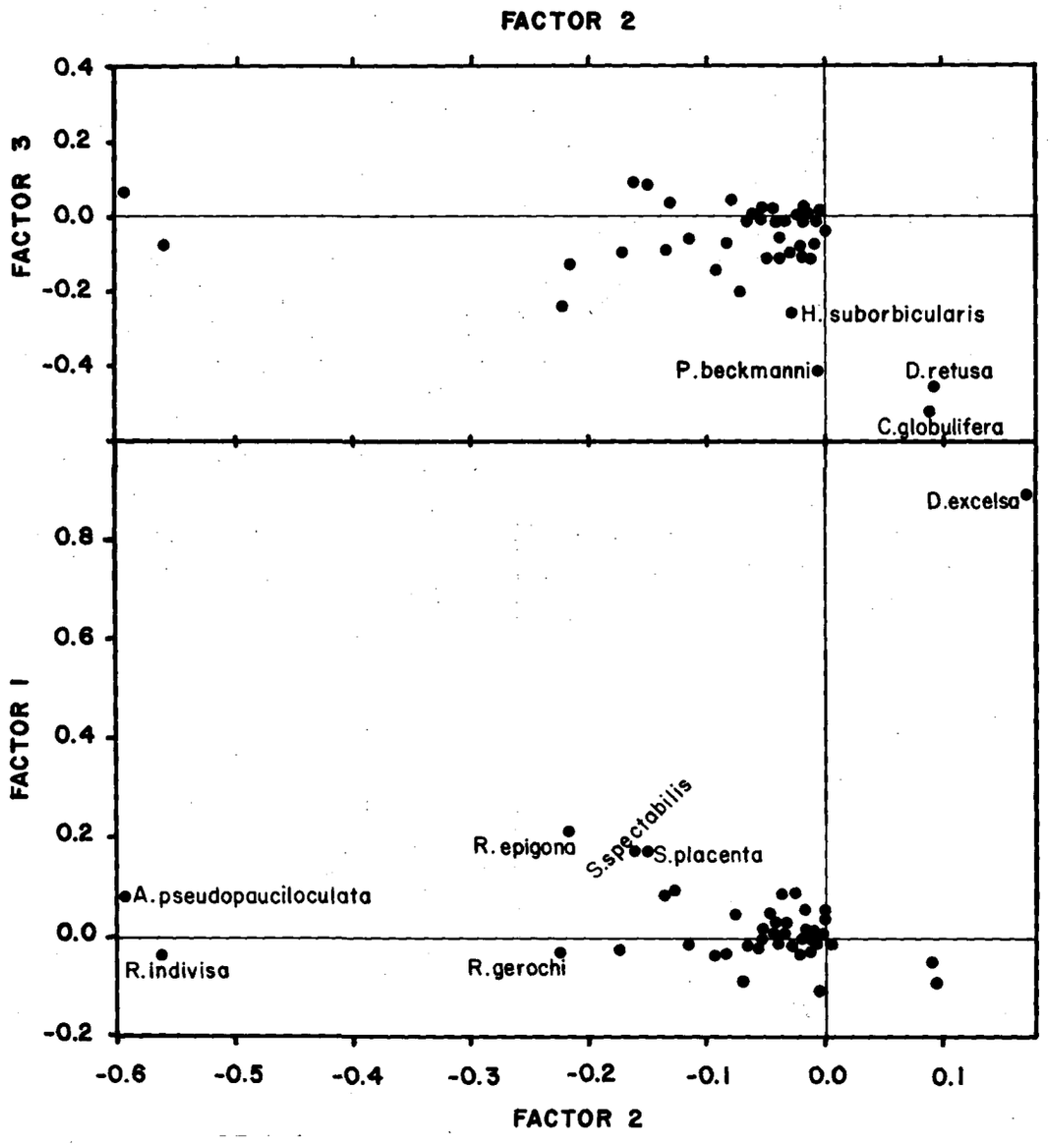


Fig. 6.
Distibution of benthic foraminiferal species on the first three Q-mode Varimax-factors.
This figure represents graphically the taxonomic composition of each faunal factor.

Haplophragmiodes ex gr. *suborbicularus*, *Trochamminoides dubius*, *T. irregularis*, and *T. subcoronatus*. The species *Ammosphaeroidina pseudopauciloculata* is present, but in much reduced abundance in comparison with the lower Lizard Springs Formation. The most distinctive forms in this assemblage are *Hyperammina* ex gr. *subnodosiformis*, *Ammodiscus planus*, *Ammobaculites* sp. 1, and two species which utilize small planktonic foraminifera in the construction of the test wall: *Rhizammina indivisa* (identical to specimens from the Guayaguayare Formation), and *Psammosphaera testacea*, a species described from the Recent Gulf of Mexico (Flint 1899), but hitherto unreported from fossil material. Other species which are unique to the upper Lizard Springs Formation are *Karreriella coniformis* and the more inflated morphotype of *Reticulophragmium* cf. *garcilassoi* with 12 or more chambers in the last whorl.

The calcareous component of the lower Lizard Springs is a typical Velasco fauna, with common *Stensioeina beccariiformis*, *Nuttallides truempyi*, *Bulimina midwayensis*, *B. trinitatensis*, *Aragonia velascoensis*, *Pullenia coryelli*, *Gyroidinoides globosus*, *Gavellinella rubiginosa* (=*G. danica*), *G. hyphalus*, *Nuttallides crassaformis*, *Osangularia velascoensis*, and *Lenticulina* spp. Calcareous foraminifera are abundant only in our samples from the basal interval of well G-287 and in outcrop samples from the upper Paleocene of Point-a-Pierre and the lower Eocene of Ravine Ampelu.

The relative abundance of *Nuttallides* spp. (mostly *N. truempyi*) is greatest in redeposited intervals between 3232 and 3248 ft (fig. 7). Tjalsma and Lohmann (1983) have shown that the *Nuttallides* fauna was the important abyssal assemblage during the Paleocene. *Stensioeina beccariiformis*, which

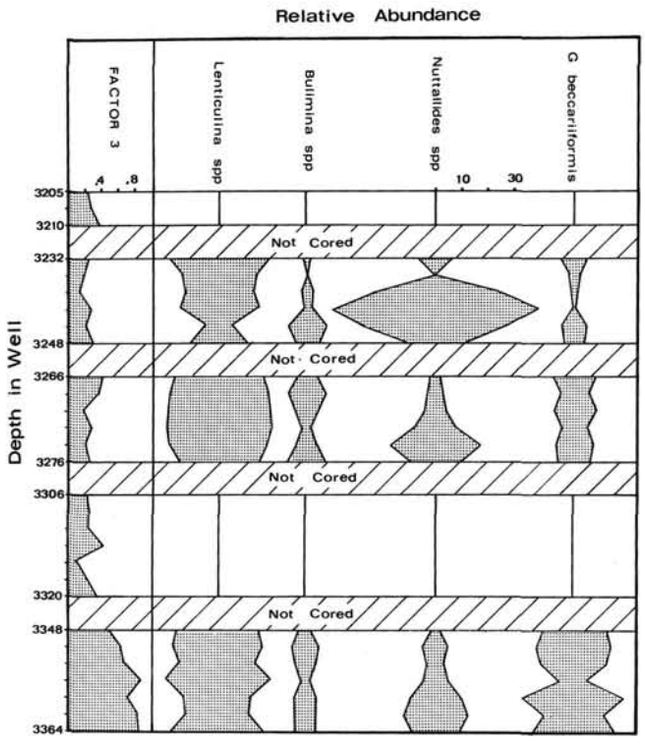


Fig. 7.
Relative abundance of dominant calcareous benthic taxa compared with the importance of faunal factor 3 in well 287.

occupies a shallower facies in the Paleocene than the *Nuttalides* fauna, displays greatest relative abundance in the basal interval. A sample from the type locality from the *Morozovella aragonensis* Zone contains a calcareous component dominated by *Lenticulina* spp. and *Bulimina* spp. which is similar to the shallow Eocene assemblage of Tjalsma and Lohmann (1983).

STRATIGRAPHY UTILITY OF AGGLUTINATED FORAMINIFERA. The ranges of 81 common agglutinated taxa in Campanian to lower Eocene strata of southeastern Trinidad are presented in figure 3 and are an updated version of data previously published by one of us (J.P. Beckmann op. cit.) supplemented by additional species. Many of the agglutinated species present are stratigraphically long-ranging forms, so their first or last occurrence in the Guayaguayare and Lizard Springs Formations is governed by local paleoecological factors. Mass extinctions at the Cretaceous/Tertiary boundary are not pronounced among flysch-type agglutinated foraminifera (Beckmann et al. 1982).

Several species of agglutinated foraminifera from Trinidad appear to be stratigraphically useful and have essentially isochronous datum levels in other areas of the North Atlantic or Tethys. The species *Rzehakina minima* and a distinctive conical form, *Trochammina ruthven-murrayi*, which have a probabilistic last occurrence beneath the Paleocene/Eocene tuff marker in the North Sea (Gradstein *et al.* this volume) range into Zones P4 and P5, respectively, in Trinidad. The first *Reticulophragmium*, (*R.* cf. *garcilassoi*), appears in Zone P4 in Trinidad. Related forms such as *R. paupera* and *R. garcilassoi*, also occur below the tuff marker in the North Sea.

The stratigraphy of agglutinated foraminifera in Cretaceous to Eocene sediments of the Outer Flysch Carpathians was compiled by Geroch (1960), Huss (1966), Hanzliková (1972, 1973, 1983), Morgiel and Olszewska (1981) and Geroch and Nowak (1984). Of the 54 stratigraphically useful species reported by Geroch and Nowak, 26 occur in Campanian to lower Eocene strata. Four of these possess first or last occurrences at roughly equivalent stratigraphic levels in Trinidad: the first occurrence of *Haplophragmoides walteri* near the base of the Selandian, and last occurrences of *Glomospira diffundens*, *Hormosina ovulum ovulum*, and *Rzehakina epigona epigona* near the top of the Paleocene. In the probabilistic zonation of the Labrador Shelf (Gradstein and Agterberg, 1982), the last occurrences of *R. epigona* and *H. ovulum ovulum* are closely associated with the last occurrence of *S. beccariiformis*, near the P5/P6 boundary (Tjalsma and Lohmann 1983). A species which has a first occurrence near the base of the Eocene in both Trinidad and Poland is *Karreriella coniformis*.

The occurrence in Trinidad of several species originally described from the Carpathians extends their worldwide stratigraphic ranges. These include *Recurvoides imperfectus*, an index form for the Albian, and *Spiroplectammina spectabilis*, which in Poland is reported by Geroch and Nowak in post-Danian formations. On the Labrador margin, *S. spectabilis* appears in the late Maastrichtian.

PALEOECOLOGY. Preliminary studies have suggested many factors that influence the distribution of agglutinated foraminifera, such as turbidity (Stainforth, 1962), poor circulation and excess CO_2 (Książkiewicz 1961, 1975), availability of food (Książkiewicz 1961), cold water temperatures (Hiltermann, 1968, 1973), calcium carbonate undersaturation (Hesse and Butt, 1976), substrate parameters (Lindenberg and Auras, 1984), or biological interactions (Bernstein and Meador 1978). However, little paleobathymetric information exists for Paleogene flysch-type agglutinated species. Brouwer (1965) searched for a recent analogue to Alpine flysch-type (*Rhabdammina*) faunas and concluded they are indicative of abyssal depths. Gradstein and Berggren (1981) reviewed

these models and proposed a generalized model for the occurrence of late Cretaceous to Paleogene flysch-type agglutinated faunas. They relate their occurrence to hydrographic and sediment properties associated with restricted bottom water circulation or the rapid deposition of fine grained clastic sediments (low O_2, low pH, high CO_2, low positive or intermittently negative Eh, corrosive bottom water) which lead to reducing substrates and high organic content. Tjalsma and Lohmann (1983) have illustrated depth variations in early Paleogene calcareous foraminifera, but flysch-type faunas are often found in regions where independent depth control is lacking. Although the occurrence of flysch-type agglutinated assemblages is not controlled by bathymetry *per se* (Gradstein and Berggren 1981), bathymetric patterns of species composition are apparent from bathyal to abyssal depths. Gradstein and Berggren (1981), note a "Type-A" flysch-type assemblage comprised primarily of large, coarsely agglutinated taxa in DSDP sites with shallow (2.5-3.5 km) paleodepths, and another "Type-B" assemblage of minute, smooth-walled varieties at deeper (>4 km) sites. A similar paleobathymetric pattern persists to the present in Recent agglutinated foraminifera from the western North Atlantic (Kaminski 1985; Schroder,1986), where assemblages along the continental slope and rise consist mainly of large coarse grained astrorhizids and hormosinids, whereas the abyssal plain assemblage consists of small, finely agglutinated lituolids. There is evidence that some representatives of the genera *Hormosina, Reophax, Trochammina, Thurammina, Rhizammina, Psammosphaera, Hyperammina*, and *Ammomarginulina* are non-selective in the material used in the construction of the test wall (Schroder 1986). As a result, their morphology may change dramatically with depth and the grain size of the substrate. Environmental stability may also play a role in determining the composition of agglutinated assemblages by favoring more opportunistic species in unpredictable depositional environments (Kaminski 1985). To what degree these bathymetric patterns are also a function of biological interactions, the availability of nutrients, or water masses has not been established.

The common occurrence of typical specimens of *Spiroplectammina spectabilis* in the relatively shallow marine lower Guayaguayare Formation of early Maastrichtian age possibly presents an interesting case for depth migration. At higher latitudes, such as Labrador, the North Sea and the Polish Carpathians, this species does not appear in flysch-type faunas until the latest Maastrichtian or early Paleocene. Perhaps *S. spectabilis* first evolved in a low latitude outer neritic to upper bathyal setting and later changed its habitat preference to deeper environments.

Dendrophrya ex gr. *excelsa* (included with *Rhabdammina* in figure 3) displays greatest relative abundance in redeposited intervals of well G-287. In flysch sediments from Alpine and Carpathian basins, faunal differences on a scale of centimeters have been observed in claystones overlying turbidites (Grun *et al.* 1964, Simpson 1969, Książkiewicz 1975, Butt 1981). At the contact between turbidite and hemipelagic layers, assemblages consisting of primitive tubular varieties occur, whereas higher in the hemipelagic layer a more diverse fauna is generally reported. This pattern has been interpreted as evidence for gradual recolonization of the sea floor after deposition by a turbidity current (Grun *et al.* 1964, Książkiewicz 1975, Butt 1981). Simpson (1969) regarded concentrations of tubular species directly above fine-grained sandstone units as evidence of winnowing by bottom currents.

Studies of living agglutinated foraminifera from the Panama Basin (Kaminski *et al.* this volume) offer an alternate interpretation of this pattern. In the Panama Basin, tubular species were found to be epibenthic, with living individuals restricted to the frothy upper 2 cm of sediment. Recolonization experiments using trays of abiotic mud indicate that contrary to *a priori* belief, tubular species are not particularly good colonizers. It is therefore more likely that the observed pattern of predominently tubular assemblages in claystones directly overlying turbidites is a result of concentration by turbidity currents that entrain the sediment surface layer as they flow downslope. An increased amount of tubular specimens would be found in turbidite claystones corresponding to the E unit of the Bouma sequence, or in any claystones with a significant redeposited component. Given the slow rates of hemipelagic deposition relative to the rates of faunal succession and the nearly ubiquitous bioturbation in hemipelagic sediments, it is unlikely that successive recolonization of the substrate would be resolvable in the F unit.

PALEOBATHYMETRY. Sedimentological and faunal evidence allow us to construct a relative paleobathymetric model for agglutinated foraminifera from southeast Trinidad in Paleocene time, but assigning well-constrained paleodepths to the assemblages is difficult due to the lack of independent depth control. Tjalsma and Lohmann (1983) assigned a paleodepth of 900 m to the Lizard Springs Formation using simple backtracking assuming oceanic basement. Since most Cretaceous species of agglutinated foraminifera continue up into the Paleocene, we can compare the generic composition of our Danian Lizard Springs assemblages with existing Cretaceous paleobathymetric models.

The bathymetric distribution of Late Cretaceous benthic foraminiferal genera in continental margin deposits of southern California was studied by Sliter and Baker (1972), who recognized inner and outer shelf, and upper, middle and lower slope assemblages. Upper slope assemblages in California were found to be dominated by calcareous genera, with *Gaudryina, Dorothia, Cribrostomoides, Bathysiphon* and *Spiroplectammina*, the most common agglutinated genera. Middle slope assemblages were dominated by agglutinated species and turrilinids, osangulariids, and anomalinids. Agglutinated genera were similar to the upper slope assemblage, with increased importance of *Ammodiscus, Hyperammina, Bathysiphon*, and *Cribrostomoides*. Haig (1979) divided mid-Cretaceous agglutinated assemblages into a shallow-water *Ammobaculites* association, an abyssal *Recurvoides* association, and a slope *Marssonella* association that can be further subdivided with the aid of calcareous taxa. Our factor assemblage 3 is dominated by ataxophragmiids and occurs in redeposited sediments, and is positively correlated with the relative abundance of *Stensioeina beccariiformis* (fig. 7). This suggests shallower paleobathymetry for factor assemblage 3 than for factors 1 and 2. Sediments in this interval were probably derived from a relatively shallow (more proximal) source area. In the basal interval of well G-287, the composition of the agglutinated assemblage resembles the upper-middle slope assemblages of Sliter and Baker (1972) and the mid slope facies of the "*Marssonella* association" of Haig (1979). In Cretaceous sediments of the western North Atlantic margin, Nyong and Olsson (1984) used downdip distance as an independent estimate of paleobathymetry. The greatest abundances of *Marssonella* and *Arenobulimina* were found at depths of 200-500 m.

The Paleocene bathymetric distribution of several species of ataxophragmiids are reported by Tjalsma and Lohmann (1983). *Clavulinoides globulifera* was found to be restricted to sites with backtracking paleodepths above 1800 m, and *Gaudryina pyramidata* possesses a maximum abundance centered at about 2000 m in Zone P1 time. Two species of *Clavulinoides* occurring in our outcrop samples possess limited depth ranges. Tjalsma and Lohmann show that *Clavulinoides trilatera* is restricted to paleodepths between 1000 and 2000 m in P3/P4 time, and *C. paleocenica*, which occurs only rarely in our samples, was reported to occur most commonly below 2000 m.

Factor assemblage 1, from the upper intervals of well G-287, contains fewer calcareous elements and a greater proportion of deeper dwelling *Nuttallides truempyi* than factor 3, and probably represents a mixture of autochthonous species and specimens redeposited from a more distal source than the basal interval. *Spiroplectammina* sp. aff. *S. dentata*, which displays maximum abundance in factor assemblage 1, was found by Nyong and Olsson (1984) to be most common in their lower slope (1500-2500 m) assemblage.

Factor assemblage 2 is the deepest assemblage in the well, and is probably *in situ*, judging from the sedimentological evidence. This assemblage contains more elements of a "Type-B" fauna reported from abyssal DSDP sites. The species composition compares well with the lower slope assemblages of Sliter and Baker (1972), which are dominated by the agglutinated genera *Glomospira, Hyperammina, Pelosina, Hormosina, Saccammina, Haplophragmoides*, and *Bathysiphon*. Haig defines an abyssal assemblage characterised by *Recurvoides, Plectorecurvoides, Uvigerinammina, Hormosina, Dendrophrya* and *Kalamopsis*. At Lizard Springs, *Kalamopsis* and *Hormosina ovulum ovulum* are most abundant in factor 2, but the genus *Recurvoides* was not found to increase in abundance from shallow to deep assemblages. Nyong and Olsson (1984) find abundant *Glomospira, Rhizammina, Uvigerinammina, Saccammina*, and *Trochammina* below 2500 m.

A "Type-B" agglutinated fauna of probable Paleocene or Early Eocene age was recovered from noncalcareous pelagic claystones of site 543A, cores 5 and 6 (Hemleben and Troester 1984). This site is presently located 600 km NNE of Trinidad and has a backtracked Paleocene paleodepth of about 5000 m. The fauna displays low diversity and consists mainly of *Glomospira charoides, Kalamopsis grzybowskii*, and *Hormosina ovulum*, with less frequent *Ammodiscus cretaceus, Glomospira irregularis, G. diffundens, Reophax scalaris, Paratrochamminoides* spp., *Hyperammina* spp., *Nodellum velascoense, Saccammina* spp., *Praecystammina globigerinaeformis*, and *Tolypammina* sp. All but two of the above species are more abundant in our deeper assemblage from noncalcareous intervals of the Lizard Springs Formation. The sole exceptions are *P. globigerinaeformis*, and *Tolypammina* spp., which were not found in our material.

Summarizing the above evidence, we interpret the Guayaguayare and Lizard Springs assemblages as reflecting deposition at upper bathyal to lower bathyal depths. Shallower paleodepths are evident in the early Maastrichtian and early Eocene, with the deeper paleodepths recorded in the Danian. However, it should be borne in mind that upper depth limits of agglutinated taxa are often elevated

in areas of thick clastic sedimentation such as the Mississippi Delta (Pflum and Frerichs 1976), therefore this estimate represents a lower limit.

COMPARISON WITH 0THER CIRCUM-ATLANTIC AND TETHYAN FLYSCH-TYPE AGGLUTINATED ASSEMBLAGES

The late Cretaceous to early Paleogene time in the Atlantic was a period of transition between a circum-equatorial circulation in the Mesozoic to a more meridional circulation pattern in the mid to late Cenozoic (Berggren and Hollister 1974). In comparison with the present day North Atlantic, Maastrichtian to Paleocene climatic and paleoceanographic conditions were more equable and ranged from subtropical at low latitudes to warm temperate at high latitudes. Equatorial circulation in the Tethyan seaway moderated polar influences resulting in the early Paleogene oceans being less stratified than the present day, with relatively little thermohaline flow at intermediate and abyssal depths (Johnson 1984).

The lowest vertical and latitudinal temperature gradients in the North Atlantic are reported in late Maastrichtian and Danian time, when equatorial surface water temperatures averaged 19°C and bottom water 10 - 12°C (Shackleton *et al.* 1984, Boersma 1984). Paleocene bottom water temperature from paleodepths of 1000-3500 m varied by only 2-3°C through time and by about 2°C from the equator to 50°N (Boersma and Premoli-Silva 1983). The resulting homogeneous water mass in the western North Atlantic has been suggested as a probable cause for the lack of discretely confined calcareous and agglutinated benthic foraminiferal assemblages at this time (Tjalsma and Lohmann 1983, Nyong and Olsson 1984).

By contrast, in early Zone P3 time, equatorial regions and their associated current systems underwent a pronounced warming, and warm water was carried to nearly 40°N (Boersma 1984). Later in the Paleocene and Early Eocene, surface water temperatures were higher than at any other time in the Cenozoic, but no rise in deep water temperature is observed (Shackleton *et al* 1984). The increase in thermal gradients and increased water column stratification led to the restriction in paleobathymetric patterns in deep water benthic taxa observed by Tjalsma and Lohmann (1983). Among planktonic foraminifera, faunal provincialization is not observed during Danian time, but develops gradually during the Late Paleocene (Berggren 1977, 1978, Haq *et al.* 1977).

Compared with planktonic and calcareous benthic foraminifera, relatively little is known about the paleobiogeography of flysch-type agglutinated foraminifera or their response to environmental changes in the Paleogene. Our revision of the taxonomy of flysch-type agglutinated species from Trinidad now allows us to make an interregional comparison of agglutinated species from other circum-North Atlantic and Tethyan regions described from the literature (table 3 and fig. 8). Diverse agglutinated assemblages have also been reported from lower Cretaceous - Eocene flysch deposits in the Eastern Alps and Carpathian Mountains (Grzybowski 1896, 1898, 1901, Geroch 1960, Brouwer 1965, Butt 1981, Olszewska 1984 and references therein), Maastrichtian to Paleogene sediments from exploratory wells on the Labrador Shelf, in the North Sea (Gradstein and Berggren 1981) and in the Norwegian-Greenland Sea (Verdenius and Van Hinte 1983). These assemblages mainly occur in thick clastic sediments that have been deposited in rapidly subsiding slope basins or troughs, where the rapid accumulation of organic-rich, carbonate-poor sediment seems to favor the development of agglutinated facies.

For comparitive purposes, we have re-examined agglutinated assemblages from the Labrador Margin, North Sea, and West Greenland in order to attempt a survey of species based on a more unified taxonomy. Additional data compiled from the Norwegian-Greenland Sea and the Carpathians reveal that at least 190 species occur in Maastrichtian to early Paleogene "Type-A" assemblages in the North Atlantic and Tethyan provinces (table 3). However, this estimate is conservative, and the list of species can probably be expanded when additional localities are included. Many of the species are cosmopolitan, but some faunal provinciality is evident in "Type-A" agglutinated assemblages from Trinidad, Poland, the Labrador Sea, and North Sea. A comparison of the assemblages of these regions follows.

LABRADOR MARGIN. Rich agglutinated assemblages have been recovered from Maastrichtian to Paleogene sediments from exploratory wells on the Labrador Shelf (Gradstein and Berggren, 1981). Subsidence in this region was greatest during the late Campanian to late Eocene phase of sea floor spreading in the Labrador Sea (Srivastava, 1978) when a thick wedge of clastic sediment was deposited. The regional geology and stratigraphy of the Labrador Sea area has been discussed by Gradstein and Williams (1976), Umpleby (1979), McWhae *et al.* (1980), Gradstein and Srivastava (1980) and Gradstein and Berggren (1981). Agglutinated foraminiferal faunas are best

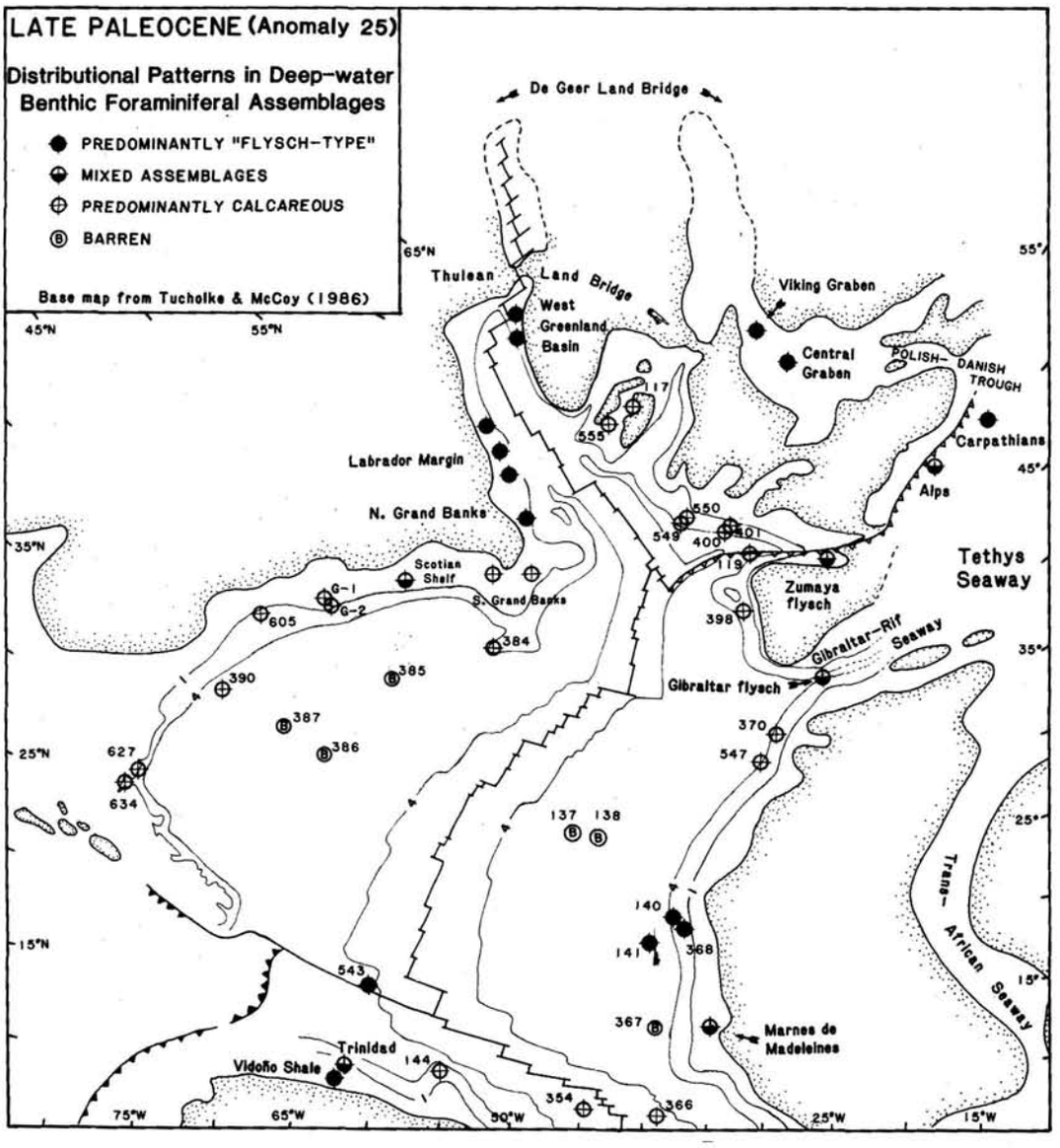


Fig. 8.
Distribution of agglutinated, calcareous and mixed benthic foraminiferal assemblages in the North Atlantic in the Late Paleocene, based on data compiled from DSDP Site reports, personal observations, and personal communication with K.G. MILLER, C.W. POAG, M. LECKIE, M. WILLIAMSON, W. KUHNT, S. GOFAS and A. von HILLEBRANDT.
Base map is the Anomaly 25 reconstruction of TUCHOLKE and McCOY (1986).

developed in the Uniform Shale of the Cartwright Formation, a dark green pyritic and micaceous shale unit of Maastrichtian to Paleocene age. An example of an agglutinated assemblage similar in composition to that found in the Guayaguayare Formation was recovered in the North Leif D-98 well. This assemblage is dominated by large, coarsely agglutinated lituolids and astrorhizids, with rare calcareous benthics, and was probably deposited in an outer neritic to upper bathyal setting. In order of decreasing relative abundance, the dominant forms are a thick-walled species of *Rhizammina*, *Haplophragmoides* ex gr. *suborbicularis*, *Recurvoides* spp., *Bathysiphon* sp., *Ammodiscus cretaceous*, and *Glomospira charoides*. Other distinctive species in this assemblage include *Hormosina ovulum ovulum*, *H. ovulum gigantea*, *Ammobaculites* sp. 3, *Gaudryina* ex gr. *cretacea*, *Uvigerinammina jankoi*, *Dorothia retusa*, *Reophax globulosus*, and *Haplophragmoides eggeri*. In comparison with the Guayaguayare Formation, the ataxophragmiids, trochamminids, and rzehakinids are poorly represented. Planktonic foraminifera are rare and consist mainly of small species of *Hedbergella*.

A downslope position on the Labrador Margin is occupied by the Indian Harbour M-52 well, which contains a well-preserved microfauna. The relative abundance of planktonics and the diversified calcareous and agglutinated benthic assemblages, together with the more distal setting of the well site, point to a bathyal depositional environment, probably upper to middle bathyal. In the

Table 3.
Distribution of agglutinated benthic foraminiferal taxa.
Data reported from (TR) Maastrichtian to Early Eocene deposits in southeast Trinidad; (PL) Maastrichtian to Paleogene formations of the Polish Flysch Carpathians; (LA) Maastrichtian to Eocene deposits in Labrador and northeast Newfoundland Margin wells; (NS) Danian to Eocene sediments from Central North Sea wells; (WG) Maastrichtian subcrop samples from Nugssuaq, West Greenland, and (NGS) Eocene sediments of Norwegian – Greenland Sea DSDP Sites 345, 346, 347, 349 and 350.

SPECIES	TR	PL	LA	NS	WG	NGS
ASTRORHIZACEA Brady, 1881						
Bathysiphon gerochi Mjatliuk			XX			
Bathysiphon microrhaphidus Samuel	XX	XX	XX	XX		
Bathysiphon sp [1]	XX	XX	XX	XX	XX	XX
Dendrophrya ex gr. *excelsa* Grzybowski	XX	XX		XX		XX
Dendrophrya latissima Grzybowski	XX	XX		XX		
Dendrophrya robusta Grzybowski		XX	XX	XX	XX	
Lagenammina grzybowskii (Schubert)	XX	XX	XX			
Rhabdammina cylindrica Glaessner [2]		XX				
Rhabdammina ex gr. *discreta* Brady	XX	XX	XX	XX	XX	XX
Rhabdammina subdiscreta Grzybowski [3]		XX				
Rhizammina grzybowskii Liszka & Liszkowa	XX	XX		XX		
Rhizammina indivisa Brady [4]	XX	XX	XX	XX	XX	XX
Psammosphaera fusca Schultze		XX	XX	XX		XX
Psammosphaera scruposa (Berthelin)	XX	XX	XX	XX		
Psammosphaera testacea Flint	XX					
Saccammina complanata (Franke)	XX	XX	XX	XX	XX	XX
Saccammina placenta (Grzybowski) [5]	XX	XX	XX	XX		
Saccammina sphaerica Brady		XX				
Saccamminoides carpathicus Geroch		XX				
Thurammina sp.	XX			XX		
HYPERAMMINACEA Eimer and Fickert, 1899						
Hyperammina dilatata Grzybowski	XX	XX	XX	XX		
Hyperammina elongata Brady	XX	XX				
Hyperammina nodata Grzybowski		XX		XX		XX
Hyperammina rugosa Verdenius & Van Hinte			XX	XX		XX
Hyperammina ex gr. *subnodosiformis* Grzybowski	XX	XX	XX			XX
AMMODISCACEA Reuss, 1862						
Ammodiscus bornemanni (Reuss)		XX				
Ammodiscus cretaceus (Reuss) [6]	XX	XX	XX	XX	XX	XX
Ammodiscus glabratus Cushman & Jarvis	XX		XX	XX		
Ammodiscus incertus (d'Orbigny)		XX				
Ammodiscus latus Grzybowski		XX	XX	XX		
Ammodiscus pennyi Cushman & Jarvis	XX	XX				
Ammodiscus peruvianus Berry [7]	XX	XX	XX	XX	XX	
Ammodiscus planus Loeblich	XX	XX	XX	XX	XX	
Ammodiscus tenuissimus Grzybowski		XX				
Ammolagena clavata (Jones & Parker)	XX	XX	XX	XX		XX
Ammovertella sp.		XX				
Glomospira charoides (Jones & Parker)	XX	XX	XX	XX	XX	
Glomospira diffundens (Cushman & Renz)	XX	XX	XX			
Glomospira glomerata (Grzybowski)	XX	XX	XX	XX		
Glomospira gordialis (Jones & Parker)	XX	XX	XX	XX	XX	
Glomospira irregularis (Grzybowski)	XX	XX	XX	XX	XX	
Glomospira serpens (Grzybowski)	XX	XX		XX		
Glomospirella grzybowskii (Jurkiewicz)		XX	XX			
Tolypammina sp.		XX		XX		
RZEHAKINACEA Cushman, 1933						
Rzehakina complanata (Grzybowski)		XX				
Rzehakina epigona (Rzehak)	XX	XX	XX		XX	
Rzehakina fissistomata (Grzybowski)		XX				
Rzehakina inclusa (Grzybowski)		XX				
Rzehakina minima Cushman & Renz	XX	XX		XX		
Spirosigmoilinella compressa Matsunaga [9]				XX		XX

Maastrichtian section, the planktonic fauna consists mostly of *Rugoglobigerina, Globigerinelloides, Heterohelix*, and rare *Abathomphalus mayaroensis*, which attests to deposition under subtropical to temperate water masses, but still in a marginal (as opposed to open ocean) setting. The agglutinated assemblage is dominated by *Bathysiphon* spp., *Glomospira charoides, Karreriella horrida,*

Table 3 (continued).

SPECIES	TR	PL	LA	NS	WG	NGS
HORMOSINACAE Haeckel, 1894						
Aschemonella ex gr. *grandis* (Grzybowski)	XX	XX	XX	XX		
Aschemonella carpathica Neagu		XX				
Hormosina excelsa Dylazanka		XX	XX	XX		XX
Hormosina ovuloides (Grzybowski)	XX	XX				
Hormosina ovulum ovulum (Grzybowski)	XX	XX	XX	XX		
Hormosina ovulum gigantea Geroch	XX	XX	XX			
Hormosina trinitatensis Cushman & Renz	XX	XX				
Hormosina sp. Gradstein & Berggren			XX			
Kalamopsis grzybowskii (Dylazanka)	XX	XX	XX	XX		
Nodellum velascoensis (Cushman)	XX	XX				
aff. *Reophax bacillaris* Brady			XX	XX		
Reophax duplex Grzybowski	XX	XX	XX	XX		
Reophax elongatus Grzybowski		XX				
Reophax globosus Sliter	XX		XX			
Reophax guttifer Brady		XX				
Reophax pilulifer Brady		XX	XX	XX	XX	XX
Reophax splendidus Grzybowski		XX				
Reophax subfusiformis Earland emend Hoglund	XX		XX	XX	XX	XX
Reophax subnodulosus Grzybowski		XX				
Reophax sp. 2	XX					
Reophax sp. Gradstein & Berggren					XX	
Subreophax pseudoscalaria (Samuel)	XX	XX				
Subreophax scalaria (Grzybowski)	XX	XX	XX	XX		
LITUOLACEA de Blainville, 1827						
Ammobaculites agglutinans (d'Orbigny)		XX	XX			
Ammobaculites deflexus (Grzybowski)		XX	XX			
Ammobaculites fontinensis (Terquem)		XX				
Ammobaculites jarvisi Cushman & Renz	XX	XX				
Ammobaculites problematicus Neagu		XX	XX			
Ammobaculites wazaczi (Grzybowski)		XX				
Ammobaculites aff. *polythalamus* Loeblich			XX	XX		
Ammobaculites sp. 1	XX			XX		
Ammobaculites sp. 2	XX					
Ammobaculites sp. 3	XX		XX			
Budashevaella cf. *multicameratus* (Voloshinova & Budasheva)	XX		XX	XX	XX	XX
Budashevaella trinitatensis (Cushman & Renz)	XX		XX	XX		
Cribrostomoides scitulus (Brady)		XX		XX	XX	
Cribrostomoides trinitatensis Cushman & Jarvis	XX	XX				
Cribrostomoides sp. 1 Gradstein & Berggren				XX		
Haplophragmoides compressa LeRoy						XX
Haplophragmoides eggeri Cushman		XX	XX	XX	XX	
Haplophragmoides cf. *glabra* Cushman & Waters	XX		XX	XX		
Haplophragmoides horridus (Grzybowski)	XX	XX				
Haplophragmoides kirki Wickenden		XX	XX	XX		XX
Haplophragmoides lamella (Grzybowski)	XX	XX		XX		
Haplophragmoides mjatliukae Maslakova		XX				
Haplophragmoides porrectus Maslakova	XX	XX				
Haplophragmoides retroseptus (Grzybowski)	XX	XX	XX			
Haplophragmoides stomatus (Grzybowski)		XX				
Haplophragmoides subglobulosus (Grzybowski)		XX				
Haplophragmoides ex gr. *suborbicularis* (Grzybowski)	XX	XX	XX	XX		
Haplophragmoides walteri (Grzybowski)	XX	XX	XX	XX	XX	XX
Haplophragmium sp. Gradstein & Berggren			XX	XX	XX	
Haplophragmoides (?) *jarvisi* (Thalmann)	XX			XX		

Hormosina ovulum ovulum, *Ammodiscus cretaceus*, *Recurvoides* ex gr. *walteri*, *R. gerochi*, and *Haplophragmoides eggeri*. Occurring in lesser abundances are *Glomospira irregularis*, *G. gordialis*, *G. diffundens*, *Ammodiscus glabratus*, *Saccammina placenta*, *Labrospira pacifica*, *Ammosphaeroidina pseudopauciloculata*, and *Trochamminoides* spp. Three species restricted to

Table 3 (continued).

SPECIES	TR	PL	LA	NS	WG	NGS
Labrospira pacifica Krashenninikov	XX	XX	XX	XX		
Lituotuba lituiformis (Brady)	XX	XX	XX	XX		XX
Phenacophragma beckmanni Kaminski & Geroch	XX	XX				
Phenacophragma elegans Kaminski	XX					
Recurvoides contortus Earland						XX
Recurvoides deflexiformis (Noth)	XX	XX	XX	XX	XX	XX
Recurvoides gerochi Pflaumann	XX	XX	XX	XX		
Recurvoides globulosus Jednorowska		XX				
Recurvoides imperfectus Hanzlikova	XX	XX				
Recurvoides pseudoregularis Mjatliuk		XX				
Recurvoides cf. subturbinatus (Grzybowski)	XX	XX				
Recurvoides walteri (Grzybowski)		XX	XX	XX		
Recurvoides varius Mjatliuk		XX				
Recurvoides sp. 1.	XX					
Recurvoides sp. 2	XX					
Sphaerammina gerochi Hanzlikova	XX	XX				
Sphaerammina subgaleata (Vasicek)		XX	XX			
Trochamminoides acervulatus (Grzybowski)		XX				
Trochamminoides dubius (Grzybowski)	XX	XX				
Trochamminoides elegans (Rzehak)		XX				
Trochamminoides heteromorphus (Grzybowski)		XX				
Trochamminoides intermedius (Grzybowski)		XX				
Trochamminoides irregularis White	XX	XX	XX			
Trochamminoides mitratus (Grzybowski)		XX				
Trochamminoides proteus (Karrer)	XX	XX				
Trochamminoides subcoronatus (Grzybowski)	XX	XX	XX	XX		
Trochamminoides subtrullisatus (Grzybowski)		XX	XX	XX		
Trochamminoides vermetiformis (Grzybowski)		XX				
LOFTUSIACEA Brady, 1884						
Reticulophragmium amplectens (Grzybowski)		XX	XX	XX		XX
Reticulophragmium cf. *garcilassoi* (Frizzel)	XX					
Reticulophragmium paupera Chapman				XX		
Cyclammina placenta (Reuss)			XX	XX		
Cyclammina rotundidorsata (Hantken)		XX	XX	XX		
SPIROPLECTAMMINACEA Cushman, 1927						
Spiroplectammina aff. *S. dentata* (Alth)	XX	XX	XX	XX	XX	
Spiroplectammina excolata Cushman	XX	XX				
Spiroplectammina navarroana (Cushman)	XX	XX	XX	XX	XX	XX
Spiroplectammina spectabilis (Grzybowski)	XX	XX	XX	XX	XX	XX
TROCHAMMINACEA Schwager, 1877						
Ammosphaeroidina pseudopauciloculata (Mjatliuk)	XX	XX	XX	XX		
Conotrochammina whangaia Finlay	XX					
Cystammina pauciloculata (Brady)		XX		XX		
Praecystammina globigerinaeformis Krashenninikov				XX		
Trochammina altiformis Cushman & Renz	XX	XX	XX	XX		
Trochammina bulloidiformis Grzybowski		XX				
Trochammina deformis Grzybowski		XX	XX	XX	XX	
Trochammina globigeriniformis Parker & Jones		XX	XX	XX	XX	XX
Trochammina quadriloba (Grzybowski)		XX		XX		
Trochammina ruthven murrayi Cushman & Renz	XX			XX		
Trochammina subvesicularis Hanzlikova		XX		XX		

the Maastrichtian portion of the Uniform Shale are *Arenobulimina dorbignyi, Dorothia oxycona,* and *Uvigerinammina jankoi.* In comparison to the North Leif well, this assemblage displays higher diversity and a greater proportion of ammodiscids, hormosinids and lituolids with a finely agglutinated wall.

Table 3 (continued).

SPECIES	TR	PL	LA	NS	WG	NGS
VERNEUILINACEA Cushman, 1911						
Gaudryina ex gr. *cretacea* (Karrer)	XX		XX			
Gaudryina ex gr. gigantea Subbotina				XX		
Gaudryina pyramidata Cushman	XX	XX				
Gaudryina rugosa d'Orbigny		XX				
Gaudryina sp.				XX	XX	
Verneuilinoides polystrophus (Reuss)	XX	XX				
ATAXOPHRAGMIACEA Schwager, 1877						
Arenobulimina americana Cushman			XX			
Arenobulimina dorbignyi (Reuss)	XX	XX	XX	XX		
Arenobulimina truncata (Reuss)	XX	XX				
Clavulinoides amorpha (Cushman)	XX	XX				
Clavulinoides aspera (Cushman)	XX	XX				
Clavulinoides globulifera (ten Dam & Sigal)	XX					
Clavulinoides paleocenica (Tjalsma & Lohmann)	XX					
Clavulinoides trilatera (Cushman)	XX					
Dorothia beloides Hillebrandt	XX	XX				
Dorothia indentata (Cushman & Jarvis)	XX	XX				
Dorothia oxycona (Reuss)	XX	XX	XX			
Dorothia princeps Cushman & Bermudez						XX
Dorothia trochoides (Marsson)		XX				
Dorothia cf. *trochoides* (Marsson)	XX					
Dorothia retusa (Cushman)	XX	XX				
"Dorothia sp. 6" Gradstein & Berggren			XX			
Eggerella palmerae (Cole)		XX				
Eggerella propinqua Brady		XX				
Eggerella trochoides (Reuss)	XX					
Karreriella coniformis (Grzybowski)	XX	XX		XX		
Karreriella conversa (Grzybowski)	XX	XX	XX	XX	XX	XX
Karreriella horrida Mjatliuk	XX	XX	XX	XX	XX	
Karreriella lenis (Grzybowski)		XX				
Karreriella siphonella (Reuss)				XX		XX
Karreriella tenuis (Grzybowski)	XX	XX				
Karreriella sp. 2	XX					
Matanzia varians (Glaessner)	XX	XX	XX	XX		
Uvigerinammina jankoi (Majzon)		XX	XX			
TEXTULARIACEA Ehrenberg, 1839						
Textularia sp. Cushman & Renz	XX					

Trinidad data are from this study. Western Carpathian data are compiled from modern Polish and Czechoslovakian literature (Geroch, 1960; Jednorowska, 1968, 1975; Hanzlikova, 1972, 1973, 1983; Huss, 1966; Samuel, 1977; Morgiel and Olszewska, 1981; Geroch and Nowak, 1984; Liszkowa and Morgiel, 1984; Olszewska, 1985). Carpathian species not found in Trinidad are those recorded by two or more authors. Labrador, West Greenland and North Sea data are from Gradstein and Berggren (1981) supplemented by additional observations. Norwegian-Greenland Sea species are from Verdenius and Van Hinte (1983).

Taxonomic notes: [1] includes *Bathysiphon filiformis, B. eocenica,* and *B. nodosariiformis.* [2] includes *Rhabdammina linearis* of Grzybowski and *Rhabdammina abyssorum* of Jurkiewicz (1967). [3] includes *Hyperammina subdiscretiformis* Mjatliuk. [4] includes *Protobotellina lofotensis.* [5] includes *Saccammina rhumbleri.* [6] includes *Ammodiscus siliceus* and *A. angustus.* [7] includes *Ammodiscus gorayskii.* [8] includes *Glomospirella biedai.* [9] includes *Rzehakina* sp. 1 of Gradstein and Berggren (1981). [10]. includes *Textularia plummerae* and *Spiroplectammina lanceolata.* [11] includes forms also designated as *Dorothia crassa* in Carpathian literature.
[12] includes forms also described as *Karreriella apicularis* in Carpathian literature and in Gradstein and Berggren (1981).

Altogether, about 70 species of agglutinated foraminifera have been found by us in Maastrichtian to Eocene deposits of the Labrador Margin, with 46 of these also occuring in Trinidad. Many agglutinated species in Maastrichtian to Danian sediments are common to both regions, but are present in different proportions. Although both assemblages were probably deposited in a comparable paleobathymetric setting, a number of forms which dominate the Labrador Margin assemblage are mainly species which occur in greater abundance in the deep assemblage in Trinidad. The species *Hormosina ovulum ovulum* and *Glomospira charoides* which are both common in the Indian Harbour well, but rare at Lizard Springs, occur in abundance at DSDP Site 543A (5000 m paleo-water depth). This suggests that the optimum depth range of these taxa may be depressed at low latitudes. Several common species from the Labrador Margin are not found in Trinidad, including *Uvigerinammina jankoi*, *Psammosphaera fusca*, *Ammobaculites agglutinans*, and *Haplophragmoides eggeri*.

NORTH SEA. In Maastrichtian to Paleocene time, the North Sea and Norwegian-Greenland Seas were isolated from the North Atlantic region by the Greenland-Scotland Ridge, which formed a barrier to the exchange of surface and deep waters until the Eocene (Eldholm and Thiede 1980, McKenna 1983, Miller and Tucholke 1983;, Berggren and Schnitker 1983). Intermittent shallow marine connections between the North Sea and the northern margin of the Tethys seaway existed across central Europe via the Danish-Polish Trough (Pozaryska 1981, Ziegler 1982, McKenna 1983).

An agglutinated assemblage is well developed in the central part of the North Sea where it appears suddenly in shaly intervals of a thick Selandian to Eocene deltaic clastic complex immediately overlying Maastrichtian to Danian carbonates (Gradstein and Berggren, 1981). The stratigraphy of these assemblages is discussed by Gradstein and Berggren (1981), Miller *et al.* (1982), King (1983), and Gradstein *et al.* (this volume). The paleobathymetry of Paleocene assemblages is discussed by G.D. Jones (this volume).

The Danian assemblage displays low diversity, and contains two species that are apparently restricted to carbonate facies, *Arenobulimina d'orbignyi* and *Matanzia varians*. The overlying clastic section contains an assemblage dominated by morphologically simple astrorhizids, ammodiscids and coarsely agglutinated lituolids. Ataxophragmiids and rzehakinids are rare in comparison to Lizard Springs, and are largely represented by *Karreriella* and less frequently, *Gaudryina*. It is interesting that the Paleocene interval in the North Sea also contains primitive *Reticulophragmium*, a genus known from Trinidad and coeval strata in Spitsbergen (J. Nagy, personal communication 1986), but absent in the Paleocene of the Labrador Sea and Polish Carpathians. The Ypresian of the North Sea contains *Haplophragmoides*(?) *jarvisi*, a species displaying morphological affinity to *Reticulophragmium* that was hitherto only known from the Paleocene of Trinidad.

The North Sea Paleocene fauna differs from contemporaneous assemblages in Trinidad and Labrador by its high diversity of tubular forms. Although all tubular varieties were initially placed in only three taxonomic designations (Gradstein and Berggren 1981), morphotypes can be found corresponding to most of the species described from the Carpathians and Greenland-Norwegian Sea listed in table 3. A number of important species in the North Sea and Labrador Margin, such as *Hormosina excelsa* and *Ammobaculites* aff. *polythalamus* are not present in Trinidad. The coarsely agglutinated astrorhizids common in the North Sea, such as *Hyperammina rugosa*, *Rhizammina grzybowskii*, and *Psammosphaera fusca*, may be facies-dependent and perhaps limited at Lizard Springs by the availability of large sand grains.

POLISH OUTER CARPATHIANS. The tectonic setting of the Outer Flysch Belt of the Carpathians in Cretaceous and Paleogene time has been variously interpreted as a marginal basin which underwent rifting without sea-floor spreading (Unrug 1982) or that of a series of submarine trenches (Koszarski and Żytko 1965) which underwent subduction in Tertiary time (Pescatore and Slaczka 1984, Koszarski 1985). Foraminiferal assemblages from the Outer Carpathians contain both boreal and tethyan elements (Hanzliková 1973), and early Paleogene flysch-type agglutinated assemblages exhibit taxonomic affinities with those from Trinidad and the North Sea (table 3).

Lithologic and microfaunal facies in the Outer Flysch Belt display maximum diversity in late Senonian to early Paleogene time, when thick turbidite sequences were deposited in rapidly subsiding troughs. From north to south these were the Skole-Tarcau, Silesian, Cernogora-Audia, Dukla-Grybow, and Magura Basins (Unrug 1979, Koszarski 1985). Sedimentary basins were separated by submarine highs which experienced mainly pelagic sedimentation. During the early-middle Miocene Alpine orogeny, flysch sequences from these basins were folded and stripped from basement forming the decollement nappes of the

Outer Flysch Belt. The main nappes are the Skole, Silesian, Dukla, and Magura nappes. The Subsilesian Unit occupies an intermediate position between the Skole and Silesian nappes, and consists of marly non-flysch sediments deposited on an interbasinal high.

During the Paleocene, lithofacies in the Carpathian basins become less differentiated as late Cretaceous clastic sedimentation gave way to more pelagic deposition. In the deep Skole, Silesian, Dukla and Magura troughs, predominantly noncalcareous pelagic claystones occur among turbidite deposits. Along the northern margin of the Carpathians, Danian debris flow deposits (Szczechura and Pozaryska 1974) contain a (predominantly neritic) Midway benthic foraminiferal fauna, while pelagic claystones and marls from the Subsilesian Unit (Huss, 1966) contain a (predominantly bathyal) Velasco fauna. The diversity of agglutinated taxa is highest in noncalcareous shales of the Subsilesian Unit, where Jednorowska (1975) records 94 species. Foraminiferal assemblages from the Subsilesian Unit most closely resemble our assemblages from Trinidad, with about 70 species in common (table 3). Therefore, we have focused our comparisons on two examples from the Subsilesian Unit; one from hemipelagic marls and claystones, and another from turbiditic claystones.

In southeastern Poland, the upper Cretaceous to lower Eocene variegated claystones of the Subsilesian Unit display changes in lithology and microfossil assemblages along a paleobathymetric transect from the axis of the unit to the flysch basins on either side (Koszarski 1985). Sediments from the slopes of the Subsilesian high are tectonically disturbed, but lateral lithofacies changes can be observed in places. The shallower sediments from the axial region consist mainly of variegated marls with foraminiferal assemblages dominated by planktonic and calcareous benthic taxa. The agglutinated genera are represented mainly by lituolids, ammodiscids, hormosinids and ataxophragmiids (especially *Dorothia, Marssonella, Tritaxia* and *Matanzia*).

On the slopes of the Subsilesian high, marly sediments are laterally replaced by reddish-brown noncalcareous pelagic shales which contain a foraminiferal assemblage comprised entirely of agglutinated forms. Further to the south, these shales are replaced by thick flysch sediments of the Silesian Basin which contain more depauperate agglutinated assemblages. In these sediments paleocurrent directions are generally longitudinal to the basin axis, indicating deposition in the deepest part of the basin. In the deep facies of the Silesian and Magura basins, Jednorowska (1975) records 65 species of agglutinated foraminifera. By synthesizing microfaunal, sedimentological and ichnofaunal evidence, Książkiewicz (1975) interpreted the paleobathymetry of the Subsilesian sediments as outer neritic-upper bathyal, and assigned upper bathyal paleodepths to sediments in the Skole and Silesian Basins. However, Koszarski and Zytko (1963) and Olszewska (1984) favor a deeper (bathyal to upper abyssal) interpretation based on the assumption of oceanic depths of the CCD in the Carpathian troughs.

Assemblages from Lizard Springs compare well with those from greenish-grey marly shales of Paleocene age from the southern paleoslope of the Subsilesian Unit exposed in the area of Sanok in southeastern Poland (Koszarski and Liszkowa 1963). The assemblage is characterized by *Rhabdammina* spp., *Dendrophrya* ex gr. *excelsa, Ammodiscus* spp., *Glomospira* spp., *Hormosina ovulum ovulum, Nodellum velascoense, Recurvoides* spp., *Saccammina placenta, Trochamminoides* spp., *Haplophragmoides walteri, Kalamopsis grzybowskii, Cystammina pauciloculata* (=*Ammosphaeroidina pseudopauciloculata auct.*), *Rzehakina epigona, R. fissistomata, Spiroplectammina spectabilis, Karreriella* spp., *Dorothia trochoides,* and *Matanzia varians.* Planktonic foraminifera are absent, and rare calcareous benthic taxa are represented mainly by *Nuttalides* spp., *Stensioeina beccariiformis, Osangularia florealis* and *Aragonia* spp. According to Koszarski and Zytko (1965) these sediments were deposited near the CCD, since nearby they grade into noncalcareous shales.

An example of Paleocene shales co-occurring with turbidites can be found in the Bryozoa-Lithothamnia Sandstone member from the Subsilesian Unit. These sediments are exposed in a tectonic window near the town of Zywiec, in the western Polish Carpathians (Geroch and Gradzinski 1955). In this member, greenish-gray to gray marly shales contain an assemblage of agglutinated foraminifera dominated by astrorhizids and lituolids. Three samples from these shales contain the following proportions of superfamilies: 40-55% Astrorhizacea; 26-35% Lituolacea; 3-8% Ammodiscacea; 4-7% Hormosinacea; 2-8% Ataxophragmiacea; 1-5% Spiroplectamminacea; around 2% Trochamminacea, and around 1% Rzehakinacea. This assemblage contains a large number of species with coarsely agglutinated walls, and distinctive forms are: *Rhabdammina* spp., *Rhizammina* spp., *Dendrophrya* ex gr. *excelsa, Aschemonella* spp., *Saccammina placenta, Ammodiscus* spp., *Glomospira diffundens, Trochamminoides* spp., *Recurvoides* spp., *Hormosina ovulum ovulum, Nodellum velascoense,*

Kalamopsis grzybowskii, Haplophragmoides walteri, Spiroplectammina spectabilis, Rzehakina epigona, R. fissistomata, Dorothia beloides, Marssonella trochoides, Tritaxia spp., *Matanzia varians,* and *Arenobulimina* spp.. Calcareous benthics are rare and poorly preserved, and consist principally of *Stensioeina beccariiformis, Nuttalides* spp., *Lenticulina velascoensis, Osangularia florealis* and *Aragonia* spp. Planktonic foraminifera are very rare, and are mainly represented by poorly preserved specimens of *Subbotina triloculinoides.* Since these samples were collected from the Bouma e + f intervals, a portion of the assemblage is probably redeposited. The poor preservation of calcareous elements suggests deposition near the CCD.

In comparison with assemblages from Lizard Springs, the relative proportions of trochamminids and rzehakinids in the Subsilesian assemblages are generally lower, and a number of rare but stratigraphically important species in the Polish Carpathians have not been found in Trinidad, including *Rzehakina inclusa, R. fissistomata* and *Hormosina excelsa.* In the relative proportion of superfamilies, the Subsilesian assemblages show closer affinity to the Paleocene assemblages from the North Sea. An intriguing, yet unexplained feature of the Paleocene Carpathian assemblages is the absence of the genera *Reticulophragmium, Conotrochammina* and *Phenacophragma,* and the low diversity of ataxophragmiids.

The most comprehensive quantitative data available on Carpathian agglutinated assemblages are given by Jurkiewicz (1967), and the general similarity between Carpathian and Lizard Springs assemblages allows us to distinguish consistent

Table 4.
Agglutinated foraminifera with greater relative abundance in deeper facies of Trinidad and the Polish Outer Carpathians. Carpathian data are compiled from JURKIEWICZ (1967). Species listed in column 2 occur in grater abundance in both the Silesian and the Skole Basins relative to the Subsilesian Unit. Column 3 lists species with greater abundance in the Magura Basin relative to the Dukla Unit.

LIZARD SPRINGS	SKOLE-SUBSILESIAN-SILESIAN	DUKLA-MAGURA
Bathysiphon sp.		
Rhizammina indivisa	*Dendrophrya* ex gr. *excelsa*	
Saccammina placenta	*Saccammina placenta*	*Saccammina placenta*
Hyperammina dilatata		
Ammodiscus spp	*Ammodiscus* spp	*Ammodiscus* spp
Glomospira spp	*Glomospira* spp	*Glomospira* spp
Rzehakina epigona		*Rzehakina epigona*
Hormosina ovuloides	*Aschemonella* spp	
Hormosina ovulum ovulum	*Hormosina ovulum ovulum*	*Hormosina ovulum ovulum*
Kalamopsis grzybowskii		*Kalamopsis grzybowskii*
Nodellum velascoensis		*Nodellum velascoensis*
Reophax duplex	*Reophax duplex*	*Reophax duplex*
	Ammobaculites deflexus	*Ammobaculites deflexus*
Haplophragmoides horridus	*Haplophragmoides horridus*	
Haplophragmoides lamella	*Haplophragmoides lamella*	
Haplophragmoides porrectus		
H. ex gr. *suborbicularis*	*H.* ex gr. *suborbicularis*	
Labrospira pacifica	??	??
Recurvoides deflexiformis	*Recurvoides deflexiformis*	*Recurvoides deflexiformis*
Recurvoides cf. subturbinatus	*Recurvoides cf. subturbinatus*	*Recurvoides cf. subturbinatus*
	Recurvoides walteri	*Recurvoides walteri*
Trochamminoides irregularis	*Trochamminoides coronatus*	*Trochamminoides coronatus*
Trochamminoides subcoronatus	*Trochamminoides subcoronatus*	*Trochamminoides subcoronatus*
Ammosphaeroidina pseudopauciloculata		*A. pseudopauciloculata*
	Trochammina altiformis	*Trochammina altiformis*
Spiroplectammina spectabilis		
Spiroplectammina navarroana		
Karreriella tenuis	*Karreriella tenuis*	
Karreriella sp. 2	*Karreriella conversa*	*Karreriella coniformis*

paleobathymetric patterns in species composition. Species that occur in greater abundance in deeper facies of the Lizard Springs Formation and the Carpathian basins in southeastern Poland (table 4) include *Saccammina placenta, Ammodiscus* spp., *Glomospira* spp., *Hormosina ovulum, Reophax duplex, Recurvoides deflexiformis*, and *Trochamminoides* spp. Jurkiewicz (1967) distinguishes *Trochamminoides coronatus* and *T. subcoronatus*, which we both include in *T. subcoronatus*. The genus *Karreriella* generally occurs in deeper facies in both Trinidad and Poland, but this group is still plagued by taxonomic problems. *Labrospira pacifica* was not recognised at the time of Jurkiewicz's study but occurs in the upper Cretaceous of the Silesian Basin (Geroch and Nowak 1984). Its occurrence in table 4 is marked by question marks.

CONCLUSIONS

(1.) Foraminiferal assemblages of the Lizard Springs and Guayaguayare formations are much more diverse than originally reported by Cushman and co-workers. At least 105 species of agglutinated foraminifera occur in Maastrichtian to lower Eocene sediments. Table 2 presents our revision of the taxonomy of Cushman and Renz (1946), which includes 34 nomenclatorial changes on a generic or species level. The late Senonian to early Eocene stratigraphic distribution of common agglutinated species is compiled for southeast Trinidad (fig. 4), and seven foraminiferal datums were found to be isochronous in other regions containing flysch-type assemblages.

(2.) Comparisons with flysch-type faunas from the North Atlantic and Tethyan regions show that although many species of agglutinated foraminifera are cosmopolitan in distribution, some degree of faunal endemism is observed. *Rzehakina* spp. and ataxophragmiids occur in greater abundance in Trinidad than in coeval bathyal flysch-type faunas in the North Atlantic and Poland. The greatest similarity is observed between the lower Lizard Springs Formation and the Subsilesian Unit of the Polish Carpathians.

(3.) The lower Lizard Springs Formation contains both in situ and penecontemporaneously redeposited assemblages. Sedimentological and calcareous microfossil evidence allows us to construct a paleobathymetric microfossil facies model for the lower Lizard Springs Formation. Three faunas were delineated by Q-mode factor analysis which explain most of the variance.

The deepest assemblage is dominated by small, finely agglutinated species such as *Ammosphaeroidina pseudopauciloculata, Rhizammina indivisa*, and *Recurvoides gerochi*, with a lesser contribution by *Rzehakina epigona, Spiroplectammina spectabilis* and *Saccammina placenta*. This assemblage occurs in bioturbated, noncalcareous clays and probably represents an *in situ* fauna in pelagic sediments deposited below a local CCD.

An assemblage strongly dominated by *Dendrophrya* ex gr. *excelsa* is found in redeposited sediments containing calcareous benthics dominated by *Nuttallides truempyi*. This fauna was probably redeposited from a deep, distal source.

A third faunal assemblage occurs in the basal interval of well G-287. This fauna is dominated by species associated with a calcareous facies, such as *Clavulinoides globulifera, Dorothia retusa, Phenacophragma beckmanni*, and *Haplophragmoides* ex. gr. *suborbicularis*. This assemblage occurs with a calcareous benthic fauna containing an increased abundance of *Stensioeina beccariiformis*, and is interpreted as being redeposited from a shallower, more proximal source.

(4.) Comparison of paleobathymetry of flysch-type agglutinated assemblages allows us to define interregional depth-related patterns. Several agglutinated genera and species consistently occur in greater abundance in deeper facies. These include the genera *Bathysiphon, Rhizammina, Ammodiscus, Glomospira, Rzehakina, Karreriella, Nodellum, Trochamminoides, Ammosphaeroidina*, small, finely agglutinated *Haplophragmoides*, and the species *Saccammina placenta, Reophax duplex, Hormosina ovulum ovulum, Recurvoides deflexiformis*, and *R. subturbinatus*. The threefold paleobathymetry of mid-Cretaceous agglutinated faunas of Haig (1979) cannot be applied to Paleocene assemblages without qualification. The relative abundance of *Recurvoides*, the nominate taxon of Haig's deep assemblage, does not change appreciably from the shallow to deep assemblages in Trinidad.

TAXONOMY

For the purpose of performing a taxonomic revision of the agglutinated taxa from the Lizard Springs Formation, we examined type specimens from the Cushman collection housed at the U.S. Natural History Museum, Washington, D.C., and from the collection of M.P. White in the Department of Invertebrate Paleontology, American Museum of Natural History, New York. In order to clarify and

refine our synonymies, we also compared specimens from Lizard Springs with type material from the collection of J. Grzybowski, the bulk of which is housed in the paleontological collections of the Jagiellonian University, Krakow, Poland. A comparative study of Grzybowski's material is hindered by the fact that J. Grzybowski did not designate holotypes. In many instances, a specimen which corresponds to the original illustration can be found, but we have found it necessary to employ open nomenclature for several of Grzybowski's species pending a taxonomic revision of the collection and the designation of lectotypes or neotypes.

In the systematic section, genera are listed alphabetically by superfamily *sensu* Loeblich and Tappan (1984). All the genera listed below are found in the Treatise of Loeblich and Tappan (1964) except *Subreophax* Saidova 1975. Table 2 presents a revision of the taxonomy of Cushman and Renz (1946).

Superfamily ASTRORHIZACEA Brady 1881

Bathysiphon microrhaphidus Samuel
Plate 1, figures 1a-b

Bathysiphon microrhaphidus SAMUEL 1977, pp 19-20, pl. 11, figs. 3-6; pl. 12, figs. 1-4; textfigure 1a.

Test a robust tube comprised of quartz grains and sponge spicules oriented parallel to the long axis of the test.

Bathysiphon sp
Plate 1, figures 2-3

Rhabdammina discreta (Brady) var. A.--GRADSTEIN and BERGGREN 1981, p. 241, pl. 1, figs. 4-6.

Silicobathysiphon dubia dubia (White).--MJATLIUK 1970, pl. 8, fig. 3.

Bathysiphon? dubia (White).--CUSHMAN and RENZ 1946, p. 12, pl. 1, figs. 4-5.

Test a straight, finely agglutinated, finely finished tube without constrictions, white in color. Width: 0.22-0.38 mm, thickness of wall: 0.05-0.07 mm. Test may be circular in cross section or compressed, with a median furrow. In Carpathian literature, this form is usually reported as *Hyperammina* sp.

The species *Kalamopsis dubia* White differs from our specimens in possessing a coarser wall and internal septae which are clearly visible in immersion oil. The type specimens from the Velasco Shale are 0.25-0.30 mm in width, and the best preserved specimen has a tubular chamber 0.95 mm in length between septae. Fragments of this species, however, can easily be mistaken for *Bathysiphon*.

Dendrophrya ex gr. *excelsa* Grzybowski
Plate 1, figures 4-5

Dendrophrya excelsa GRZYBOWSKI 1898, p. 16, pl. 10, figs. 2-4. --GEROCH 1960, pl. 1, figs. 1-9.--VIALOV and DABAGIAN 1967, p. 29, pl. 2, fig. 2a,b, pl. 3, fig. 1a,b. textfigure 2.--HANZLIKOVA 1972, p. 32, pl. 2, fig. 6.--SAMUEL 1977, p. 23, pl. 2, figs. 3-8; pl. 10, fig. 4.--VERDENIUS and VAN HINTE 1983, p. 198, pl. 3, figs. 3, 4.

Dendrophrya cf. *excelsa* Grzybowski.--SCHREIBER 1980, p. 126, pl. 2, fig. 3.

cf. *Dendrophrya gwidoensis* MJATLIUK 1970, p. 63, pl. 7, figs. 1, 9.

Test tubular, moderately coarse, flattened. Fragments are mostly straight, less commonly branched. Width: 0.20-0.30 mm, thickness of wall: 0.02-0.04 mm. Specimens in the Grzybowski collection display considerable variation in the thickness of the wall and size of agglutinated grains, therefore we use open nomenclature for this group, pending revision of Grzybowski's types. Our specimens most closely resemble those illustrated by Geroch (1960) and Vialov and Dabagian (1967) from the Grzybowski Collection.

Dendrophrya latissima Grzybowski
Plate 1, figure 6

Dendrophrya latissima GRZYBOWSKI 1898, p. 17, pl. 10, fig. 8.--JURKIEWICZ 1967, p. 45, pl. 1, fig. 16.--SAMUEL 1977, p. 23, pl. 2, fig. 10a-b; pl. 10, fig. 5.--VIALOV and DABAGIAN 1967, p. 31, pl. 2, fig. 1a,b, pl. 3, fig. 2a,b, textfigure 3.

Test a wide, flattened tube with thin wall. Width: 0.55-0.72 mm, thickness of wall: 0.02-0.04 mm.

Lagenammina grzybowskii (Schubert)
Plate 2, figure 7

Reophax difflugiformis Brady.--GRZYBOWSKI 1898, p. 255, pl. 10, figs. 11-12. --GZYBOWSKI 1901, p. 266, pl. 7, fig. 4.

Reophax grzybowskii SCHUBERT 1901, p. 20, pl. 1, fig. 13.

Saccammina difflugiformis (Brady).--JEDNOROWSKA 1975, p. 40, pl. 1, figs. 4-5.

Test coarse, flask-shaped, with wide apertural neck. Schubert (1901) placed Grzybowski's specimens from Krosno in the synonymy of *L. grzybowskii*. Our specimens from the Guayaguayare Formation correspond closely to specimens from Krosno in the Grzybowski Collection.

Psammosphaera scruposa (Berthelin)
Plate 2, figure 5

Haplophragmium scruposum BERTHELIN 1880, p. 21, pl. 1, fig. 1.

Psammosphaera laevigata White.--HANZLIKOVA 1972, p. 33, pl. 1, figs. 7-8.--TRUJILLO 1960, p. 302, pl. 43, fig. 1.

Psammosphaera sp. var. B.--GRADSTEIN and BERGGREN 1981, p. 241, pl. 1, fig. 16. cf. *Psammosphaera fusca* Schultze.--GRUN 1969, pl. 59, figs. 1a-2b.

Psammosphaera scruposa (Berthelin).--HANZLIKOVA 1973, p. 136, pl. 1, fig. 4a-b.

Test spherical, with depressed center and thick edge. Wall thick, made of moderately coarse, well-sorted quartz grains. Agglutinated grains are finer and more uniform in size than in *P. fusca* Schultze.

Psammosphaera testacea Flint
Plate 2, figure 6

Psammosphaera fusca Schultze var. *testacea* FLINT 1899, p. 268, pl. 8, fig. 2.

Psammosphaera testacea Flint.--KAMINSKI 1983, p. 9, pl. 3, fig. 6.

Test wholly comprised of small planktonic foraminifera tests of fairly uniform dimensions. Wall a single layer thick. Found in a sample from the upper Lizard Springs Formation in Ravine Ampelu.

Rhabdammina ex gr. *discreta* Brady
Plate 1, figures 8-9

Rhabdammina discreta BRADY 1881, p. 48, pl. 22, figs. 7-10.--CUSHMAN and RENZ 1946, p. 12, pl. 1, fig. 1.

Rhabdammina div. sp.--HEMLEBEN and TROESTER 1984, p. 522, pl. 1, figs. 3-5.

Hyperammina intermedia MJATLIUK 1970, pl. 1, figs. 16-17; pl. 2, figs. 11-12; pl. 3, figs. 6-8, 12; pl. 4, fig. 3; pl. 6, figs. 1-4.

Rhabdammina ex gr. *discreta* Brady.--GEROCH 1960, p. 36, pl. 1, figs. 12-15.

Bathysiphon discreta (Brady) var. B.--GRADSTEIN and BERGGREN 1981, p. 240, pl. 1, figs. 7-10.

Distinguished by its thick, coarsely agglutinated, well-sorted wall and rectilinear test. Width: 0.20-0.38 mm, thickness of wall: 0.06-0.10 mm.

Rhizammina grzybowskii Liszka and Liszkowa
Plate 1, figure 7

Rhizammina grzybowskii LISZKA and LISZKOWA, 1981, p. 164, pl. 1, figs. 1a-b.

Test a robust, coarsely agglutinated tube with a thick wall. Width: 0.38-0.70 mm, thickness of wall: 0.10-0.18 mm. Wall is made of poorly sorted grains and contains carbonate material.

Rhizammina indivisa Brady
Plate 1, figures 10-13

Rhizammina indivisa BRADY 1884, p. 277, pl. 29, figs. 5-7.--GRADSTEIN and BERGGREN 1981, p. 240, pl. 1, figs. 1-3.--GEROCH 1966, pl. 1, figs. 1-7.

Saccorhiza ramosa (Brady).--CUSHMAN and RENZ 1946, p. 6, pl. 1, figs. 10-12.--JURKIEWICZ 1967, pp. 45-46, pl. 1, fig. 18.

Test unbranching, thin-walled and commonly flattened and distorted. Two morphotypes occur in our material: specimens from the Paleocene are silicified and finely finished, but Maastrichtian and Early Eocene specimens contain small planktonic foraminifera incorporated in the wall and thereby resemble Brady's forms. Smooth varieties are 0.10-0.25 mm in width, mean around 0.18 mm. Variety with planktonic foraminifera: 0.18-0.50 mm in width.

Saccammina complanata (Franke)
Plate 2, figure 8

Pelosina complanata FRANKE 1912, pl. 3, fig. 1a-b.--CUSHMAN and RENZ 1946, p. 13, pl. 1, fig. 8.

Saccammina scruposum (Berthelin).--WHITE 1928a, p. 183, pl. 27, fig. 5.

Proteonina complanata (Franke).--GLAESSNER 1937, pp. 355-356, pl. 1, fig. 3.

Saccammina placenta (Grzybowski).--SCHREIBER 1980, p. 126, pl. 2, fig. 4.--GRADSTEIN and BERGGREN 1981, pl. 2, fig. 5.

Saccammina grzybowskii (Schubert).--HEMLEBEN and TROESTER 1984, p. 522, pl. 1, fig. 14.

Saccammina cf. *complanata* (Franke).--ROGL 1976, pl. 3, figs. 7-8.

Saccammina complanata (Franke).--KRASHENNINIKOV 1974, p. 644, pl. 7, figs. 10a-b.

Specimens are spherical in outline, flattened, rather coarsely agglutinated, with an aperture on a thin neck, usually at the periphery. A slide labeled "*Pelosina complanata*" in the Cushman Collection (C.C. 46468) from Ravine Ampelu also contains specimens of *Hormosina ovuloides* and *Hyperammina dilatata*.

Saccammina placenta (Grzybowski)
Plate 2, figure 9

aff. *Orbulinaria rhumbleri* FRANKE 1925, p. 6, pl. 1, fig. 2.

Reophax placenta GRZYBOWSKI 1898, pp. 276-277, pl. 10, figs. 9-10.

Saccammina rhumbleri (Franke).--CUSHMAN and RENZ 1946, p. 13, pl. 1, figs. 6-7.

Bogdanovicziella complanata (Franke).--MJATLIUK 1970, pp. 51-52, pl. 7, fig. 12a-b; pl. 8, figs 5-10; pl. 15, figs. 3-4.

Saccammina placenta (Grzybowski).--HANZLIKOVÁ 1972, p. 33, pl. 1, fig. 9.--GRADSTEIN and BERGGREN 1981, p. 241, pl. 2, fig. 3.

Test finely agglutinated, usually with a depressed center. Although not mentioned by Grzybowski (1898), this species has been shown to possess an aperture on a minute neck (Geroch, 1960). Differs from *S. complanata* in its more finely agglutinated test and more delicate neck, located at any position on the test surface *S. placenta* may have been more spherical than *S. complanata*, hence the random position of the aperture. Cushman and Jarvis (1932) also included *Hormosina ovulum* in their concept of "*S. rhumbleri*".

Thurammina sp.
Plate 2, figure 14

Test large, unilocular, suboval in outline, with 3 to 5 apertures located at the end of short mammillate protuberances often situated at one end of the test. Smaller individuals possess fewer apertures. Wall thick, with the size of the grains variable. Specimens from redeposited intervals of well G-287 have a wall comprised of 2 layers of medium to coarse sand grains. Specimens from non-calcareous autochthonous intervals utilize finer particles and

have a more finely finished test. Test is often compressed.

Differs from T. *glabra* ten Dam from the Eocene of the Netherlands in possessing fewer apertures.

Superfamily HYPERAMMINACEA Eimer and Fickert 1899

Hyperammina dilatata Grzybowski
Plate 2, figures 1-2

Hyperammina dilatata GRZYBOWSKI 1896, pp. 274-275, pl. 8, fig. 17.--LISZKA and LISZKOWA 1981, p. 162, pl. 1, fig. 8.

Hyperammina dilatata Rzehak.--JURKIEWICZ 1967, p. 43, pl. 1, fig. 14.

Unilocular chambers with thick, finely agglutinated wall. Differs from *H. ovuloides* in possessing a broader apertural opening. Grzybowski's holotype is somewhat smaller in size than our specimens, but otherwise identical. Specimens of *H. dilatata* were given the field name "*Nodosinella* (single chambered)" by P.W. Jarvis, but Cushman did not recognise this form and placed Jarvis' specimens in slides together with *Saccammina complanata* and *Nodellum velascoense*.

Hyperammina elongata Brady
Plate 1, figures 14-15

Hyperammina elongata BRADY 1878, p. 433, pl. 20, fig. 2a-b.--SAMUEL 1977, p. 20, pl. 10, figs. 1-2.--KAMINSKI 1983, p. 10, pl. 2, fig. 3.

Test consists of a globular proloculus and a cylindrical tube, often compressed. Wall thin, finely agglutinated.

Hyperammina ex gr. *subnodosiformis* Grzybowski
Plate 1, figures 16-17

Rhabdammina annulata Grzybowski.--JURKIEWICZ 1967, p. 40, pl. 1, fig. 4.

--SAMUEL 1977, p. 17, pl. 1, fig. 9; pl. 9, figs. 1-4.

Hyperammina subnodosiformis GRZYBOWSKI 1898, p. 274, pl. 10, fig. 5.--GEROCH 1960, pp. 38-39, pl. 1, fig. 21.--JURKIEWICZ 1967, pp. 42-43, pl. 1, figs. 10-11.

We have included in this group all finely agglutinated tubes with irregular annular constrictions, though the degree of constriction may vary. Specimens are often flattened. Our specimens from Lizard Springs differ from the types of *H. subnodosiformis* from the Grzybowski Collection in possessing a more finely finished test and a thicker wall. Grzybowski's specimens are slightly coarser and are strongly compressed.

Confusion exists in the literature between this species and *Rhabdammina annulata*. Our specimens most closely resemble those illustrated by Samuel (1977) as *R. annulata*, but Liszka and Liszkowa (1981) report that specimens labeled *R. annulata* in Grzybowski's collection actually belong in *Reophax* and most closely resemble *Reophax subnodulosa* Grzybowski.

Superfamily AMMODISCACEA Reuss 1862

Ammodiscus cretaceus (Reuss)
Plate 3, figure 7

Operculina cretacea REUSS 1845, p. 35, pl. 13, figs. 64-65.

Cornospira cretacea (Reuss).--REUSS 1860. p. 177, pl. 1, fig. 1a-b.--WHITE 1928a, p. 185, pl. 27, fig. 9.

Ammodiscus involvens GRZYBOWSKI 1896, p. 279, pl. 8, fig. 38.

Ammodiscus polygyrus GRZYBOWSKI 1896, p. 280, pl. 8, fig. 34.

Ammodiscus angygyrus GRZYBOWSKI 1896, p. 280, pl. 8, fig. 37.

Cornospira angusta FRIEDBERG 1901, pl. 1, fig. 8.

Ammodiscus angustus (Friedberg).--LISZKA and LISZKOWA 1981, pp. 171-173, pl. 2, figs. 3-5.

Grzybowskiella angusta (Friedberg).--MJATLIUK 1970, pp. 70-71, pl. 11, fig. 12; pl. 12, figs. 1a-4b, 6a-b; pl. 21, fig. 9.

Ammodiscus ex gr. *cretaceus* (Reuss).--PFLAUMANN 1964, pp. 86-88, pl. 10, figs. 22-24, 26-30.

Ammodiscus cretaceus cretaceus (Reuss).--KRASHENNINIKOV and PFLAUMANN 1977, p. 569, pl. 2, fig. 7.

Ammodiscus cretaceus (Reuss).--SCHREIBER 1980, pp. 127-128, pl. 2, fig. 13.--GRADSTEIN and BERGGREN 1981, pl. 2, figs. 12-13.--MILLER ET AL. 1982, p. 19, pl. 1, fig. 17.--HEMLEBEN and TROESTER 1984, p. 517, pl. 1, fig. 17.

Test large, biconcave, evolute with coil suture, finely agglutinated, with 8 to 10 whorls. Characterized by fine, radial striations on the surface of the test. We follow Reuss' (1860) species concept, since specimens fitting this description collected by Reuss from the Maastrichtian of Westphalia are preserved in the Cushman Collection.

Ammodiscus glabratus Cushman and Jarvis
Plate 3, figure 8a-b

Ammodiscus glabratus CUSHMAN and JARVIS 1928, p. 86, pl. 12, fig. 6.

--HILLEBRANDT 1962, p. 25, pl. 1, fig. 3.--KRASHENNINIKOV and PFLAUMANN 1977, p. 569, pl. 2, figs. 8-9.

Grzybowskiella glabrata (Cushman and Jarvis).--MJATLIUK 1970, pp. 71-72, pl. 12, fig. 7a-b.

Test thick, biconcave, involute, without coil suture or striations, very finely agglutinated, silicified. Holotype (C.C. 9683) is 0.90 mm in diameter and possesses 10 whorls. Paratypes have up to 12 whorls. Smaller in size and more involute than *A. cretaceus*, with more whorls.

Ammodiscus pennyi Cushman and Jarvis
Plate 3, figures 9-10

Ammodiscus pennyi CUSHMAN and JARVIS 1928, p. 87, pl. 12, figs. 4-5.--MALLORY 1959, p. 108, pl. 1, fig. 13a-b.--HUSS 1966, pp. 19-20, pl. 3, figs. 5-8.--WEBB 1975, p. 834, pl. 1, fig. 8.

The holotype of *A. pennyi* is missing from the Cushman Collection, but paratypes and additional unfigured specimens from the Lizard Springs

Formation are present. The test is large, comprised of few whorls, with globular proloculus and wide coiled chamber. Wall thick, coarse, with much cement. Coiling may be slightly irregular, and a single specimen from the Lantern Marl (lower Lizard Springs Formation) in the Cushman Collection uncoils as in *A. latus* Grzybowski, an index species for the late Eocene of the Flysch Carpathians in Poland. This species differs from the type specimens of *A. latus* in its larger dimensions, thicker and coarser wall, and more numerous, slightly irregular coils. Specimens illustrated by Krashenninikov and Pflaumann (1977) as *A. pennyi* probably correspond to *Lituotuba*.

Ammodiscus peruvianus Berry
Plate 3, figures 11-12

Ammodiscus cf. *A. incertus* (d'Orbigny).--MALLORY 1959, p. 108, pl. 1, fig. 11a-b.

Ammodiscus sp. (aff. *gorlicensis* Grzybowski).--JURKIEWICZ 1967, p. 58, pl. 2, figs. 10, 12.

Ammodiscus peruvianus BERRY 1928, p. 403, fig. 27.--ROGL 1976, pl. 2, fig. 23.--GRADSTEIN and BERGGREN 1981, p. 241, pl. 2, figs. 14-15.

Test distinguished by its eliptical outline. Finely agglutinated. We cannot discount the possibility that these are not deformed specimens of *A. glabratus*.

Ammodiscus planus Loeblich
Plate 3, figure 13

Ammodiscus planus LOEBLICH 1946, p. 133, pl. 22, fig. 2.--HUSS 1966, p. 19, pl. 3, figs. 1-4.

A small, very thin-walled, compressed, finely agglutinated test of several whorls. Diameter of tube may increase slightly in the last 1-2 whorls. Differs from *A. glabratus* in smaller dimensions and lesser thickness.

Ammolagena clavata (Jones and Parker)
Plate 3, figure 24

Trochammina irregularis (d'Orbigny) var. *clavata* JONES and PARKER 1860, p. 304.

Ammolagena clavata (Jones and Parker).--MILLER ET AL. 1982, p. 20, pl. 1, fig. 9.

Test pseudoattached to benthic foraminifera.

Glomospira charoides (Jones and Parker)
Plate 3, figures 14-15

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

Ammodiscus charoides (Jones and Parker).--GRZYBOWSKI 1896, pp. 280-281, pl. 8, figs. 39-43.

Glomospira charoides (Jones and Parker).--GEROCH 1960, pp. 46-47, pl. 4, figs. 1, 2, 5.--JURKIEWICZ 1967, pp. 57-58. pl. 2, figs. 16-17; textfigure 7a-f. --GRADSTEIN and BERGGREN 1981, p. 241, pl. 3, figs. 5-7.--KAMINSKI 1983, p. 12, pl. 5, fig. 1.

Glomospira charoides (Jones and Parker) var. corona CUSHMAN and JARVIS 1928, p. 89, pl. 12, figs. 9-11.

Glomospira charoides corona Cushman and Jarvis.--HILLEBRANDT 1962, p. 25, pl. 2, fig. 24a-c.

Glomospira corona (Cushman and Jarvis).--KRASHENNINIKOV 1974, pl. 7, fig. 5.--HEMLEBEN and TROESTER 1984, p. 518, pl. 1, fig. 19.

In our view, the differences between *G. charoides* and *G. corona* reflect ontogeny.

Glomospira diffundens (Cushman and Renz)
Plate 3, figures 18-19

Glomospira gordialis (Jones and Parker) var. *diffundens* CUSHMAN and RENZ 1946, p. 15, pl. 1, fig. 30.--GEROCH 1960, pp. 46-47, pl. 4, fig. 1; pl. 10, fig. 2.--HEMLEBEN and TROESTER 1984, p. 519, pl. 1, fig. 21.

Glomospira diffundens (Cushman and Renz).--MORGIEL and OLSZEWSKA 1981, p. 8, pl. 1, figs. 13-14.--GEROCH and NOWAK 1984, pl. 1, fig. 10.

Distinguished by its robust test, broad chamber and its tendency towards planispirality in later chambers.

Glomospira glomerata (Grzybowski)
Plate 3, figure 16

Ammodiscus glomeratus GRZYBOWSKI 1898, p. 285, pl. 11, fig. 4.

Glomospira glomerata (Grzybowski).--SAMUEL 1977, p. 28, pl. 23, figs. 1-2.

Test finely agglutinated, with narrow chamber in broad S-shaped coils. Distinguished from *G. irregularis* in its more open coiling.

Glomospira gordialis (Jones and Parker)
Plate 3, figure 17

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

Glomospira gordialis (Jones and Parker).--CUSHMAN and JARVIS 1928, p. 87, pl. 12, fig. 7.--JURKIEWICZ 1967, pp. 59-60, pl. 2, fig. 23; textfigure 8a-d.

Similar to *G. charoides* but more irregularly coiled.

Glomospira irregularis (Grzybowski)
Plate 3, figures 20-21

Ammodiscus irregularis GRZYBOWSKI 1898, p. 285, pl. 11, figs. 2-3.

Glomospira irregularis (Grzybowski).-- GLAESSNER 1937, p. 359, pl. 1, fig. 7.--MASLAKOVA 1955, pp. 45-46, pl. 3, fig. 3.--JURKIEWICZ 1967, pp. 61-62, pl. 2, figs. 18-19; textfigure 9a-c.--GRADSTEIN and BERGGREN 1981, p. 246, pl. 3, figs. 1-4.--MILLER ET AL. 1982, p. 19, pl. 1, fig. 12.--HEMLEBEN and TROESTER 1984, p. 519, pl. 1, fig. 22.

Test comprised of a broad, irregularly coiled tube, often flattened. Wall moderately coarse.

Glomospira serpens (Grzybowski)
Plate 3, figures 22-23

Ammodiscus serpens GRZYBOWSKI 1898, p. 285, pl. 10, fig. 31.

Glomospira rostokiensis MJATLIUK 1970, pp. 68-69, pl. 11, figs. 16a-18b.

Glomospira sp. A.--BECKMANN 1960, fig. 1.

Glomospirella gaultina (Berthelin).--HANZLIKOVA 1973, pp. 140-141, pl. 2, figs. 14-15.
Glomospirella serpens (Grzybowski).--SAMUEL 1977, p. 30, pl. 4, fig. 2; pl. 22, fig. 4.
Trochamminoides dubius (Grzybowski).--SAMUEL 1977, p. 45, pl. 25, figs. 5-6.
Glomospira serpens (Grzybowski).--GEROCH 1960, p. 47, pl. 4, fig. 13.--JURKIEWICZ 1967, p. 62, pl. 2, figs. 24, 27.--MILLER ET AL. 1982, pl. 1, fig. 13.--HEMLEBEN and TROESTER 1984, p. 519, pl. 1, fig. 23.
Test eliptical, comprised of a broad, finely agglutinated chamber in 2 or 3 whorls.

Although the original description of *Ammodiscus serpens* mentions a rough or "slightly rough" test (Grzybowski, 1898; 1901), we have included smoothly finished forms because of similar morphology. In the Grzybowski Collection, there are numerous specimens labeled *A. serpens* which possess smoothly finished tests. Mjatliuk (1970) described finely finished forms as G. *rostokiensis*.

Superfamily RZEHAKINACEA Cushman 1933

Rzehakina epigona (Rzehak)
Plate 7, figures 6a-7

Silicina epigona RZEHAK 1895, p. 214, pl. 6, fig. 1
Rzehakina epigona epigona (Rzehak).--HILTERMANN 1974, pl. 5, figs. 1, 2, 5-7, 9, 15, 19, 20, 23, 25, 42-44; pl. 6, figs. 27-29, 34 (with synonyms).--GEROCH and NOWAK 1984, pl. 3, fig. 12.
Rzehakina epigona (Rzehak).--JEDNOROWSKA 1975, pp. 47-48, pl. 3, figs. 8-9.--MORGIEL and OLSZEWSKA 1981, p. 9, pl. 2, fig. 13.
We follow Hiltermann's usage in including *R. epigona* var. *lata* Cushman and Renz in the synonymy of *R. epigona*.

Rzehakina minima Cushman and Renz
Plate 7, figures 8-9

Rzehakina epigona (Rzehak) var. *minima* CUSHMAN and RENZ 1946, p. 24, pl. 3, fig. 5.
Rzehakina epigona minima (Cushman and Renz).--HILTERMANN 1974, pp. 44-45, pl. 5, figs. 10, 11, 16-18, 21, 22, 24, 28; pl. 6, figs. 9, 10, 14, 15, 31-33. (with synonyms).
Rzehakina minima Cushman and Renz.--HANZLIKOVA 1972, p. 39, pl. 4, fig. 11.
Test evolute, laterally compressed, with many whorls. We follow Hiltermann's definition of the species and include *Spiroloculina simplex* Grzybowski and *Spiroloculina complanata* Grzybowski in the synonymy.

Superfamily HORMOSINACEA Haeckel 1894

Aschemonella ex gr. *grandis* (Grzybowski)
Plate 2, figure 11-13

Reophax grandis GRZYBOWSKI 1898, p. 277, pl. 10, figs. 13-15.
Aschemonella sp.--GEROCH 1960, pl. 1, figs. 24-25.
Aschemonella sp. (aff. *scabra*).--JURKIEWICZ 1967, p. 52, pl. 1, fig. 26. cf. *Aschemonella carpathica* NEAGU 1964, pp. 582-586, pl. 27, figs. 1-3;.textfigure 1, 5-8; textfigure 2, 2-4; textfigure 3, 1-3; textfigure 4, 1-6.
Test large, medium to finely agglutinated, suboval in outline, flattened. In our material, two possible varieties of *Aschemonella* exist. The first possesses a large phialine aperture. The second more closely resembles *A. carpathica*, in possessing embracing chambers or with apertures located at opposite ends of the test. Both varieties can be found in the Grzybowski Collection labeled *Reophax grandis*. We have included both types in the group *A.* ex gr. *grandis* due to the fragmentary nature of our specimens.

Hormosina ovuloides (Grzybowski)
Plate 2, figures 3-4

Reophax ovuloides GRZYBOWSKI 1901, p. 268, pl. 7, fig. 3.
Hormosina ovuloides (Grzybowski).--SAMUEL 1977, p. 33, pl. 3, figs. 14-15; pl. 16, figs. 3, 4.
Test finely agglutinated, finely finished. Almost always found as single, oval or slightly pear-shaped chambers with long necks, often compressed. This species may actually belong in *Hormosinella* Stchedrina (1969), which was erected for varieties of *Hormosina* with a long apertural neck (Type species: *Reophax distans* Brady).

Hormosina ovulum ovulum (Grzybowski)
Plate 2, figure 10

Reophax ovulum GRZYBOWSKI 1896, p. 276, pl. 8, figs. 8, 9.
Hormosina ovulum (Grzybowski).--MASLAKOVA 1955, p. 41, pl. 1, fig. 9.--GEROCH 1960, p. 43, pl. 2, figs. 20-22; pl. 10, figs. 8-9.--JURKIEWICZ 1967, pp. 52-53, pl. 1, fig. 28.--HEMLEBEN and TROESTER 1984, p. 520, pl. 2, fig. 7.
Pelosina caudata (Montanaro-Gallitelli).--HANZLIKOVA 1972, p. 34, pl. 1, figs. 2-6 (with synonyms).
Carpathiella ovulum (Grzybowski).--MJATLIUK 1966, pp. 262-263, pl. 1, figs. 2-4b; pl. 2, figs. 1-3; pl. 3, fig. 2.--MJATLIUK 1970, p. 52, pl. 8, fig. 12;.pl. 9, figs. 8-13.
Carpathiella ovulum ovulum (Grzybowski).--SZCZECHURA and POZARYSKA 1974, p. 27-28, pl. 3, fig. 19.
Hormosina ovulum ovulum (Grzybowski).--SANDULESCU 1972, p. 25, pl. 2, figs. 16-17 (with synonyms).--GEROCH and NOWAK 1984, pl. 1, figs. 19, 21.
Always found in subspherical, unilocular fragments. Wall thick, finely agglutinated. Distinguished from *H. ovulum gigantea* Geroch by its smaller dimensions. Specimens in the Cushman Collection were found in a slide labeled *Saccammina rhumbleri* from material collected by P.W. Jarvis.

Mjatliuk (1966) designated *H. ovulum* the genotype for *Carpathiella*, which was distinguished from *Hormosina* by its cryptocrystaline siliceous wall.

Hormosina trinitatensis Cushman and Renz
Plate 3, fig. 1

Hormosina globulifera Brady var. trinitatensis CUSHMAN and RENZ 1946, p. 14, pl. 1, figs. 15-19.

Hormosina trinitatensis Cushman and Renz).--HANZLIKOVÁ 1972, p. 37, pl. 3, fig. 10.--JEDNOROWSKA 1975, p. 47, pl. 3, fig. 1.

Test large, 2 - 4 chambers rapidly increasing in size. Wall medium to coarse. Test is commonly compressed in any plane. Many authors use the name *Reophax pilulifer* Brady for this form, but we reserve this name for forms with a coarser, single-layered wall. We place this species in *Hormosina* based on Hofker's (1972) definition of *Hormosina* possessing a multilayered wall.

Kalamopsis grzybowskii (Dylążanka)
Plate 1, figures 18-20

Hyperammina grzybowskii DYLAZANKA 1923, pp. 65-66.--GEROCH 1960, p. 39, pl. 1, figs. 22-23; pl. 10, fig. 7.--JURKIEWICZ 1967, pl. 1, figs. 6-8.

Silicobathysiphon dubia dubia (White).--MJATLIUK 1970, p. 48, pl. 8, figs. 1-2, 4.

Kalamopsis grzybowskii (Dylążanka).--PFLAUMANN 1964, pp. 79-80, pl. 10, figs.14-15.--HANZLIKOVÁ 1972, p. 36, pl. 2, fig. 8.--HEMLEBEN and TROESTER 1984, p. 550, pl. 2, figs. 3-5.

Mostly single-chambered, flattened fragments often displaying constrictions at one end. Wall thin, finely finished. Differs from *K. dubia* in its smaller dimensions and thinner wall.

Nodellum velascoense (Cushman)
Plate 1, figures 21-22

Nodosinella velascoensis CUSHMAN 1926, p. 583, pl. 20, figs. 9a-b.

Nodellum velascoensis (Cushman).--CUSHMAN and JARVIS 1932, p. 8, pl. 1, figs. 15-17.

Nodellum velascoense (Cushman).--GLAESSNER 1937, p. 358, pl. 1, fig. 6. --MASLAKOVA 1955, p. 42, pl. 1, fig. 8.--SANDULESCU 1973, p. 21, pl. 1, figs. 1-6.--GEROCH 1960, p. 44, pl. 3, figs. 4-7.

Hormosina velascoensis (Cushman).--NEAGU 1970, p. 35, pl. 2, fig. 16.

Reophax velascoensis (Cushman).--HEMLEBEN and TROESTER 1984, p. 521, pl. 2, fig. 12.

Test large, finely agglutinated, often compressed. Cushman (1926) refers to this form as "chitinous" but the nature of the test wall needs to be resolved. More common in non-calcareous shales. Cushman's slides of *N. velascoensis* from Trinidad also contain specimens of *Hyperammina dilatata, Hormosina ovuloides, H. ovulum*, and *Reophax scalaria.*

Reophax duplex Grzybowski
Plate 2, figure 15

Reophax duplex GRZYBOWSKI 1896, pp. 276-277, pl. 8, figs. 23-24.--JURKIEWICZ 1967, pp. 50-51, pl. 1, fig. 27; textfigure 5a-h.--SAMUEL 1977, p. 34, pl. 3, fig. 3.--LISZKA and LISZKOWA 1981, p. 167, pl. 1, fig. 12.

Test large, comprised of two embracing chambers of unequal size. Grzybowski's specimens of *R. duplex* are smaller and possess a rather coarse wall, but also include forms with a finely agglutinated wall under this name.

Reophax globosus Sliter
Plate 3, figure 4

Reophax globosus SLITER 1968, p. 43, pl. 1, fig. 12.

Test of medium size, built of 5-7 embracing chambers. Aperture terminal, without a neck. Wall coarse. This form resembles the Recent species *R. regularis* Höglund.

Reophax subfusiformis Earland, emend Höglund.
Plate 2, figures 18-19.

Reophax subfusiformis Earland, emend HÖGLUND 1947, p. 82, figs. 43-50.--GRADSTEIN and BERGGREN 1981, p. 248, pl. 2, figs. 8,9.--VERDENIUS and VAN HINTE 1983, p. 191, pl. 4, fig. 6.

Test small, with fusiform last chamber. Wall medium grained. Rare.

Reophax sp. 2
Plate 3, figures 2-3

aff. *Reophax splendidus* Grzybowski.--JEDNOROWSKA 1968, p. 45, pl. 1, figs. 3, 4. aff. *Reophax troyeri* TAPPAN 1960, p. 291, pl. 1, fig. 12.

Test small, elongate, comprised of 4-5 chambers, partially embracing, gradually increasing in size. Aperture on a short neck. Wall finely agglutinated, test often compressed. Specimens from Lizard Springs resemble *R. splendidus* Grzybowski figured by Jednorowska (1968) or *Hormosina glabra* Cushman and Stainforth (1945) from the Cipero marl of Trinidad in the shape of the chambers, but differ in possessing a well-developed apertural neck, as in *R. troyeri.*

Subreophax pseudoscalaria Samuel
Plate 3, figures 5-6

Reophax pseudoscalaria SAMUEL 1977, p. 36, pl. 3, fig. 4a-b.

Robust fragments of up to 8 chambers, usually deformed. Chambers are larger and more embracing than in *S. scalaria.*

Subreophax scalaria (Grzybowski)
Plate 2, figures 16-17

Reophax guttifera Brady var. *scalaria* GRZYBOWSKI 1896, p. 277, pl. 8, fig. 26.

Reophax guttifera scalaris Grzybowski.--JURKIEWICZ 1967, pp. 47-48, pl. 1, fig. 25.

Reophax scalaris Grzybowski.--HEMLEBEN and TROESTER 1984, p. 521, pl. 2, figs. 10-11.

Reophax? sp. CUSHMAN and RENZ 1946, p. 14, pl.1, fig. 14.

Reophax splendidus Grzybowski.--GLAESSNER 1937, p. 356, pl. 1, fig. 4.--MASLAKOVA 1955, p. 39, pl. 1, fig. 7.

Reophax scalaria Grzybowski.--SAMUEL 1977, pp. 35-36, pl. 3, fig. 6a-b; pl. 19, fig. 4.--LISZKA and LISZKOWA 1981, pp. 168-169, pl. 1, fig. 15.

Test comprised of numerous disc-shaped, partially embracing chambers, slowly increasing in size. The test is often not rectilinear, but bent or curved as in *S. adunca* (Brady). Specimens of *Reophax scalaria* in the Cushman Collection were found in a slide labeled "*Ammobaculites coprolithiforme*" (C.C. 12611) from the "Hobson Clay" of Trinidad.

Superfamily LITUOLACEA de Blainville 1827

Ammobaculites jarvisi Cushman and Renz
Plate 4, figure 4

Ammobaculites jarvisi CUSHMAN and RENZ 1946, p. 46, pl. 19, fig. 6.--HUSS 1966, pl. 5, figs. 9-10.

Test very large, coarsely agglutinated, with 3 or 4 chambers in planispiral portion and up to 4 chambers in the uniserial part. Test is often deformed.

Ammobaculites sp. 1
Plate 4, figures 1-2

aff. *Ammobaculites agglutinans filiformis* Earland.--JURKIEWICZ 1967, pp. 81-82, pl. 5, fig. 4.

Test consists of a somewhat evolute planispiral part with 5-6 chambers followed by a uniserial portion of up to 5 globular chambers. Wall medium to finely agglutinated, finely finished. In overall morphology, this species resembles *A. midwayensis* Plummer or specimens of *A. fragmentaria* Cushman from the Bonham Clay of Texas (C.C. 26829), but differs in possessing a more finely agglutinated wall with much cement.

Ammobaculites sp. 2
Plate 4, figure 3

Ammobaculites coprolithiformis (Schwager).--CUSHMAN and RENZ 1946, p. 19, pl. 2, fig. 6.

Test robust, with thick wall. Initial planispiral part consists of 4 chambers, uniserial portion of up to 4 chambers, about the same diameter as the planispiral part, with parallel sides. This species differs markedly from the neotype of *Haplophragmium coprolithiforme coprolithiforme* erected by Lindenberg (1967) from the Middle Jurassic of southwest Germany. Lindenberg (1967) refers to Cushman's specimens from Lizard Springs as "*Ammobaculites*? sp."

Ammobaculites sp. 3
Plate 4, figures 5-7

Ammobaculites sp. cf. *A. americanus* Cushman.--KAMINSKI 1985, pl. 1, fig. 3.

Discammina compressa (Goes).--SCHRODER 1986, pl. 17, figs. 17-18.

Test large, evolute planispiral with 2 1/2 whorls and 8-11 chambers in the last whorl. Chambers increase in size slowly, and a short, narrow, uniserial part is occasionally present. Wall is fine to coarse. Specimens from turbidite clays are more coarsely agglutinated. This species bears closest resemblance to the recent species of *Ammobaculites* described by Schröder (1986) as *Discammina compressa* from the Continental Rise off Nova Scotia. Differs from *A.* cf. *fontinensis* illustrated by Geroch (1960) in the thinner, more evolute test and more numerous chambers.

Budashevaella cf. *multicamerata* (Voloshinova and Budasheva)
Plate 5, figure 1a-b; plate 10, figure 1a-b

Circus multicameratus VOLOSHINOVA and BUDASHEVA 1961, p. 201, pl. 7, figs. 6a-c; pl. 8, figs. 1a-c, 7.

Budashevaella multicamerata (Voloshinova and Budasheva).--McDOUGALL 1980. pl. 3, figs. 4-5.--VERDENIUS and VAN HINTE 1983, p. 195, pl. 7, figs. 3, 4, 8-10.

Test large, coarsely agglutinated, with streptospiral initial portion and evolute planispiral latter portion. Ten chambers in the last whorl. Aperture a basal slit.

Budashevaella trinitatensis (Cushman and Renz)
Plate 5, figure 2a-b; plate 10, figures 2-3

Haplophragmoides flagleri Cushman and Hedberg var. *trinitatensis* CUSHMAN and RENZ 1946, p. 18, pl. 2, figs. 2, 3.

Test large, finely agglutinated, somewhat more involute than *B. multicamerata*, with fewer chambers in the last whorl. Sutures appear broad when well preserved, slightly depressed. Holotype of *B. trinitatensis* (C.C. 46506) has 8 1/2 chambers in the last whorl. Paratypes (C.C. 46508) have 6 1/2 to 7 1/2 chambers, and show a slight tendency towards streptospirality.

Cribrostomoides trinitatensis Cushman and Jarvis
Plate 6, figures 1a-3

Cribrostomoides trinitatensis CUSHMAN and JARVIS 1928, p. 91, pl. 12, figs. 12a-b.

Cribrostomoides cretacea Cushman and Goudkoff 1944.--HANZLIKOVA 1972, p. 42, pl. 6, fig. 1.

Cribrostomoides subglobosus (G.O. Sars).--JEDNOROWSKA 1968, pp. 49-50, pl. 5, fig. 1a-c.

Test large, finely agglutinated, with 6-7 chambers in the last whorl. Apertural face low, aperture consisting of a number of low openings at the base of the last chamber. Coiling is involute, but large specimens display a slight tendency towards streptospirality.

Cushman and Jarvis' (1932) figure of the holotype (C.C. 9728) shows high, triangular apertural openings. These are, in fact, dark colored grains. Well preserved specimens display low, broad openings. Cushman and Renz's plesiotype slide (C.C. 46510) contains specimens of *Haplophragmoides suborbicularis* (with a slit-like aperture) as well as

Recurvoides imperfectus (with an oval aperture) along with specimens of *C. trinitatensis*.
In our material, deformed or poorly preserved specimens show no distinct apertural pores, and are difficult to distinguish from *H.* ex gr. *suborbicularis*.

Haplophragmoides cf. *glabra* Cushman and Waters
Plate 5, figures 3-4

aff. *Haplophragmoides glabra* CUSHMAN and WATERS 1927, p. 83, pl. 10, figs. 6a-b.
Haplophragmoides glabra Cushman and Waters.--CUSHMAN and JARVIS 1928, p. 18, pl. 2, fig. 1.
Test involute, finely agglutinated, with 6 chambers in the last whorl. Sutures straight, flush with the surface of the test.

Our specimens correspond to those labeled *H. glabra* in Cushman's collection from Lizard Springs. These differ from the holotype from the Navarro Formation in possessing a more finely agglutinated test and fewer chambers in the last whorl (the holotype has 9). These specimens may be an early variety of *H. walteri* (Grzybowski), since they resemble a juvenile form of that species.

Haplophragmoides horridus (Grzybowski)
Plate 5, figure 11a-b

Haplophragmium horridum GRZYBOWSKI 1901, pp. 54-55, pl. 7, fig. 12.
Haplophragmoides horridus (Grzybowski).--JURKIEWICZ 1967, pp. 74-75, pl. 4, fig. 3.--JEDNOROWSKA 1975, p. 48, pl. 5, fig. 1a-b.--SAMUEL 1977, p. 39, pl. 29, fig. 1.
Test large, involute, with 4 - 4 1/2 triangular chambers in the last whorl. Wall coarsely agglutinated. Rare.

Haplophragmoides lamella (Grzybowski)
Plate 5, figures 5-6b

Trochammina lamella GRZYBOWSKI 1898, p. 34, pl. 11, fig. 25.--SAMUEL 1977, p. 51, pl. 26, figs. 5-6.
Haplophragmoides lamella (Grzybowski).--JURKIEWICZ 1967, p. 74, pl. 4, fig. 2.
--JEDNOROWSKA 1968, p. 47, pl. 4, figs. 1a-b, 2.
Test small, slightly evolute, lobate, with 4 globular chambers in the last whorl. Sutures depressed; wall finely agglutinated. Test is often compressed. Uncompressed specimens have an open umbilicus, however, compressed specimens appear involute, and closely resemble Grzybowski's figure.

H. decussatus Krashenninikov differs in its smaller size and more involute coiling. *H. kirki* Wickenden differs in possessing less globular chambers, and a more involute test with a quadrate outline.

Haplophragmoides porrectus Maslakova.
Plate 5, figures 7-8

Haplophragmoides mjatliukae Maslakova.--JEDNOROWSKA 1968, p. 47, pl. 4, fig. 3a-c.
Haplophragmoides porrectus MASLAKOVA 1955, pp. 47-48, pl. 3, figs. 5-6. --SAMUEL 1977, p. 41, pl. 6, fig. 3a-b.
Test finely agglutinated, with 5 1/2 subglobular chambers in the last whorl. Sutures thin, depressed, straight. Umbilicus open. Test is often compressed in any plane. First described from the Paleocene of the Ukrainian Carpathians (Maslakova, 1955).

Haplophragmoides retroseptus (Grzybowski)
Plate 5, figures 9a-10b

Cyclammina retrosepta GRZYBOWSKI 1896, p. 284, pl. 9, figs. 7-8.
Haplophragmoides retrosepta (Grzybowski).--HILLEBRANDT 1962, p. 27, pl. 1, fig.2a-b.
Recurvoides retroseptus (Grzybowski).--JEDNOROWSKA 1975, pp. 49-50, pl. 5, fig. 3a-b.
Haplophragmoides retroseptus (Grzybowski).--HANZLIKOVA 1972, p. 41, pl. 5, fig. 5.
Test large, coarsely agglutinated, with 5-6 chambers in the last whorl. Uniumbilicate, with coil suture. Differs from *H. suborbicularis* in its more compressed test and slightly asymmetric coiling in later chambers.

Although the holotype of *H. retroseptus* from Wadowice (Grzybowski, 1896) is missing, specimens from the Grzybowski Collection of Gorlice (Grzybowski, 1901) correspond closely to our material.

Haplophragmoides ex gr. *suborbicularis* (Grzybowski)
Plate 5, figures 12-13b

Cyclammina suborbicularis RZEHAK 1887, p. 68. (nomen nudum)
Cyclammina suborbicularis Rzehak.--GRZYBOWSKI 1896, p. 24, pl. 9, figs. 5-6.
Haplophragmoides suborbicularis suborbicularis (Grzybowski).--JURKIEWICZ 1967, p. 77, pl. 4, figs. 12-13.
Cribrostomoides? ex gr. *suborbicularis* (Grzybowski).--MJATLIUK 1970, pp. 76-77, pl. 18, fig. 3a-b.
Haplophragmoides (Cribrostomoides) suborbicularis (Grzybowski).--LISZKA and LISZKOWA 1981, pp. 176-177, pl. 3, fig. 2a-3b.
Haplophragmoides suborbicularis (Grzybowski).--GEROCH 1960, pl. 5, fig. 1a, b.--JEDNOROWSKA 1968, p. 48, pl. 5, fig. 4a-c.--SAMUEL 1977, p. 41, pl. 6, figs. 5a-b.
Test large, involute, much inflated, with 6 chambers in the last whorl. Wall coarse, but finely finished. Aperture an areal slit near the base of the last chamber, seldom well preserved. Specimens of *H.* ex gr. *suborbicularis* in the Grzybowski Collection from Wadowice are smaller in size, coarsely agglutinated, and possess a poorly visible, eliptical aperture.
Recent specimens of *"Cribrostomoides" subglobosus* have an oval, areal aperture (Kaminski, 1983; pl. 8, fig. 3) and correspond to forms described as *Cribrostomoides* sp. A from the North Sea (Gradstein and Berggren, 1981, pl. 6, fig. 12).

Haplophragmoides walteri (Grzybowski)
Plate 5, figures 14-15

Trochammina walteri GRZYBOWSKI 1898, p. 290, pl. 11, fig. 31.
Trochammina tenuissima GRZYBOWSKI 1898, p. 290-291, pl. 11, fig. 30.
Haplophragmoides excavata Cushman and Waters.--CUSHMAN and JARVIS 1932, p. 12, pl. 3, fig. 1.
Haplophragmoides grzybowskii MJATLIUK 1950, p. 268, pl. 1, figs. 9-10. Asanospira grzybowskii (Mjatliuk).--MJATLIUK 1970, pp. 77-78, pl. 17, figs. 3-4b.
Asanospira walteri (Grzybowski).--MJATLIUK 1970, pp. 78-79, pl. 19, figs. 5a-7; pl. 20, figs. 1a-2b.
Haplophragmoides walteri (Grzybowski).--GLAESSNER 1937, p. 12, pl. 1, fig. 11.
--GEROCH 1960, pp. 49-50, pl. 5, fig. 5.--GRADSTEIN and BERGGREN 1981, pp. 250-252, pl. 6, figs. 5-7.--MILLER ET AL. 1982, p. --VERDENIUS and VAN HINTE 1983, pp. 192-193, pl. 5, figs. 1-2.
Test planispiral, compressed, with circular outline and 8 or more chambers in the last whorl. Wall finely agglutinated.

H. excavata differs in its more inflated, evolute test and coarser, poorly sorted agglutinated material incorporated in the wall. The holotype of *H. excavata* is missing from the Cushman Collection, but enough paratypes exist to distinguish this species from *H. walteri*. *H. excavata* is described in detail by Mello (1971) as *H. excavata excavata*.

Haplophragmoides(?) *jarvisi* (Thalmann)
Plate 7, figures 1a-2b; plate 10, figures 8-9

Nonion cretaceum CUSHMAN and JARVIS (1932), p. 41, pl. 12, figs. 12a-b.
Nonion jarvisi THALMANN 1932, p. 313.
This species has a finely agglutinated, silicified wall and should be removed from the family Nonionidae. It is distinguished by its very limbate sutures and irregularly shaped umbilical lobes that end in a blind canal which appears on the surface as a glassy elevated area. The apertural face contains coarser agglutinated grains, as in many species of *Cyclammina*, but there is no evidence of alveoles or supplementary apertures. These features are probably of generic significance and a new genus may need to be erected.

This species probably evolved from an early form of *H. walteri* in P 4 time, since transitional forms were found. Specimens from Trinidad are larger than those from the North Sea, where it ranges into the Middle Eocene (Gradstein *et al.* this volume).

Labrospira pacifica Krashenninikov
Plate 4, figure 11

Labrospira pacifica KRASHENNINIKOV 1973, p. 209, pl. 2, fig. 4a, b.
Labrospira cf. *pacifica* Krashenninikov.--GEROCH and NOWAK 1984, pl. 1, figs. 22-23.
Test small, finely agglutinated, involute planispiral, with 3 chambers in the last whorl and a slit-like aperture surrounded by a lip. Specimens are compressed in any plane. Sutures are straight and flush with the surface of the test.

Lituotuba lituiformis (Brady)
Plate 4, figures 14-15

Trochammina lituiformis BRADY 1879, p. 59, pl. 5, fig. 16.
Lituotuba lituiformis (Brady).--CUSHMAN and JARVIS 1928, p. 90, pl. 12, fig. 15a-b.
Trochamminoides lituiformis (Brady).--JURKIEWICZ 1967, pp. 65-67, pl. 3, figs. 2-3; textfigure 12a-g.
Test with an irregularly coiled initial portion and an uncoiling later part, often compressed. More common in the noncalcareous shales.

Phenacophragma beckmanni Kaminski and Geroch
Plate 4, figures 8-9; plate 10, figures 6-7

Ammomarginulina sp. A.--BECKMANN 1960, fig. 2.
aff. *Ammomarginulina stephensoni* (Cushman).--WEBB 1975, p. 835, pl. 2, fig. 17. aff. *Alveophragmium planum* BYKOVA 1939, p. 20, pl. 1, fig. 10, textfigure 1a-b. *Phenacophragma beckmanni* KAMINSKI and GEROCH (1987), p. 98, pl. 1, figs. 1-7, textfigures 1-4.
Test large, comprised of an evolute planispiral coil of 2 whorls with 8 chambers in the last whorl, followed by a short uniserial part of up to 3 chambers, when present. Aperture basal in early chambers, later indistinct, probably areal. Test is strongly compressed, carinate, coarsely agglutinated. In later chambers short hemiseptae extend into the chambers from the sutures and periphery.

Phenacophragma elegans Kaminski
Plate 4, figure 10; plate 10, figures 10-13

Phenacophragma elegans KAMINSKI and GEROCH (1987), p. 99, pl. 1, figs. 8-14, textfigures 5-8.
Test thin, finely agglutinated, with evolute planispiral part consisting of 3 whorls with 11 chambers in the last whorl, and a uniserial part of 3 chambers, when present. In later chambers short hemiseptae extend into the chambers from the periphery.

Recurvoides deflexiformis (Noth)
Plate 6, figure 3a-b; plate 10, figure 15a-b

Trochammina deflexiformis NOTH 1912, p. 14, pl. 1, fig. 10.
Recurvoides deflexiformis (Noth).--GEROCH 1960, p. 52, pl. 5, fig. 6.--JURKIEWICZ 1967, p. 79, pl. 4, fig. 15.--HANZLIKOVÁ 1972, p. 42, pl. 6, figs. 2-3.--VERDENIUS and VAN HINTE 1983, p. 193, pl. 5, fig. 5. cf. *Recurvoides globosus* JEDNOROWSKA 1968, pp. 50-51, pl. 4, fig. 5a-c; pl. 15, figs. 1-5.
Test subspherical, initially densely streptospiral, but the last whorl is nearly planispiral. 8-9 chambers in the peripheral whorl. Chambers oval with thick intercameral sutures, flush with the surface of the test. Coiling direction changes abruptly.

Recurvoides gerochi Pflaumann
Plate 6, figure 7

Recurvoides sp. 1.--GEROCH 1960, p. 52, pl. 3, fig. 13.

Recurvoides gerochi PFLAUMANN 1964, pp. 102-104, pl. 14, fig. 1a-d.

Recurvoides gerochi Pflauman (non Hanzlikova).--HANZLIKOVA 1972, p. 43, pl. 4, figs. 4-6.

cf. *Recurvoides varius* MJATLIUK 1970, pp. 81-82, pl. 6, figs. 24-25; pl. 20, figs. 5a-10b; pl. 21, fig. 2; pl. 22, fig. 1a-b; pl. 27, fig. 2.

Test finely to moderately coarsely agglutinated, with spherical chambers arranged in evolute, irregularly streptospiral coils. Approximately 6 chambers in the last whorl; due to abrupt changes in coiling direction 2 or 3 coils visible on the exterior of the test.

Our specimens tend to be slightly smaller and more finely finished than the type specimens from the Paleocene Cieçżkowice Beds of Poland. Differs from *R. deflexiformis* in its smaller size and more irregular, evolute coiling.

Recurvoides sp. 1
Plate 6, figure 4a-b

cf. *Cyclammina globulosa* GRZYBOWSKI 1896, p. 285, pl. 9, fig. 10.

cf. *Recurvoides globulosus* (Grzybowski).--HANZLIKOVA 1972, p. 43, pl. 6, fig. 7.

Test subspherical, finely to moderately coarsely agglutinated, streptospiral with axis of coiling changing regularly. 5-6 chambers in the last whorl, with 7-8 chambers visible from the exterior. Apertural face high, with areal aperture.

Recurvoides imperfectus Hanzlikova
Plate 6, figures 5-6; plate 10, figures 4a-c

Recurvoides imperfectus HANZLIKOVA 1953, pl. 9, fig. 1 (nomen nudum)

Haplophragmoides imperfectus (Hanzlikova).--HANZLIKOVA 1965, p. 38, fig. 7.

Recurvoides imperfectus HANZLIKOVA 1966, pp. 111-112, pl. 5, figs. 1-8.--GEROCH 1966, pp. 443-444, pl. 10, figs. 4-5.--SAMUEL 1977, pp 42-43. textfigure 1c.

Test large, subspherical, involute, with 11-13 chambers in the last whorl. Wall finely agglutinated, finely finished. Aperture oval, at base of the last chamber. Axis of coiling changes regularly.

Recurvoides cf. *subturbinatus* (Grzybowski)
Plate 6, figures 8a-9b

Haplophragmium subturbinatum GRZYBOWSKI 1898, p. 280, pl. 10, fig. 23.

cf. *Thalmannammina subturbinata* (Grzybowski).--POKORNY 1951, p. 469, figs. 1-3.--HANZLIKOVÁ 1972, pp. 43-44, pl. 7, fig. 5.--SAMUEL 1977, pp. 43-44, pl. 27, fig. 3.

Test finely agglutinated, involute, with 3-4 chambers in the last whorl, 5 chambers visible from the exterior. Test is often flattened. Carpathian forms are slightly larger and display 6-9 chambers in the last whorl. This species was designated the genotype of *Thalmannammina*, which is probably synonymous with *Recurvoides*.

Recurvoides sp. 2 (Grzybowski)
Plate 6, figures 10a-11b

aff. *Recurvoides anormis* MJATLIUK 1970, pp. 84-85, pl. 18, fig. 4; pl. 19, figs. 1-4.

Recurvoides ex gr. *walteri* (Grzybowski).--GRADSTEIN and BERGGREN 1981, p. 253, pl. 7, figs. 5-7.

Test large, coarsely agglutinated, streptospiral with 5-6 chambers in the last whorl, and chambers increasing rapidly in size. Aperture oval, near the base of the last chamber. Axis of coiling changes regularly. The species *Recurvoides walteri* from the Grzybowski Collection differs in possessing a finer wall, and chambers which increase in size more slowly. Mjatliuk (1970) provides an emended description of *R. walteri*. Differs from *Recurvoides* sp. 1 in its more involute coiling and larger size.

Sphaerammina gerochi Hanzlikova
Plate 4, figures 12-13; plate 10, figure 16a-b

Sphaerammina gerochi HANZLIKOVA 1972, p. 45, pl. 8, figs. 4-7.

Cystammina subgaleata Vasicek.--GEROCH 1960, p. 67, pl. 2, figs. 13-17.

Test planispiral, finely agglutinated, with final chamber almost completely embracing preceding whorls. Aperture areal, often indistinct.

Trochamminoides dubius (Grzybowski)
Plate 4, figures 16-17

Ammodiscus dubius GRZYBOWSKI 1901, p. 274, pl. 8, figs. 12, 14.

cf. *Ammodiscus septatus* GRZYBOWSKI 1898, p. 283, pl. 11, fig. 1.--JURKIEWICZ 1967, p. 58, pl. 2, fig. 22.

Trochamminoides velascoensis Cushman.--HANZLIKOVA 1972, p. 44, pl. 8, fig. 3.

Trochamminoides dubius (Grzybowski).--NEAGU 1970, p. 38, pl. 2, fig. 20.

Test round, flattened, comprised of 4 whorls, with 4 1/2 chambers in the last whorl. Finely agglutinated.

Trochamminoides irregularis White
Plate 4, figure 18

Trochammina acervulata Grzybowski.--FRIEDBERG 1901, pl. 1, fig. 9a-b

Trochamminoides acervulatus (Grzybowski).--JURKIEWICZ 1967, pp. 72-73, pl. 4, fig. 1; textfigure 15a-e.

Haplophragmoides coronata (Brady).--CUSHMAN and JARVIS 1928, p. 90, pl. 12, fig. 17.--CUSHMAN and JARVIS 1932, p. 11, pl. 2, figs. 13-15.

Trochamminoides irregularis WHITE 1928b, p. 307, pl. 42, fig. 1.--GLAESSNER 1937, p. 360, pl. 1, fig. 9a-b.--HANZLIKOVA 1972, p. 44, pl. 8, fig. 1.

Test consists of large, flattened chambers coiled in an irregular manner. Shape of the test is variable due to compaction.

White's specimens of *T. irregularis* from the Velasco Shale are crushed and poorly preserved. White apparently included planispiral forms in his species concept since the type slide also contains a specimen of *T. subcoronatus*.

Trochamminoides subcoronatus (Grzybowski)
Plate 4, figure 19

Trochammina subcoronata GRZYBOWSKI 1896, pp. 283-284, pl. 9, fig. 3a-c. --GRZYBOWSKI 1898, p. 287, pl. 11, fig. 11.
Trochammina contorta GRZYBOWSKI 1898, p. 287, pl. 11, figs. 12-14.
Trochamminoides coronatus (Brady).--JURKIEWICZ 1967, pp. 67-68, pl. 3, figs. 4, 5, 10; textfigure 13.
Haplophragmoides coronatus (Brady).--HUSS 1966, pp. 24-25, pl. 4, figs. 1-10.
Trochamminoides contortus (Grzybowski).--JURKIEWICZ 1967, p. 68, pl. 3, fig. 6.
Trochamminoides subcoronatus (Grzybowski).--JURKIEWICZ 1967, pp. 71-72, pl. 3, fig. 15; textfigure 14.
Test large, finely agglutinated, made up of globular chambers in an evolute planispire. Often flattened.

Trochamminoides proteus (Karrer)
Plate 4, figure 20

Trochammina proteus KARRER 1866, pl. 1, fig. 8
Trochamminoides proteus (Karrer).--WHITE 1928b, p. 308, pl. 42, fig. 2. --SAMUEL 1977, pp. 46-47, pl. 5, fig. 5a-b.
Test large, comprised of 3-4 whorls with 7-9 chambers in the last whorl. We follow White's (1928) definition of the species.

Differs from *Trochamminoides elegans* (Grzybowski) in possessing fewer, more elongated chambers that are usually flattened.

Superfamily LOFTUSIACEA Brady, 1884

Reticulophragmium cf. *garcilassoi* (Frizzel)
Plate 7, figures 3-5b, Plate 10, figure 5

aff. *Cyclammina garcilassoi* FRIZZEL 1943, p. 338, pl. 55, fig. 11.
Cyclammina cf. *garcilassoi* Frizzel.--CUSHMAN and RENZ 1946, p. 19-20, pl. 2, fig. 11.
Test large, evolute, with straight sutures, excavate umbilicus and subacute periphery, finely agglutinated. Two morphotypes are discernable in our material, both of which were called *Cyclammina* cf. *garcilassoi* by Cushman. The taxonomy of the early cyclamminids is still uncertain, therefore, in this study we have elected to follow Cushman's terminology for Lizard Springs pending a more complete revision of this group.

Paleocene specimens of *R.* cf. *garcilassoi* possess about 8 chambers in the last whorl and have alveolar structures concentrated at the sutures and along the peripheral margin. Alveoles near the sutures appear elongated. This morphotype resembles *R. paupera* from the Paleocene of the North Sea. Specimens from the Early Eocene are more inflated, biumbilicate, have more chambers, more evenly distributed alveoles and a distinct *Reticulophragmium*-type aperture, with coarser grains in the apertural face. In peripheral view, this morphotype bears resemblance to *R. amplectens* (Grzybowski), but differs in possessing a deep, evolute, open umbilicus.

The holotype of *C. garcilassoi* differs in its larger size, more sinuous sutures, and in possessing alveoles that are evenly distributed on the chamber walls. The holotype is more involute and has a tendency to evolute development only in the final chambers.

Superfamily SPIROPLECTAMMINACEA Cushman 1927

Spiroplectammina sp. aff. *S. dentata* (Alth)
Plate 7, figures 10-11

cf. *Textularia dentata* ALTH 1850, p. 262, pl. 13, fig. 13 (macrospheric form) cf. *Spiroplectammina dentata* (Alth).--CUSHMAN 1932, p. 91, pl. 11, fig. 7a-b (microspheric form).
Macrospheric forms consist of an initial spire of 5 chambers, followed by a biserial part of around 12 chambers. Microspheric forms are less abundant, are larger and contain 20 or more chambers. Occurs in redeposited intervals in well G-287.

The designation *S. dentata* has been widely used in flysch-type faunas, however, the usage of this name ought to be restricted to morphotypes as found in the Maastrichtian marls from Lwow. Alth (1850) illustrated only a macrospheric individual, but both forms co-occur in our topotype material from Lwow. Since the Alth collection no longer exists, Cushman's specimen from the Lwow Marl ought to be designated a neotype.

Spiroplectammina excolata (Cushman)
Plate 7, figure 12

Textularia excolata CUSHMAN 1926, p. 585, pl. 15, fig. 9a-b.--GLAESSNER 1937, pl. 2, fig. 1.
Spiroplectammina subhaeringensis (Grzybowski).--SZCZECHURA and POZARYSKA 1974, pp. 31-32, pl. 3, fig. 17.--TJALSMA and LOHMANN 1983, p. 20, pl. 2, fig. 3.
Spiroplectammina excolata (Cushman).-CUSHMAN 1946, p. 27, pl. 5, figs. 9a-b, 10a-b.--HILLEBRANDT 1962, pp. 29-30, pl. 3, figs. 16-17.--HOFKER 1966, p. 306, pl. 66, figs. 7-8.--BECKMANN ET AL. 1982, p. 119, pl. 6, fig. 21.
S. excolata is characterised by its broad and thick test, smooth finish, thick and raised sutures.
Test is often flattened. This species resembles *S. subhaeringensis* (Grzybowski) from the upper Senonian of the Carpathian flysch, but differs in its thinner wall, finer finish, and in possessing steeper, more irregular sutures in adult individuals.

Spiroplectammina navarroana Cushman
Plate 7, figures 13-15

Spiroplectammina navarroana CUSHMAN 1932, pp. 96-96, pl. 11, fig. 14. --GRADSTEIN and BERGGREN 1981, p. 260, pl. 3, figs. 11-12.

Textularia concinna Reuss.--CUSHMAN and JARVIS 1928, p. 91, pl. 13, fig. 1.

Gaudryina foeda (Reuss).-CUSHMAN and RENZ 1946, pl. 2, fig. 18.

Originally described by Cushman (1932) as possessing a small initial spire followed by a straight biserial part. Cushman's holotype (USNM 371545) and paratype (C.C. 26887) however, are wholly biserial when viewed in a wetting medium in transmitted light. The initial portions of both specimens appear to be broken off.

Specimens from Lizard Springs are more elongate, possessing a greater number of chambers than Cushman's specimens from the Upper Clay member of the Navarro Formation.

Spiroplectammina spectabilis (Grzybowski)
Plate 7, figures 16-18

Spiroplecta spectabilis GRZYBOWSKI 1898, p. 293, pl. 12, fig. 12.

Spiroplectammina spectabilis (Grzybowski).--KAMINSKI 1984, pl. 1, 2. (with synonymy).

The morphology and synonymy of this species has been extensively rewiewed by Hiltermann (1974) and Kaminski (1984). Specimens from Lizard Springs are relatively small, thin, and finely finished.

Superfamily TROCHAMMINACEA Schwager 1877

Ammosphaeroidina pseudopauciloculata (Mjatliuk)
Plate 8, figures 3a-5

Trochammina pauciloculata Brady.--GRZYBOWSKI 1896, p. 283, pl. 8, figs. 51-52.

Cystamminella pseudopauciloculata MJATLIUK 1966, p. 264, pl. 1, figs. 5a-7b; pl. 2, fig. 6; pl. 3, fig. 3, (with synonyms).--MJATLIUK 1970, p. 104, pl. 15, fig. 6; pl. 30, figs. 10a-14b.

Specimens from Lizard Springs are 3 or 4 chambered, finely finished, and commonly compressed. Aperture indistinct, probably basal.

The genus *Cystamminella* Mjatliuk 1966 was distinguished by its siliceous wall, and is considered here to be a junior synonym of *Ammospheroidina*. This species was recognised by P.W. Jarvis, who assigned it the field name "Haplophragmoides 25". Specimens of *A. pseudopauciloculata* were found in a slide containing paratypes of *Trochammina altiformis* in the Cushman Collection (C.C. 46565). The specimen labeled *Trochammina pauciloculata* in the collection of J. Grzybowski is slightly coarser-grained than our specimens from Lizard Springs, but is morphologically identical.

Conotrochammina whangaia Finlay
Plate 7, figures 19-20b

cf. *Trochammina* sp. A.--BECKMANN 1960, fig.

Conotrochammina whangaia FINLAY 1940, p. 448, pl. 62, figs. 1-2.--WEBB 1975, p. 835, pl. 3, figs. 5-6.

Test is medium grained, coiled in a high trochoid spire of 3-4 whorls. Sutures flush with the surface of the test, visible only in exceptionally well-preserved specimens. 4 chambers visible on the umbilical side. Umbilicus open; aperture a round areal opening in the center of the apertural face. Our specimens from the Danian most closely resemble Finlay's forms. This species is diagnostic for the Paleocene of New Zealand (Webb 1975). A morphotype with a deeper, more open umbilicus occurs in the *Planorotalites pseudomenardii* zone of the Lizard Springs Formation. These were called *Trochammina* sp. *A* by Beckmann (1960) and is tentatively placed here in *C. whangaia*.

Trochammina altiformis Cushman and Renz
Plate 8, figures 1a-2b

Trochammina globigeriniformis (Parker and Jones) var. *altiformis* CUSHMAN and RENZ 1946, p. 24, pl. 3, figs. 7-11.

Trochammina globigeriniformis altiformis Cushman and Renz.--HILLEBRANDT 1962, p. 47, pl. 2, fig. 25a-b.

Trochammina cf. *altiformis* Cushman and Renz.--GEROCH 1960, p.65, pl. 7, fig. 3.

Trochammina altiformis Cushman and Renz.--GEROCH 1960, p.64, pl. 6, fig. 12. --JURKIEWICZ 1967, p. 91, pl. 6, fig. 12.--WEBB 1975, p. 835, pl. 3, figs. 7-9.

Distinguished by its large dimensions and high trochoid spire, showing all previous chambers. Large specimens are coarsely agglutinated, compressed in any plane, and occasionally display early whorls darker in color. Small specimens are finely finished. The holotype (C.C. 46567) contains 18 chambers in 4 1/2 whorls, is exceptionally well preserved, and has a smoother test than Cushman and Renz's paratypes (C.C. 46567).

Specimens from the Polish Carpathians and North Sea are smaller and more finely agglutinated.

Trochammina ruthven-murrayi Cushman and Renz
Plate 8, figure 6a-c

Trochammina ruthven-murrayi CUSHMAN and RENZ 1946, pp 24-25, pl. 3, fig. 13.

Trochammina aff. *albertensis* Wickenden.--GRADSTEIN and BERGGREN 1981, p. 258, pl. 9, figs. 1-4.

A high-spired form, comprised of up to 4 whorls, with a shape resembling *Globotruncana contusa*. Specimens from Lizard Springs are identical to those from the Paleocene of the North Sea.

Superfamily VERNEUILINACEA Cushman 1911.

Gaudryina pyramidata Cushman
Plate 8, figure 7

Gaudryina laevigata Franke var. *pyramidata* CUSHMAN 1926, p. 587, pl. 16, fig. 8a-b.
Gaudryina (Pseudogaudryina) pyramidata Cushman.--CUSHMAN and RENZ 1946, p. 21, pl. 2, fig. 21.
Gaudryina carinata Franke.--HANZLIKOVA 1972, p. 51, pl. 11, fig. 4.
Gaudryina pyramidata Cushman.--HILLEBRANDT 1962, p. 35, pl. 1, fig. 34; pl. 15, fig. 8.--SCHREIBER 1980, p. 135, pl. 3, fig. 3.--HEMLEBEN and TROESTER 1984, p. 518, pl. 4, figs. 16-17.
Test is robust, finely agglutinated, rapidly increasing in size. Our specimens correspond closely to Cushman's types from the Lizard Springs Formation.

Gaudryina ex gr. *cretacea* (Karrer)
Plate 9, figure 3

aff *Verneuilina cretacea* KARRER 1870, p. 164, pl. 1, fig. 1.
Gaudryina cretacea (Karrer).--CUSHMAN 1937a, pp. 40-41, pl. 6, figs. 3-9.
We adopt the concept of Cushman (1937a) for this species. Distinctive features are the triangular cross section which often continues into the short biserial part, the curved sutures which are often raised in later chambers, and the coarse, thick wall. Our specimens are finer grained, have a longer triserial portion and lower biserial chambers than Karrer's specimens from the type locality in Leitzensdorf, Austria (C.C. 19534), and more closely resemble specimens from the Senonian of Bavaria (C.C. 19535, C.C. 19263).

Verneuilinoides polystrophus (Reuss)
Plate 8, figure 8

Bulimina polystropha REUSS 1846, p. 109, pl. 24, fig. 53a-b.
Verneuilina polystropha (Reuss).--CUSHMAN and RENZ 1946, p. 20, pl. 2, fig. 16.
Verneuilinoides polystrophus (Reuss).--HANZLIKOVA 1972, p. 54, pl. 13, fig. 7.
Test wholly triserial, coarsely agglutinated, with globular chambers.

Superfamily ATAXOPHRAGMIACEA Schwager,1877

Arenobulimina dorbignyi (Reuss)
Plate 8, figure 9

Bulimina d'orbignyi REUSS 1845, p. 38, pl. 13, fig. 74.
Arenobulimina d'orbignyi (Reuss).--HANZLIKOVA 1972, pp. 55-56, pl. 12, fig. 15. --GRADSTEIN and BERGGREN 1981, p. 261, pl. 5, figs. 5-7.--HEMLEBEN and TROESTER 1984, p. 517, pl. 4, fig. 21.
Test is small, finely agglutinated and finely finished.

Arenobulimina truncata (Reuss)
Plate 8, figure 10

Bulimina truncata REUSS 1845, p. 37, pl. 8, fig. 73.
Arenobulimina truncata (Reuss).---CUSHMAN 1937b, p. 40, pl. 4, figs. 15-16. --NEAGU 1970, p. 44, pl. 8, fig. 3.
Differs from *A. dorbignyi* in its less tapering test, larger chambers, more prominent sutures, and fewer chambers per whorl.

Clavulinoides amorpha (Cushman)
Plate 8, figure 13

Clavulina amorpha CUSHMAN 1926, p. 589, pl. 17, fig. 5.
Tritaxia amorpha (Cushman).--TJALSMA and LOHMANN 1983, p. 20, pl. 1, fig. 5. --DAILEY 1983, pl. 1, fig. 7.
Pseudoclavulina amorpha (Cushman).--CUSHMAN 1946, p. 31, pl. 9, figs. 3,4
A species with a columnar uniserial part.

We placed this form in *Clavulinoides* following the usage of Banner & Desai (1985). Sectioned specimens do not show canaliculi, but our specimens are recrystalized and the primary structure may have been lost.

Clavulinoides aspera (Cushman)
Plate 8, figures 11a-12

Clavulina trilatera CUSHMAN var. *aspera* CUSHMAN 1926, p. 589, pl. 17, fig. 3. --CUSHMAN and JARVIS 1928, p. 93, pl. 13, fig. 5.
Clavulinoides aspera (Cushman).--CUSHMAN 1946, p. 38, pl. 7, figs. 24-30
Tritaxia aspera (Cushman).--TJALSMA and LOHMANN 1983, p. 20, pl. 1, fig. 1. --DAILEY 1983, pl. 1, fig. 8.
Test large, triangular in cross section throughout, coarsely agglutinated.

Clavulinoides globulifera (ten Dam and Sigal)
Plate 8, figures 14-15

Pseudoclavulina globulifera TEN DAM and SIGAL 1950, p. 32, pl. 2, figs. 5-7.
Tritaxia globulifera (ten Dam and Sigal).--TJALSMA and LOHMANN 1983, p. 20, pl. 1, figs. 3-4. --DAILEY 1983, pl. 1, fig. 9.
Test large, with triangular initial portion and globular uniserial chambers.

Clavulinoides paleocenica (Tjalsma and Lohmann)
Plate 9, figure 1

Tritaxia paleocenica TJALSMA and LOHMANN 1983, p. 21, pl. 1, figs. 6-8.
Wholly triserial, triangular test with characteristic rounded aperture surrounded by a thin lip.

The absence of an internal toothplate excludes this species from *Tritaxia*, but whether this form belongs in *Clavulinoides* or *Pseudoclavulina* (sensu Banner and Desai, 1985) is unclear. Our specimens do not display canaliculi or pseudopores, but this may be an artifact of recrystalization.

Clavulinoides trilatera (Cushman)
Plate 9, figure 2

Clavulina trilatera CUSHMAN 1926, p. 588, pl. 17, fig. 2.
Clavulinoides trilatera (Cushman).--CUSHMAN 1946, p. 38, pl. 9, figs. 10-16.
Tritaxia trilatera (Cushman).--BECKMANN 1978, p. 769, pl. 1, fig. 17.--TJALSMA and LOHMANN 1983, p. 21, pl. 1, fig. 2. --DAILEY 1983, pl. 1, fig. 10.
Test small, triangular, tricarinate, with simple aperture and interior. We follow the usage of Banner and Desai (1985) in placing this species in *Clavulinoides*. In our material canaliculi were not present in sectioned specimens, possible due to recrystalization.

Dorothia beloides Hillebrandt
Plate 9, figures 4-5

Dorothia beloides HILLEBRANDT 1962, p. 39, textfigure 3, pl. 2, figs. 8-14; pl. 15, figs. 12-13.
Distinguished by its elongated ovoid shape and long multiserial to irregularly biserial growth stage. Hillebrandt (1962) reports this species from Lizard Springs. Occurs in the upper part of the Lizard Springs Formation.

Dorothia indentata (Cushman and Jarvis)
Plate 9, figures 7-8

Gaudryina indentata CUSHMAN and JARVIS 1928, p. 92, pl. 13, fig. 7.
Marssonella indentata (Cushman and Jarvis).--CUSHMAN 1946, p. 44, pl. 12, figs. 6-7.--SCHREIBER 1980, pp. 140-141, pl. 5, fig. 8.
Easily distinguished from *D. oxycona* by its thin, finely agglutinated wall, concave apertural face, and its tendency to be crushed.

Dorothia oxycona (Reuss)
Plate 9, figure 9

Gaudryina oxycona REUSS 1860, p. 33, pl. 12, fig. 3.--CUSHMAN and JARVIS 1932, p. 18, pl. 5, figs. 1-2
Marssonella oxycona (Reuss) var. *trinitatensis* CUSHMAN and RENZ 1946, pp. 22-23, pl. 2, fig. 29.
Dorothia oxycona (Reuss).--KRASHENNINIKOV and PFLAUMANN 1974, p. 570, pl. 4, figs. 1-2. Marssonella oxycona (Reuss).--CUSHMAN 1946, pp. 43-44, pl. 12, figs. 3-5. --SCHREIBER 1980, p. 141, pl. 6, figs. 5-6. (with synonymy).
Test large, coarsely agglutinated with thick wall, conical in shape, with aperture a deep re-entrant at the base of the last chamber.

Dorothia retusa (Cushman)
Plate 9, figures 6, 11

Gaudryina retusa CUSHMAN 1926, p. 588, pl. 16, fig. 10a-b. --WHITE 1928, p. 313, pl. 42, figs. 8-9. --CUSHMAN and JARVIS 1932, p. 17, pl. 4, figs. 7-10. *Dorothia retusa* (Cushman).--CUSHMAN 1946, p. 46, pl. 13, figs. 1-4. --HILLEBRANDT 1962, p. 41, pl. 1, fig. 31a-b. --JEDNOROWSKA 1975, p. 53, pl. 6, fig. 4.
Test robust with early chambers low, increasing slowly in size, and inflated chambers in the biserial part. Aperture rounded in early part, later an elongate interiomarginal opening. Slides labeled *D. retusa* in the Cushman Collection from the material collected by P.W. Jarvis contain many specimens of *Matanzia varians*. Unfortunately, the plesiotypes of Cushman and Jarvis were not among the specimens in the collection.

Our specimens correspond closely with type specimens of D. *retusa* from the Velasco Shale, though our specimens tend to be larger. *Dorothia pupa* described from the Upper Cretaceous of Germany is a closely related form, and young specimens appear similar to our specimens from Lizard Springs. However, large topotype specimens of *D. pupa* in the Cushman Collection are barrel-shaped, decreasing in diameter distally as first pointed out by Cushman (1937a).

Dorothia cf. *trochoides* (Marsson)
Plate 9, figure 10

Gaudryina crassa Marsson var β. *trochoides* MARSSON 1878, p. 159, pl. 3, fig. 27d-f.
Marssonella sp. A.--BECKMANN 1960, fig. 5.
Dorothia cf. *oxycona* (Reuss).--BECKMANN ET AL. 1982, p. 110, pl. 4, fig. 25.
Gaudryina trochoides Marsson.--WHITE 1928b, p. 314, pl. 42, fig. 11.
Dorothia trochoides (Marsson).--TJALSMA and LOHMANN 1983, p. 12, pl. 2, figs. 5-6.
Small, thick-walled, round in cross-section, with maximum width near the center. Differs from *Dorothia oxycona* in its smaller size, finer finish, and less flairing, barrel-shaped test. Not found crushed.

Eggerella trochoides (Reuss)
Plate 9, figures 12-13

Globigerina trochoides REUSS 1845, p. 36, pl. 12, fig. 32.
Eggerella trochoides (Reuss).--CUSHMAN and RENZ 1946, p. 232, pl. 2, fig. 20.
Test triserial, with globular chambers, finely finished. Rare.

Karreriella coniformis (Grzybowski)
Plate 9, figures 15-16

Gaudryina coniformis GRZYBOWSKI 1898, p. 39, pl. 12, fig. 7.
Plectina? cf. *coniformis* (Grzybowski).--GEROCH 1960, pp. 60-61, pl. 6, fig. 13.
Plectina coniformis (Grzybowski).--SANDULESCU 1973, pp. 38-39, pl. 15, fig. 20.
Karreriella coniformis (Grzybowski).--MJATLIUK 1970, p. 115, pl. 34, figs. 1-9.--SAMUEL 1977, p. 54, pl. 22, fig. 3.--GEROCH and NOWAK 1984, pl. 2, fig. 13.
Test small, barrel-shaped, tapering at both ends, with a short apertural neck. Common in the upper Lizard Springs Formation. H.H. Renz recognised this form, assigning it the field name "Gaudryina 24". The type specimens in the Grzybowski Collection are slightly larger and coarser grained but are otherwise identical.

Karreriella conversa (Grzybowski)
Plate 9, figures 17-18b

Gaudryina conversa GRZYBOWSKI 1901, p. 224, pl. 8, figs. 15-16.

Gaudryina bentonensis (Carmen).--CUSHMAN and RENZ 1946, p. 21, pl. 2, fig. 19.

Karreriella (Karrerulina) aegra FINLAY 1940, p. 451, pl. 62, figs. 21-22, 25-26.

Karreriella indigena MJATLIUK 1970, pp 116-117, pl. 34, figs. 10a-14b.

Karreriella apicularis (Cushman).--GRADSTEIN and BERGGREN 1981, p. 263, pl. 4, figs. 11, 13, 15.

Plectina aff. *conversa* (Grzybowski).--HEMLEBEN and TROESTER 1984, p. 521, pl. 4, fig. 24.

Plectina conversa (Grzybowski).--GEROCH 1960, p. 59, pl. 6, fig. 7. --HANZLIKOVA 1972, p. 59, pl. 13, fig. 14.

Karreriella conversa (Grzybowski).--WEBB 1975, p. 835, pl. 3, fig. 12. --VERDENIUS and VAN HINTE 1983, p. 196, pl. 7, fig. 5.

Test with multiserial initial trochospiral part and twisted biserial latter portion. Often compressed. Although the type specimens of this species are missing from the Grzybowski Collection, we feel this name should be conserved. Our specimens closely resemble those from the Magura Unit at Bartne, Poland (Grzybowski locality 108). *Karreriella conversa* may be a senior synonym to *K. apicularis* (Cushman) which occurs widely in the modern North Atlantic (C. Schröder, personal communication, 1985).

Karreriella horrida Mjatliuk
Plate 9, figures 19-20

Plectina cf. *apicularis* (Cushman).--GEROCH 1960, p. 60, pl. 6, fig. 9.

Karreriella horrida MJATLIUK 1970, pp. 114-115, pl. 5, fig. 9; pl. 33, fig. 15-16c.

Test consists of an initial multiserial part followed by a long triserial part, round in cross-section, with parallel sides. Medium to finely agglutinated. Common in a sample from Zone P4.

Karreriella tenuis (Grzybowski)
Plate 9, figure 21a-b

Gaudryina tenuis GRZYBOWSKI 1898, p. 295, pl. 12, fig. 9-10.

Plectina tenuis (Grzybowski).--JURKIEWICZ 1967, p. 96, pl. 5, fig. 19. --JEDNOROWSKA 1968, p. 61, pl. 8, figs. 5-7.

A thin, minute form with inflated chambers and a finely agglutinated wall. Rare.

Karreriella sp. 2
Plate 9, figure 22

pars *Karreriella pocutica* MJATLIUK 1970, pp. 111-112, pl. 33, fig. 2a-b.

Test small, finely agglutinated, with short multiserial trochospiral portion which increases rapidly in size, and a biserial part of 2-4 chambers. Final 2 chambers are disproportionally large and enveloping. Aperture terminal, a round opening at the end of a short neck.

Matanzia varians (Glaessner)
Plate 9, figure 14a-b; plate 10, figure 14

Textulariella? varians GLAESSNER 1937, p. 366-367, pl. 2, fig. 15.

Matanzia simulans FINLAY 1940a, p. 314, pl. 25, figs. 21-23.

Textulariella trinitatensis CUSHMAN and RENZ 1946, p. 23, pl. 3, figs. 1-3.

Textulariella trinitatensis CUSHMAN and RENZ var. *subcylindrica* CUSHMAN and RENZ 1946, p. 23, pl. 3, fig. 4.

Ramesella mariae VASICEK 1947, p. 246, pl. 2, figs. 14a-b.

cf. *Textulariella cushmani* TEN DAM and SIGAL 1950, pp. 33-34, pl. 2, figs 13a-16.

Textulariella varians Glaessner.--HILLEBRANDT 1962, pp. 45-46, pl. 1, figs. 27-28b; textfigure 4.

Ramesella varians (Glaessner).--BECKMANN ET AL. 1982, p. 118, pl. 6, figs. 37-38.

Matanzia varians (Glaessner).--JURKIEWICZ 1967, pp. 94-95, pl. 5, fig. 17. --HANZLIKOVÁ 1972, p. 61, pl. 12, figs. 10-14.

Test is finely agglutinated and translucent. Longitudinal partitions are clearly visible in wetting medium. Hillebrandt (1962) distinguished a megalospheric A-form (= *Textulariella trinitatensis* var. *subcylindrica*) and a microspheric B-form (= *T. trinitatensis*) of this species.

Specimens from the noncalcareous shales are laterally compressed, and differ from North Sea and Carpathian forms in their fine wall structure and degree of compaction, which is negligable in other regions.

Superfamily TEXTULARIACEA Ehrenberg 1839

Textularia sp.
Plate 9, figure 23

Textularia sp. CUSHMAN and RENZ 1946, p. 20, pl. 2, fig. 14.

A coarsely agglutinated form with a flairing test comprised of 5 or 6 pairs of chambers. Always flattened. Rare.

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Appendix-Table 1.
Abundance Data from well G-287.

DEPTH in well G-287:	3207		3232		3237		3246		3266		3270		3274		3306		3311		3316		3320		3350		3355		3362	
	3205	3210	3234	3240	3248	3268	3272	3276	3309	3314	3318	3348	3353	3359	3364													
Bathysiphon sp.	7	9	1	5	20	15	13	28	7	20	6	7	7	8	5	22	7	0	3	16	10	13	0	3	1	6	1	0	0
Rhabdammina ex gr. discreta	0	4	3	4	1	1	5	5	6	4	0	3	6	7	7	1	5	0	17	4	4	4	13	15	7	5	3	2	10
Dendrophrya ex gr. excelsa	84	96	66	53	84	91	87	76	52	24	82	77	72	43	28	15	8	13	22	22	15	42	68	32	58	14	31	16	37
Dendrophrya latissima	20	0	0	5	1	0	2	11	0	4	0	10	3	4	0	0	4	0	4	1	0	0	0	0	7	0	2	3	0
Rhizammina indivisa	11	8	12	27	22	20	13	17	16	19	22	22	31	21	46	24	53	46	36	46	34	21	29	27	18	2	18	11	16
Saccammina complanata	4	8	6	8	8	14	0	9	14	12	8	7	5	5	26	12	5	8	15	20	6	10	0	12	0	12	11	13	3
Saccammina placenta	32	17	12	14	35	41	16	14	7	19	19	15	19	10	11	13	9	12	8	24	20	17	3	6	2	3	5	0	2
Thurammina sp.	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	1	5	1
Hyperammina dilatata	0	2	2	2	5	1	0	2	3	1	3	0	0	7	0	6	1	2	2	3	0	1	0	0	0	0	0	0	0
Hyperammina elongata	1	0	1	1	0	0	1	0	3	2	1	4	1	1	0	0	0	3	0	3	1	1	1	0	1	0	1	0	0
H. ex. gr. subnodosiformis	0	0	0	0	0	0	0	0	0	1	1	1	4	0	2	0	0	1	0	4	0	0	0	0	0	0	0	0	0
Ammodiscus cretaceus	0	0	0	1	8	0	2	0	0	5	0	1	1	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
Ammodiscus glabratus	2	7	0	2	3	1	3	5	4	2	1	5	3	3	1	4	1	3	5	3	6	3	0	1	2	2	1	3	2
Ammodiscus pennyi	0	0	0	1	0	0	1	1	2	2	6	0	2	0	0	2	0	3	1	4	1	0	0	0	0	0	0	0	0
Ammodiscus peruvianus	5	8	0	2	0	1	2	2	1	1	0	2	3	4	1	9	1	0	0	6	3	8	0	4	0	1	2	4	1
Ammolagena clavata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Glomospira charoides	2	12	0	2	11	3	9	7	13	3	8	7	3	2	7	3	7	2	5	5	7	3	2	0	2	0	0	1	2
Glomospira irregularis	4	2	1	5	7	5	3	1	3	1	1	5	5	4	6	1	3	3	2	4	0	3	2	0	0	0	0	0	0
Glomospira serpens	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Rzehakina epigona	11	31	16	40	29	33	34	39	41	39	41	18	30	16	11	29	14	15	31	20	39	25	12	24	31	3	29	14	12
Aschemonella ex gr. grandis	14	3	3	21	3	7	7	3	3	3	11	4	11	15	2	0	0	3	10	13	6	13	7	13	4	8	11	9	3
Hormosina ovuloides	0	2	2	2	2	5	0	4	4	6	4	4	17	8	6	4	0	0	1	2	0	1	0	0	0	0	0	0	0
Hormosina ovulum ovulum	0	0	0	0	0	0	0	0	0	0	0	2	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix-Table 1 (continued).

DEPTH in well G-287:	3207		3232		3237		3246		3266		3270		3274		3306		3311		3316		3320		3350		3355		3362	
	3205	3210	3234	3240	3248	3268	3272	3276	3309	3314	3318	3348	3353	3359	3364													
Hormosina trinitatensis	5	15	12	16	18	22	19	16	9	9	9	14	14	19	6	6	5	14	25	20	18	19	15	12	11	8	16	12	4
Kalamopsis grzybowskii	2	2	1	2	6	1	1	2	0	1	3	1	0	1	0	1	0	1	2	3	1	1	1	0	0	0	0	2	2
Nodellum velascoensis	2	0	0	0	11	8	0	0	0	0	0	0	6	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0
Reophax globosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0
Reophax subfusiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Reophax sp. 2	0	0	1	2	0	0	1	2	0	0	1	0	0	3	2	0	2	3	0	0	1	1	0	0	1	0	0	1	1
Subreophax scalaria	1	0	0	2	1	1	1	0	0	0	0	0	0	2	2	2	0	1	0	2	0	0	0	0	0	0	0	0	0
Ammobaculites jarvisi	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	3	1	0	3	0	6	0
Ammobaculites sp 1	6	10	0	1	0	0	2	10	8	4	16	2	4	13	13	11	7	6	10	17	3	3	5	7	1	15	2	2	2
Ammobaculites sp 3	1	0	1	4	4	0	4	0	0	0	1	0	1	1	6	1	0	0	1	3	0	2	0	3	4	9	9	3	0
Budashevaella trinitatensis	3	1	0	0	12	0	0	7	8	6	6	6	5	1	2	0	8	3	0	9	4	4	0	0	1	0	6	2	2
B. cf. multicameratus	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Cribrostomoides trinitatensis	0	0	0	0	0	5	0	1	8	0	?	2	0	0	3	0	8	0	0	1	0	5	8	0	1	1	6	4	4
Haplophragmoides cf. glabra	1	1	0	2	0	0	1	4	2	3	3	0	0	0	0	1	1	4	0	5	0	0	0	0	3	0	0	2	0
Haplophragmoides horridus	2	0	0	0	2	0	0	4	0	0	0	0	0	1	0	5	4	1	1	2	1	2	0	0	0	0	1	3	0
Haplophragmoides lamella	0	2	2	3	0	0	2	2	1	0	2	0	3	2	4	5	6	2	0	12	4	4	0	0	3	3	0	3	1
Haplophragmoides porrectus	0	0	0	2	3	0	1	1	1	0	1	2	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	0
Haplophragmoides retroseptus	20?	7?	27	19	5	1	2	7	6	6	12?	2	5	8?	7	4	4	4	4	21	11	25	16	4	10	28?	11	14	9
H. ex gr. suborbicularis	?	?	?	?	9	2	6	1	2	1	?	3	2	?	3	1	4	2	1	0	0	4	1	0	0	0	0	0	0
Labrospira pacifica	0	0	1	0	0	3	2	1	3	0	0	2	2	3	0	0	2	1	0	0	1	2	0	0	0	1	0	0	2
Lituotuba lituiformis	0	0	0	0	0	1	0	0	4	1	0	4	0	0	0	0	0	1	1	5	0	0	0	0	0	0	0	0	0
Phenacophragma beckmanni	0	15	11	0	0	0	0	0	0	0	0	0	0	0	7	13	2	4	2	7	9	4	14	25	14	34	16	40	7
Phenacophragma elegans	0	0	0	1	1	3	1	0	0	0	0	0	1	1	5	1	0	0	1	1	6	0	7	0	0	0	1	22	3

Appendix-Table 1 (continued).

DEPTH in well G-287:	3207			3232		3237		3246		3266		3270		3274		3306		3311		3316		3320		3350		3355		3362	
	3205		3210		3234		3240		3248		3268		3272		3276		3309		3314		3318		3348		3353		3359		3364	
Sphaerammina gerochi	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Recurvoides deflexiformis	5	1	0	0	6	0	2	2	4	0	3	1	8	2	0	0	0	1	1	0	2	2	1	0	0	0	0	0	0
Recurvoides gerochi	4	6	1	1	11	1	8	15	3	9	24	16	30	12	10	34	18	16	16	7	14	27	12	6	13	15	23	25	15
Recurvoides imperfectus	0	0	0	0	0	0	0	4	0	0	0	8	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Recurvoides cf. subturbinatus	2	0	1	1	3	0	2	2	4	4	2	1	1	2	4	1	1	2	2	7	0	1	0	0	0	0	0	0	0
Recurvoides sp. 1	2	1	1	0	7	1	0	0	4	0	0	0	0	3	7	2	3	6	9	7	4	4	0	0	0	0	0	0	0
Recurvoides sp. 2	0	0	1	1	2	0	0	0	8	2	0	0	7	0	4	0	4	2	3	2	3	1	2	12	10	4	7	6	10
Trochamminoides dubius	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trochamminoides irregularis	0	0	0	2	0	2	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Trochamminoides proteus	0	0	0	1	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trochamminoides subcoronatus	3	0	0	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Spiroplectammina dentata	0	0	0	0	0	0	0	0	0	3	1	5	5	6	7	0	0	3	0	15	0	0	0	0	0	0	0	0	0
Spiroplectammina excolata	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spiroplectammina navarroana	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	7	5	5	3	8	0	0	0	0	0	0	0
Spiroplectammina spectabilis	14	38	37	12	7	20	27	32	14	26	21	9	18	18	7	8	26	10	22	4	37	1	1	0	0	0	1	0	0
Conotrochammina whangaia	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	14	3	6	13	1	14	9	9	7	8	6	9	24	12
Trochammina altiformis	6	5	5	7	6	4	1	2	6	3	4	3	5	6	5	6	12	8	12	2	15	6	8	2	7	8	6	21	10
Trochammina ruthven-murrayi	0	4	4	2	2	0	0	0	2	0	1	0	1	2	6	7	2	1	0	0	7	3	2	3	3	0	5	0	0
Ammosph. pseudopauciloculata	36	18	2	30	44	51	21	47	31	13	19	33	30	32	34	57	42	27	27	90	40	22	18	12	8	15	20	21	7
Gaudryina pyramidata	0	0	0	0	0	1	0	0	0	0	4	3	1	2	0	1	9	3	0	1	4	0	10	11	7	6	6	1	9
Verneuilinoides polystrophus	16	3	11	0	4	0	1	2	9	6	5	2	7	4	0	0	3	1	1	4	1	0	0	3	0	0	3	0	0
Arenobulimina dorbignyi	0	0	0	0	3	0	2	0	4	3	5	0	0	0	0	1	0	1	4	3	8	1	2	6	3	5	10	5	4
Clavulinoides globulifera	8	9	8	0	0	0	3	4	7	37	23	0	2	0	1	0	15	0	23	3	0	1	0	10	47	26	25	17	52

Appendix-Table 1 (continued).

DEPTH in well G-287:	3207		3232		3237		3246		3266		3270		3274		3306		3311		3316		3320		3350		3355		3362	
	3205	3210	3234	3240	3248	3268	3272	3276	3309	3314	3318	3348	3353	3359	3364													
Dorothia indentata	4	9	32	1	7	6	4	2	1	3	6	8	13	4	3	5	7	10	2	16	2	3	3	1	1	13	6	5	8
Dorothia oxycona	0	10	4	0	0	0	3	2	0	0	0	2	4	3	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Dorothia retusa	0	2	0	0	3	0	9	9	1	1	5	2	5	11	2	0	0	0	1	0	4	2	17	13	10	44	16	30	26
Dorothia cf. trochoides	1	0	4	10	10	6	10	9	5	0	7	4	4	3	2	0	1	3	1	6	4	0	0	0	0	1	0	0	0
Eggerella trochoides	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Karreriella conversa	3	2	10	2	1	1	0	1	0	0	3	3	2	0	1	0	1	9	16	4	1	1	1	5	8	4	4	7	5
Karreriella sp 2	2	2	0	0	1	0	0	8	2	2	0	2	5	7	0	4	3	1	0	2	7	1	0	0	0	0	0	1	0
Matanzia varians	3	3	3	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	4	2	0	0	0	0	0	0	0
Textularia sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix-Table 2.
Descriptions of petrographic slides examined from well G-287.

DEPTH	DESCRIPTION
3205	Uniform noncalcareous clay with discontinuous organic-rich laminae
3207	Uniform noncalcareous clay
3210	Uniform noncalcareous clay with discontinuous organic-rich laminae
3232	Uniform clay with organic-rich laminae and burrows
3234	Uniform clay with organic-rich burrow
3237	Contact between calcareous silt-rich and noncalcareous layer
3240	Uniform clay with organic-rich streaks
3246	Uniform clay with calcareous silt and organic-rich streaks
3248	Uniform clay with organic-rich burrow
3266	Clay with calcareous silt, veins, and organic-rich streaks
3268	Clay with calcareous silt and organic-rich streaks
3270	Clay with calcareous silt layer
3272	Clay with calcareous silt and organic-rich streaks
3274	Clay with calcareous silt layer
3306	Noncalcareous clay with discontinuous organic-rich streaks and burrow
3309	Mottled noncalcareous clay with organic-rich burrow
3311	Uniform noncalcareous clay with discontinuous organic-rich streaks
3314	Uniform noncalcareous clay with discontinuous organic-rich streaks
3316	Mottled noncalcareous clay with organic-rich burrow
3318	Uniform noncalcareous clay with discontinuous organic-rich streaks
3320	Noncalcareous clay with discontinuous organic-rich streaks and burrow
3348	Uniform clay with calcareous silt and organic-rich burrow
3350	Dark colored clay with calcareous silt and organic-rich burrow
3353	Uniform clay with calcareous silt
3355	Uniform clay with calcareous silt and organic-rich burrow
3359	Clay with calcareous silt and discontinuous organic-rich streaks
3362	Contact between calcareous silt and noncalcareous layer
3364	Dark colored clay with calcareous silt and organic-rich burrow

PLATE 1

Figure 1a-b. *Bathysiphon microrhaphidus* Samuel
Danian, Sample 287/3355, 1, x275; 2, x75.

Figure 2-3. *Bathysiphon* sp.
Danian, well 287, 2, x90; 3, x65.

Figure 4-5. *Dendrophrya* ex gr. *excelsa* Grzybowski
Sample 163/4566, x80.

Figure 6. *Dendrophrya latissima* Grzybowski
Sample 163/4566, x75.

Figure 7. *Rhizammina grzybowskii* Liszka and Liszkowa
Lower Maastrichtian, Sample 163/1110, x55.

Figure 8-9. *Rhabdammina* ex gr. *discreta* Brady
Danian, Sample 287/3353, x60.

Figure 10-13. *Rhizammina indivisa* Brady
10-11, Paleocene, Sample 163/4566 x90; 12-13, upper Maastrichtian, Sample 163/1108, x60.

Figure 14-15. *Hyperammina elongata* Brady
Paleocene, Sample 163/4566, x110.

Figure 16-17. *Hyperammina* ex gr. *subnodosiformis* Grzybowski
Danian, Sample 287/3276, x80.

Figure 18-20. *Kalamopsis grzybowskii* (Dylazanka)
18, Danian, sample 287/3232, x100; 19, Paleocene, sample 163/4566, x55; 20, Paleocene, sample 163/4566, x90.

Figure 21-22. *Nodellum velascoense* (Cushman)
Paleocene, 21, Sample 163/4566, x75; 22 Sample 164/4566, x55.

All scale bars 100 microns

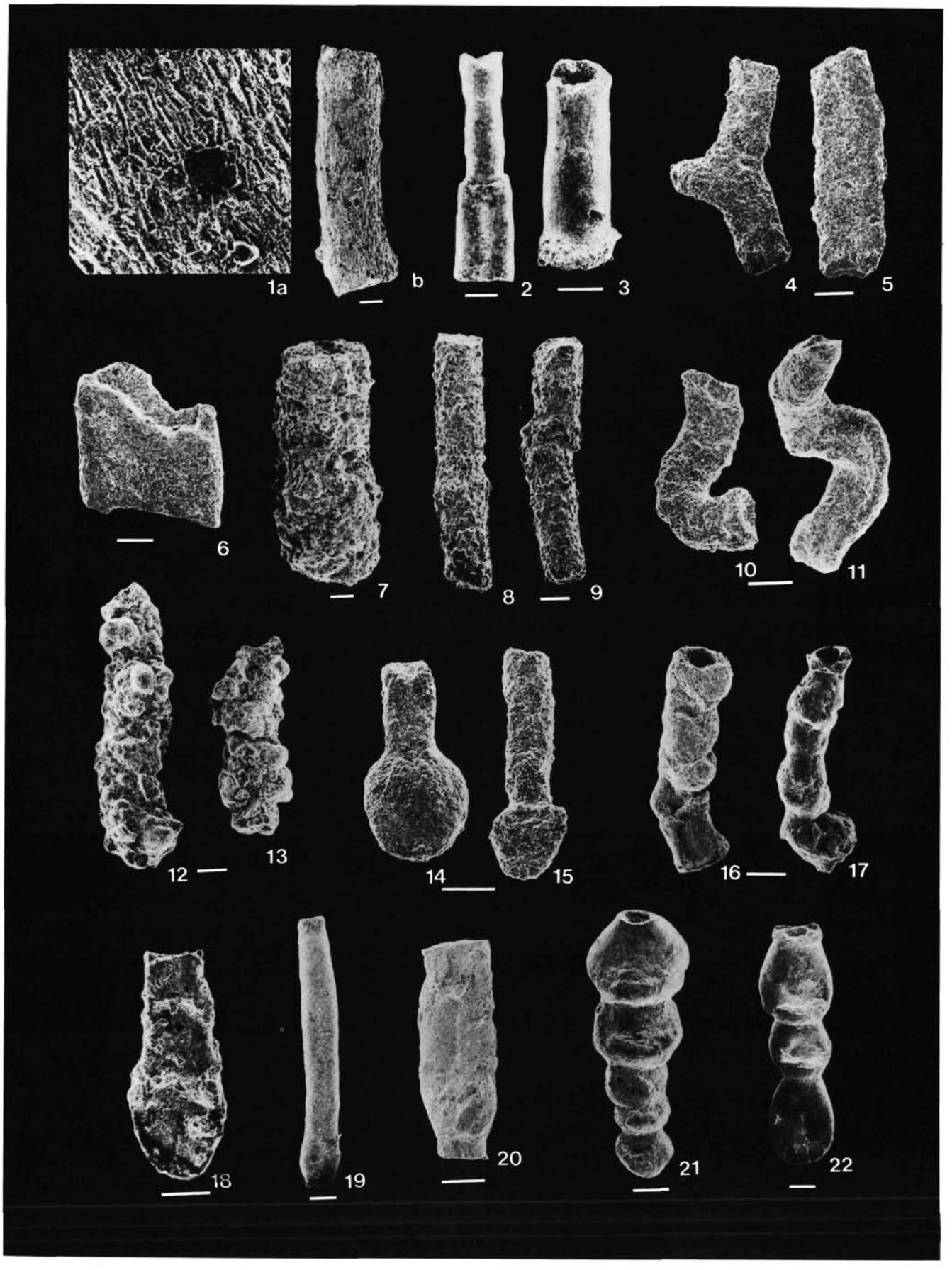

PLATE 2

Figure 1-2. *Hyperammina dilatata* Grzybowski
Danian, 1, Sample 287/3276, x100; 2, Sample 287/3276, x65.

Figure 3-4. *Hormosina ovuloides* (Grzybowski)
3, Danian, Sample 287/3276, x100; 4, Paleocene, Sample 163/4566, x110.

Figure 5. *Psammosphaera scruposa* (Berthelin)
White Upper Paleocene, Sample TC-174, x100.

Figure 6. *Psammosphaera testacea* Flint
Lower Eocene, Sample Rz-283, Ravine Ampelu, x75.

Figure 7. *Lagenammina grzybowskii* (Schubert)
Lower Maastrichtian, Sample 163/1110, x110.

Figure 8. *Saccammina complanata* (Franke)
Upper Maastrichtian, Sample 163/1108, x110.

Figure 9. *Saccammina placenta* (Grzybowski)
Paleocene, Sample 163/4566, x130.

Figure 10. *Hormosina ovulum ovulum* (Grzybowski)
Paleocene, Sample 163/4566, x130.

Figure 11-13. *Aschemonella* ex gr. *grandis* (Grzybowski)
Danian, 11, Sample 287/3272, x47; 12, Sample 287/3220, x 55; 13, Sample 287/3314, x47.

Figure 14. *Thurammina* sp.
Danian, Sample 287/3355, x47.

Figure 15. *Reophax duplex* Grzybowski
Paleocene, Sample 163/4566, x80.

Figure 16-17. *Subreophax scalaria* (Grzybowski)
16, Paleocene, Sample 163/4566, x100; 17, Danian, Sample 287/3276, x65.

Figure 18-19. *Reophax subfusiformis* Earland, emend. Hoglund
Danian, 18, Sample 287/3320, x90; 19, Sample 287/3320, x110.

All scale bars 100 microns

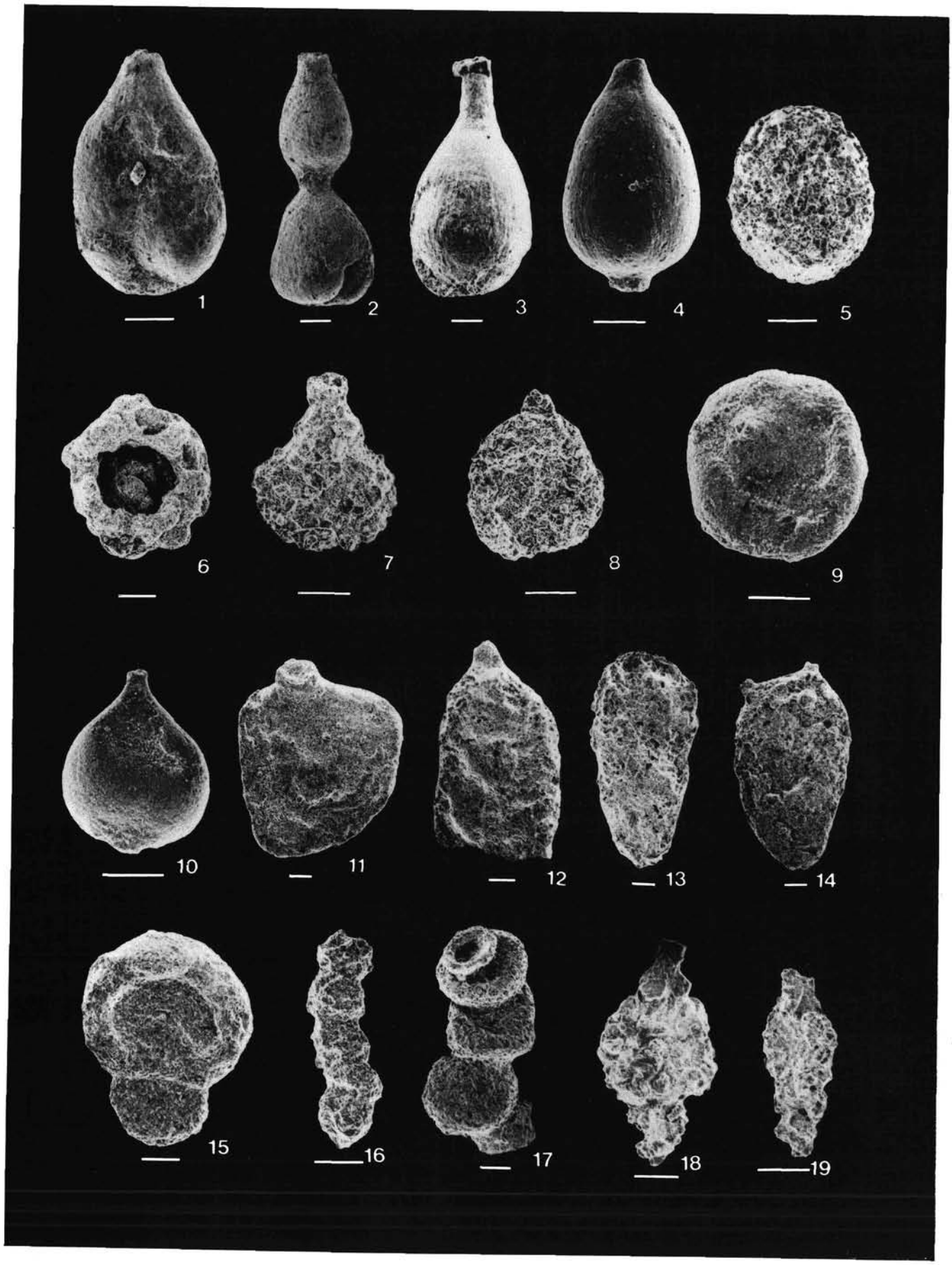

PLATE 3

Figure 1. *Hormosina trinitatensis* Cushman and Jarvis
Paleocene, Sample 163/4566, x80.

Figure 2-3. *Reophax* sp. 2
2, Danian, Sample 287/3234, x100; 3, Paleocene, Sample 163/4566, x100.

Figure 4. *Reophax globosus* Sliter Danian, Sample 287/3353, x65.

Figure 5-6. *Subreophax pseudoscalaria* (Samuel)
5, Upper Paleocene, Ravine Ampelu, x55. 6, Upper Maastrichtian, Sample G-163/1108, x75.

Figure 7. *Ammodiscus cretaceus* (Reuss) U
pper Paleocene, Ravine Ampelu, x50.

Figure 8a,b. *Ammodiscus glabratus* Cushman and Jarvis
Upper Maastrichtian, Sample 163/1108, x90.

Figure 9-10. *Ammodiscus pennyi* Cushman and Jarvis
Danian, 9, Sample 287/3248 x80; 10, Sample 287/3248, x65.

Figure 11-12. *Ammodiscus peruvianus* Berry
11, Danian, Sample 287/3248, x80; 12, Paleocene, Sample 163/4566, x80.

Figure 13. *Ammodiscus planus* Loeblich
Upper Maastrichtian, Sample 163/1108, x135.

Figure 14-15. *Glomospira charoides* (Jones and Parker)
Danian, 14, Sample 287/3248, x110; 15, Sample 287/3248, x150.

Figure 16. *Glomospira glomerata* (Grzybowski)
Upper Paleocene, Sample TC-145, x80.

Figure 17. *Glomospira gordialis* (Jones and Parker)
Danian, Sample 287/3276, x135.

Figure 18-19. *Glomospira diffundens* (Cushman and Renz)
Upper Paleocene, Sample TC-145, x80.

Figure 20-21. *Glomospira irregularis* (Grzybowski)
Paleocene, Sample 163/4566, x80.

Figure 22-23. *Glomospira serpens* (Grzybowski)
22, lower Eocene, Sample Rz-283, x70; 23, Danian, Sample 287/3320, x100.

Figure 24. *Ammolagena clavata* (Jones and Parker)
Upper Paleocene, Sample TC-145, x80.

All scale bars 100 microns

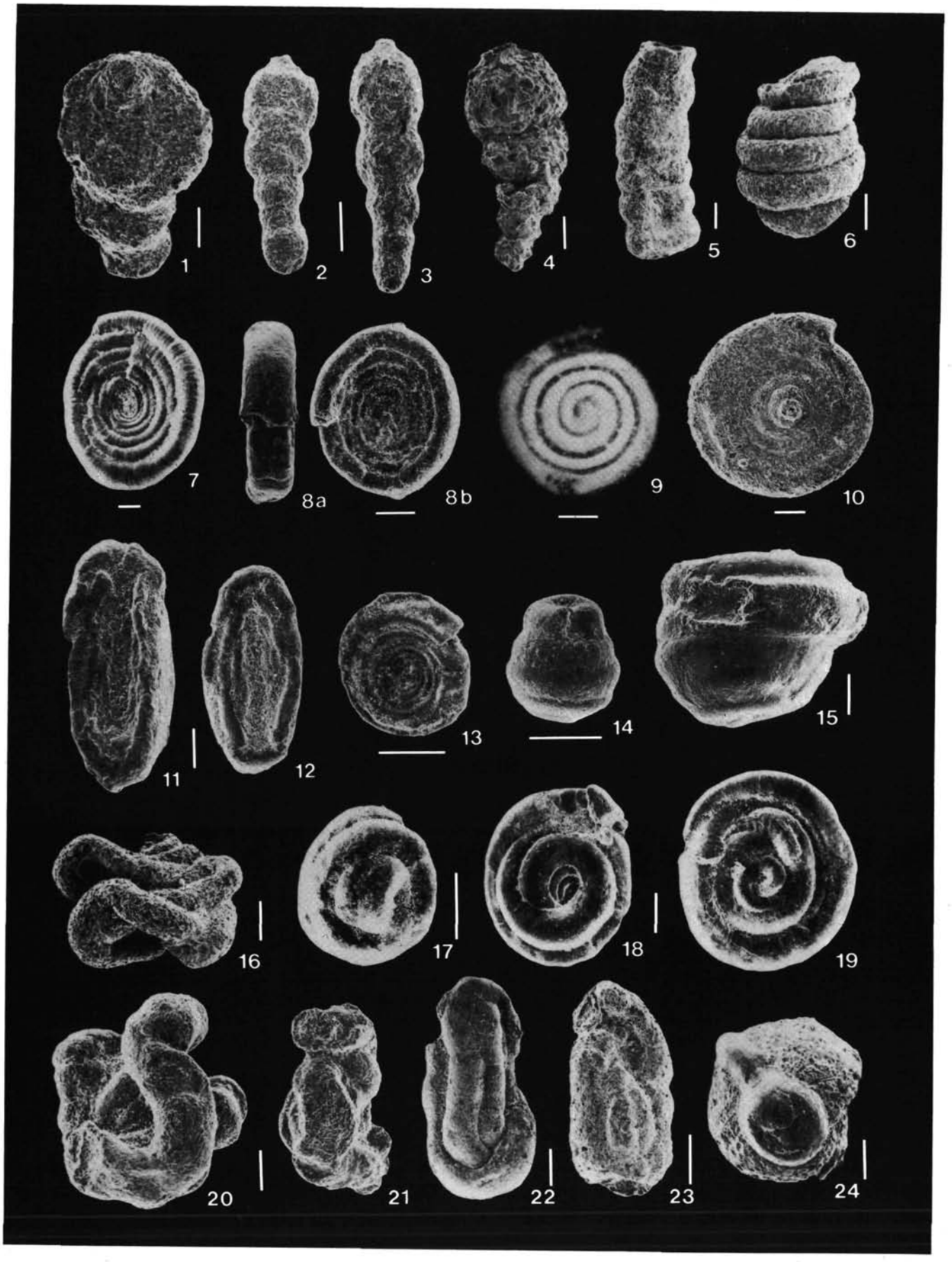

PLATE 4

Figure 1-2. *Ammobaculites* sp. 1
Danian, 1, Sample 287/3316, x110; 2, Sample 287/3316, x75.

Figure 3. *Ammobaculites* sp. 2
Lower Eocene, Sample Rz-283, x75.

Figure 4. *Ammobaculites jarvisi* Cushman and Renz
Danian, Sample 287/3355, x47.

Figure 5-7. *Ammobaculites* sp. 3
5, x65; 6, x80; 7, x80.

Figure 8-9. *Phenacophragma beckmanni* Kaminski and Geroch
Danian, Sample 287/3355, x110.

Figure 10. *Phenacophragma elegans* Kaminski
Danian, Sample 287/3272, x35

Figure 11. *Labrospira pacifica* Krashenninikov
11, upper Maastrichtian, Sample 163/4566, x100.

Figure 12-13. *Sphaerammina gerochi* Hanzlikova
Paleocene, Sample 163/4566, x90.

Figure 14-15. *Lituotuba lituiformis* (Brady)
14, Danian, Sample 287/3276, x100; 15, Paleocene, Sample 163/4566, x80.

Figure 16-17. *Trochamminoides dubius* (Grzybowski)
Paleocene, Sample 163/4566, x75.

Figure 18. *Trochamminoides irregularis* White
Paleocene, Sample 163/4566, x75.

Figure 19. *Trochamminoides subcoronatus* (Grzybowski)
Paleocene, Sample 163/4566, x55.

Figure 20. *Trochamminoides proteus* (Karrer)
Paleocene, Sample 163/4566, x55.

All scale bars 100 microns

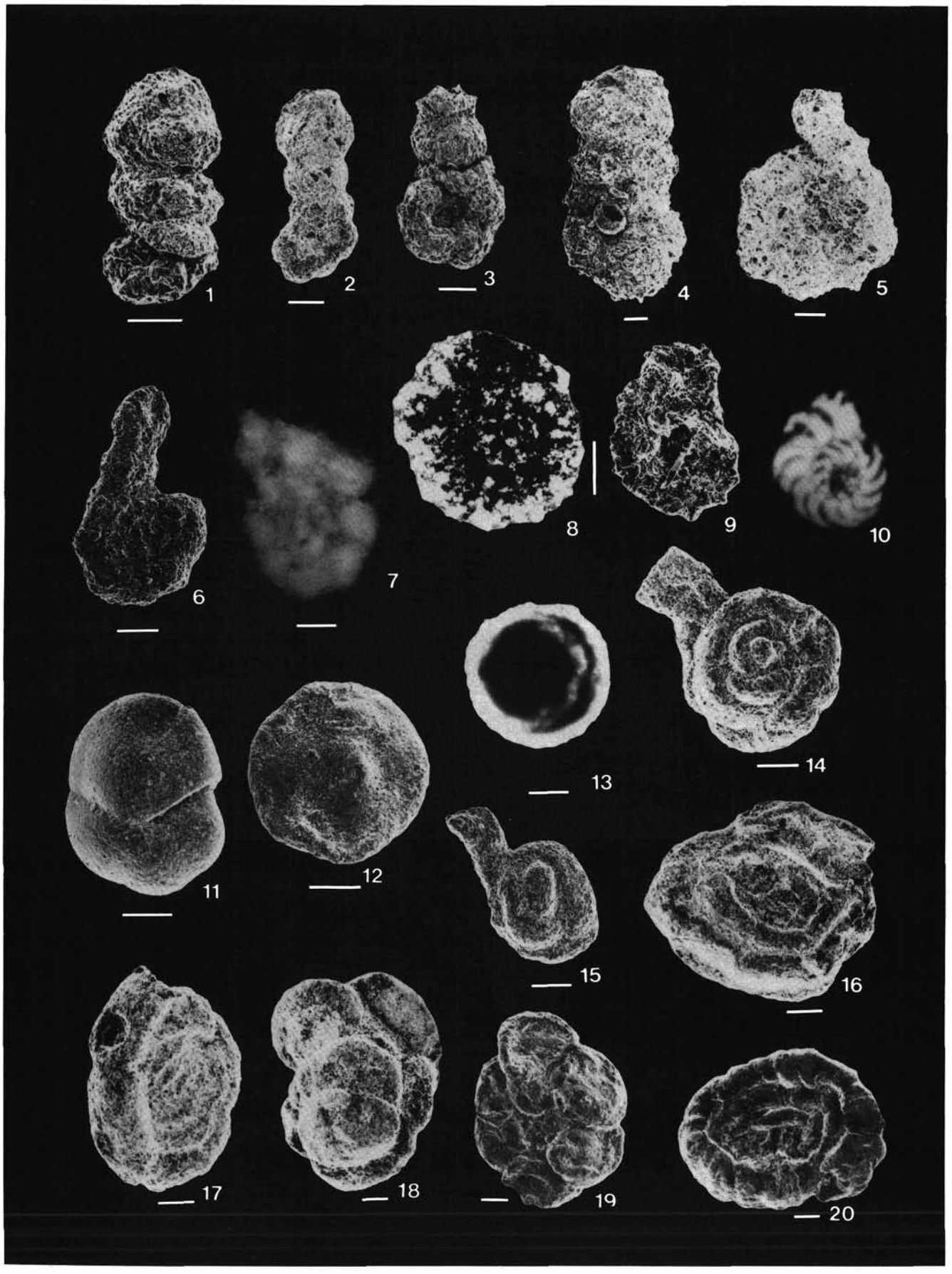

PLATE 5

Figure 1a-b. *Budashevaella* cf. *multicameratus* (Voloshinova and Budasheva) Paleocene, Sample 163/4566, x70.

Figure 2a-b. *Budashevaella trinitatensis* (Cushman and Renz). Danian, Sample 287/3248, x110.

Figure 3-4. *Haplophragmoides* cf. *glabra* Cushman and Waters 3, Upper Paleocene, Sample TC-145, x130; 4, Paleocene, Sample 163/4566 x90.

Figure 5-6b. *Haplophragmoides lamella* (Grzybowski). Paleocene, Sample 163/4566, x150.

Figure 7-8. *Haplophragmoides porrectus* Maslakova 7, Danian, Sample 287/3316, x135; 8, Upper Paleocene, Sample TC-145, x135.

Figure 9a-10b. *Haplophragmoides retroseptus* (Grzybowski) Danian, 9a-b, Sample 287/3320, x75; 10a-b, Sample 287/3234, x80.

Figure 11a-b. *Haplophragmoides horridus* (Grzybowski) Danian, well 287, x80.

Figure 12-13b. *Haplophragmoides* ex gr. *suborbicularis* (Grzybowski) 12, Upper Paleocene, Sample TC-174, x80; 13a-b, Danian, Sample 287/3276, x80.

Figure 14,15. *Haplophragmoides walteri* (Grzybowski) Paleocene (Zone P2), Sample TC-145, x110.

All scale bars 100 microns

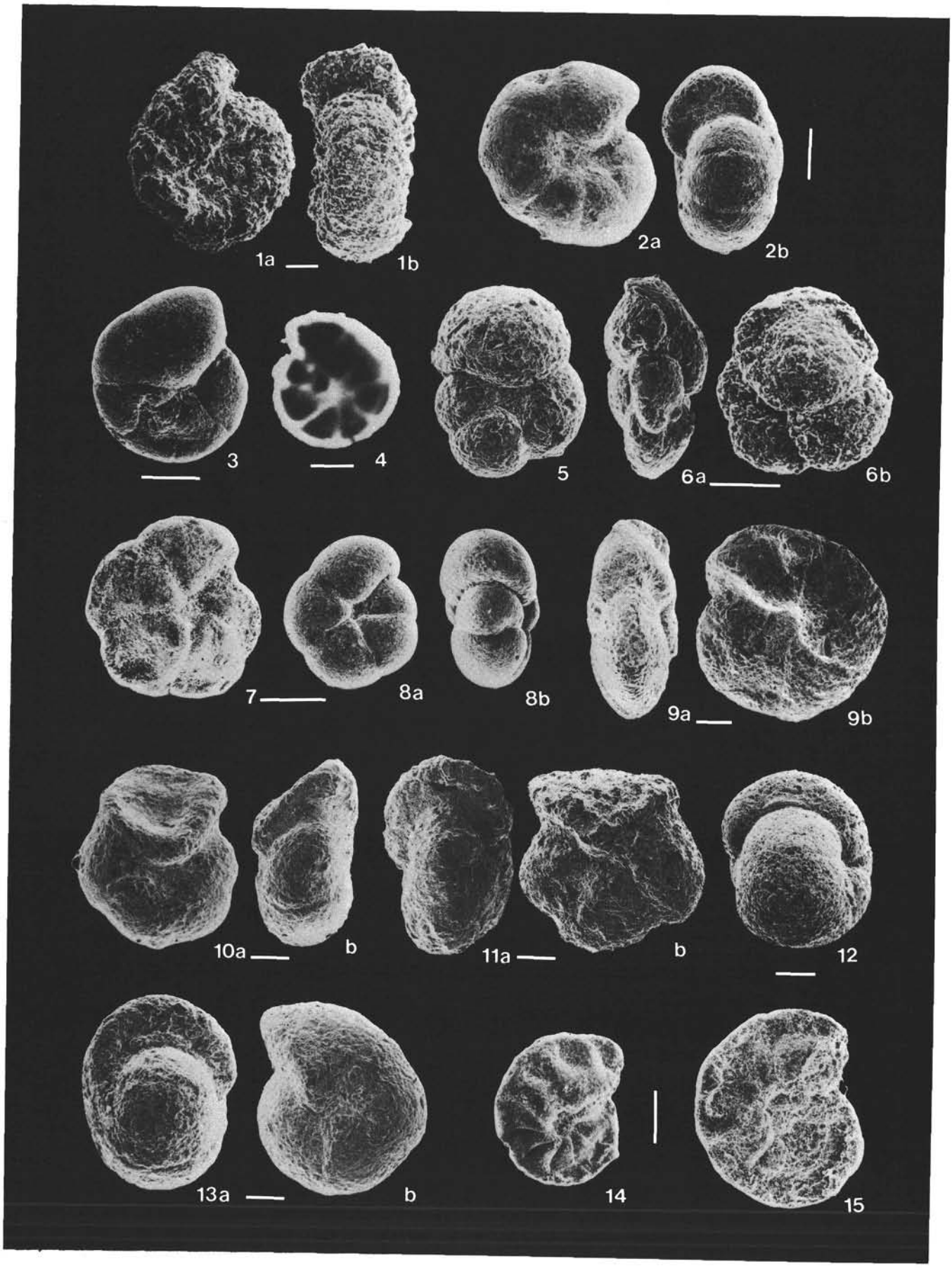

PLATE 6

Figure 1a-2b. *Cribrostomoides trinitatensis* Cushman and Jarvis
Danian, 1a-b, Sample 287/3276, x100; 2a, Sample 287/3276, x90; 2b, x275.

Figure 3a-b. *Recurvoides deflexiformis* (Noth)
Danian, Sample 287/3270, x80.

Figure 4a-b. *Recurvoides* sp. 1
Upper Paleocene, Sample TC-145, x135.

Figure 5-6. *Recurvoides imperfectus* Pflaumann
Danian, Sample 287/3237, x130.

Figure 7. *Recurvoides gerochi* Hanzlikova
x135.

Figure 8a-9b. *Recurvoides* cf. *subturbinatus* (Grzybowski)
Danian, 8a-b, Sample 287/3234, x80; 9a-b, Sample 287/3276, x110.

Figure 10a-11b. *Recurvoides* sp 2.
Danian, 10a-b, Sample TC-145, x100; 11a-b, Sample 287/3220, x110.

All scale bars 100 microns

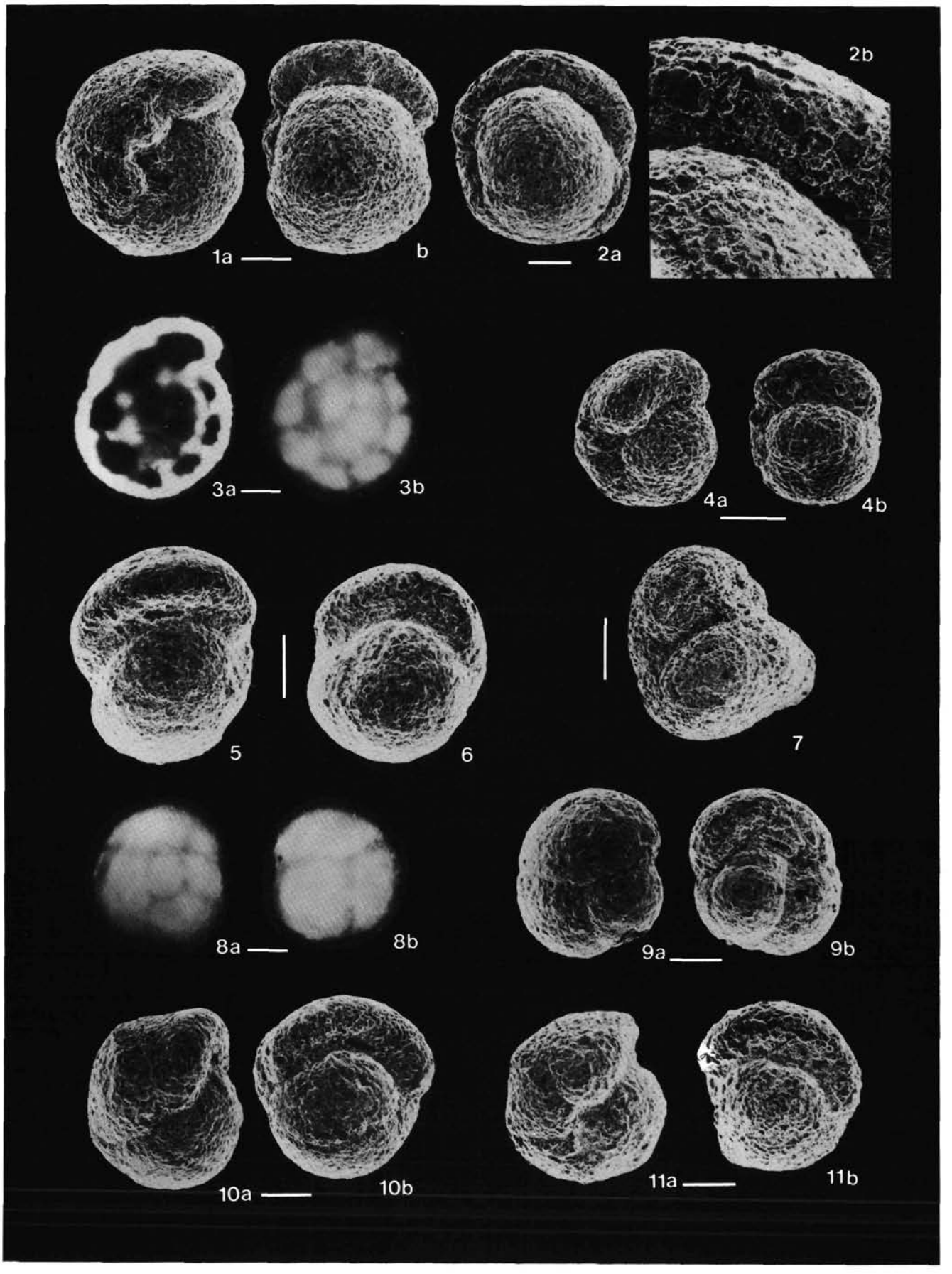

PLATE 7

Figure 1a-2b. *Haplophragmoides*(?) *jarvisi* (Thalmann)
Upper Paleocene, Ravine Ampelu, x105.

Figure 3. *Reticulophragmium* cf. *garcilassoi* Frizzel
Upper Paleocene morphotype, Ravine Ampelu, x100.

Figure 4a-b. *Reticulophragmium* cf. *garcilassoi* Frizzel
Upper Paleocene morphotype, Sample 163/4566, x80.

Figure 5a-b. *Reticulophragma* cf. *garcilassoi* Frizzel
Lower Eocene morphotype, Sample Rz-283, Ravine Ampelu, x100.

Figure 6a-7. *Rzehakina epigona* (Rzehak)
6a-b, Paleocene, Sample 163/4566, x80; 7, Danian, Sample 287/3237, x110; 4, Sample 163/4566, x90.

Figure 8-9. *Rzehakina minima* (Cushman and Renz)
Paleocene, Sample 163/4456, x110.

Figure 10-11. *Spiroplectammina* sp. aff. *S. dentata* (Alth)
Danian, 10, Sample 287/3274, x110; 11, Sample 287/3274, x65.

Figure 12. *Spiroplectammina excolata* (Cushman)
Danian (Zone P2), Sample 1107,x110.

Figure 13-15. *Spiroplectammina navarroana* Cushman
Paleocene, Sample 163/456,x85.

Figure 16-18. *Spiroplectammina spectabilis* (Grzybowski)
Paleocene, 16, Sample 163/4566 x55; 17-18, Sample 163/4566, x100.

Figure 19-20b. *Conotrochammina whangaia* Finlay
Danian, Sample 287/3416, 19 x110; 20a, x190; 20b, x650.

All scale bars 100 microns

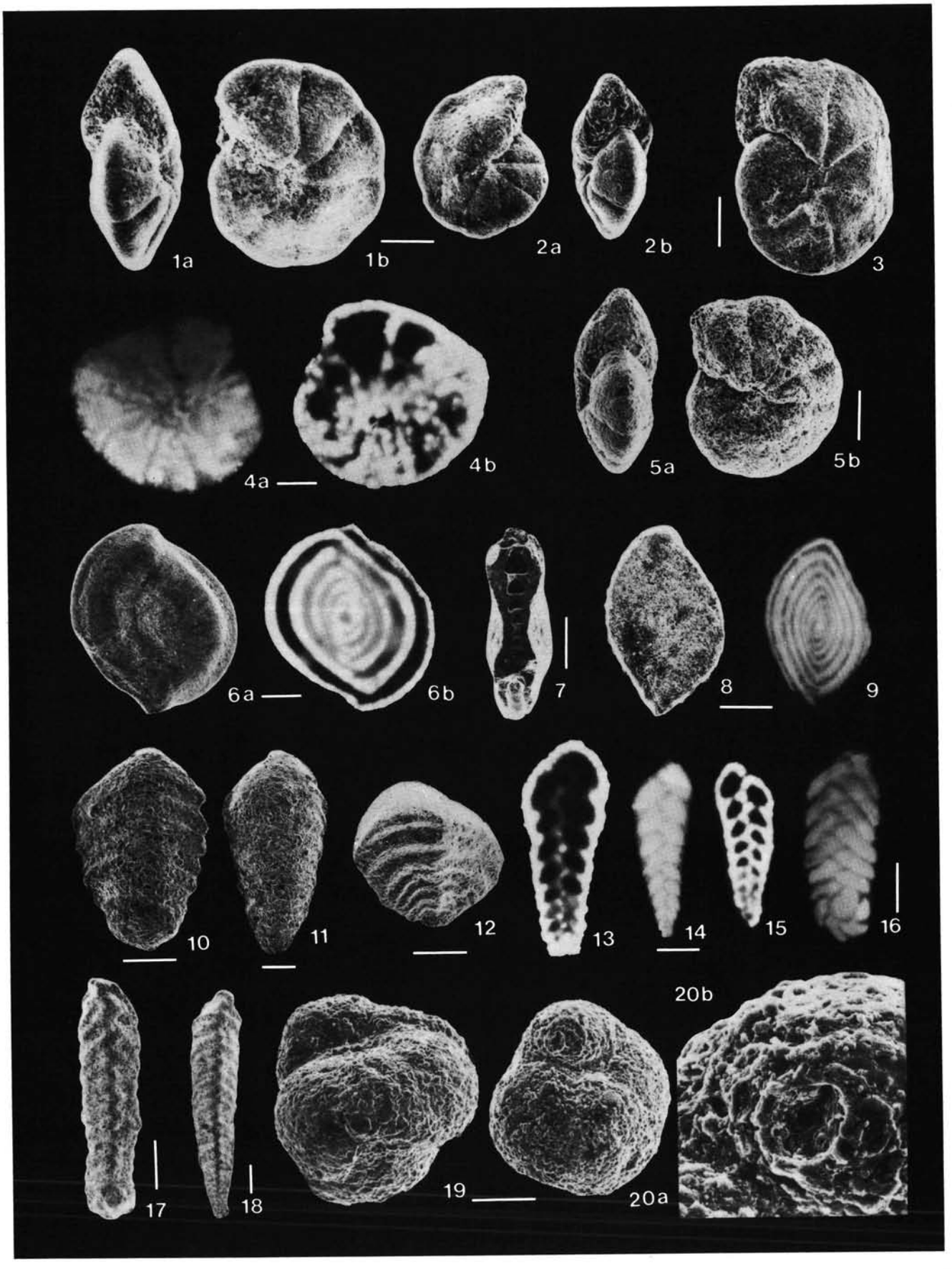

PLATE 8

Figure 1a-2b. *Trochammina altiformis* (Cushman and Renz)
1a-b, x95; 2a-b, x100.

Figure 3a-5. *Ammosphaeroidina pseudopauciloculata* (Mjatliuk)
Danian, well 287, 3a-b, compressed specimen, x100; 4a-b, uncompressed specimen x100; 5, 5-chambered specimen, Sample 287/3276, x110.

Figure 6a-c. *Trochammina ruthven-murrayi* (Cushman and Renz)
Danian, Sample 287/3276, x130.

Figure 7. *Gaudryina pyramidata* (Cushman)
Danian, Sample 287/3248, x75.

Figure 8. *Verneuilinoides polystropha* (Reuss)
Paleocene, Sample 163/4566, x100.

Figure 9. *Arenobulimina dorbignyi* (Reuss)
Danian, Sample 287/3362, x187.

Figure 10. *Arenobulimina truncata* (Reuss)
Upper Paleocene, Sample TC-174, x183.

Figure 11a-12. *Clavulinoides aspera* (Cushman)
Upper Paleocene, Sample TC-174, 11a, x475; 11b, x110; 12, x75.

Figure 13. *Clavulinoides amorpha* (Cushman)
Upper Paleocene, Sample TC-174, x75.

Figure 14-15. *Clavulinoides globulifera* (ten Dam and Sigal)
14, upper Paleocene, Sample TC-174, x55; 15, Danian, Sample 287/3248, x55.

All scale bars 100 microns

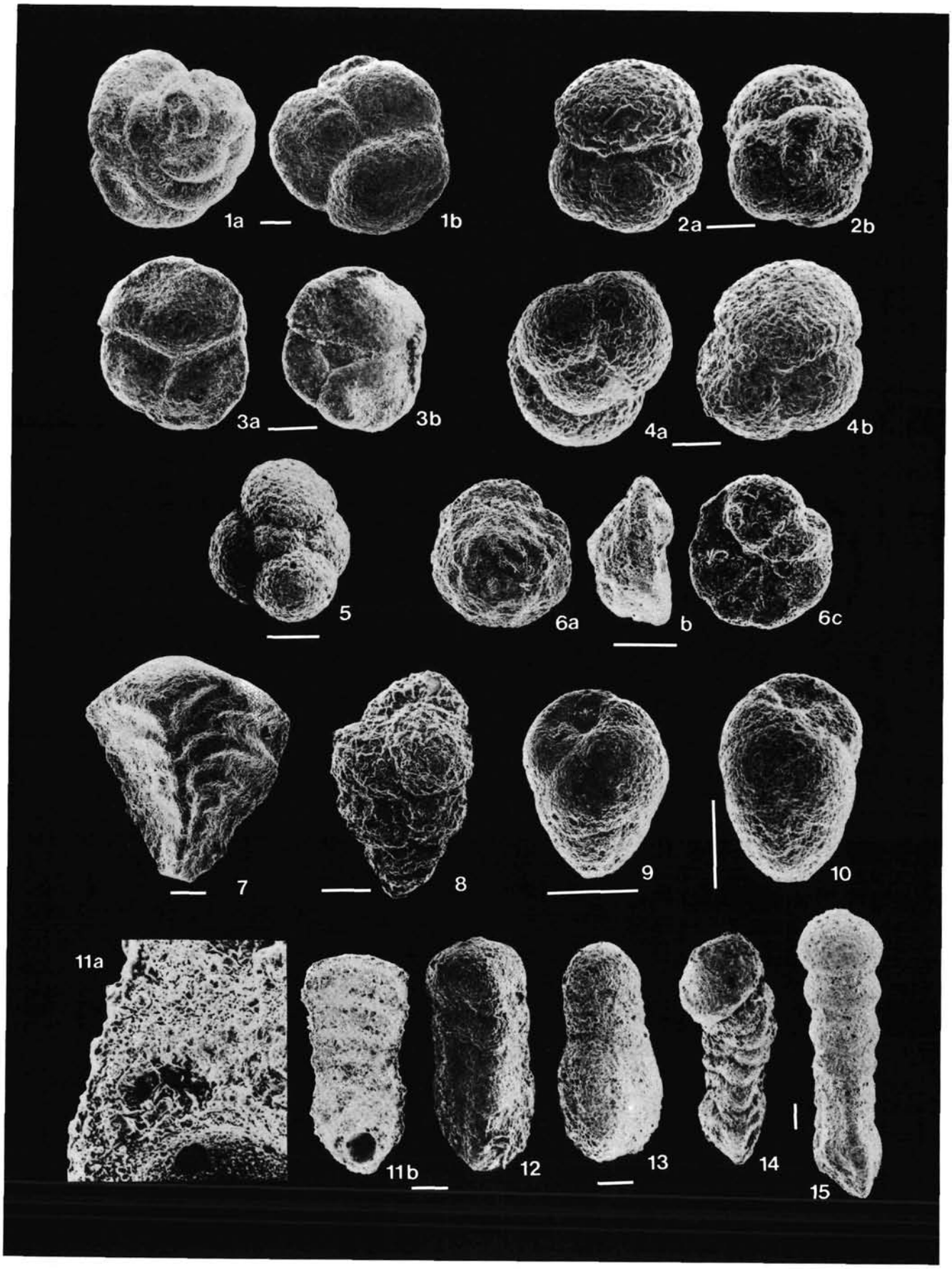

PLATE 9

Figure 1. *Clavulinoides paleocenica* (Tjalsma and Lohmann)
Upper Paleocene, Sample TC-145, x110.

Figure 2. *Clavulinoides trilatera* (Cushman)
Upper Paleocene, Sample TC-145, x100.

Figure 3. *Gaudryina* ex gr. *cretacea* (Karrer)
Upper Maastrichtian, Sample 163/1108, x50.

Figure 4-5. *Dorothia beloides* Hillebrandt
Upper Paleocene, 4, Ravine Ampelu, x90; 5, Sample TC-174, x135.

Figure 6,11. *Dorothia retusa* (Cushman)
Danian, Sample 287/3355, x75.

Figure 7-8. *Dorothia indentata* (Cushman and Jarvis)
Danian, Sample 287/3353, x75.

Figure 9. *Dorothia oxycona* (Reuss)
Paleocene, Sample 163/4566, x100.

Figure 10. *Dorothia* cf. *trochoides* (Marsson)
Danian, 10, Sample 287/3272, x135; 11, Sample 287/3234, x165.

Figure 12-13. *Eggerella trochoides* (Reuss)
Danian, Sample 287/3272, x170.

Figure 14a-b. *Matanzia varians* (Glaessner)
Upper Paleocene, Sample TC-174, 14a, x110; 14b, x230.

Figure 15-16. *Karreriella coniformis* (Grzybowski)
Lower Eocene, Sample Rz-283, Ravine Ampelu, x105.

Figure 17-18b. *Karreriella conversa* (Grzybowski)
Danian, 17, Sample TC-145 x110; 18a-b, Sample 287/3316, x80.

Figure 19-20. *Karreriella horrida* Mjatliuk
Danian (Zone P2), Sample 1107, x110.

Figure 21a-b. *Karreriella tenuis* (Grzybowski)
Paleocene, Sample 163/4566, x80.

Figure 22. *Karreriella* sp. 2.
Danian, Sample 287/3309, x180.

Figure 23. *Textularia* sp.
Danian, Sample 287/3276, x110.

All scale bars 100 microns

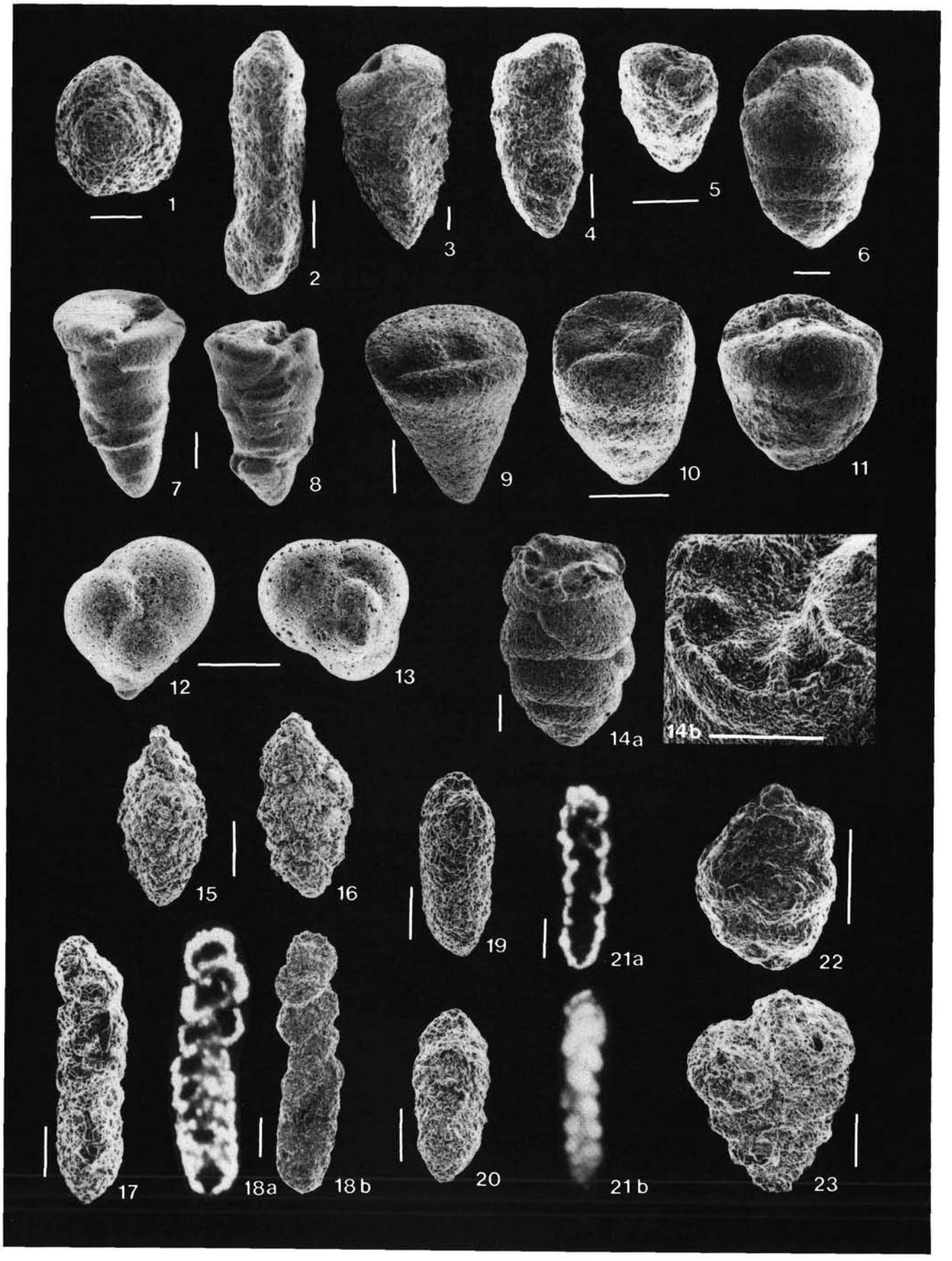

PLATE 10

Figure 1a-b. *Budashevaella* cf. *multicameratus* (Voloshinova and Budasheva)
Paleocene, Sample 163/4566.

Figure 2-3. *Budashevaella trinitatensis* (Cushman and Renz)
Danian, Sample 287/3248.

Figure 4a-c. *Recurvoides imperfectus* Pflaumann
Danian, Sample 287/3272.

Figure 5. *Reticulophragmium* cf *garcilassoi* Frizzel
(Paleocene morphotype)Danian (Zone P2), Sample TC-145.

Figure 6-7. *Phenacophragma beckmanni* Kaminski and Geroch
Danian, Sample 287/3355. 7, Holotype; 6, Paratypes.

Figure 8-9. *Haplophragmoides*(?) *jarvisi* (Thalmann)
Late Paleocene (Zone P5), Ravine Ampelu.

Figure 10-13. *Phenacophragma elegans* Kaminski
Danian, Sample 287/3272. 10, Holotype; 11-13 Paratypes.

Figure 14. *Matanzia varians* (Glaessner)
Paleocene, sample 163/4456.

Figure 15a-b. *Recurvoides deflexiformis* (Noth)
Danian, Sample 287/3270.

Figure 16a-b. *Sphaerammina gerochi* Hanzlikovà
Paleocene, sample 163/4566.

Camera lucida drawings
All scale bars 100 microns