6. BIOSTRATIGRAPHY OF CALCAREOUS NANNOFOSSILS: LEG 47B, DEEP SEA DRILLING PROJECT

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INTRODUCTION

The one site drilled during Leg 47B is located on the southern flank of the Vigo Seamount near the west coast of Spain (Figure 1) in a water depth of 3920 meters. Of the 1740 meters of sediment that were penetrated, 145 cores were recovered. Calcareous nannofossils were found that ranged in age from late Hauterivian (Early Cretaceous) to Pleistocene. Due to poor preservation, nannofossils occur intermittently through the Early Cretaceous. Turonian through Santonian age nannofossils were not found due to a sedimentary hiatus and non-preservation. Sediments of middle Campanian through Pleistocene age contain nannofossils in a fairly continuous sequence. A sedimentary hiatus was noted in the middle Miocene.

PRESERVATION

The distribution of calcareous nannofossils in deep-sea sediments is largely dependent on their preservation. Selective dissolution and overcalcification are important factors in species identification and distribution, and affect biostratigraphic results.

Surficial pitting, destruction of fine structures, fragmentation, and lack of solution-susceptible taxa are evidence of dissolution. Placoliths frequently show dissolution features, while discoasters show overgrowth or secondary calcification. Some secondary calcification may also be seen in placoliths. This phenomenon is discussed in detail by Wise and Kelts (1972), Adelseck et al. (1973), and Martini (1976). In this report, preservation of Tertiary nannofossils was recorded in two categories: (a) placolith preservation, and (b) discoaster preservation. Preservation of Cretaceous and Pleistocene nannofossils was recorded using only the preservation scale as modified from Bukry (1973). It may be described as follows:

+5 = Complete recrystallization and secondary calcification; coccoliths unrecognizable; essentially a micrite.

+4 = Marked recrystallization and secondary calcification; few identifiable coccoliths.

+3 = Marked recrystallization and secondary calcification; some problem in identification; fine structures obscured.

+2 = Moderate recrystallization and secondary calcification; almost all taxa recognizable; fine structures mostly obliterated.

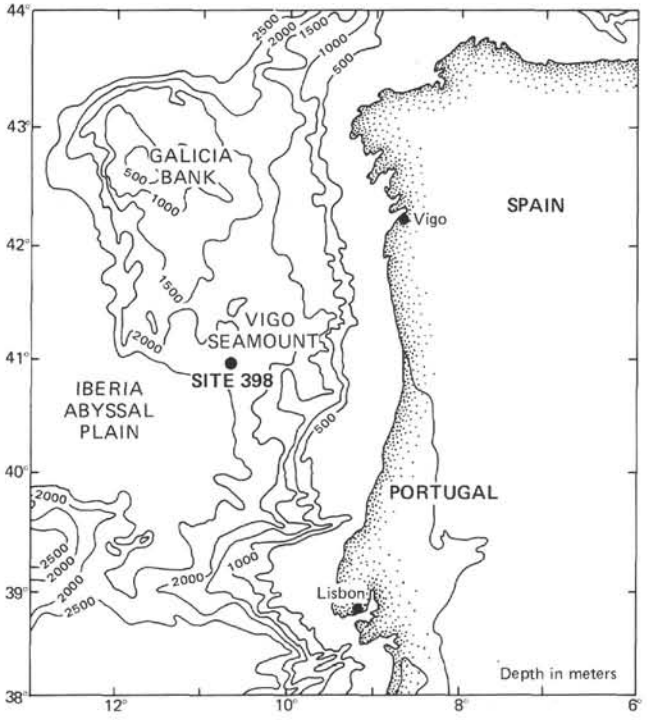

Figure 1. *Location of DSDP Site 398.*

+1 = Mild recrystallization and secondary calcification; some thickening of discoasters; fine structures visible.

−1 = Mild etching; no difficulty in species identification; most fine structures intact.

−2 = Solution more marked; holococcoliths and solution susceptible taxa are absent.

−3 = Marked dissolution; central areas of placoliths are enlarged; all fine structures are obliterated.

−4 = Marked dissolution; only most resistant taxa remaining; much fragmentation.

−5 = Barren of coccoliths and other calcareous material.

METHODS

Samples were processed using the standard smear-slide technique. Light microscopy was used in the examination of 700 samples. Table 1 lists the calcareous nannofossils species considered in this report. No taxonomic descriptions are included here, as all these taxa are well described elsewhere. References and detailed

TABLE 1
Calcareous Nannofossil Species at DSDP Site 398
(listed alphabetically)

Mesozoic

Corollithion achylosum (Stover) Thierstein
Tetralithus aculeus (Stradner) Gartner
Lithraphidites alatus Thierstein
Podorhabdus albianus Black
Hayesites albiensis Manivit
Parhabdolithus angustus (Stradner, Adamiker, and Maresch)
Loxolithus armilla (Black and Barnes) Nöel
Parhabdolithus asper (Stradner) Manivit
?*Watznaueria barnesae* (Black) Perch-Nielsen
Stephanolithion bigotii Deflandre
Watznaueria biporta Bukry
Watznaueria britannica (Stradner) Reinhardt
Lithraphidites carniolensis (Deflandre
Lucianorhabdus cayeuxii Deflandre
Cruciellipsis chiastia (Worsley) Thierstein
Markalius circumradiatus (Stover) Perch-Nielsen
Watznaueria communis Reinhardt
Cretarhabdus conicus Bramlette and Martini
Tetralithus copulatus Deflandre
Nannoconus colomii (deLapparent) Kamptner
Prediscosphaera cretacea (Arkhangelsky) Gartner
Cretarhabdulus crenulatus Bramlette and Martini
Zygolithus crux Deflandre and Fert
Chiastozygus cuneatus (Lyul'eva) Čepek and Hay
Cruciellipsis cuvillieri Manivit
Arkhangelskiella cymbiformis Vekshina
Microrhabdulus decoratus Deflandre
Cyclagelosphaera deflandrei (Manivit) Roth
Zygodiscus diplogrammus (Deflandre) Gartner
Braarudosphaera discula Bramlette and Riedel
Cribrosphaerella ehrenbergii Arkhangelsky
Nannoconus elongatus Brönnimann
Parhabdolithus embergeri (Nöel) Stradner
Corollithion exiguum Stradner
Eiffellithus eximius (Stover) Perch-Nielsen
Lithastrinus floralis Stradner
Nephrolithus frequens Gorka
Marthasterites furcatus (Deflancre and Fert) Deflandre
Ethmorhabdus gallicus Nöel
Tetralithus gothicus Deflandre
Rucinolithus hayi Stover
Micrantholithus hochschulzi (Reinhardt) Thierstein
Rucinolithus irregularis Thierstein
Certolithoides kamptneri Bramlette and Martini
Stephanolithion laffittei Nöel
Diazomatolithus lehmanni Nöel
Chiastozygus litterarius (Gorka) Manivit
Kamptnerius magnificus Deflandre
Tetralithus malticus Worsley
Cyclagelospharea margereli Nöel
Vagalapilla matalosa (Stover) Thierstein
Conosphaera mexicana Trejo
Micula mura (Martini) Bukry
Tetralithus nitidus Martini
Garnerago obliquum (Stradner) Nöel
Calcicalithina oblongata (Worsley) Thierstein
Tetralithus obscurus Deflandre
Micrantholithus obtusus Stradner
Broinsonia parca (Stradner) Bukry
Manivetella pemmatoides (Deflandre ex Manivit) Thierstein
Tetralithus pyramidus Gardet
Lithraphidites quadratus Stradner
Tetralithus quadratus Stradner
Parhabdolithus regularis (Gorka) Bukry
Cruciellipsis staurolithina (Worsley) Stradner
Micula staurophora (Gardet) Stradner
Cretarhabdus surirellus (Deflandre and Fert) Reinhardt
Tetralithus trifidus (Stradner) Bukry
Nannoconus trutti Brönnimann

TABLE 1 — *Continued*

Eiffellithus turriseiffeli (Deflandre) Reinhardt
Nannoconus wassali Brönnimann

Cenozoic

Sphenolithus abies Deflandre *in* Deflandre and Fert
Reticulofenestra abisecta (Müller) Roth and Thierstein
Ceratolithus acutus Gartner and Bukry
Zygodiscus adamas Bramlette and Sullivan
Chiphragmalithus alatus Martini
Helicopontospheara ampliaperta (Bramlette and Wilcoxon) Hay
Ceratolithus amplificus Bukry and Percival
Discolithina anisotrema Kamptner
Coronocyclas annula Cohen
Discoaster asymmetricus Gartner
Discoaster aulakos Hay
Discoaster barbadiensis Tan Sin Hok
Sphenolithus belemnos Bramlette and Wilcoxon
Discoaster bellus Bukry and Percival
Discoaster bifax Bukry
Braarudosphaera bigelowi (Gan and Braarud) Deflandre
Zygrhablithus bijugatus (Deflandre) Deflandre
Discoaster binodosus Martini
Reticulofenestra bisecta (Hay, Mohler, and Wade) Roth
Prinsius bisulcus (Stradner) Hay and Mohler
Discoaster bollii Martini and Bramlette
Marthasterites bramlettei Brönnimann and Stradner
Discoaster brouweri Tan Sin Hok
Discoaster calcaris Gartner
Chiasmolithus californicus (Sullivan) Hay and Mohler
Catinaster calyculus Martini and Bramlette
Sphenolithus capricornutus Bukry and Percival
Gephyrocapsa caribbeanica Boudreaux and Hay
Triquerorhabdulus carinatus Martini
Coccolithus cavus Hay and Mohler
Discoaster challengeri Bramlette and Riedel
Sphenolithus ciperoensis Bramlette and Wilcoxon
Syracosphaera clathrata Roth and Hay
Rhabdosphaera clavigera Murray and Blckmann
Catinaster colaitus Martini and Bramlette
Quinquerhabdulus colossicus Bukry and Bramlette
Helicopontospheara compacta (Bramlette and Sullivan) Hay
Heliorthus conicnnus Martini
Sphenolithus conicus Bukry
Chiasmolithus consuetus (Bramlette and Sullivan) Hay and Mohler
Marthasterites contortus (Stradner) Bukry
Toweius craticulus Hay and Mohler
Ceratolithus cristatus Kamptner
Chiasmolithus danicus (Brotzen) Hay and Mohler
Discoaster deflandrei Bramlette and Reidel
Camplyosphaera dela (Bramlette and Sullivan) Hay and Mohler
Ceratolithus delicatus Gartner
Discoasteroides diastypus Bramlette and Sullivan
Pontosphaera discopora Schiller
Sphenolithus distentus Bramlette and Wilcoxon
Ellipsolithus distichus Sullivan
Pontosphaera distincta (Bramlette and Sullivan) Roth and Thierstein
Discoaster distinctus Martini
Braarudosphaera discula Bramlette and Riedel
Coccolithus doronicoides Black and Barnes
Discoaster druggi Bramlette and Wilcoxon
Zygolithus dubius Deflandre *in* Deflandre and Fert
Cruciplacolithus eminens (Bramlette and Sullivan) Hay and Mohler
Camplyosphaera eodela Bukry and Percival
Coccolithus eopelagicus (Bramlette and Riedel) Bramlette and Sullivan
Discoaster exilis Martini and Bramlette
Erisonia fenestrata (Deflandre) Stradner
Cyclicargolithus floridanus (Roth and Hay) Bukry
Cyclococcolithus formosa (Kamptner) Wilcoxon
Scapholithus fossilis Deflandre
Sphenolithus furcatolithoides Deflandre
Chiasmolithus gigas (Bramlette and Sullivan) Radomski
Rhabdosphaera gladius Bramlette and Sullivan

TABLE 1 — *Continued*

Chiasmolithus grandis (Bramlette and Riedel) Gartner
Discoaster hamatus Martini and Bramlette
Sphenolithus heteromorphus Deflandre
Reticulofenestra hillae Bukry and Percival
Syracosphaera histrica Kamptner
Emiliania huxleyi (Lohmann) Hay and Mohler
Reticulofenestra insignata Roth and Hay
Discoaster intercalaris Bukry
Helicopontosphaera intermedia (Martini) Hay and Mohler
Markalius inversus (Deflandre) Bramlette and Martini
Triquetrorhabdulus inversus Bukry and Bramlette
Fasciculithus involutus Bramlette and Sullivan
Discolithina japonica Takayama
Helicopontosphaera kamptneri Hay and Mohler
Discoasteroides kuepperi Stradner
Coronocyclas kingii Roth
Heliolithus kleinpellii Sullivan
Discoaster kugleri Martini and Bramlette
Pseudoemiliania lacunosa (Kamptner) Gartner
Discoaster lautus Hay
Cyclococcolithus leptoporus (Murray and Blackmann) Wilcoxon
Discoaster lidzi Hay
Discoaster lodoensis Bramlette and Riedel
Helicopontosphaera lophota (Bramlette and Sullivan) Bukry
Ellipsolithus macellus Bramlette and Sullivan
Cyclococcolithus macintyrei (Bukry and Bramlette) Wilcoxon
Discoaster mediosus Bramlette and Sullivan
Discoasteroides megastypus Bramlette and Sullivan
Discolithina millepuncta Gartner
Lanternithus minutus Stradner
Coccolithus miopelagicus Bukry
Umbellosphaera mirabilis Lohmann
Discoaster mohleri Bukry and Percival
Discoaster moorei Bukry
Sphenolithus moriformis (Brönnimann and Stradner) Bramlette and Wilcoxon
Pontosphaera multipora (Kamptner) Martini
Discoaster multiradiatus Bramlette and Riedel
Discoaster miris Deflandre
Discoaster neorectus Bukry
Discoaster nephados Hay
Coronocyclas nitescens Hay, Mohler, and Wade
Discoaster nobilis Martini
Discoaster nodifer (Bramlette and Riedel) Bukry
Discoaster nonaradiatus Klumpp
Chiasmolithus oamaruensis (Deflandre) Hay, Mohler, and Wade
Reticulofenestra oamaruensis (Deflandre) Stradner
Helicopontosphaera obliqua (Bramlette and Wilcoxon) Roth and Thierstein
Transversopontis obliquipons (Deflandre) Hay, Mohler, and Wade
Sphenolithus obtusus Bukry
Gephyrocapsa oceanica Kamptner
Sphenolithus pacificus Martini
Pemmatoides papillum Martini
Helicopontosphaera parallela (Bramlette and Wilcoxon) Bukry
Coccolithus pelagicus (Wasllich) Schiller
Discoaster pentaradiatus Tan Sin Hok
Discoaster perplexus Bramlette and Riedel
Zygolithus plectopons Bramlette and Sullivan
Sphenolithus predistentus Bramlette and Wilcoxon
Ceratolithus primus Bukry and Percival
Sphenolithus pseudoradians Bramlette and Wilcoxon
Reticulofenestra pseudoumbilica Gartner
Syracosphaera pulchra Lohmann
Discoaster quinqueramus Gartner
Helicopontosphaera recta (Bramlette and Wilcoxon) Muller
Isthmolithus recurvus Deflandre *in* Deflandre and Fert
Heliolithus riedeli Bramlette and Sullivan
Heliocopntosphaera reticulata (Bramlette and Wilcoxon) Roth
Reticulofenestra reticulata Gartner and Smith
Pontosphaera rimosa Bramlette and Sullivan
Cyclolithella robusta (Bramlette and Sullivan) Stradner
Braarudosphaera rosa Levin and Jorger

TABLE 1 — *Continued*

Ceratolithus rugosus Bukry and Bramlette
Triquetrorhabdulus rugosus Bramlette and Wilcoxon
Discoaster saipanensis Bramlette and Sullivan
Discaoster saundersi Hay
Fasciculithus schaubi Hay and Mohler
Reticulofenestra scissura Hay, Mohler, and Wade
Pontosphaera scutellum Kamptner
Discolithina segmenta Bukry and Percival
Helicopontosphaera sellii Bukry and Bramlette
Helicopontosphaera seminulum (Bramlette and Sullivan) Stradner
Zygodiscus sigmoides Bramlette and Sullivan
Chiasmolithus solitus (Bramlette and Sullivan) Locker
Biantholithus sparsus Bramlette and Martini
Cruciplacolithus staurion (Bramlette and Sullivan) Gartner
Ericsonia subdisticha (Roth and Hay) Roth
Discoaster sublodoensis Bramlette and Sullivan
Ericsonia subpertosa Hay and Mohler
Discoaster surculus Martini and Bramlette
Discoaster tamalis Kamptner
Discoaster tani Bramlette and Riedel
Cruciplacolithus tenuis (Stradner) Hay and Mohler
Rhabdosphaera tenuis Bramlette and Sullivan
Marthasterites tribrachiatus (Bramlette and Riedel) Deflandre
Ceratolithus tricorniculatus Gartner
Reticulofenestra umbilica (Levin) Martini and Ritzkowski
Catinaster umbrellus? Bukry
Discoaster variabilis Martini and Bramlette
Micrantholithus vesper Deflandre and Fert

descriptions may be found by consulting the annotated index of calcareous nannofossils (Loeblich and Tappan, 1968, 1969, 1970a, 1970b, 1971, and 1973).

Abundance estimates were tabulated using a logarithmic scale which was related to more traditional letter symbols. The abundance catagories used are as follows:

A = Abundant: 10^1; ten or more specimens of a taxon per field of view at 640× magnification.

C = Common: 10^0; One specimen per field of view at 640× magnification.

F = Few: 10^{-1}; 0.1 to 0.9 specimens per field of view at 640× magnification.

R = Rare: 10^{-2}; 0.01 to 0.09 specimens per field of view at 640× magnification.

V = Very rare: 10^{-3}; 0.001 to 0.009 specimens per field of view at 640× magnification.

CALCAREOUS NANNOFOSSIL ZONATION

Cretaceous

Cretaceous zonations have been proposed by a number of investigators (Čepek and Hay, 1969; Manivit, 1971; Thierstein, 1971, 1973, 1976; Worsley, 1971; Roth and Thierstein, 1972; Roth, 1973). Most are based on epicontinental sections which contain somewhat different nannofossil assemblages than are found in deep-sea sediments. Due to poor preservation in much of the Cretaceous sequence at Site 398, a number of the biostratigraphic subdivisions frequently used by these investigators were not recognizable. The Cretaceous zonation used in this report is modified from that proposed by Thierstein (1976) and summarized in Figure 2. A detailed distribution of Cretaceous nannofossils found at Site 398 is given in Figure 3. The

AGE	ZONE	BOUNDARY DATUM
Maestrichtian	*Micula mura*	*Last Micula mura*
	Lithraphidites quadratus	First *Micula mura*
Campanian	*Tetralithus trifidus*	Last *Tetralithus trifidus*
	Tetralithus aculeus	First *Tetralithus trifidus*
	Broinsonia parca	First *Tetralithus aculeus*
Santonian	*Tetralithus obscurus*	First *Broinsonia parca*
Coniacian	*Marthasterites furcatus*	First *Tetralithus obscurus*
Turonian	*Micula staurophora*	First *Marthasterites furcatus*
	Gartnerago obliquum	First *Micula staurophora*
Cenomanian	*Lithraphidites alatus*	First *Gartnerago obliquum*
Albian	*Eiffellithus turriseiffeli*	First *Lithraphidites alatus*
	Prediscosphaera cretacea	First *Eiffellithus turriseiffeli*
Aptian	*Parhabdolithus angustus*	First *Prediscosphaera cretacea*
	Lithastrinus floralis	First *Parhabdolithus angustus*
Barremian	*Chiastozygus litterarius*	First *Lithastrinus floralis*
Hauterivian	*Calcicalithina oblongata*	First *Chiastobygus litterarius*
	Cruciellipsis cuvillieri	Last *Cruciellipsis cuvillieri*
		Last *Lithraphidites bollii*

Figure 2. *Summary of Cretaceous calcareous nannofossil zonation used in this study.*

following is a brief description of the Cretaceous nannofossil zones used here and their representation at this site.

Cruciellipsis cuvillieri Zone

Boundaries: Base—last *Lithraphidites bollii*; Top—last *C. cuvillieri.*

Position: Cores 398D-138 through 398D-136.

Assemblage: *Watznaueria barnesae, Parhabdolithus asper, Nannoconus colomii, Cretarhabdulus crenulatus, Parhabdolithus embergeri, Nannoconus wassali, Calcicalithina oblongata, Cruciellipsis cuvillieri.*

Remarks Nannofossils are generally poorly preserved with micritization in limestone layers and dissolution in interbedded sediments. *C. cuvillieri* is rare and poorly preserved. The base of this zone was not penetrated.

Age: Late Hauterivian.

Calcicalithina oblongata Zone

Boundaries: Base—last *C. cuvillieri*; Top—first *Chiastozygus litterarius.*

Position: Cores 398-D-135 through 398D-128.

Assemblage: *C. oblongata, P. asper, W. barnsae, P. embergeri, Zygodiscus diplogrammus, Zygolithus crux, C. crenulatus, Micrantholithus hochschulzi, N. colomii, N. wassali, Cruciellipsis chiastia.*

Remarks: Nannofossils are poorly preserved. *C. oblongata* is rare.

Age: Late Hauterivian to late Barremian.

Chiastozygus litterarius Zone

Boundaries: Base—first *Chiastozygus litterarius*; Top—first *Lithastrinus floralis.*

Position: Cores 398D-127 through Section 398D-109-2.

Assemblage: *C. litterarius, P. asper, Z. diplogrammus, C. crenulatus, W. barnesae, Z. crux, C. chiastia, P. embergeri.*

Remarks: Preservation is better at the base of this zone than in the upper part. Many cores are barren between 398D-119 and 398D-111.

Age: Late Barremian to middle Aptian.

Lithastrinus floralis Zone

Boundaries: Base—first *L. floralis*; Top—first *Parhabdolithus angustus.*

Position: Core 398D-109-1 through Section 398D-108-3.

Assemblage: Similar to the *C. litterarius* Zone plus *L. floralis.*

Remarks: Nannofossils are generally poorly preserved in this interval with occasional better-preserved layers. Some reworking of *Nannoconus colomii* is noted in Cores 398D-127 through 398D-124.

Age: Middle Aptian.

Parhabdolithus angustus Zone

Boundaries: Base—first *P. angustus*; Top—first Prediscosphaera cretacea.

Position: Section 398D-108-2 through Core 398D-98.

Assemblage: Similar to the *L. floralis* Zone plus *P. angustus, Nannoconus elongatus*, less *N. colomii.*

Remarks: Preservation is better in the base of this zone than at the top. The zonal boundaries cannot be precisely determined due to poor preservation.

Age: Middle Aptian.

Prediscosphaera cretacea

Boundaries: Base—first *P. cretacea*; Top—first *Eiffellithus turriseiffeli.*

Position: Cores 398D-97? through 398D-61.

Assemblage: Similar to *P. angustus* Zone plus *P. cretacea, Corollithion achylosum, Podorhabdus albianus.*

Remarks: Preservation is generally poor through this interval. Poor preservation prevents exact determination of the base of this zone. It is approximately 380 meters thick.

Age: Early to middle Albian.

Eiffellithus turriseiffeli Zone

Boundaries: Base—first *E. turriseiffeli*; Top—first *Lithraphidites alatus.*

Position: Core 398D-60 through Section 398D-57-2.

Assemblage: Similar to *P. cretacea* Zone plus *E. turriseiffeli.*

Remarks: Preservation is generally better than in lower cores.

Age: Late Albian.

Lithraphidites alatus Zone

Boundaries: Base—first *L. alatus*; Top—first *Gartnerago obliquum.*

Position: Sections 398D-57-1 through 398D-56-2.

Assemblage: Similar to *E. turriseiffeli* Zone plus *L. alatus.*

Remarks: *L. alatus* is rare and poorly preserved. The top of this zone was not recognized.

Age: Cenomanian.

Gartnerago obliquum Zone

Boundaries: Base—first *G. obliquum*; Top—first *Micula staurophora.*

Position: Not encountered at this site.

Age: Early Turonian.

Micula staurophora Zone

Boundaries: Base—first *M. staurophora*; Top—first *Marthasterites furcatus.*

Position: Not encountered at this site.

Age: Middle Turonian to late Turonian.

Marthasterites furcatus Zone

Boundaries: Base—first *Marthasterites furcatus*; Top—first *Tetralithus obscurus.*

Position: Not encountered at this site.

Age: Coniacian.

Tetralithus obscurus Zone

Boundaries: Base—first *Tetralithus obscurus*; Top—first *Broinsonia parca.*

Position: Not encountered at this site.

Age: Santonian.

Broinsonia parca Zone

Boundaries: Base—first *Broinsonia parca*; Top—first *Tetralithus aculeus.*

Position: Not encountered at this site.

Age: Early Campanian.

Tetralithus aculeus Zone

Boundaries: Base—first *Tetralithus aculeus*; Top—first *Tetralithus trifidus.*

Position: Section 398D-50-6 through Core 398D-48.

Assemblage: *T. aculeus, Ceratolithoides kamptneri, B. parca, Tetralithus gothicus, P. cretacea, Arkhangelskiella cymbiformis, M. staurophora, C. crenulatus, E. turriseiffeli, G. obliquum.*

Remarks: Nannofossils are fairly well-preserved. The actual base of this zone is absent due to a sedimentary hiatus and/or non-preservation of nannofossils.

Age: Middle Campanian.

Tetralithus trifidus Zone

Boundaries: Base—first *T. trifidus*; Top—last *T. trifidus.*

Position: Cores 398D-48 through 398D-46.

Assemblage: Similar to the *T. aculeus* Zone plus *T. trifidus, Tetralithus gothicus.*

Remarks: Nannofossils are moderately well-preserved. The Campanian-Maestrichtian boundary is placed at the base of *Eiffellithus eximius* in Core 398D-46.

Age: Late Campanian to early Maestrichtian.

Lithraphidites quadratus Zone

Boundaries: Base—last *T. trifidus*; Top—first *Micula mura.*

Position: Cores 398D-45 through 398D-43.

Assemblage: *L. quadratus, A. cymbiformis, Tetralithus quadratus, G. obliquum, M. staurophora, E. turriseiffeli, P. embergeri, C. crenulatus, C. kamptneri, B. parca.*

Remarks: *L. quadratus* occurs rarely. Nannofossils are moderately well preserved.

Age: Mid-Maestrichtian.

Micula mura Zone

Boundaries: Base—first *Micula mura*; Top—last *Micula mura.*

Position: Core 398D-42 through Sample 398D-41-2, 40 cm.

Assemblage: Similar to *L. quadratus* Zone plus *M. mura.*

Remarks: Nannofossils are moderately well preserved. *Nephrolithus frequens* was not found, probably indicating a tropical or subtropical environment.

Age: Late Maestrichtian.

Cenozoic

Several investigators have established nannofossil zonations for the Cenozoic (Bramlette and Sullivan, 1961; Bramlette and Wilcoxon, 1967; Hay et al., 1967; Gartner, 1969; Martini, 1971; Edwards, 1971; Bukry, 1973). In many cases, these zonations are not applicable in the deep sea due to dissolution which alters the species composition, and also due to other paleoenvironmental factors. The biostratigraphic subdivision used in this report is similar to that proposed by Martini (1971) and is summarized in Figure 4. The distribution of Cenozoic calcareous nannofossils at Site 398 is shown in Figures 5 and 6.

Markalius inversus Zone

Boundaries: Base—last *Micula mura*; Top—first *Cruciplacolithus tenuis.*

Position: Sample 398D-41-2, 39 cm through Section 398D-41-1.

Assemblage: *Markalius inversus.*

Remarks: Preservation is poor with much reworking of Cretaceous species. Species diversity is very low.

Age: Early Paleocene (Danian).

Cruciplacolithus tenuis Zone

Boundaries: Base—first *C. tenuis*; Top—first *Chiasmolithus danicus.*

Position: Core 398D-49.

Assemblage: *Markalius inversus, Ch. danicus, C. tenuis, Zygodiscus sigmoides, Coccolithus pelagicus.*

Remarks: Preservation is moderately good. The *C. tenuis* zone cannot be differentiated from the *Ch. danicus Zone.* Reworked Cretaceous species are present.

Age: Early Paleocene.

Chiasmolithus danicus Zone

Boundaries: Base—first *C. danicus*; Top—first *Ellipsolithus macellus.*

Position: Core 398D-40.

Assemblage: Same as *C. tenuis* Zone.

Age	Zone	Sample (Interval in cm)	Preservation	Reworking	*Watznauria barnseae*	*Watznauria biporta*	*Watznauria communis*	*Arkhangelskiella cymbiformis*	*Broinsonia parca*	*Gartnerago obliquum*	*Kamptnerius magnificus*	*Tetralithus aculeus*	*Tetralithus copulatus*	*Tetralithus gothicus*	*Tetralithus nitidus*	*Tetralithus obscurus*	*Tetralithus pyramidus*	*Tetralithus quadratus*	*Tetralithus trifidus*	*Micula mura*	*Micula staurophora*	*Parhabdolithus angustus*	*Parhabdolithus asper*	*Parhabdolithus embergeri*	*Parhabdolithus regularis*	*Cruciellipsis chiastia*	*Cruciellipsis cuvillieri*	*Prediscosphaera cretacea*	*Lithraphidites alatus*	*Lithraphidites quadratus*	*Loxolithus armilla*
Maestrichtian	*Micula mura*	41-2, 45	– 3		F			F							F			F		F	C							R		F	F
		41-2, 47	– 2		C			F							F					F	F			R				R		F	R
		41-3, 80	– 3		C			F				F			F			F		F	A							F			
		41-4, 80	– 3		C			C				F			F			F		F	C							R			
		41-5, 57	– 3		C			C				F			F			F		F	C							R		F	
		41-6, 40	– 3		C			F	F			F			F			F		F	C							R			
		41-7, 20	– 3		C			F				F			F			R		F	C							F			
		41- CC	– 3		C			F				F			F			R		F	C							F			
		42-1, 55	– 2		C			C				F			F			F		F	C							F		R	
		42-2, 60	– 3		C			F	R			F			F			F		F	C							F		R	
		42-3, 42	– 3		C			C		R		F			F					F	C							F		R	
		42-3, 79	– 2		C			C	R	F		F			F			R		R	C				R			C		R	
		42- CC	– 2		C			C	R	F		F			F			R		R	C				R			F		R	
	Lithraphidites quadratus	43-1, 36	– 2		C			C	V	F		F			F			R			C			R	R			C		V	
		43-2, 80	– 3		C			C	R	F		F			R						C							F			
		43-3, 116	– 2		C			C	R	F		F			R						C							C			
		43-4, 58	– 3		C			C	R	F		F			F						C			R				F			
		43-5, 84	– 3		C			C	R	F		F			F			R			C			R	R			F			
		43-6, 27	– 3		C			C	R	F		F			F	R		F			C							C		R	F
		43, CC	– 3		C			C	R	F		F			F	R					C							F		R	F
		44-1, 115	– 3		C			F	R	F	R	F			F	R					C			F				F		R	F
		44-2, 35	– 3		C			C	R	F	R	F			F	R					C			F				F			F
		44-3, 90	– 3		C			F	R	F	R	F			F			R			C			F				F			F
		44-4, 56	– 3		C			C	R	F		F			F						C			F				ı			F
		44-5, 7	– 3		C			C	R	F		C			F						C			F				F			F
		44-6, 33	– 3		C			F	R	F		C									C			F				F			F
		44, CC	– 3		C			F	R	F		C									C			F				F			F
		45-1, 55	– 3		C			F	R	F		C									C			F				F			F
		45-2, 68	– 3		C			F	R	F		F									F			F				F			F
		45-3, 41	– 3		C			F	F	F		F			F						C			R				F			F
		45-4, 91	– 3		C			F	R	F		F			F						C			R				F			F
		45-5, 75	– 3		C			F	F	C		F			F						F			F				F			F
		45-6, 43	– 3		C			F	F	F		F									F			F				F			F
Campanian	*Tetralithus trifidus*	46-1, 85	– 2		C			R	F	F		F		R					R		F			F	R			F			F
		46-2, 9	– 4		C				F	F		F						R			C			R				F			F
		46-3, 58	– 3		C				F	F		F		F			R		F		C			R				F			F
		46-4, 86	– 4		C				F	R		F		R			R		F		C			R				F			F
		47-1, 99	– 2		C			R	F	F		F	V	F			F	R	C		C			F				F			F
		47-2, 62	– 2		C			R	F	F	R	F	V	F			R		F		C			F				F			F
		47-3, 103	– 3		C				F	F	R	F	R	F			R		F		F			R				F			F
		47-4, 102	– 3		C				F	F		F		F			R		F		F			R				F			F
		47-5, 79	– 3		C				F	R		F	V	F			R		F		C			R				F			F
		47, CC	– 2		C			R	F	R		F		F	F		R		F		C			R				F			F
		48-1, 33	– 3		C			R	C			F		F	F		F		F		C			R				F			F
		48-2, 132	– 3		C			F	F			F	R	F	F		F	R	F		C							F			F
		48-3, 95	– 3		C			R	F	R		F	R	F	F		F		F		C							F			F
		48-4, 30	– 3		C				F	F		F		F					F		C							F			F
		48-5, 14	– 3		C			F	F			C	R	F			F		F		F							F			F
		48-6, 82	– 3		C			R	F	F		F	R	F			F		F		C			R				F			F
		48, CC	– 3		C			F	F	F		F		F	F				C		C			R				F			F
	Tetralithus aculeus	49-1, 13	– 3		C				F	F		F		F	F						C			F				F			F
		49-1, 14	– 4		C				F			F		R	F						C							R			F
		50-1, 55	– 3		C				F			F		R							C			F				F			F
		50-2, 15	– 3		C				F			F		R	F						C			F				F			F
		50-3, 8	– 3		C				C			F		R	F						C							F			F
		50-4, 8	– 3		C			F	C			F		R	F						C			R				R			F
		50-5, 97	– 3		C				F			F			F						C							R			F
		50-6, 10	– 5		C			R	F	F		F			F						C			F				F			F

Figure 3. *Distribution of Mesozoic calcareous nannofossils at Site 398.*

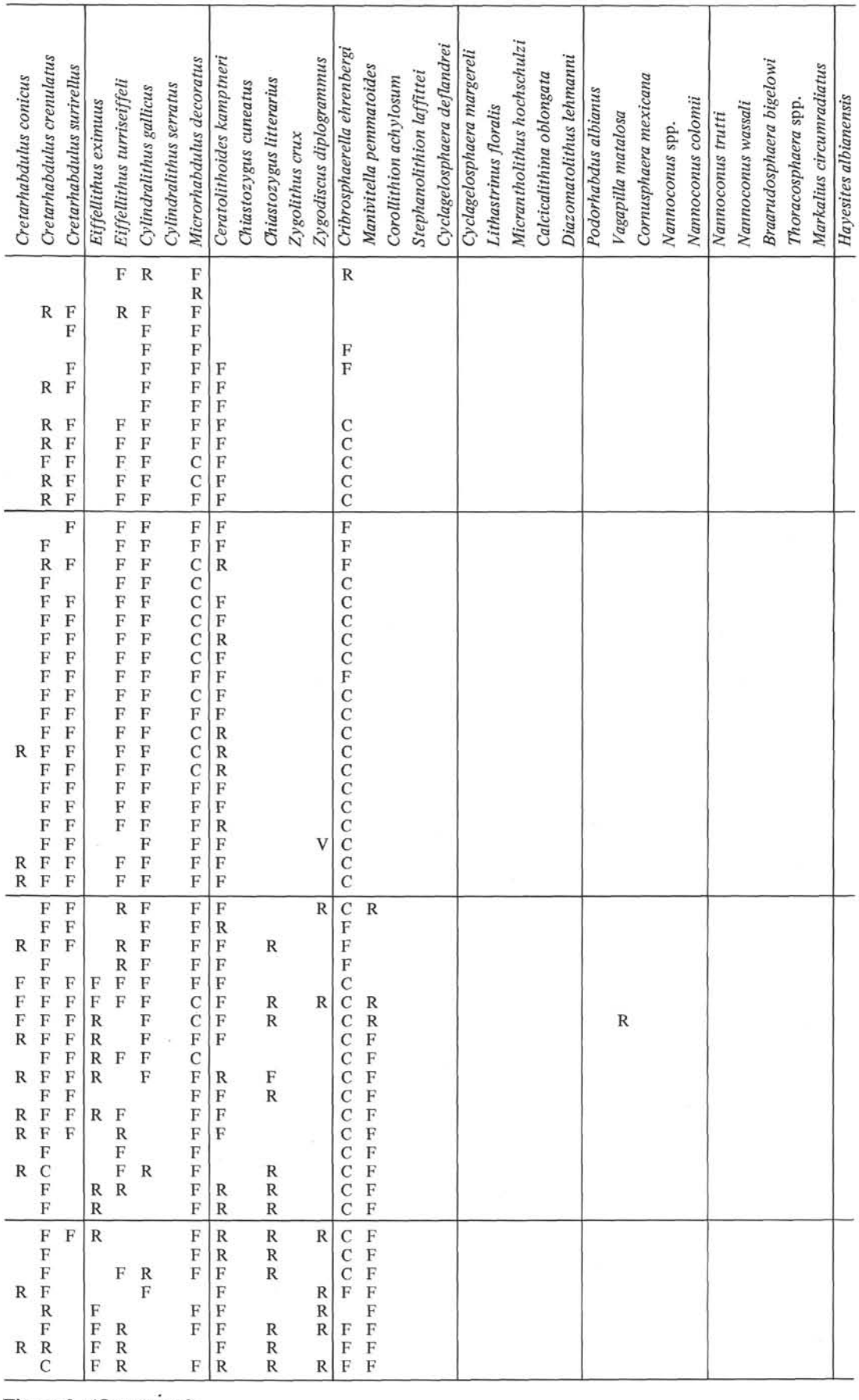

Figure 3. *(Continued).*

Age	Zone	Sample (Interval in cm)	Preservation	Reworking	*Watznauria barnseae*	*Watznauria biporta*	*Watznauria communis*	*Arkhangelskiella cymbiformis*	*Broinsonia parca*	*Gartnerago obliquum*	*Kamptnerius magnificus*	*Tetralithus aculeus*	*Tetralithus copulatus*	*Tetralithus gothicus*	*Tetralithus nitidus*	*Tetralithus obscurus*	*Tetralithus pyramidus*	*Tetralithus quadratus*	*Tetralithus trifidus*	*Micula mura*	*Micula staurophora*	*Parhabdolithus angustus*	*Parhabdolithus asper*	*Parhabdolithus embergeri*	*Parhabdolithus regularis*	*Cruciellipsis chiastia*	*Cruciellipsis cuvillieri*	*Prediscosphaera cretacea*	*Lithraphidites alatus*	*Lithraphidites quadratus*	*Loxolithus armilla*
?	?	50-7, 30	– 5																												
		50, CC	– 5																												
		51-2, 50	– 5																												
		51-3, 99	– 5																												
		51, CC	– 5		V																										
		52-3, 33	– 5																												
		52-4, 44	– 5																												
		52, CC	– 5																												
		53-1, 130	– 5		V																										
		53-2, 141	– 5																												
		53-5, 70	– 5																												
		53, CC	– 5																												
		54-1, 46	– 5																												
	?	54, CC	– 5																												
		55-1, 94	– 5																												
		56-1, 15	– 5		V																										
		56-1, 116	– 5																												
		56-2, 65	– 5																												
Cenomanian	*Lithraphidites alatus*	56-3, 90	– 4		C																										
		56-3, 105	– 3		C																R	R						F			F
		56-4, 68	– 2		C		R																	F				F	R		F
		56-5, 113	– 2		C		R															F		F				F			F
		56-6, 51	– 2		C		R																	F					R		
		56, CC	– 2		C		R																	F				R	V		F
		57-1, 25	– 3		C		R															R	R	F				R	V		F
Late Albian	*Eiffelithus turriseiffeli*	57-2, 49	– 3		C		R															R	F	F				F			F
		57-3, 87	– 3		C		F															R	R	F				F			F
		57-4, 21	– 3		C		F															F	F	F				F			F
		57-5, 88	– 3		C		R															R	F	F				F			F
		57, CC	– 3		C		R															R	R	F				F			F
		58-1, 122	– 3		C		R															R	R	F				F			F
		58-2, 87	– 4		C		R															R	R	F							F
		58, CC	– 4		C																	R	R	R							
		59-1, 82	– 5																			R									
		59-2, 90	– 3		C																	F	F	F				F			F
		59-3, 47	– 4		C																	R		F				F			F
		59-4, 19	– 3		C																		F	F				R			F
		59-5, 41	– 5																												
		59-6, 14	– 3		C																		R		R		F				
		59-7, 34	– 3		C																	R	R		R		F				F
		59, CC	– 3		C																	R	R	F	R		F				F
		60-1, 109	– 3		C																		R	F	R		F				F
		60-3, 15	– 3		C																		R	F	F						F
		60-3, 102	– 3		C																		R		R						F
		60, CC	– 3		C																										F
Albian	*Prediscosphaera cretacea*	61-1, 40	– 3		C																		R	F	R		F				F
		61-2, 65	– 3		C		R															R	R	F	R		F				F
		62-1, 66	– 4		C		R																F	F	R						F
		62-2, 24	– 3		C																	R		F	F		F				F
		62-3, 27	– 4		F																			R							
		62-4, 81	– 4		C																	R	R					R			F
		62-5, 110	– 4		F																							R			
		62-6, 66	– 4		F																		R					R			R
		62-7, 27	– 4		F																										
		63-1, 49	– 3		C	R																	F	F	R		F				
		63-2, 89	– 5																												
		63-3, 13	– 4		C																		F				F				F
		63-3, 95	– 5																												

Figure 3. *(Continued).*

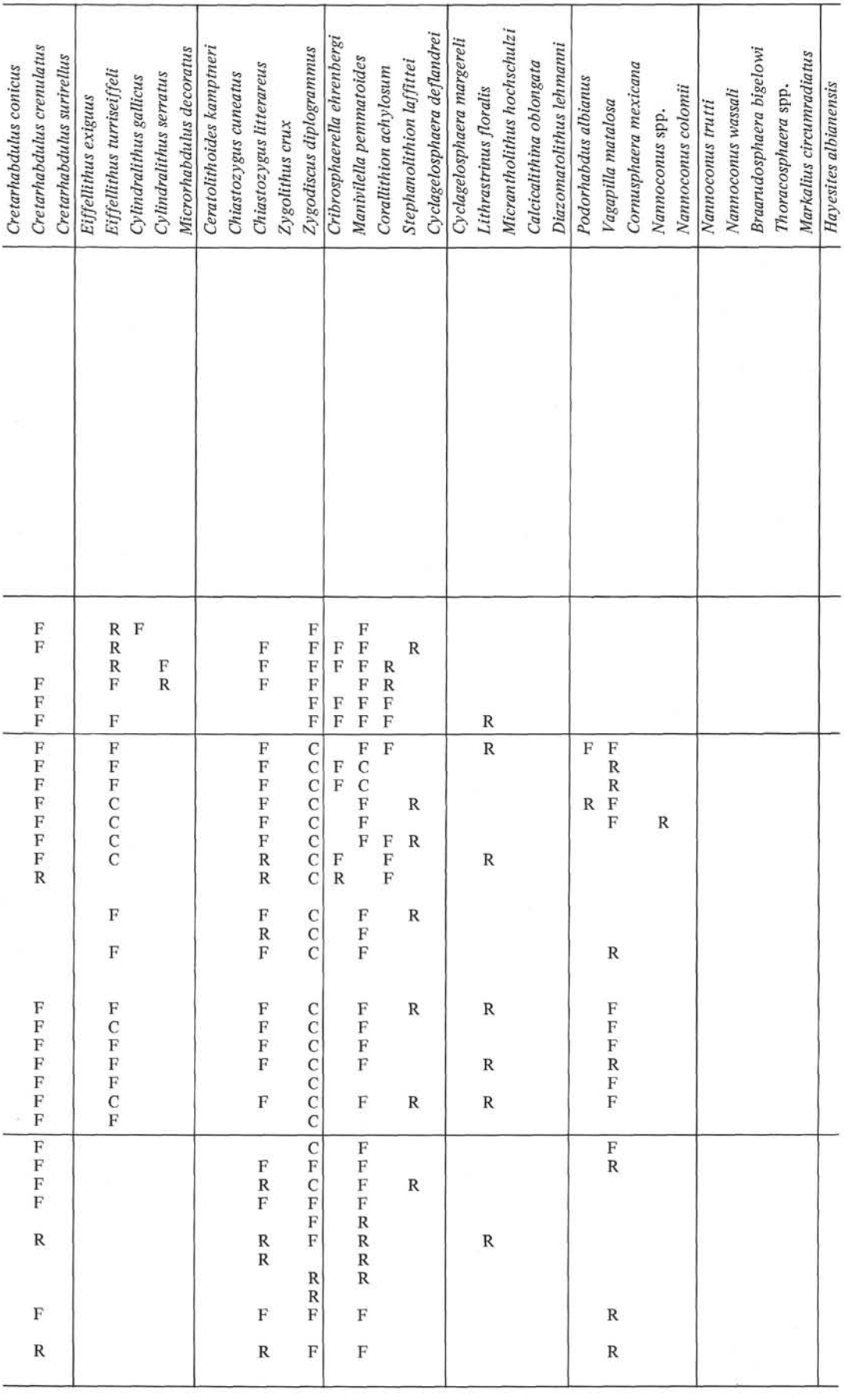

Figure 3. *(Continued).*

Age	Zone	Sample (Interval in cm)	Preservation	Reworking	*Watznauria barnseae*	*Watznauria biporta*	*Watznauria communis*	*Arkhangelskiella cymbiformis*	*Broinsonia parca*	*Gartnerago obliquum*	*Kamptnerius magnificus*	*Tetralithus aculeus*	*Tetralithus copulatus*	*Tetralithus gothicus*	*Tetralithus nitidus*	*Tetralithus obscurus*	*Tetralithus pyramidus*	*Tetralithus quadratus*	*Tetralithus trifidus*	*Micula mura*	*Micula staurophora*	*Parhabdolithus angustus*	*Parhabdolithus asper*	*Parhabdolithus embergeri*	*Parhabdolithus regularis*	*Cruciellipsis chiastia*	*Cruciellipsis cuvillieri*	*Prediscosphaera cretacea*	*Lithraphidites alatus*	*Lithraphidites quadratus*	*Loxolithus armilla*
Albian	*Prediscosphaera cretacea*	63-4, 25	– 5																											
		63-5, 94	– 4		F																									
		63-6, 82	– 5		R																									
		63-6, 85	– 5		R																	R								R
		65-1, 63	– 4		F																	R			R					R
		65-2, 66	– 4		C																	F	R							F
		65-3, 46	– 3		C																	F	F		R		F			F
		65-4, 78	– 3		C																	F	F		F		F			F
		65-5, 55	– 4		C																	F	R		F		R			F
		65-6, 66	– 4		C																R	F	F		F		F			F
		65-7, 17	– 4		F																V	F								
		66-1, 91	– 4		F		R															F	R		R					F
		66-2, 30	– 4		F																	R								R
		66, CC	– 4		F																R	R								R
		67-1, 76	– 4		R	R																R								R
		67-2, 116	– 3		C	F	R														R	R	R		R		R			C
		67-3, 9	– 5																											
		67-4, 25	– 3		C	F	R														F	R	F		F		F			F
		67-4, 49	– 4		R																R	R	F							F
		68-1, 101	– 4		R																									V
		68-2, 9	– 5		R																									
		68-3, 45	– 4		F	R															R	R	R		R		R			R
		68-4, 33	– 5		R																									
		68-5, 24	– 5		R																									
		68-5, 68	– 4		R																R	R	R							
		69-1, 27	– 4		F																		R							R
		69-2, 23	– 3		C		R															F	F		R		R			F
		69-3, 50	– 5		R																									
		69-4, 74	– 3		C	F															F	F	F		R		R			F
		69-5, 66	– 3		C	F															R	C	F		F		F			F
		69-5, 86	– 4		F	F															R									
		69, CC	– 4		F																R									
		70-1, 48	– 3		C	F																F	F		F		R			F
		70-2, 36	– 4		C	R																F	R		R		F			F
		70-3, 45	– 3		C	F	R														F	F	F							F
		70-3, 92	– 5																											
		71-1, 64	– 4		C	F																F	F		R					F
		71-2, 78	– 3		C	F																F	F				R			F
		71-3, 91	– 4		C	R	R															F	F		R		R			F
		71-4, 84	– 5		R																	V								
		71-4, 92	– 5																											
		72-1, 27	– 4		C	F	R														R	F	F				R			F
		72-2, 127	– 3		C	F	F																F		F					F
		72-3, 134	– 5		V																									
		72-4, 91	– 4		C		F															F	F				R			F
		72-5, 56	– 5		V																									
		72-6, 8	– 4		F																									F
		72-7, 10	– 5																											
		72, CC	– 5																											
		73-1, 9	– 5		V																	V								
		73-2, 127	– 3		C	F	R														F	F	F					F		F
		73-3, 93	– 4		C		R															F	F		F					F
		73-4, 36	– 4		C	F	R															F	R		R					F
		73-5, 11	– 4		C		R															F			R					F
		73-6, 8	– 3		C																F	C	F		R		F			F
		73-6, 67	– 4		C																R	C	F							F
		74-1, 54	– 3		C	F	F														F	C								F
		74-2, 81	– 4		C	F	R															F	F		R					F
		74-3, 34	– 4		C	F																C	F							F

Figure 3. *(Continued).*

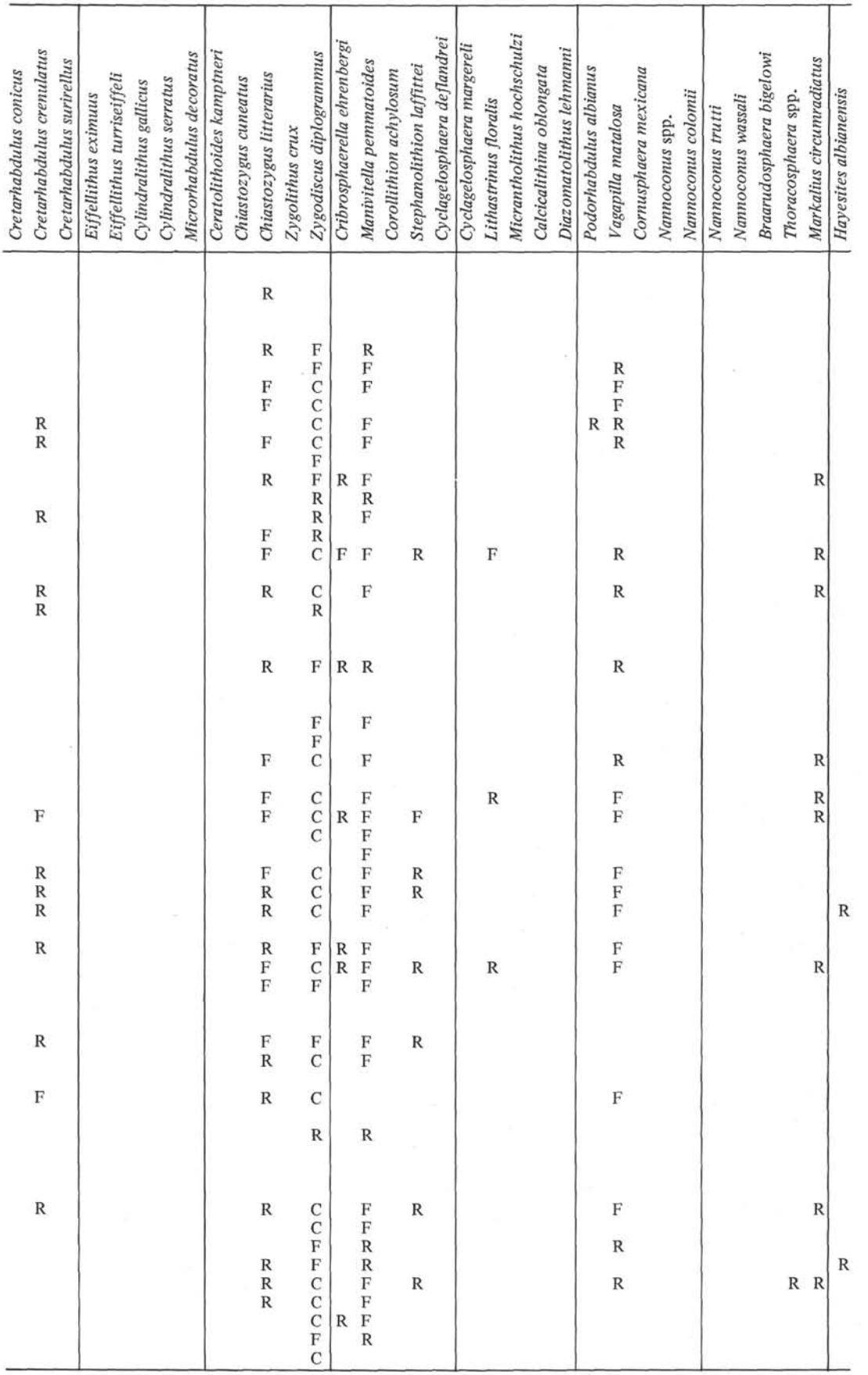

Figure 3. *(Continued).*

Age	Zone	Sample (Interval in cm)	Preservation	Reworking	*Watznauria barnseae*	*Watznauria biporta*	*Watznauria communis*	*Arkhangelskiella cymbiformis*	*Broinsonia parca*	*Gartnerago obliquum*	*Kamptnerius magnificus*	*Tetralithus aculeus*	*Tetralithus copulatus*	*Tetralithus gothicus*	*Tetralithus nitidus*	*Tetralithus obscurus*	*Tetralithus pyramidus*	*Tetralithus quadratus*	*Tetralithus trifidus*	*Micula mura*	*Micula staurophora*	*Parhabdolithus angustus*	*Parhabdolithus asper*	*Parhabdolithus embergeri*	*Parhabdolithus regularis*	*Cruciellipsis chiastia*	*Cruciellipsis cuvillieri*	*Prediscosphaera cretacea*	*Lithraphidites alatus*	*Lithraphidites quadratus*	*Loxolithus armilla*
Albian	*Prediscosphaera cretacea*	74-4, 121	– 3		C																		C		R		R		F
		74-5, 32	– 3		C		R																C	F	R				F
		74-6, 33	– 3		C	F																F	C		R		R		F
		75-1, 106	– 3		C	F																	C	F	F				F
		75-2, 74	– 4		C	F	R																F						F
		75-3, 75	– 5																											
		75-4, 10	– 4		C	F	F																F						F
		75, CC	– 5																											
		76-1, 51	– 4		R																		R							
		76-2, 119	– 4		C	F																R	C	F				R		F
		76-3, 92	– 4		C																		C	F	R					F
		77-1, 116	– 4		R																									
		77-3, 119	– 4		C	F	F																F	F						F
		77-5, 62	– 5																											
		77-5, 117	– 4		V																		V							
		77-6, 13	– 4		R																									
		77-7, 39	– 4		F	R																								R
		77, CC	– 5		V																									
		78-1, 22	– 4		F	V																	R							R
		78-2, 24	– 5		R																									R
		78-3, 79	– 5																											
		78-4, 110	– 4		F	R																		V						R
		78-5, 126	– 4		F																									
		78-6, 35	– 4		R																		V							V
		78, CC	– 5																											
		79-2, 142	– 5		V																									
		79-4, 81	– 5																											
		79-5, 29	– 5																											
		80-1, 90	– 4		R																									
		80-3, 110	– 5																											
		80-4, 86	– 4		F																									
		80-4, 104	– 5		R																									
		81-1, 28	– 5																											
		81-3, 88	– 5																											
		81-4, 120	– 5		V																									
		82-1, 59	– 5		R																									
		82-2, 81	– 5																											
		82-3, 126	– 5																											
		82-4, 131	– 5																											
		82-6, 97	– 5																											
		82, CC	– 5																											
		83, CC	– 4		R																									V
		84-1, 44	– 3		C	F	F															F	C		F		R			F
		84-2, 126	– 5		R																									
		84-3, 104	– 4		R																									
		84-5, 100	– 5																											
		84-6, 119	– 4		F	F	R																R							R
		85-1, 34	– 5																											
		85-2, 123	– 2		C	F	F																F	F	F		R			F
		85-3, 67	– 5																											
		85-4, 115	– 3		C	F																	C	F	R		R			
		86-1, 131	– 3		C	F																F	C	F	F		V			F
		86-2, 13	– 3		C	F																R	C	F	F		R			F
		86-3, 19	– 5																											
		86-4, 19	– 4		F		R																R							
		86-5, 57	– 3		C	F																	F	F	F					F
		86-5, 146	– 5																											
		87-1, 54	– 3		C	F																F	C	F	F					C

Figure 3. *(Continued).*

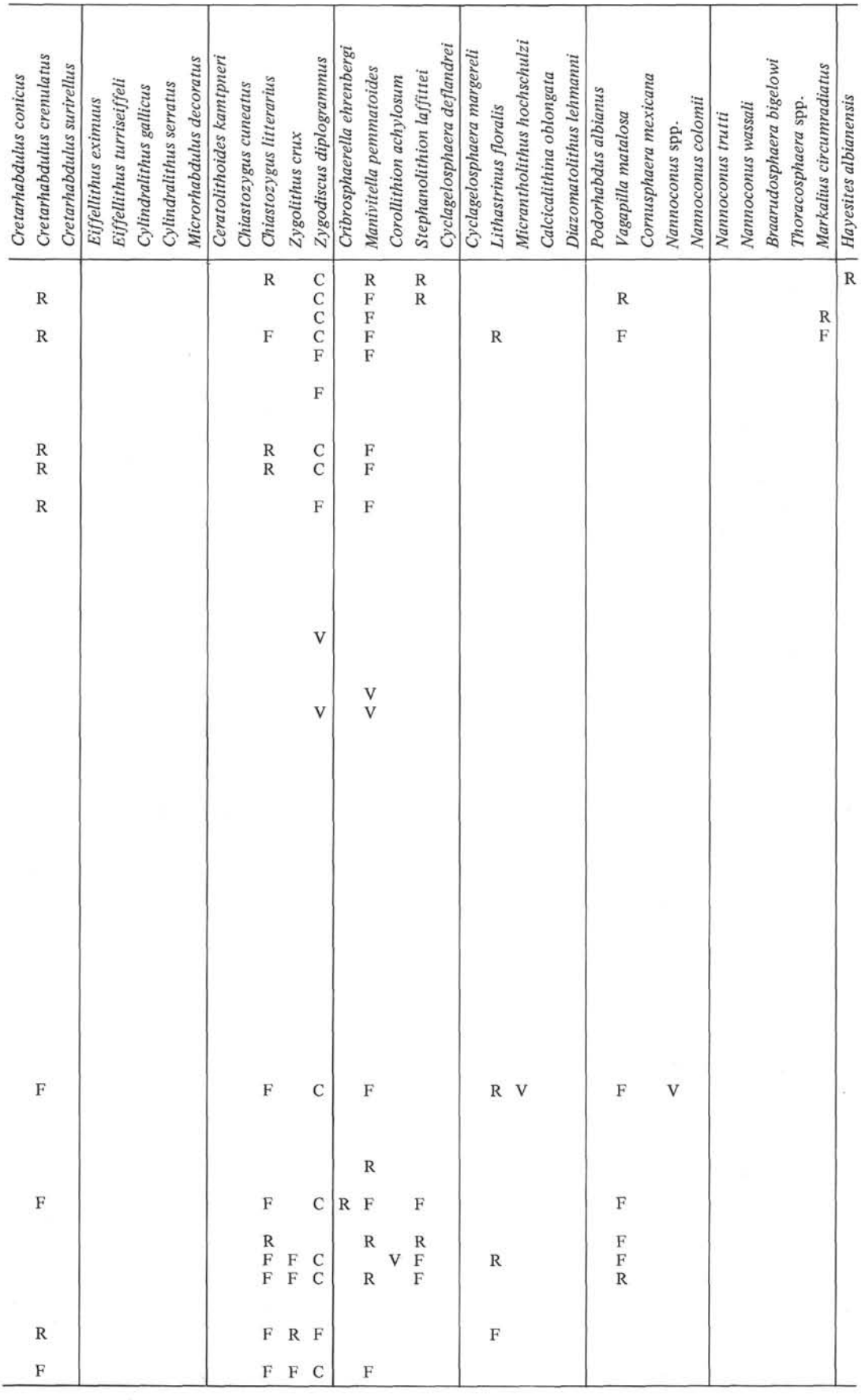

Figure 3. *(Continued).*

Age	Zone	Sample (Interval in cm)	Preservation	Reworking	*Watznauria barnseae*	*Watznauria biporta*	*Watznauria communis*	*Arkhangelskiella cymbiformis*	*Broinsonia parca*	*Gartnerago obliquum*	*Kamptnerius magnificus*	*Tetralithus aculeus*	*Tetralithus copulatus*	*Tetralithus gothicus*	*Tetralithus nitidus*	*Tetralithus obscurus*	*Tetralithus pyramidus*	*Tetralithus quadratus*	*Tetralithus trifidus*	*Micula mura*	*Micula stauropbora*	*Parhabdolithus angustus*	*Parhabdolithus asper*	*Parhabdolithus embergeri*	*Parhabdolithus regularis*	*Cruciellipsis chiastia*	*Cruciellipsis cuvillieri*	*Prediscosphaera cretacea*	*Lithraphidites alatus*	*Lithraphidites quadratus*	*Loxolithus armilla*
Albian	*Prediscosphaera cretacea*	87-2, 92	– 5																											
		87-3, 43	– 5																											
		87-4, 34	– 5																											
		87-5, 107	– 5																											
		87, CC	– 5																											
		88-1, 34	– 5																											
		88-2, 90	– 5		R																									
		88-3, 86	– 5																											
		88-5, 74	– 5		V																									
		88-6, 76	– 5																											
		88, CC	– 5																											
		89-1, 71	– 5																											
		89-2, 110	– 5																											
		89-3, 86	– 5																											
		89-4, 88	– 5																											
		89-5, 93	– 4		F																		R							
		89, CC	– 5																											
		90-1, 32	– 5																											
		90-2, 12	– 4		F																		R			R				
		90-3, 104	– 5																											
		90-4, 50	– 5																											
		90, CC	– 5																											
		91-1, 38	– 5																											
		91-2, 116	– 4		F		F																R			R				R
		91-4, 93	– 4		F		R																							
		91-5, 20	– 5																											
		92-1, 125	– 5																											
		92-2, 118	– 5																											
		92-3, 101	– 4		F		R																F	R		R		V		R
		92-4, 123	– 4		F		R																							
		92-6, 139	– 4		R	R																				R				
		92-7, 24	– 5																											
		93-1, 108	– 4		F		R																							
		94-1, 134	– 4		F																		R	R						
		94-2, 7	– 5		F		R																							
		94, CC	– 5																											
		95-1, 27	– 5																											
		95-2, 32	– 5				V																							
		95-4, 84	– 4		F		R																							R
		95-5, 6	– 5		V																									
		95-6, 122	– 5		V																									
		96-1, 32	– 5																											
		96-2, 29	– 5		V																									
		96-3, 92	– 4		R		R																							
		96-4, 33	– 5																											
		96-5, 74	– 5																											
		96-6, 124	– 5																											
		96, CC	– 5		V																									
		97-1, 86	– 4		R																									
		97-2, 123	– 5																											
		97-4, 110	– 5		V																									
		97-5, 91	– 4		F																									
		97, CC	– 4		F		R																R							F
	Parhabdolithus angustus	98-1, 100	– 5																											
		98-2, 55	– 5																											
		99-1, 18	– 4		F																			R						R
		99-2, 133	– 5		V																									
		99-3, 78	– 5																											

Figure 3. *(Continued).*

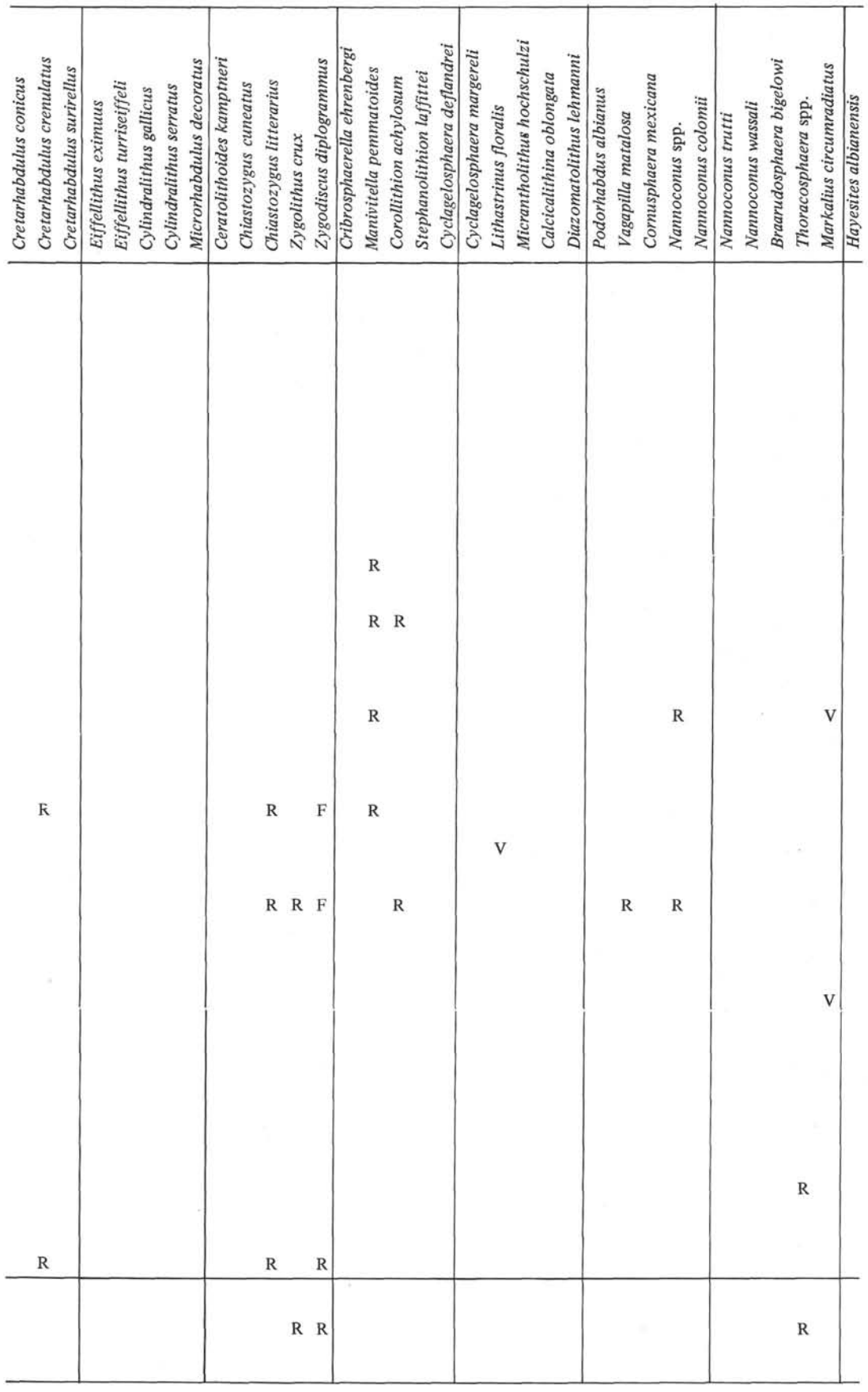

Figure 3. *(Continued).*

Age	Zone	Sample (Interval in cm)	Preservation	Reworking	*Watznauria barnseae*	*Watznauria biporta*	*Watznauria communis*	*Arkhangelskiella cymbiformis*	*Broinsonia parca*	*Gartnerago obliquum*	*Kamptnerius magnificus*	*Tetralithus aculeus*	*Tetralithus copulatus*	*Tetralithus gothicus*	*Tetralithus nitidus*	*Tetralithus obscurus*	*Tetralithus pyramidus*	*Tetralithus quadratus*	*Tetralithus trifidus*	*Micula mura*	*Micula staurophora*	*Parhabdolithus angustus*	*Parhabdolithus asper*	*Parhabdolithus embergeri*	*Parhabdolithus regularis*	*Crucicllipsis chiastia*	*Crucicllipsis cuvillieri*	*Prediscosphaera cretacea*	*Lithraphidites alatus*	*Lithraphidites quadratus*	*Loxolithus armilla*
Aptian	*Podorhabdolithus angustus*	99-5, 51	– 5		V																									
		99-6, 104	– 5		V																									
		99, CC	– 5		V																									
		100-1, 17	– 5																											
		100-2, 13	– 5																											
		100-3, 51	– 5																											
		100-4, 8	– 5		V																									
		100-5, 99	– 5																											
		100-6, 4	– 5																											
		100-6, 50	– 4		R																		R							
		101-1, 116	– 4		F																									
		101-2, 125	– 4		R	R																								R
		101-4, 102	– 3		C																		F	F						F
		101-6, 40	– 5		V																									
		101-6, 148	– 5																											
		102-1, 64	– 5																											
		102-2, 51	– 3		C	F	R																R	R		R				F
		102-3, 107	– 5																											
		102-4, 105	– 5		V																									
		102-5, 88	– 5																											
		102, CC	– 5																											
		103-1, 136	– 4		C	F	F																							F
		103-2, 22	– 3		C		F															R	F	F		F				F
		103-3, 45	– 3		C	F																	F	F		F				F
		103-5, 84	– 3		C	F	F																F	F		F				F
		103-6, 56	– 3		C	F																F	F	F		F				C
		103, CC	– 3		C	F																	C	F						F
		104-1, 128	– 3		C	F																	C	R						F
		104-2, 68	– 3		C	C																F	C	R						F
		104-3, 103	– 3		C	F																F	C	F						F
		104-4, 10	– 3	X	C	F																F	C	F		F				F
		104, CC	– 3	X	C																	F	C	F						F
		105-1, 73	– 4	X	F																			F						
		105-2, 77	+ 2	X	F																									
		105-3, 113	– 3		C	F	F															F	C	F						F
		106-1, 118	– 4		C																									
		106-2, 83	– 3		C																	F	C	F						F
		106-3, 28	– 3		C																	F	C	F						F
		106-4, 66	– 4		C	F																	F	F						F
		106-5, 30	– 3		C		F															F	C	F						F
		106-6, 39	– 3		F		F																C	F						C
		106, CC	– 5																											
		107-1, 79	– 3		C		R															R	C	F		F				F
		107-2, 94	– 4		C	F																R	C	F		F				F
		107-3, 69	– 5																											
		107-4, 52	– 3	X	C	F																	C	F		F				F
		107-5, 51	– 3	X	C	F	F															F	C	F						F
		108-1, 23	– 4		F	R																				F				
		108-2, 106	– 3		C	F	R															R	F	F						F
	Lithastrinus floralis	108-4, 42	– 5		V																									
		108-5, 85	– 4		C	F	F																F							
		108-6, 16	– 3		C	F	F																F							
		108, CC	– 5																											
		109-1, 120	– 4		C																		F	F		F				F
		109-2, 99	– 3		C																		C	F		F				F
	a	109-3, 32	– 4		C	F																	F							R
		109, CC	– 4		C																		F	R						F

Figure 3. *(Continued).*

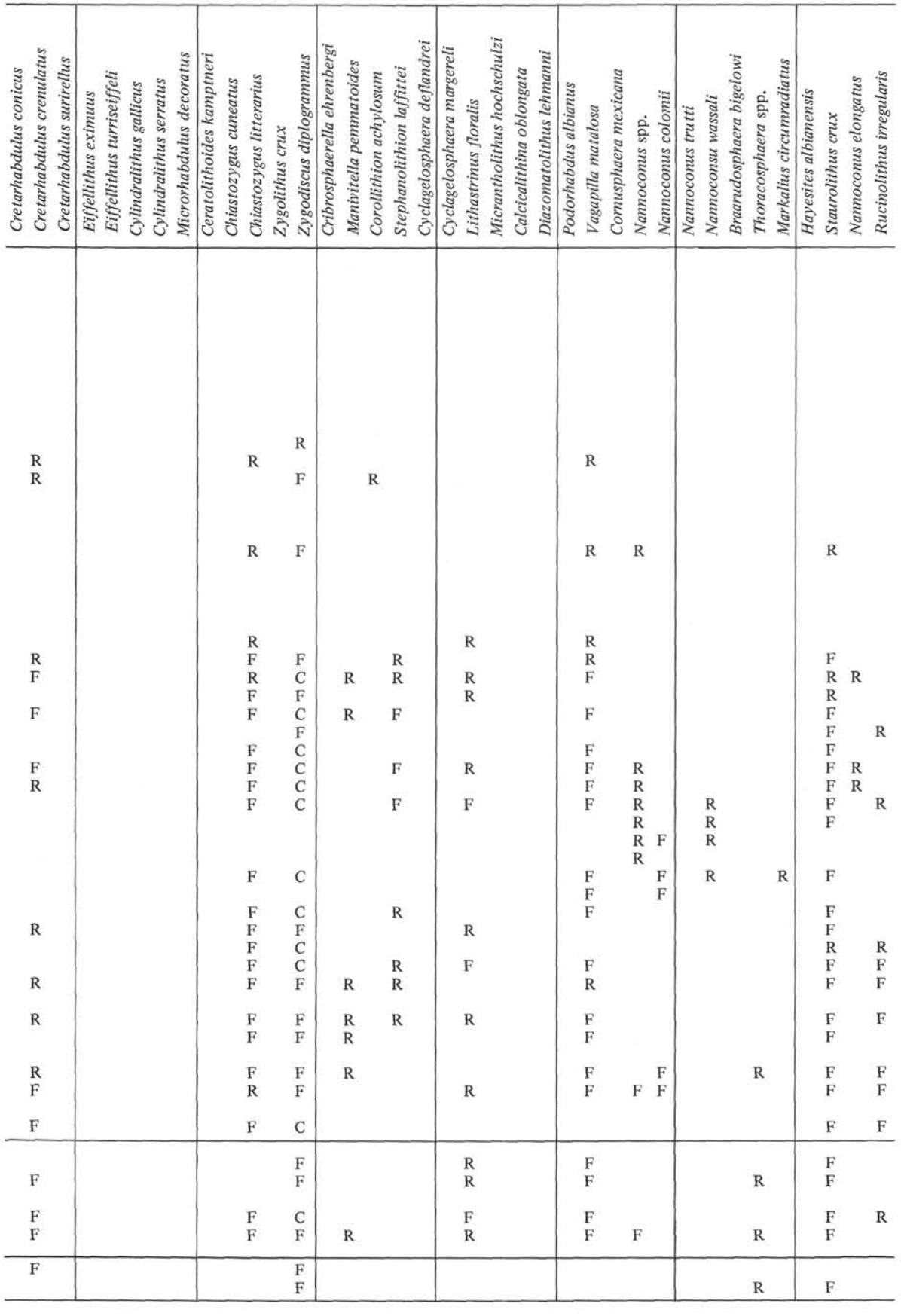

Figure 3. *(Continued).*

Age	Zone	Sample (Interval in cm)	Preservation	Reworking	*Watznauria barnseae*	*Watznauria biporta*	*Watznauria communis*	*Arkhangelskiella cymbiformis*	*Broinsonia parca*	*Gartnerago obliquum*	*Kamptnerius magnificus*	*Tetralithus aculeus*	*Tetralithus copulatus*	*Tetralithus gothicus*	*Tetralithus nitidus*	*Tetralithus obscurus*	*Tetralithus pyramidus*	*Tetralithus quadratus*	*Tetralithus trifidus*	*Micula mura*	*Micula staurophora*	*Parhabdolithus angustus*	*Parhabdolithus asper*	*Parhabdolithus embergeri*	*Parhabdolithus regularis*	*Cruciellispis chiastis*	*Cruciellipsis cuvillieri*	*Prediscosphaera cretacea*	*Lithraphidites alatus*	*Lithraphidites quadratus*	*Loxolithus armilla*
Aptian	*Chiastozygus litterareus*	110, CC	– 4		C	R	R															R	R							
		111-1, 21	– 4		C	F																								
		111-2, 58	– 5																											
		111-3, 80	– 5																											
		111-4, 45	– 5																											
		111-6, 61	– 5																											
		111, CC	– 3		F																V		R							
		112-1, 100	– 5																											
		112-3, 65	– 5																											
		112-4, 98	– 4		F		R															R								
		112-5, 53	– 4		C	F																F	R							F
		112, CC	– 5		V																	V								
		113-1, 98	– 5		V																									
		113-2, 43	– 4		F	R																								
		113-3, 76	– 3		C																	F	F		R					R
		113-4, 93	– 5																											
		113-5, 82	– 5		V																									
		113-7, 7	– 5																											
		113, CC	– 3																											
		114-1, 53	– 5																											
		114-2, 99	– 3		C																	F	R							
		114-4, 146	– 5		V																									
		114-5, 131	– 4		C																	F	F							
		115-1, 112	– 5																											
		115-2, 147	– 5																											
		115-3, 115	– 4		F	R																R								R
		115, CC	– 5																											
		116-1, 141	– 5																											
		116-2, 41	– 5																											
		116-3, 73	– 5																											
		117-1, 138	– 5																											
		117-2, 137	– 5																											
		117-3, 146	– 5																											
		117-4, 8	– 5																											
		117-5, 29	– 5																											
		117-6, 22	– 5		V																									
		117, CC	– 5																											
		118-1, 2	– 4		F																	V								
		118-2, 130	– 5																											
		118-3, 41	– 5		V																									
		118-4, 103	– 5																											
		118-6, 99	– 5																											
		118-7, 40	– 5																											
		119-1, 21	– 5																											
		119-2, 18	– 5																											
		119-4, 40	– 5																											
		119-4, 115	– 5																											
		119-5, 10	– 5																											
		119-6, 33	– 5																											
		119, CC	– 5																											
		120-1, 51	– 4		F	R																F	R							
		120-2, 14	– 4	X	F	R																	R							
		120-3, 13	– 3		C	F																F	F		R					
		120-4, 87	– 3		C																	C	C							
		120-6, 33	– 3		C	F	F															C	F						F	
		120, CC	– 3		C																	C	F							
		121-1, 21	– 4	X	F																	R								
		121-3, 101	– 3		C		F															F	R							
		121-6, 5	– 3		C																	C	F		F				F	

Figure 3. *(Continued).*

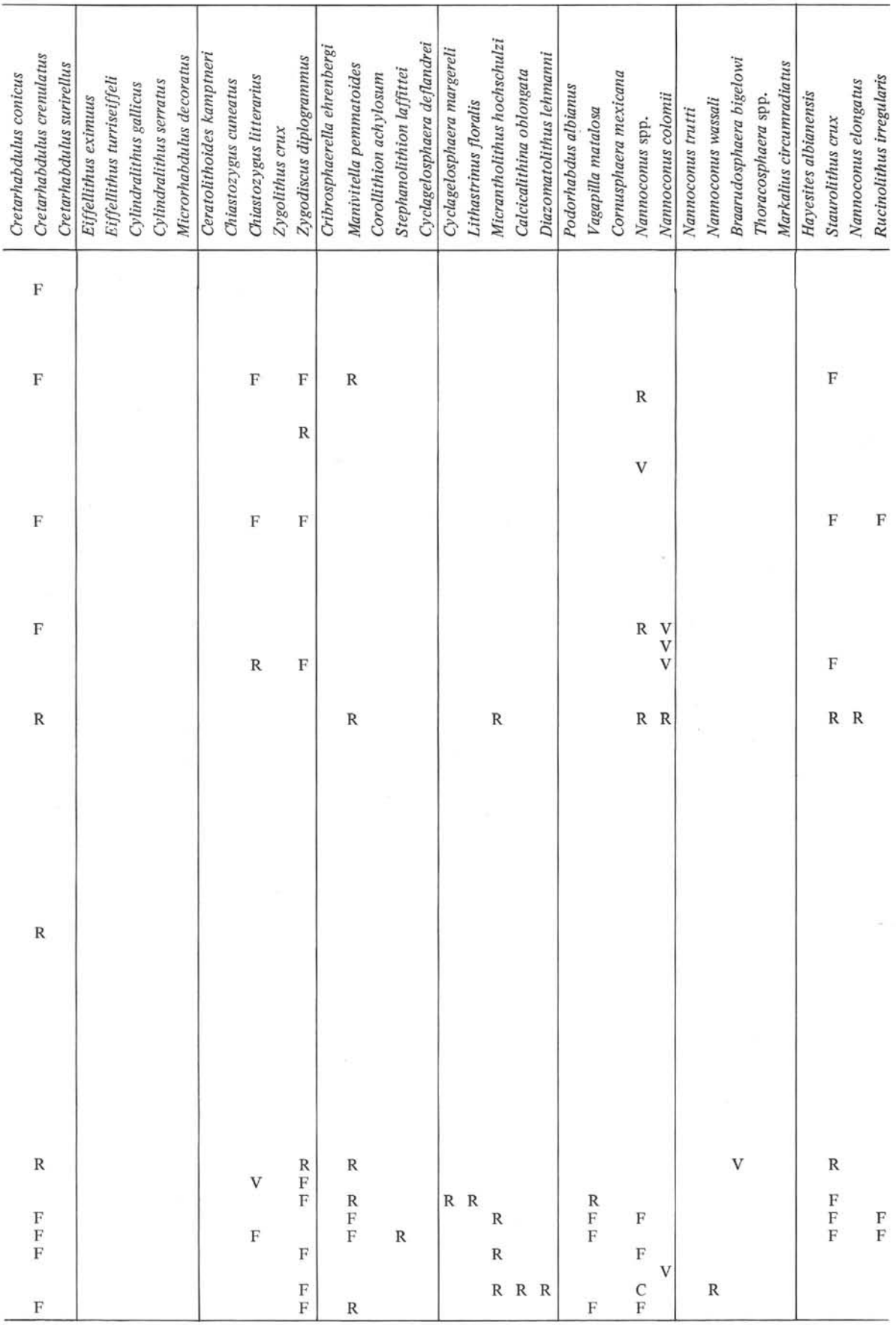

Figure 3. *(Continued).*

Age	Zone	Sample (Interval in cm)	Preservation	Reworking	*Watznauria barnseae*	*Watznauria biporta*	*Watznauria communis*	*Arkhangelskiella cymbiformis*	*Broinsonia parca*	*Gartnerago obliquum*	*Kamptnerius magnificus*	*Tetralithus aculeus*	*Tetralithus copulatus*	*Tetralithus gothicus*	*Tetralithus nitidus*	*Tetralithus obscurus*	*Tetralithus pyramidus*	*Tetralithus quadratus*	*Tetralithus trifidus*	*Micula mura*	*Micula staurophora*	*Parhabdolithus angustus*	*Parhabdolithus asper*	*Parhabdolithus embergeri*	*Parhabdolithus regularis*	*Cruciellipsis chiastia*	*Cruciellipsis cuvillieri*	*Prediscosphaera cretacea*	*Lithraphidites alatus*	*Lithraphidites quadratus*	*Loxolithus armilla*
Aptian	a	122-1, 85	– 4		C	F																F	F						F	
		122-3, 34	– 3		C																	C								
		122-4, 90	– 3		A	F																C								
		122-7, 10	– 4		C																	F	F							
		123-1, 82	– 3		A	F																C	F							
Barremian	*Nannoconus colomii*	123-3, 86	– 3		C																	C	F							
		123-5, 72	– 3		C																	C								
		124-1, 86	– 4		C	F																C								
		124-4, 3	– 3		C		F															C	F							
		124-4, 49	– 4	X	C																	C	F							
		125-1, 118	– 4		R																									
		125-4, 25	– 4		C																		F							
		125-6, 13	– 4		C																		F							
		125, CC	– 4		C																	F	F							
		126-1, 110	– 4		C																	F								
		126-3, 111	– 3	X	C																	C								
	Calcicalithina oblongata	126-5, 27	– 3		C																	C	R		R					
		127-1, 42	– 3		C	F																C	F							
		127-3, 2	– 3		C																	C								
		127-5, 120	– 4		C																	C								
		127, CC	– 3		C																	C	F							
		128-1, 73	– 3		C	F																C	F							
		128-3, 63	– 3		C																	C								
		128-4, 105	– 3		C																	C	R							
		129-1, 49	– 4		C	F																F								
		129-4, 27	– 4		C																	C	F							
		129-7, 33	– 4		C																	C								
		130-1, 26	– 4		C																	F								
		130-4, 73	– 4		C																	C	F							
		130-5, 5	– 5																											
		131-1, 20	– 4		C																	C								
		132-1, 24	+ 5																											
		132-2, 144	– 3		C																	C	F							
		132-3, 82	– 4		C																	F	F							
		133-1, 22	– 4		C																	F	F							
		133-4, 55	– 4		C																	C								
		133, CC	– 4		C																	C	F							
		134-1, 62	– 4		C																	C								
		134-4, 6	– 4		C		F															C	F							
		135-1, 67	– 4		C																	C	F							
		135-4, 13	– 4		C																	C	F							
		135, CC	– 3		C																	C	F							
Late Hauterivian	*Cruciellipsis cuvillieri*	136-1, 68	– 4		C																	C				R				
		136-3, 3	– 4		C																	F	F			R				
		136-3, 80	– 4		C																	F	F							
		137-1, 31	– 4		C																	F	F							
		137-3, 131	– 4		C																	F	F							
		138-1, 58	– 4		C																	F	F							
		138-2, 52	– 4		C																	F	F							

[a]*Chiastozygus litterarius.*

Figure 3. *(Continued).*

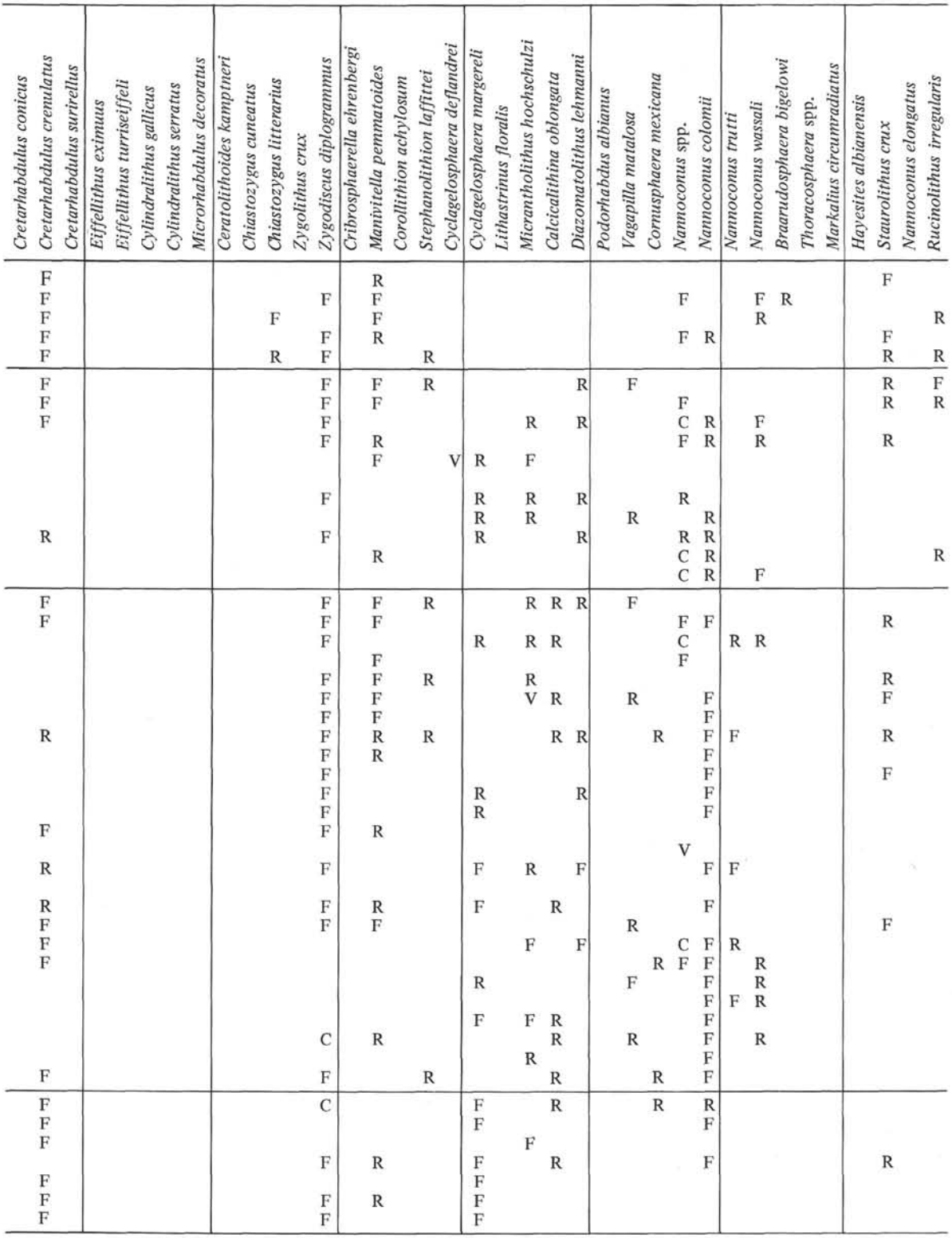

Figure 3. *(Continued).*

AGE	ZONE	BOUNDARY DATUM
Pleistocene	*Emiliania huxleyi*	Recent
	Gephyrocapsa oceanica	First *Emiliania huxleyi*
	Pseudoemiliania lacunosa	Last *Pseudoemiliania lacunosa*
Pliocene	*Discoaster brouweri*	Last *Discoaster brouweri*
	Discoaster pentaradiatus	Last *Discoaster pentaradiatus*
	Discoaster surculus	Last *Discoaster surculus*
	Reticulofenestra pseudoumbilica	Last *Reticulofenestra pseudoumbilica*
	Discoaster asymmetricus	Last *Ceratolithus tricorniculatus*
	Ceratolithus tricorniculatus	First *Discoaster asymmetricus*
Miocene	*Discoaster quinqueramus*	Last *Discoaster quinqueramus*
	Discoaster calcaris	First *Discoaster quinqueramus*
	Discoaster hamatus	Last *Discoaster hamatus*, Last *Discoaster neorectus*
	Catinaster coalitus	First *Discoaster hamatus*
	Discoaster kugleri	Last *Discoaster kugleri*
	Discoaster exilis	First *Discoaster kugleri*
	Sphenolithus heteromorphus	Last *Sphenolithus heteromorphus*
	Helicopontosphaera ampliaperta	Last *Helicopontosphaera ampliaperta*
	Sphenolithus belemnos	First *Sphenolithus heteromorphus*, Last *S. belemnos*
	Discoaster druggi	Last *Discoaster druggi*
	Triquetrorhabdulus carinatus	First *Discoaster druggi*
Oligocene	*Sphenolithus ciperoensis*	Last *Sphenolithus ciperoensis*, Last *R. bisecta*
	Sphenolithus distentus	Last *Sphenolithus distentus*
	Sphenolithus predistentus	First *Sphenolithus ciperoensis*
	Helicopontosphaera reticulata	Last *Reticulofenestra umbilica*
	Ericsonia subdisticha	Last *Cyclococcolithus formosa*
Eocene	*Sphenolithus pseudoradians*	Last *Discoaster barbadiensis*, Last *D. saipanensis*
	Isthmolithus recurvus	First *Sphenolithus pseudoradians*
	Chiasmolithus oamaruensis	First *Isthmolithus recurvus*
	Discoaster saipanensis	First *Chiasmolithus oamaruensis*
	Discoaster nodifer	Last *Chiasmolithus solitus*
	Chiphragmalithus alatus	First *Reticulofenestra umbilica*, Last *D. sublodoensis*
	Discoaster sublodoensis	First *Chiphragmalithus alatus*
	Discoaster lodoensis	First *Discoaster sublodoensis*
	Marthasterites tribrachiatus	Last *Marthasterites tribrachiatus*
	Discoaster binodosus	First *Discoaster lodoensis*
	Marthasterites contortus	Last *Marthasterites contortus*
Paleocene	*Discoaster multiradiatus*	First *Marthasterites contortus*
	Discoaster mohleri	First *Discoaster multiradiatus*
	Heliolithus kleinpellii	First *Discoaster mohleri*
	Fasciculithus tympaniformis	First *Heliolithus kleinpellii*
	Ellipsolithus macellus	First *Fasciculithus tympaniformis*
	Chiasmolithus danicus	First *Ellipsolithus macellus*
	Cruciplacolithus tenuis	First *Chiasmolithus danicus*
	Markalius inversus	First *Cruciplacolithus tenuis*
	Micula mura	Last *Micula mura*

Figure 4. *Summary of Cenozoic calcareous nannofossil zonation used in this study.*

Remarks: This zone could not be differentiated from the *C. tenuis* Zone.

Age: Early Paleocene.

Ellipsolithus macellus Zone

Boundaries: Base—first *E. macellus*; Top—first *Fasciculithus tympaniformis.*

Position: Section 398D-39-4.

Assemblage: Similar to the *C. tenuis/Ch. danicus* zones plus *E. macellus, Ericsonia subpertosa.*

Remarks: *E. macellus* is very rare in this interval. Preservation is moderately good.

Age: Early Paleocene.

Fasciculithus tympaniformis Zone

Boundaries: Base—first *F. tympaniformis*; Top—first *Heliolithus kleinpellii.*

Position: Sections 398D-39-3 through 398D-38-4.

Assemblage: Similar to *E. macellus* Zone plus *F. tympaniformis, Heliorthus concinnus, Coccolithus eopelagicus, Chiasmolithus bidens.*

Remarks: Sections 398D-38-4 and 398-38-5 are tentatively placed in this zone because they are barren of nannofossils. Preservation of nannofossils in the remainder of the interval is fair to good.

Age: Middle Paleocene.

Heliolithus kleinpelli Zone

Boundaries: Base—first *H. kleinpelli*; Top—first *Discoaster mohleri.*

Position: Sections 398D-38-3 through 398D-38-1.

Assemblage: Similar to *F. tympaniformis* Zone plus *H. kleinpelli, Fasciculithus involutus, Fasciculithus schaubi, Toweius craticulus, Cyclolithella robusta.*

Remarks: *H. kleinpelli* is very rare. Preservation is generally good. Fasciculiths predominate.

Age: Middle Paleocene.

Discoaster mohleri Zone

Boundaries: Base—first *Discoaster mohleri*; Top—first *Discoaster multiradiatus.*

Position: Core 398D-37.

Assemblage: Similar to *H. kleinpellii* Zone plus *Discoaster mohleri, Discoaster nobilis, Chiasmolithus consuetus*, and less *Chiasmolithus danicus.*

Remarks: Preservation is moderately good.

Age: Middle to late Paleocene.

Discoaster multiradiatus Zone

Boundaries: Base—first *Discoaster multiradiatus*; Top—first *Marthasterites contortus.*

Position: Core 398D-36.

Assemblage: Similar to *D. mohleri* Zone plus *D. multiradiatus, Cruciplacolithus eminens, Chiasmolithus californicus.*

Remarks: Discoasters dominate the assemblage. Fasciculiths are also abundant. Preservation is fair to good.

Age: Late Paleocene.

Marthasterites contortus Zone

Boundaries: Base—first *M. contortus*; Top—last M. contortus.

Position: Core 398D-35.

Assemblage: *Discoaster multiradiatus, Discoasteroides diastypus, D. nobilis, F. involutus, F. tympaniformis, F. schaubi, Ch. californicus, Ch. bidens, Ch. consuetus, Coccolithus eopeligicus, Cr. eminens, C. pelagicus, E. subpertosa.*

Remarks: *M. contortus* is rare. Preservation is fair to good. Some reworking was noted across the Paleocene/Eocene boundary.

Age: Early Eocene.

Discoaster binodosus Zone

Boundaries: Base—last *M. contortus*; Top—first *Discoaster lodoensis.*

Position: Cores 398D-35 through 398D-33.

Assemblage: *D. binodosus, Discoaster barbadiensis, D. multiradiatus, D. nobilis, D. diastypus, Cruciplacolithus staurion, Ch. consuetus, Ch. californicus, Ch. bidens, C. eopelagicus, E. subpertosa, Zygrhablithus bijugatus.*

Remarks: Some improvement in preservation is noted in the upper portion of this zone.

Age: Early Eocene.

Marthasterites tribrachiatus Zone

Boundaries: Base—first *Discoaster lodoensis*; Top—last *M. tribrachiatus.*

Position: Section 398D-33-1 through Core 398D-32.

Assemblage: Similar to *D. binodosus* Zone plus *M. tribrachiatus, Sphenolithus radians, Chiasmolithus solitus, Cyclococcolithus formosa.*

Remarks: *M. tribrachiatus* is common. Preservation is generally good.

Age: Early Eocene.

Discoaster lodoensis Zone

Boundaries: Base—last *M. tribrachiatus*; Top—first *Discoaster sublodoensis.*

Position: Cores 398D-31 through 398D-28.

Assemblage: Similar to *M. tribrachiatus* Zone plus *Discoaster nonaradiatus* and less *M. tribrachiatus.*

Remarks: The *D. lodoensis* and *Discoaster sublodoensis* Zones could not be differentiated. Preservation is good.

Age Middle Eocene.

Discoaster sublodoensis Zone

Boundaries: Base—first *D. sublodoensis*; Top—first *Chiphragmalithus alatus.*

Position: Cores 398D-31 through 398D-28.

Assemblage: Same as *D. lodoensis* Zone.

Remarks: This zone could not be differentiated from the *D. lodoensis* Zone.

Age: Middle Eocene.

Age	Zone	Sample (Interval in cm)	Preservation (General)	Preservation (Discoaster)	Reworking	*Discoaster barbadiensis*	*Discoaster binodosus*	*Discoaster deflandrei*	*Discoaster diastypus*	*Discoaster distinctus*	*Discoaster keupperi*	*Discoaster lautus*	*Discoaster lodoensis*	*Discoaster megastypus*	*Discoaster mohleri*	*Discoaster multiradiatus*	*Discoaster murus*	*Discoaster nobilis*	*Discoaster nodifer*	*Discoaster nonaradiatus*	*Discoaster saipanensis*	*Discoaster strictus*	*Discoaster sublodoensis*	*Discoaster tani*	*Catinaster umbrellus*	*Marthasterites tribrachiatus*	*Chiphragmalithus alatus*	*Tribrachiatus contortus*	*Bantholithus sparsus*	*Fasciculithus involutus*	*Fasciculithus schaubi*	*Fasciculithus tympaniformis*	*Heliorthus concinnus*	*Heliolithus kleinpelli*	*Triquetrorhabdulus carinatus*	*Triquetrorhabdulus inversus*	*Camplyosphaera dela*	*Camplyosphaera rodela*	*Cruciplacolithus eminens*	*Cruciplacolithus staurion*	*Cruciplacolithus tenuis*	*Helicopontosphaera compacta*	*Helicopontosphaera intermedia*	*Helicopontosphaera lophota*	*Helicopontosphaera parallela*
Oligocene	*Sphenolithus ciperoensis*	13-1, 50	– 3	+ 3				C			F																												F		
		13-3, 79	– 3	+ 3				C			F																							F					F		
		13-5, 69	– 3	+ 3				C			F																							F					C		
		13, CC	– 3	+ 3				C			F																												C		
		14-1, 34	– 3	+ 3				C			F																							F					C		
		14, CC	– 3	+ 3				C			F																												C		
	a	15-1, 82	– 3	+ 3				C			R																												F		R
		15-3, 62	– 3	+ 3				C			F																												F		R
		15-5, 52	– 3	+ 3				C			F																												F		
		15, CC	– 3	+ 3				C			F																														R
	b	16, CC	– 4	+ 3				F																																	
		17-1, 15	– 3	+ 3				F			R													V															R		
		17, CC	– 3	+ 3				F																R														R		
		18, CC	– 4	+ 3				R																																	
	c	19-1, 105	– 3	+ 3			R	R			R													R															R		
Eocene	d	19-3, 94	– 3	+ 2		F		F											F		F			F																	
		19-5, 80	– 3	+ 2		F		F											F		C			F																	
		19, CC	– 3	+ 3		C	F												R		F																				
	Discoaster saipanensis/ Chiasmolithus oamaruensis	20-1, 89	– 3	+ 3		F													R		F																				
		20-3, 40	– 3	+ 2		C	R														F																				
		20-5, 65	– 3	+ 2		C	F												F		C			F																	
		20, CC	– 3	+ 2		C	F														F																				
		21-1, 68	– 2	+ 2		C	F												C		C																				
		21-3, 62	– 3	– 2		F															F																				
		21, CC	– 4	+ 2		F															F																				
		22-1, 78	– 4	+ 2		R		R													R																				
		22-3, 108	– 3	+ 2		C	R			R									F		C			R												R					
		22-4, 54	– 4																																							
		22-5, 68	– 2	+ 2	X	F	R			R									R		F																				
		22, CC	– 4	+ 2		F													R		F																				
	Discoaster nodifer	23-1, 70	– 2	+ 2		F													F		C	R																			
		23-3, 80	– 3	+ 2		F	F			V									R		F	R																			
		23, CC	– 2	+ 2		F	F												R																					
		24-1, 94	– 3	+ 2		F	F			R									F		F	R		R																	
		24-3, 95	– 3	+ 2		F													F					R																	
		24-5, 67	– 2	+ 2		F	F			R									F		F			F																R	
		24, CC	– 2	+ 2	X	C	F														R																			R	
		25-1, 82	– 3	+ 2	X	F	R			V									R		R	F				R															
		25, CC	– 2	+ 2		F				R														R																	
		26-1, 53	+ 1	– 2		F	F			R														F																R	
		26-3, 102	– 3	+ 2		F															R					R															
		26-5, 50	– 3	+ 2		C	F												R	F	F	R				F															
		26-7, 31	– 2	+ 2		F				R									R	R	R					F														R	
		26, CC	– 2	+ 2		F				R									R	R	R					F														R	
	e	27-1, 50	– 2	+ 2		F	R												R	F			R			F														R	
		27-3, 78	– 2	+ 2		C	F												R	F			C													R				R	
		27-5, 85	– 2	+ 1	X	F													F	F			F			R							R							F	
		27, CC	– 2	+ 1		F	R			R									F	F			F			V							R								
	Discoaster lodoensis/ Discoaster sublodoensis	28-1, 70	– 2	+ 1		F		R											F	F			F										R								
		28-3, 75	– 3	+ 2	X	C	R	R												F			F										F			F					
		28-5, 63	– 3	+ 3		F		R												F			F										F			F			F		
		28-6, 12	– 3	+ 3		F	R													F			F										R			R			R		
		29-1, 80	– 3	– 2		F	V	R					F							R			F										F			R			R		
		29-3, 76	– 3	+ 2	X	F	F	R					F							R			C										F			F					
		29-5, 84	– 3	+ 2		C							F							R			F													F					
		29-7, 10	– 3	+ 2	X	C		R					C										F													F					
		29, CC	– 2	+ 2		C		R					C										F													F					
		30, CC	– 2	+ 2		F	R	R					C										F													F					
		31-1, 76	– 3	+ 2		F	R	R					C										F													F					
		31-3, 43	– 3	+ 1		C	R	R					C				F						F			V										R					
		31, CC	– 3	+ 1		C	F	R	R				C				F						F																		
	f	32-1, 8	– 3	+ 1		F		F					C				F									C															
		32-3, 57	– 4	+ 1		F	R	F			F		C				R									A															
		32-5, 54	– 3	+ 2		F	R	F			F		C				F	F								C							R								
		32-6, 67	– 2	+ 2		F	R	F			F		C				R									C							R								
		33-1, 107	– 2	+ 3		R		F			F		F				F									C										F				F	
	Discoaster binodosus	33-3, 94	– 3	+ 2		F	R	F			F															C										F				F	
		33-5, 91	– 3	+ 2	X	F	R	F			R						V	F								C														F	
		33, CC	– 2	+ 2		F	R	F			R							R	F								C													R	
		34-1, 14	– 3	+ 2		F		R						R			R		F							F														F	
		34-3, 35	– 2	+ 1		F		R						R			R	R	F																					R	
		34-5, 132	– 3	+ 2	X	R		R							R		R	F	R																					R	
		34-7, 22	– 3	+ 2	X	R		R						R			C		F											F							R			R	
		34, CC	– 3	+ 2	X	R	V	R									C		F							V				F										R	
	g	35-1, 66	– 3	+ 2	X			R						F			F		F								R				F										
		35-3, 123	– 3	+ 2										F			F		F								R				F	F									
		35-5, 140	– 3	+ 2	X												C		F										F		C	F									
		35, CC	– 3	+ 2													C		F										F	F	C									

Figure 5. *Distribution of Paleogene calcareous nannofossils at Site 398.*

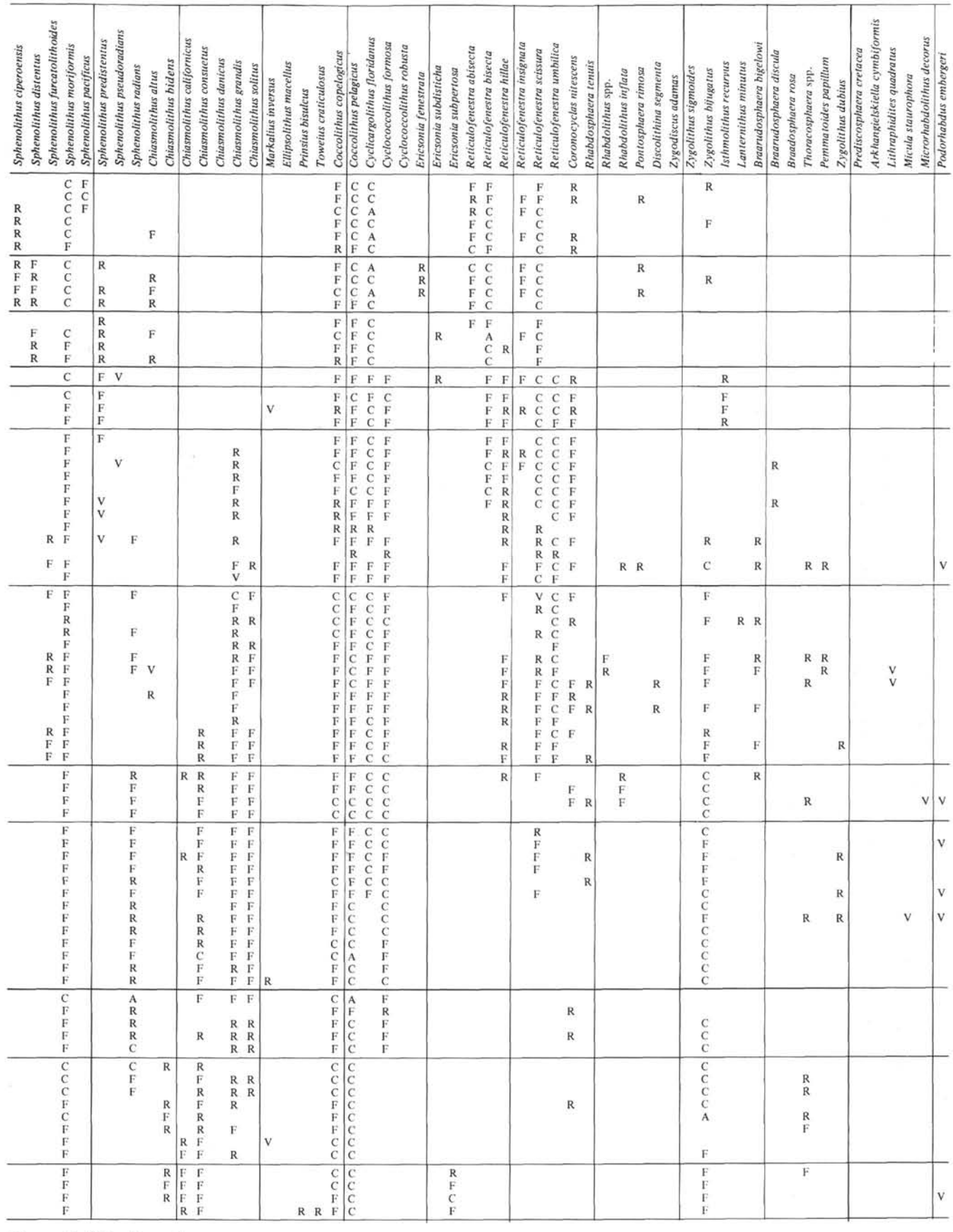

Figure 5. *(Continued).*

Age	Zone	Sample (Interval in cm)	Preservation (General)	Preservation (Discoaster)	Reworking	*Discoaster barbadiensis*	*Discoaster binodosus*	*Discoaster deflandrei*	*Discoaster diastypus*	*Discoaster distinctus*	*Discoaster keupperi*	*Discoaster lautus*	*Discoaster lodoensis*	*Discoaster megastypus*	*Discoaster mohleri*	*Discoaster multiradiatus*	*Discoaster murus*	*Discoaster nobilis*	*Discoaster nodifer*	*Discoaster nonradiatus*	*Discoaster saipanensis*	*Discoaster strictus*	*Discoaster sublodoensis*	*Discoaster tani*	*Catinaster umbrellus*	*Marthasterites tribrachiatus*	*Chiphragmalithus alatus*	*Tribrachiatus contortus*	*Bantholithus sparsus*	*Fasciculithus involutus*	*Fasciculithus schaubi*	*Fasciculithus tympaniformis*	*Heliorthus concinnus*	*Heliolithus kleinpellii*	*Triquetrorhabdulus carinatus*	*Triquetrorhabdulus inversus*	*Camplyosphaera dela*	*Camplyosphaera eodela*	*Cruciplacolithus eminens*	*Cruciplacolithus staurion*	*Cruciplacolithus tenuis*	*Helicopontosphaera compacta*	*Helicopontosphaera intermedia*	*Helicopontosphaera lophota*	*Helicopontosphaera parallela*
Paleocene	*Discoaster multiradiatus*	36-1, 70	−3	+2	X									V		C		F											F	C	C							F					
		36-3, 74	−3	+2											R	C		F											F	C	C							F					
		36-4, 40	−3	+2										F		C		F											R	F	F	F						R					
		36-5, 76	−3	+2											R	C		F											F	C	C							F					
		36-7, 33	−4	+2											R	F		F											F	F	C							F					
		36, CC	−3	+2											F	C		F											F	C	C							F					
	h	37-1, 41	−2	−2											F			F													F						R			R		
		37-3, 28	−3	−2											F			R													F	F					F					
		37, CC	−3	−2											F			R													F	R	R				F					
	i	38-1, 137	−2																												F	F	F							R		
		38-3, 66	−2																												C	F	R							F		
	j	38-4, 99	−5																																							
		38-5, 103	−5																																							
		39-1, 110	−3																												F									C		
		39-2, 121	−3																												F									C		
		39-3, 44	−3		X																										F	F								C		
	k	39-4, 39	−2		X																											F								C		
		39-4, 136	−2		X																											R								C		
	l	40-1, 7	−3		X																								V											C		
		40-2, 75	−3																																						C		
		40-2, 102	−3		X																																				C		
		40-3, 102	−2																																						C		
		40-4, 76	−2		X																																				C		
		40-5, 91	−2		X																																				F		
		40-6, 58	−3																																						F		
	l	40-7, 27	−3		X																								V											F		
		40, CC	−3		X																																				F		
	m	41-1, 82	−3		X																								R													
		41-2, 30	−3		X																																					
		41-2, 39	−3		X																																					
Cret.	n	41-2, 41	−4																																							

[a] *Sphenolithus distentus*
[b] *Sphenolithus predistentus*
[c] Lower Oligocene (undiff.)
[d] *S. pseudoradian/I. recurvusi*
[e] *Chiphragmalithus alatus*
[f] *Marthasterites tribrachiatus*
[g] *Tribrachiatus contortus*
[h] *Discoaster mohleri*
[i] *Heliolithus kleinpellii*
[j] *Fasciculithus tympaniformis*
[k] *Ellipsolithus macellus*
[l] *Cruciplacolithus tenuis/Chiasmolithus danicus*
[m] *Markalius inversus*
[n] *M. mura*

Figure 5. *(Continued).*

Chiphragmalithus alatus Zone

Boundaries: Base—first *C. alatus*; Top—first *Reticulofenestra umbilica,* last *D. sublodoensis,* last *Rhabdosphaera gladius.*

Position: Core 398D-27.

Assemblage: Similar to *D. lodoensis/D. sublodoensis* Zones plus *C. alatus, Discoaster nodifer, Cyclicargolithus floridanus, Zygolithus dubius,* less *Discoaster lodoensis, D. diastypus.*

Remarks: Preservation is good. *C. alatus* is not particularly common. *R. gladuis* was not found. The first appearance of *R. umbilica* was used to define the top of this zone.

Age: Middle Eocene.

Discoaster nodifer Zone

Boundaries: Base—first *R. umbilica,* last *D. sublodoensis,* last *R. gladius*; Top—last *Chiasmolithus solitus.*

Position: Cores 398D-26 through 398D-23.

Assemblage: Similar to *C. alatus* Zone plus *Rhabdosphaera inflata, Sphenolithus furcatolithoides, Discoaster saipanensis, Discoaster tani, R. umbilica, Reticulofenestra hillae,* less *D. sublodoensis.*

Remarks: Preservation is good. Some reworking was noted.

Age: Middle Eocene.

Discoaster saipanensis Zone

Boundaries: Base—last *Chiasmolithus solitus*; Top—first *Chiasmolithus oamaruensis.*

Position: Cores 398D-22 through 398D-21.

Assemblage: Similar to *D. nodifer* Zone less *Ch. solitus, D. nonaradiatus, C. alatus, Ch. californicus.*

Remarks: This zone is not differentiated from the *Chiasmolithus oamaruensis* Zone. *C. oamaruensis* is very rare. Preservation is fair. Considerable siliceous debris is present.

Age: Late Eocene.

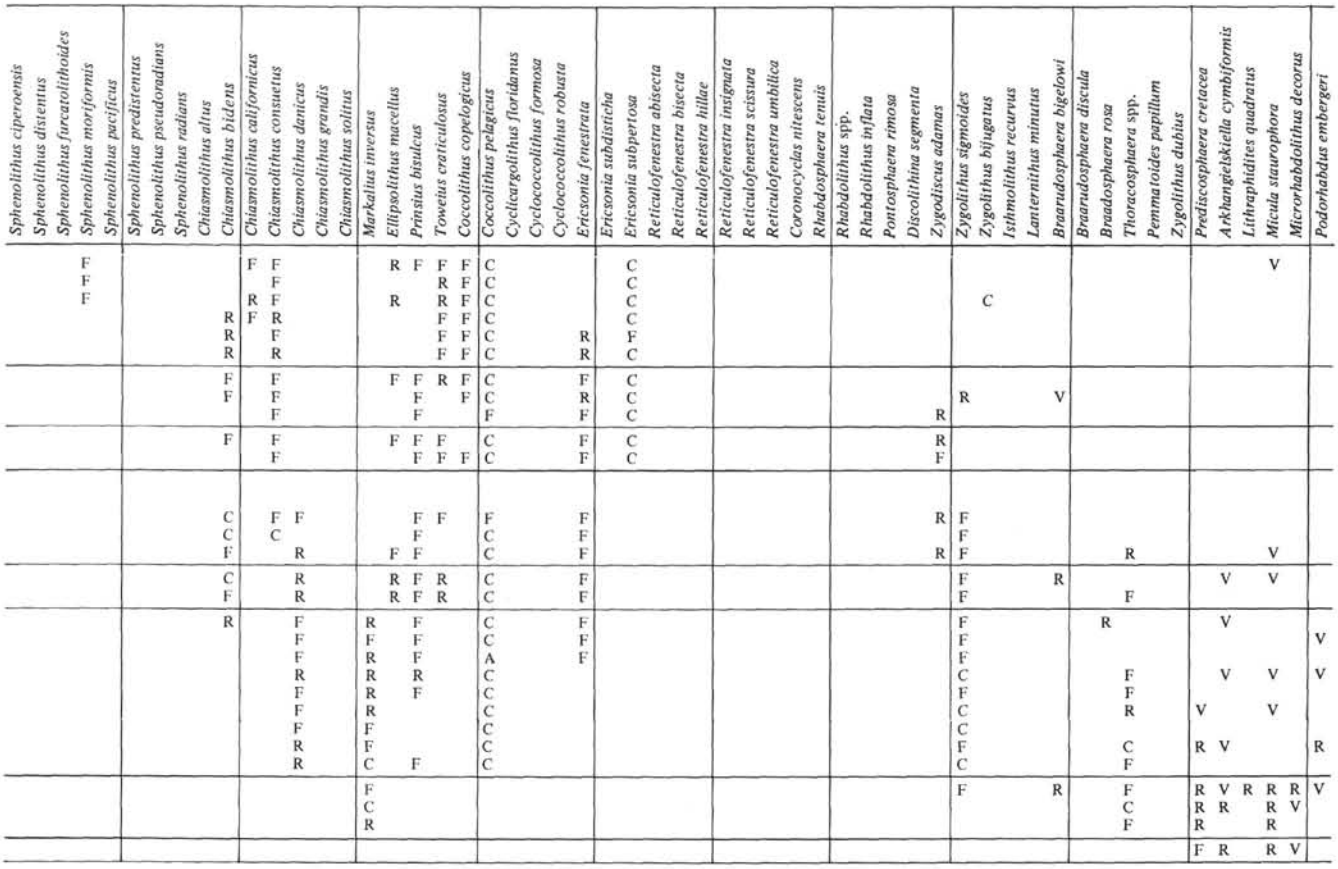

Figure 5. *Continued.*

Chiasmolithus oamaruensis Zone

Boundaries: Base—first *C. oamaruensis*; Top—first *Isthmolithus recurvus.*

Position: Cores 398D-22 through 398D-21.

Assemblage: Same as *D. saipanensis* Zone.

Remarks: This zone could not be differentiated from the *C. saipanensis* Zone.

Age: Late Eocene.

Isthmolithus recurvus Zone

Boundaries: Base—first *I. recurvus; Top—first Sphenolithus pseudoradians.*

Position: Core 398D-20 through Section 398D-19-2

Assemblage: *I. recurvus, Reticulofenestra bisecta, D. saipanensis, D. barbadiensis, D. tani. Discoaster deflandrei, Chiasmolithus grandis, D. nodifer, Cyclococcolithus formosa, R. umbilica, R. hillae, C. floridanus, C. eopelagicus, C. pelagicus, Sphenolithus predistentus, D. binodosus.*

Remarks: Preservation is poor with much siliceous debris. Cool conditions are indicated. This zone is not differentiated from the *S. pseudoradians* Zone. *S. pseudoradians* occurs very rarely.

Age: Late Eocene.

Sphenolithus pseudoradians Zone

Boundaries: Base—first *S. pseudoradians*; Top—last *D. barbadiensis*, last *D. saipanensis.*

Position: Core 398D-20 through Section 398D-19-2.

Assemblage: Same as *I. recurvus* Zone.

Remarks: This zone is not differentiated from the *I. recurvus* Zone.

Age: Late Eocene.

Ericsonia subdisticha Zone

Boundaries: Base—last *D. barbadiensis*, last *D. saipanensis*; Top—last *C. formosa.*

Position: Section 398D-19-1.

Assemblage: Similar to *I. recurvus/S. pseudoradians* Zones plus *E. subdisticha*, less *D. barbadiensis, D. saipanensis.*

Remarks: Preservation is very poor. This zone was not differentiated from the *Helicopontosphaera reticulata* Zone. The early Oligocene section is very thin.

Age: Early Oligocene.

Helicopontosphaera reticulata Zone

Boundaries: Base—last *C. formosa*; Top—last *R. umbilica.*

Position: Section 398D-19-1.

Assemblage: Same as *E. subdisticha* Zone.

Remarks: This zone was not differentiated from the *E. subdisticha* Zone.

Age: Early Oligocene.

Age	Zone	Sample (Interval in cm)	Preservation (General)	Preservation (Discoaster)	Reworking	*Discoaster asymmetricus*	*Discoaster aulakos*	*Discoaster bellus*	*Discoaster bollii*	*Discoaster brouweri*	*Discoaster calcaris*	*Discoaster challengeri*	*Discoaster deflandrei*	*Discoaster druggi*	*Discoaster exilis*	*Discoaster formosa*	*Discoaster intercalaris*	*Discoaster kugleri*	*Discoaster lautus*	*Discoaster moorei*	*Discoaster neorectus*	*Discoaster nodifer*	*Discoaster pentaradiatus*	*Discoaster quinqueramus*	*Discoaster surculus*	*Discoaster tamalis*	*Discoaster variabilis*	*Pseudoemiliania lacunosa*	*Gephyrocapsa caribbeanica*	*Gephyrocapsa oceanica*	*Cyclolithella annula*	*Coccolithus doronicoides*
Pleistocene	*Gephyrocapsa oceanica*	2-1, 95	– 2																									C	F		C
		2-2, 99	– 2		X																			R				F	C	R	F
		2-3, 44	– 2		X	V									V													C	F	R	F
		2-4, 89	– 2																									A	C	R	F
		2-5, 34	– 2		X																							A	F	R	C
		2-6, 7	– 2		X																							C	F	R	A
		2, CC	– 2																									C	C	R	C
	Pseudoemiliania lacunosa	3-1, 98	– 2		X																						C	C	F	R	C
		3-2, 99	– 2																								R	A	F	R	C
		3-3, 67	– 2		X																						C	A	F	C	C
		3-4, 69	– 2																								C	A	F	R	C
		3-5, 85	– 2																								C	F	C	R	F
		3, CC	– 2		X																						C	F	C	R	C
Pliocene	*Discoaster surculus*	4-1, 100	– 2																								F	F	F	R	F
		4-2, 95	– 2		X												V					V					F	F	F	F	F
		4-3, 94	– 2		X					V		V			V		V							V			F	F	F		F
		4-4, 106	– 2																								C	F			C
		4-5, 29	– 2																								C	C		R	F
		4, CC	– 2		X																						C	F		R	C
		A-1-1, 75	– 2		X												V					V		V			F	C			F
		A-1-2, 64	– 2		X	V											V					V		V			C	C		R	C
		A-1-3, 110	– 2	+ 1		F				R							V					V		V	R		F	F		R	
		A-1-4, 83	– 2	+ 1									V				R							V			C	C	F	R	
		A-1-5, 92	– 2	+ 1		R				R							R			V					V	V	F	C	F		
	a	A-1-6, 54	– 2	+ 1		F		R		R							V							F	V		C	C	R	C	
		A-1, CC	– 2	+ 1		F				C		V											R	C	F					C	
	Discoaster asymmetricus	A-2-1, 84	– 3	+ 1		F				R		R					R						V	R							
		A-2-2, 79	– 2	+ 1		F		R		R		R					R						R	R							
		A-2-3, 106	– 2	+ 1	X					F							F						F	F							
		A-2-4, 86	– 3	+ 1						F							F			V			R	R							
		A-2-5, 81	– 2	+ 1						F							F						F	F							
		A-2-6, 88	– 2	+ 1	X	R				F			V				F						F	F							
		A-2, CC	– 2	+ 1		F				F		V												F							
		B-1-1, 100	– 2	+ 1		V				F		R	V				F						F	R		R					
		B-1-2, 66	– 2	+ 1		R				F		R	V				F						R	F		V					
		B-1-3, 91	– 2	+ 1		R				F		R					R						F	R		R					
		B-1-4, 52	– 3	+ 1		R				F		R					F			V			F	R		R					
		B-1-5, 96	– 2	+ 1		R				F		R					F						F	R		R					
		B-1-6, 15	– 2	+ 1		R				F		F					R			V			R			R					
		B-1, CC	– 2	+ 1		R				R		F					F							R		F					
	b	D-2-1, 83	– 2	+ 1	X					R																R					
		D-2-1, 120	– 3	+ 1									V																		
	c	D-2-2, 83	– 3	+ 1						R							R						R	R		F					
		D-2-3, 17	– 2	+ 1						F		F					F			V						F					
		D-2, CC	– 2	+ 1						F		F					F			V				R		F					
Miocene	*Discoaster quinqueramus*	D-3-1, 70	– 2	+ 1						F		R												V		F					
		D-3-2, 65	– 3	+ 1						F		F					F							R		F					
		D-3-3, 69	– 2	+ 1						F		F					R			V			R	R		F					
		D-3-4, 73	– 2	+ 1						F		F					F					V				F					
		D-3-5, 108	– 2	+ 2						F		F					F			V			R	V		F					
		D-3-6, 103	– 2	+ 2						F		F					F			R		R		R		C					
		D-3, CC	– 2	+ 1					V	F		F					F						R	R		F					
		D-4-1, 66	– 2	+ 2						R		F					R			R		R		V		C					

Figure 6. *Distribution of Neogene calcareous nannofossils at Site 398.*

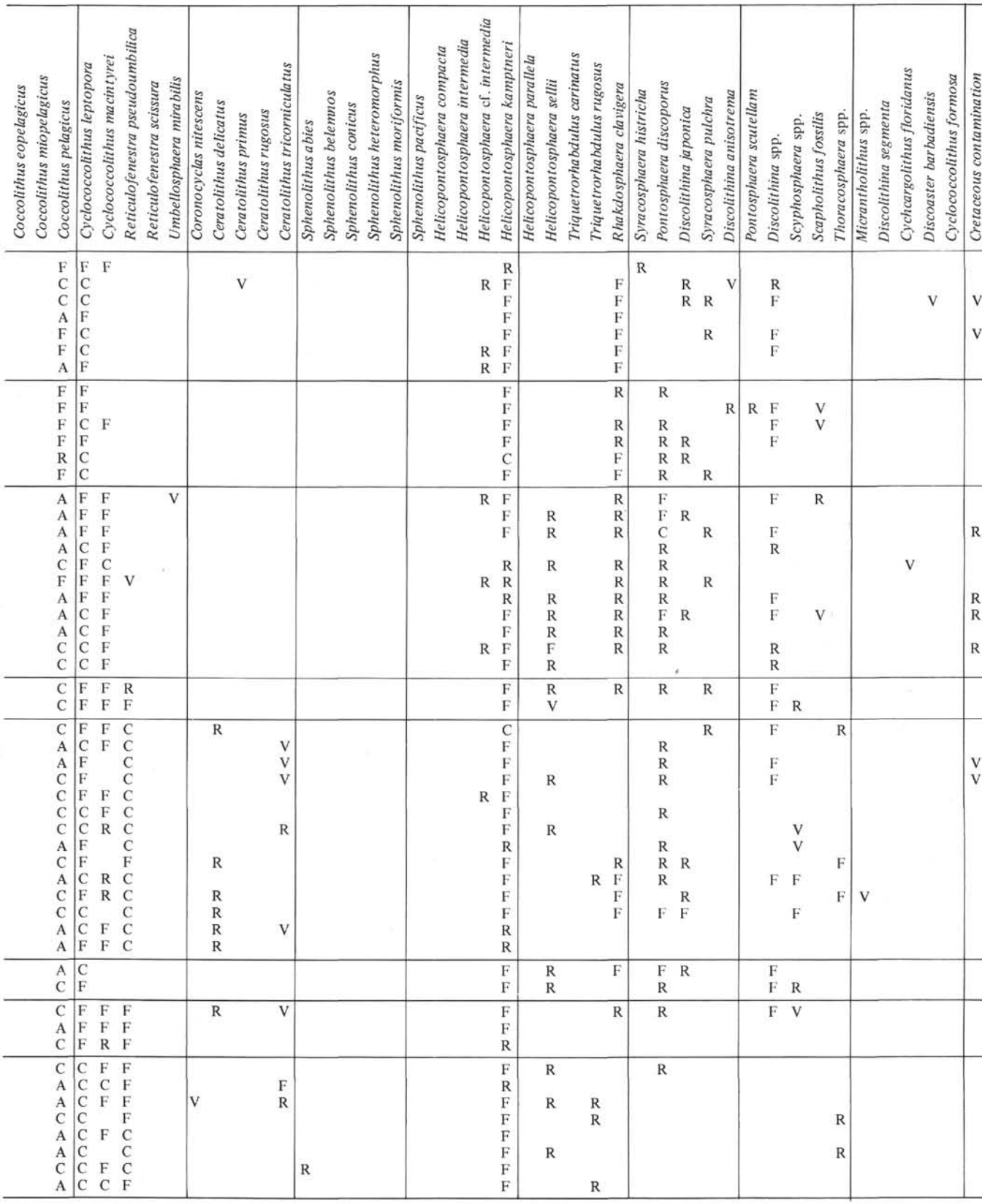

Figure 6. *(Continued).*

Age	Zone	Sample (Interval in cm)	Preservation (General)	Preservation (Discoaster)	Reworking	*Discoaster asymmetricus*	*Discoaster aulakos*	*Discoaster bellus*	*Discoaster bollii*	*Discoaster brouweri*	*Discoaster calcaris*	*Discoaster challengeri*	*Discoaster deflandrei*	*Discoaster druggi*	*Discoaster exilis*	*Discoaster formosa*	*Discoaster intercalaris*	*Discoaster kugleri*	*Discoaster lautus*	*Discoaster moorei*	*Discoaster neorectus*	*Discoaster nodifer*	*Discoaster pentaradiatus*	*Discoaster quinqueramus*	*Discoaster surculus*	*Discoaster tamalis*	*Discoaster variabilis*	*Pseudoemiliania lacunosa*	*Gephyrocapsa caribbeanica*	*Gephyrocapsa oceanica*	*Cyclolithella annula*	*Coccolithus doronicoides*
Miocene	*Discoaster calcaris*	D-4-2, 72	– 2	+ 2						R	F									R	R					C					
		D-4-3, 88	– 2	+ 2						R	F				F					R	F					C					
		D-4-4, 75	– 2	+ 2				R		R	F				R					R							C					
		D-4-5, 80	– 2	+ 2							R				R						R					C					
		D-4-6, 57	– 2	+ 2							R				R					R	R					C					
		D-4, CC	– 3	+ 2																	V					F					
	Discoaster kugleri	D-5-1, 66	– 2	+ 1					F						F			R		R						C					
		D-5-3, 51	– 2	+ 2	X		R		F						F			R		R						F					
		D-5-5, 87	– 2	+ 3	X		F		R						F			R								C					
		D-5, CC	– 3	+ 3			R		R						R			R		R						F					
	d	D-6-1, 86	– 2	+ 3											F											A					
	Sphenolithus heteromorphus	D-6-3, 51	– 2	+ 3											R											C					
		D-6-5, 67	– 2	+ 3											R											C					
		D-6-7, 14	– 2	+ 3								F			F											C					
		D-6, CC	– 3	+ 3			V					F			F											C					
		D-7-1, 80	– 2	+ 3								F			F											C					
		D-7-3, 88	– 2	+ 3								F		F	F											C					
		D-7-5, 80	– 2	+ 3								C			F											C					
		D-7-7, 26	– 2	+ 3								C			F											C					
		D-7, CC	– 2	+ 3								C			F											C					
		D-8-1, 93	– 2	+ 3								C														F					
		D-8-3, 79	– 3	+ 3								C																			
		D-8-5, 74	– 3	+ 3								C																			
		D-8, CC	– 3	+ 3								C																			
	Discoaster druggi	D-9-1, 103	– 3	+ 3								C		R																	
		D-9-3, 95	– 3	+ 3								C		R																	
		D-9-5, 103	– 3	+ 3								C		F																	
		D-9-7, 36	– 2	+ 3								C		R																	
		D-9, CC	– 3	+ 3								C		F																	
		D-10, CC	– 3	+ 2			R					C		R																	
	e	D-12-1, 130	– 4	+ 1								C							R		F										
		D-12-3, 50	– 2	+ 2								C																			
		D-12-5, 56	– 3	+ 2								C																			
		D-12, CC	– 3	– 3								C							R												

[a] *Reticulofenestra pseudoumbilica*
[b] (slump) *D. surculus*
[c] *Ceratolithus tricorniculatus*
[d] *D. exilis ?*
[e] *Triquetrorhabdulus carinatus*

Figure 6. *(Continued).*

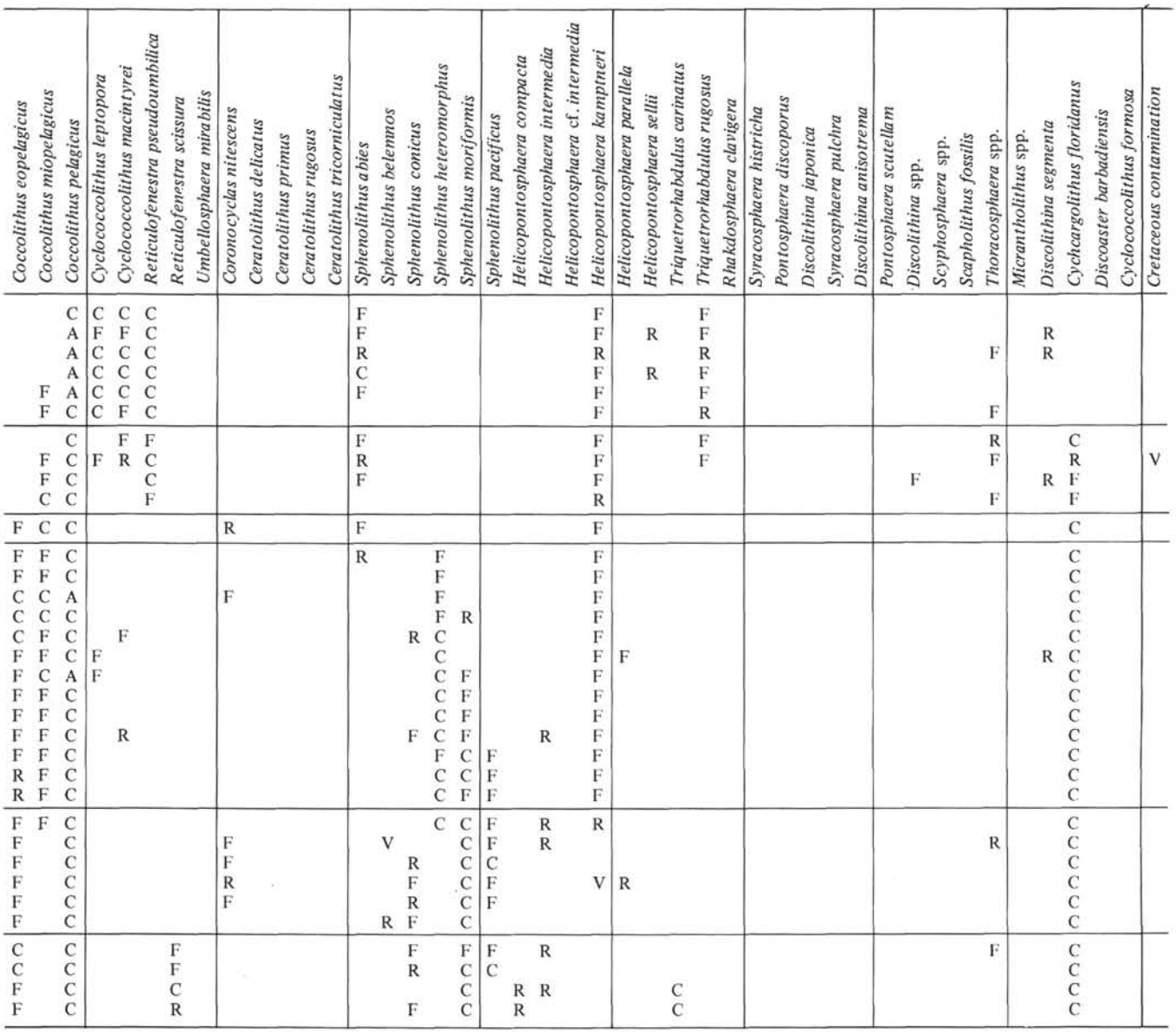

Figure 6. *(Continued).*

Sphenolithus predistentus Zone

Boundaries: Base—last *R. umbilica*; Top—first *Sphenolithus ciperoensis.*

Position: Cores 398D-18 through 398D-16.

Assemblage: *S. predistentus, Sphenolithus distentus, D. tani, D. deflandrei, Reticulofenestra scissura, C. floridanus, C. eopelagicus, Sphenolithus moriformis, Chiasmolithus altus, C. pelagicus.*

Remarks: Preservation is fair to moderately good. Sphenoliths are sparse.

Age: Middle Oligocene.

Sphenolithus distentus Zone

Boundaries: Base—first *Sphenolithus ciperoensis*; Top—last *S. distentus.*

Position: Core 398D-15.

Assemblage: Similar to *S. predistentus* Zone plus *S. ciperoensis, Helicopontosphaera intermedia, Reticulofenestra abisecta,* less *D. tani.*

Remarks: Preservation is somewhat better than in earlier Oligocene cores. Sphenoliths are rare.

Age: Middle to late Oligocene.

Sphenolithus ciperoensis Zone

Boundaries: Base—last *S. distentus*; Top—last *S. ciperoensis*, last *R. bisecta.*

Position: Cores 398D-13 through 398D-14.

Assemblage: Similar to the *S. distentus* Zone plus *Triquetrorhabdulus carinatus*, less *S. distentus.*

Remarks: Sphenoliths are rare. Preservation of nannofossils is moderately good. Discoasters show marked overcalcification.

Age: Late Olitocene.

Triquetrorhabdulus carinatus Zone

Boundaries: Base—last *S. ciperoensis*, last *R. bisecta*; Top—first *Discoaster druggi.*

Position: Core 398D-12.

Assemblage: *D. deflandrei, T. carinatus, Sphenolithus conicus, C. floridanus, C. eopelagicus, S. moriformis, C. pelagicus, R. scissura.*

Remarks: Preservation is fair to poor in this interval. Discoasters are badly overcalcified. *T. carinatus* is sparse.

Discoaster druggi Zone

Boundaries: Base—first *D. druggi*; Top—last *D. druggi.*

Position: Cores 398D-10 through 398D-9.

Assemblage *D. druggi, S. moriformis, D. deflandrei, C. pelagicus, S. conicus, C. eopelagicus, Helicopontosphaera kamptneri.*

Remarks: Preservation is fair with badly overcalcified discoasters.

Age: Early Miiocene.

Sphenolithus belemnos Zone

Boundaries: Base—last *D. druggi*; Top—first *Sphenolithus heteromorphus*, last *S. belemnos.*

Position: Not encountered at this site.

Age: Early Miocene.

Helicopontosphaera ampliaperta Zone

Boundaries: Base—first *S. heteromorphus*, last *S. belemnos*; Top—last *H. ampliaperta.*

Remarks: This zone was not recognized. *H. ampliaperta* was not found in any samples examined. This may be due to non-preservation, a stratigraphic hiatus, or a coring gap.

Age: Early Miocene.

Sphenolithus heteromorphus Zone

Boundaries: Base—last *Helicopontosphaera ampliaperta*; Top—last *S. heteromorphus.*

Position: Cores 398D-8 through 398D-6.

Assemblage: *S. heteromorphus, D. deflandrei, Discoaster exilis, Discoaster variabilis, C. pelagicus, Cyclococcolithus leptopora, H. kamptneri, Sphenolithus abies, C. floridanus.*

Remarks: Preservation was moderately good. *S. heteromorphus* is a dominant component of this assemblage.

Age: Early to Middle Miocene.

Discoaster exilis Zone

Boundaries: Base—last *S. hetermorphus*; Top—first *Discoaster kugleri.*

Position: Section 398D-6-1.

Assemblage: Similar to the *S. heteromorphus* Zone less *S. heteromorphus, D. deflandrei*, and *S. moriformis.*

Remarks: No *S. heteromorphus* was found. Preservation is good.

Age: Middle Miocene.

Discoaster kugleri Zone

Boundaries: Base—first *D. kugleri*; Top—last *D. kugleri.*

Position: Core 398D-5.

Assemblage: Similar to *D. exilis* Zone plus *D. kugleri, Discoaster bollii.*

Remarks: *D. kugleri* forms a minor component of the nannofossil assemblage. Preservation is generally good.

Age: Middle Miocene.

Catinaster coalitus Zone

Boundaries: Base—last *D. kugleri*; Top—first *Discoaster hamatus.*

Position: This zone was not encountered.

Age: Middle Miocene.

Discoaster hamatus Zone

Boundaries: Base—first *D. hamatus*; Top—last *D. hamatus.*

Position: This zone was not encountered.

Age: Middle to Late Miocene.

Discoaster calcaris Zone

Boundaries: Base—last *D. hamatus, first Discoaster neorectus*; Top—first *Discoaster quinqueramus.*

Position: Sample 398D-4, CC through Section 398D-4-2.

Assemblage: *D- exilis, Discoaster brouweri, Discoaster challengeri, D. variabilis, D. intercalaris, D. neorectus, Coccolithus miopelagicus, C. pelagicus, C. leptopora, Cyclococcolithus macintyrei, H. kamptneri, S. abies, Reticulofenestra pseudoumbilica.*

Remarks: *Discoaster calcaris* was not found. *D. neorectus* which is correlative with the *D. calcaris* zone is used to define this zone. Preservation is good throughout.

Age: Late Miocene.

Discoaster quinqueramus Zone

Boundaries: Base—first *D. quinqueramus*; Top—last *D. quinqueramus.*

Position: Sample 398D-4-1 through Core 398D-3.

Assemblage: Similar to the *D. calcaris* Zone plus *D. quinqueramus, Discoaster moorei.*

Remarks: Preservation in this interval is good. *D. quinqueramus* forms a minor component of the nannofossil assemblage in this zone.

Age: Late Miocene.

Ceratolithus tricorniculatus Zone

Boundaries: Base—last *D. quinqueramus*; Top—first *Discoaster asymmetricus.*

Position: Sample 398D-2, CC through Section 398D-2-2.

Assemblage: Similar to the *D. quinqueramus* Zone plus *C. tricorniculatus*, less *D. quinqueramus, C. miopelagicus.*

Remarks: Preservation is generally good. Ceratoliths are rare.

Age: Early Pliocene.

Discoaster asymmetricus Zone

Boundaries: Base—first *D. asymmetricus*; Top—last *C. tricorniculatus.*

Position: Cores 398B-1 through 398A-2.

Assemblage: Similar to the *C. tricorniculatus* Zone plus *D. asymmetricus, Ceratolithus delicatus.*

Remarks: Preservation is generally good in this interval. *C. tricorniculatus is very rare.*

Age: Early Pliocene.

Reticulofenestra pseudoumbilica

Boundaries: Base—last *C. tricorniculatus*; Top—last *R. pseudoumbilica.*

Position: Sample 398A-1, CC through Section 398A-1-6.

Assemblage: Similar to the *D. asymmetricus* Zone less *C. tricorniculatus.*

Remarks: Preservation is good throughout.

Age: Early Pliocene.

Discoaster surculus Zone

Boundaries: Base—last *R. pseudoumbilica*; Top—last *D. surculus.*

Position: Sections 398D-2-1 and 398A-1-5 through 398A-1-1.

Assemblage: *D. surculus, D. asymmetricus, D. challengeri, D. exilis, Discoaster tamalis, C. leptopora, C. macintyrei, C. pelagicus, H. kamptneri, Rhabdosphaera clavigera, Helicopontospharea sellii.*

Remarks: The presence of the *D. surculus* Zone age sediments in Section 398D-2-1 is probably due to a coring disturbance. Discoasters are rare at the top of this zone. Some reworking was noted. Preservation is generally good throughout.

Age: Late Pliocene.

Discoaster pentaradiatus Zone

Boundaries: Base—last *D. surculus*; Top—last *D. pentaradiatus.*

Position: Not recognized.

Age: Late Pliocene.

Discoaster brouweri Zone

Boundaries: Base—last *D. pentaradiatus*; Top—last *D. brouweri.*

Position: Not recognized.

Age: Late Pliocene.

Pseudoemiliania lacunosa Zone

Boundaries: Base—last *D. brouweri*; Top—last *P. lacunosa.*

Position: Core 398-3.

Assemblage: *Gephyrocapsa oceanica, Gephyrocapsa caribbeanica, P. lacunosa, C. leptopora, C. macintyrei, H. kamptneri, R. clavigera, C. pelagicus, Coccolithus doronicoides, Syracosphaera histricha.*

Remarks: The Pliocene/Plesitocene boundary is obscured by marked reworking across it. The boundary is placed at the last discoaster occurrence. Preservation is good with many solution susceptible taxa present.

Age: Early Pleistocene.

Gephyrocapsa oceanica Zone

Boundaries: Base—last *P. lacunosa*; Top—first *Emiliania huxleyi.*

Position: Core 398-2.

Assemblage: Similar to the *P. lacunosa* Zone less *P. lacunosa.*

Remarks: Preservation is good. Many solution susceptible taxa are present. No *E. huxleyi* was found.

Age: Late Pleistocene.

Emiliania huxleyi Zone

Boundaries: Base—first *E. huxleyi*; Top—Recent.

Position: Not recovered at this site.

Age: Holocene.

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