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DISTRIBUTION AND TAXONOMY OF LATE QUATERNARY DIATOMS FROM GRAVITY CORES L13-81-G117, L13-81-G138, L13-81-G145, AND TT197-G330, NORTHERN CALIFORNIA CONTINENTAL SLOPE

by

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INTRODUCTION

The purpose of this report is to document the distribution of late Quaternary diatoms on the northern California continental slope. Analyses were generated as part of a multi-disciplinary study of Quaternary paleoclimatology along northern California. Associated reports include Gardner et al., 1983; 1984; 1988; Gardner and Hemphill-Haley, 1986; and Anderson et al., 1987; 1989.

Diatoms from four gravity cores collected on the continental slope off northern California (Table 1; Figure 1) are discussed in terms of ecological or biostratigraphic significance. Questions addressed include: 1) What do diatoms suggest about the paleoclimatic conditions along the northern California continental margin during the late Pleistocene and Holocene?; 2) Can diatoms be used to delimit the Pleistocene- to Holocene transition in this area?; 3) How are diatoms distributed differently between finely-laminated and bioturbated upper slope deposits in this area?; and 4) Can diatoms be used to make estimates of amount of winnowing or restricted pelagic sedimentation in this area? Interpretations are based on quantitative and qualitative analyses of diatom species. Taxonomic descriptions of 64 commonly occurring species or groups are included under Floral List at the end of the report. Quantitative frequency data of the samples are provided in Tables 4 through 7.

DEFINITIONS

Diatoms secrete an hydrous opaline silica shell, or *frustule*, composed of two inter-connecting *valves*. The valves are ornamented with various patterns of areolae, pores, processes, striae, and hyaline areas on which the taxonomy of species is based. The valves typically disarticulate when the organism dies. Diatoms species may be classified as marine, brackish or freshwater, and through passive transport and redeposition, marginal marine deposits may often contain representatives of each these environments. *Planktonic* species only live suspended in the water column; *meroplanktonic* species are mostly planktonic but spend part of their life cycle on the bottom in a resting stage. Planktonic species may prefer the *neritic* zone, the area underlain by the continental shelf, or more *oceanic* conditions seaward of the shelf-slope break. *Benthic* species live within the upper few millimeters of sediment, or attached to various kinds of substrate; *tychopelagic* species are typically chain-forming benthic diatoms that break free to become accidental members of the plankton.

METHODS

Diatom strewn slides were prepared from approximately 1 to 2 cm^3 of sediment collected either at regular intervals, or along lithologic boundaries in the gravity cores. Each sample was slowly dried at 90° C, cooled, weighed, then transferred to a 250-ml beaker. Organic carbon and calcium carbonate were digested with 10 ml each 1 M HCl and 30% H_2O_2. After the reactions were completed, distilled water was added to bring the sample to 250 ml. After 1 hr, the supernatant with colloidal material still in suspension was discarded. This step was repeated at one-hour intervals until the sample was pH neutral and clear of suspended colloidal material. The sample was then suspended in 15 ml of distilled water, allowed to settle for a few seconds, and a few drops transferred to a 22 x 30 mm cover slip and allowed to dry overnight. The cover slips were permanently fixed to glass slides by gently heating Hyrax mounting medium on a hot plate.

If diatoms were abundant, between 300-400 valves per sample were counted along random traverses. Where rare, entire samples were viewed and all specimens counted. Broken valves were counted according to the technique discussed in Schrader and Gersonde (1978).

SUMMARY OF CORE LITHOLOGIES AND DIATOM DISTRIBUTIONS

L13-81-G138.

Gravity core L13-81-G138 (4.4 m length) was recovered from a depth of 2531 m on the lower continental slope off northern California (Figure 1). Sediments are bioturbated throughout and ^{14}C ages indicate that the Pleistocene-Holocene transition occurs in this core between 70 and 90 cm (Table 2). The subtropical diatom *Pseudoeunotia doliolus*, only found in Holocene sediments off northern California (Gardner and Hemphill-Haley, 1986), is common in the upper part of the core to 60 cm, with a few valves observed as deep as 110 cm, possibly because of downward bioturbation. Therefore, the Pleistocene-Holocene boundary is estimated at 70 cm in this core.

Diatoms are abundant throughout the core, except in coarser-grained samples at 80, 140, 260, and 400 cm. A few subtropical oceanic species (Figure 2) are either restricted to (*P. doliolus*) or more common in (*Roperia tesselata, Rhizosolenia hebetata* forma *semispina, R. styliformis*), in Holocene deposits above 70 cm. *Thalassiosira eccentrica* and other neritic *Thalassiosira* spp. (Figure 3) are uniformly distributed downcore. *Thalassionema nitzschioides* (Figure 4) is abundant in both Pleistocene and Holocene sediment, sometimes exceeding 50% of the total assemblage. Below 250 cm, *Stephanopyxis dimorpha* is the dominant species (Figure 5), although its ecological significance is equivocal. It was originally described by Schrader (1973) from Pleistocene sediment at DSDP Site 173 (off Cape Mendocino), but its modern ecology has not been reported. It may be part of the neritic plankton like *S. turris* (Cupp, 1943), or a tychopelagic species like *Paralia sulcata* (Hendey, 1964). Similar to both these species, the sturdy valves of *S. dimorpha* may be easily reworked, and thus it could be the end product of a winnowed and reworked diatom assemblage. High relative frequencies of combined freshwater and benthic diatoms, and *Paralia sulcata* (Figure 5), occur in sediment with a ^{14}C age of about 16,000 yr B.P. between 100-160 cm, and could represent an increase in freshwater output from the Russian River and the other smaller coastal streams between Bodega Bay and Point Arena (Figure 1), or may represent downslope transport of relict outer shelf deposits

L13-81-G117

Gravity core L13-81-G117 (0.98 m length) was recovered from a depth of 695 m on the upper continental slope (Figure 1). It can be divided into three sections based on lithology: (1) Pleistocene laminated or varved silty clay below 70 cm; (2) Pleistocene-age bioturbated clayey silt between 15 and 70 cm; and (3) Holocene-age fine-grained sand and coarse silt from 0 to 8 cm. The ages for this core are based on both conventional and AMS ^{14}C dating (Table 2). Hiatuses at 8 cm and 15 cm are in excess of 10,000 years based on radiocarbon data (Table 2). Multiple hiatuses are observable in laminated sediment below 70 cm, where series annual couplets (varves) are truncated by overlying layers, showing the prevalence of small-scale hiatuses in upper slope deposits that would be unrecognizable in bioturbated deposits (Anderson et al., 1987).

Pseudoeunotia doliolus and *Roperia tesselata* are restricted to Holocene sediment at the top of the core (Figure 6). The ratio of *Chaetoceros* spp. resting spores to total diatom valves is mostly less than 1 from 0 cm to 70 cm, but increases to as much as 6 in varved sediment below 70 cm (Figure 7). *Thalassiosira* spp. (including *T. pacifica*, *T. eccentrica*, *T. hendeyi*,, *T. oestrupii*, etc.; Table 5) are abundant in varved sediment, whereas *Thalassionema* spp. (including *T. nitzschioides* and *T. nitzschioides* var. *parva*) are more abundant above 70 cm, although frequencies fluctuate widely. *Stephanopyxis dimorpha* is abundant in sediment between 30 cm and 70 cm (Figure 8), and similar to its occurrence in L13-81-G138, it is not certain if this represents winnowed material or an indicative paleoecological assemblage. *Paralia sulcata* and *Actinoptychus senarius* are tychopelagic species, and show parallel trends in abundance (Figure 8), but do not closely match the abundance pattern for *S. dimorpha*.

Varved sediment below 70 cm in L13-81-G117 is indicative of deposition within a strong oxygen-minimum zone (OMZ) impinging on the northern California continental slope during the Pleistocene (Gardner and Hemphill-Haley, 1986; Anderson et al., 1987; Anderson et al., 1989). Varved sediments are fine grained (silt; classification system of Shepard, 1954) and contain abundant finely-silicified species of *Thalassiosira* and resting spores of *Chaetoceros*, indicating a period of high productivity of coastal diatoms. Bioturbated sediments are slightly coarse grained (sandy silt) and contain greater percentages of robust diatoms than is found in varved sediment. It is possible that these sediments may have been winnowed, or displaced downslope overburden-induced failure of outer-shelf sediments, or by local tectonic activity along the continental margin.

L13-81-G145

Gravity core L13-81-G145 (1.29 m length) was collected from a depth of 698 m on the continental slope (Figure 1). Similar to L13-81-G117, the upper few centimeters of the core are composed of a coarse silt or fine-sand, and there are sections of bioturbated silt and well-preserved varved clayey silt. Varved sediment is found from 6 to 16 cm, 50 to 65 cm, and below 100 cm. Laminae disrupted by overlying burrows are found from 84 to 100 cm. Only *Pseudoeunotia doliolus* is restricted to Holocene sediment above 6 cm (Figure 9). *Roperia tesselata* and *Rhizosolenia hebetata* var. *semispina* are distributed in Holocene and Pleistocene sediments. A ^{14}C age of about 25,000 yr B.P. in varved sediment at 11-12 cm suggests a that a large hiatus is represented by the contact between the coarse silt Holocene sediment above 6 cm and the underlying varves.

Occurrences of several planktonic species, including *Pseudopodosira elegans*, *Denticulopsis seminae*, *Coscinodiscus radiatus*, and *Actinocyclus curvatulus* (Figure 10), indicate higher frequencies in the finer-grained varved sediment than in intervening bioturbated sediment. Ratios of Chaetoceros spp. resting spores to total diatom valves (Figure 11) are higher in varved sediment relative to bioturbated sediment, although values are not as high as in similar deposits in L13-81-G117. Relative frequencies of *Thalassionema* spp. (includes *Thalassionema nitzschioides* and *T. nitzschioides* var. *parva*) and *Thalassiosira* spp. (combined values for *T. decipiens, T. eccentrica, T.*

oestrupii, *T. lineata*, *T. pacifica*, etc.; Table 6) are higher in varved sediment relative to intervening bioturbated sediment. Freshwater and benthic diatoms, and *Stephanopyxis dimorpha*, are dominant in bioturbated sediment at 30-40 cm and 70 cm (Figure 12), and may be the result of increased winnowing of slope deposits, or be reworked relict sediment from the outer shelf.

TT197-G330

Gravity core TT197-G330 (1.55 m length) was collected from a depth of 700 m on the upper continental slope off Point Arena (Figure 1). The diatom assemblages in this core are rather enigmatic and are interpreted as having accumulated beneath a strong upwelling center that developed off Point Arena during the late Pleistocene (Hemphill-Haley, 1987). TT197-G330 can be divided into three section based on lithology: a) 0-2 cm, hemipelagic mud with containing Holocene-age diatoms (*Pseudoeunotia doliolus*; Figure 13); b) 3-55 cm, coarse silt or fine-grained glauconitic sand containing only rare, probably reworked, diatom valves; and c) 55-150 cm, faintly to distinctly laminated clayey silt. Diatoms are common in the uppermost hemipelagic unit and the lower varved unit (Figure 14; Table 7), but rare in the middle glauconitic sand, and consequently the frequency data are not statistically comparable to the more diatomaceous sediments in the core. In comparison to varved sediment in L13-81-G117 and L13-81-G145, varved sediment in TT197-G330 contains lower relative frequencies of planktonic species such as *Thalassionema* spp. and *Thalassiosira* spp. (Figure 13). Diatom assemblages are instead dominated by heavily-silicified species like *Stephanopyxis dimorpha* (Figure 14), *S. kulmii*, *Endictya* sp. 1, and miscellaneous benthic diatoms (Table 7). *Chaetoceros* spp. resting spores, which were abundant in varved sediment in L13-81-G117, occur in low numbers in TT197-G330 (Figure 13).

LATE QUATERNARY PALEOCLIMATOLOGY BASED ON DIATOMS

With the exception of the *Pseudoeunotia doliolus*, Holocene or modern assemblages do not differ from Pleistocene diatom assemblages. There is no evidence for higher frequencies of subarctic or boreal species (e.g., *Denticulopsis seminae*, *Thalassiosira trifulta*, *T. gravida*) during in Pleistocene sediment, but rather a consistent occurrence of the same neritic species presently being produced off the California coast (Cupp, 1943; Garrison, 1980) and collected in sediment traps deployed in 1980-81 (Anderson et al., 1987). Prior to full glacial conditions (about 40,000-25,000 yr B.P.), strong coastal upwelling resulted in high diatom productivity and sedimentation of diatom frustules, and a decrease in oxygen levels in the OMZ impinges on the slope. Diatoms in core TT197-G330 suggest that a strong Pleistocene upwelling center, similar to that now located off Cabo Nazca, Peru, and Point Conception in southern California (Jones et al., 1988) developed off the coastal promontory of Point Arena, which resulted in the restricted deposition of planktonic diatoms on the seafloor in this area. Local upwelling and high primary productivity helped to maintain a strong OMZ either continuously or episodically between about 42,000 yr B.P. and 25,000 yr B.P., as indicated by the oldest varves in TT197-G330 and the youngest varves in L13-81-G145. As the upper contact of the varved sediment in each core is truncated by an unconformity, however, the age of the transition to an aerobic OMZ is not known. Additional data from the Klamath Plateau at 42°N (Anderson et al., 1989) suggests that a strong OMZ existed in that area about 12,000 yr B.P.

EVIDENCE FOR THE PLEISTOCENE TO HOLOCENE TRANSITION

The Subarctic Front may have had sharper thermal gradients and extended farther south during glacial episodes of the Pleistocene, creating a sharp temperature or salinity boundary for subtropical oceanic species (Sancetta 1979; 1983). Comparison of the ^{14}C dates with the distribution of *Pseudoeunotia doliolus* in the 4 cores discussed in this report, plus data from additional cores in this area (V1-80-G22: Gardner and Hemphill-Haley, 1986; V1-80-P3: J. Barron, pers. comm.) strongly suggests that *P. doliolus* is restricted to Holocene-age deposits off northern California. Other subtropical species that are more common in Holocene than Pleistocene sediments include *Roperia tesselata, Hemidiscus cuneiformis*, and *R. hebetata* forma *semispina*. These species, including *P. doliolus*, are part of the modern-day Transition Domain of Venrick (1971). Why *P. doliolus* was singly excluded from the northern California continental margin during the Pleistocene is not clear, although it may have some correlation with the retreat of the Subarctic Front. Alternately, strong thermal gradients at the seaward edge of the California Current may have formed a temperature barrier to *P. doliolus*. Sancetta et al. (1992) suggest that increased stratification in the California Current may have affected the distribution of *P. doliolus* in Holocene deposits off Oregon. Regardless of the paleoecological controls on its distribution, however, it forms a reliable marker for the Pleistocene-Holocene transition over a large area.

DIATOM DISTRIBUTIONS IN LAMINATED VERSUS BIOTURBATED UPPER-SLOPE DEPOSITS

Contrasts between diatom assemblages in varved and bioturbated deposits may be a reflection of different degrees of preservation for diatom frustules between the two deposits. Using core G117 as an example, varved sediment contains an uncommonly well-preserved diatom record. Varved sediments contain higher frequencies of finely-silicified species (e.g., *Thalassiosira* spp.) that are rapidly produced in the water column. Studies have shown that dissolution of diatom frustules is rapid in the uppermost few tens of centimeters in bioturbated sediments (Kadko et al., 1983; Diester-Haas, 1978). But, because the varved deposits are not stirred by burrowing organisms, interstitial waters may maintain higher concentrations of dissolved silica relative to the typical undersaturated seawater conditions, and thus enhance the preservation of diatom frustules after burial. Environmental factors favoring preservation of varves may also indirectly contribute to better preservation of delicate diatom frustules. However, the kinds of planktonic diatom that are produced most abundantly during upwelling off northern California (Cupp, 1943; Garrison, 1980), including those collected in sediment traps deployed along the lower slope (Anderson et al., 1987), are poorly represented even in the best-preserved varves. For example, *Skeletonema costatum*, and *Bacteriastrum* spp., which along with *Chaetoceros* spp. are probably the most important diatoms in biological or fisheries studies, are rarely preserved in sediments. As noted by Donegan and Schrader (1982) in their study of Quaternary varves in the Gulf of California, the occurrence of a few specimens of *S. costatum* implies unusually high input of diatoms to the seafloor so that a few, rather than none, survive the burial process. As part of their reproductive strategy, *Chaetoceros* spp. form heavily-silicified resting spores, and these can be used as a rough proxy for productivity levels of these diatoms. Unfortunately this can provide only a rough estimate, or rather an *underestimate*, as only a small percentage of vegetative cells will produce a resting spore (Sancetta, 1989).

Bioturbated sediment is more likely to contain concentrations of species less resistant to dissolution under normal burial conditions (e.g., *Thalassionema nitzschioides, Actinocyclus curvatulus, Coscinodiscus* spp., large specimens of *Thalassiosira eccentrica*) but not produced in volumes as large as finely-silicified "bloom" species. For example, in L13-81-G138, the frequencies of the less-productive but more robust diatoms exceed the frequencies of the rapidly-produced but easily-dissolved bloom diatoms. In the case of winnowing or redeposition, resulting deposits will be dominated by robust and hydrodynamically-stable diatoms (e.g., *Stephanopyxis* spp., *Endictya* sp. 1). Bioturbation in these cores will naturally blur the biostratigraphic record to some degree. However, the Pleistocene to Holocene transition, an important biostratigraphic boundary, is clearly discernible in these sediments.

DIATOM EVIDENCE FOR RESTRICTED PELAGIC SEDIMENTATION AND WINNOWING

The varved sediment in L13-81-G117 contains the best fossil diatom record yet recovered from the continental slope off northern California. These deposits contain species of various sizes and shapes, including high frequencies of finely-silicified planktonic species and fewer numbers of benthic and reworked specimens associated with lateral transport at depth. When diatom assemblages in varved sediment in core TT197-TT197-G330 are compared to those in L13-81-G117, it is clear that depositional processes that allowed for massive accumulation of diatom frustules on the upper slope for L13-81-G117 did not operate equally for TT197-G330. Sediments in TT197-G330 are fine-grained and finely laminated, comparable to varves in L13-81-G117, which precludes removal of finely silicified species through winnowing. Rather than being winnowed after deposition, it is more likely that planktonic species were prevented from reaching the seafloor in the vicinity of TT197-G330. Results of studies by Jones et al. (1983; 1988) in modern upwelling centers off Peru and southern California may help to explain the diatom assemblages in varved sediment in TT197-G330. An upwelling center is an area of intensified upwelling and primary productivity relative to the rest of the coast, and develops along coastal promontories like Point Arena. Near the core of well-developed upwelling centers, diatom productivity may be very limited, with planktonic species like *Chaetoceros* spp. and finely silicified *Thalassiosira* spp. produced in massive numbers at the surface some distance away from the core of the upwelling center where strong surface currents begin to wane, forming productivity fronts. Thus, directly below the upwelling center, which may extend over several tens of kilometers, the combined action of low productivity and strong lateral advection of surface currents results in a greatly reduced flux of planktonic diatoms to the underlying seafloor. The direction of the strongest lateral transport is equatorward (*i.e.*, southward), or in the direction of average alongshore wind stress (Jones et al., 1988). This may explain why higher numbers of diatoms accumulated in varved sediments of comparable age in L13-81-G117, located 85 km to the south. With the exclusion of planktonic species in sediments beneath the core of the upwelling center (the area of maximum surface-water velocities), lateral transport and reworking of diatoms at depth would result in assemblages dominated by robust, easily-reworked species. Lateral transport at depth, as documented in sediment trap studies in Saanich Inlet (Sancetta, 1989), is a plausible explanation for the anomalous diatom assemblages (dominated by *Stephanopyxis dimorpha*, possibly a tychopelagic species, and the freshwater *Aulacoseira* spp.) in well-preserved, finely laminated sediments in TT197-G330. The unusual diatom assemblages in these Pleistocene sediments then record strong coastal upwelling: The presence of finely silicified planktonic species in *modern* sediment off Point Arena is an indication that the intensity of surface currents associated with upwelling has been reduced so that planktonic debris is presently reaching the underlying seafloor.

In the situation where robust diatoms, equivalent to those found in fine-grained laminated sediment in G330, occur in coarser-grained material, sediment reworking or winnowing is suspected. Strong bottom currents that could remove fine-grained sediment would likewise remove diatom valves of comparable hydrodynamic stability. Even with poor preservation in bioturbated sediment, absence of less-robust species and coarser grain size may be an indication that the deposit is winnowed.

CONCLUSIONS

Diatoms are abundantly distributed in late Quaternary sediments on the northern California continental slope. Similarities in diatom assemblages between the 4 cores studied include the consistent occurrence of *Pseudoeunotia doliolus* to define Holocene sediment, and the occurrences of robust species like *Stephanopyxis dimorpha* and *Aulacoseira granulata* in coarser-grained deposits. Laminated or varved sediment recovered in the three upper-slope cores suggest stronger upwelling during periods of the Pleistocene as compared with the present situation, although the temporal and spatial variations in the strength of coastal upwelling resulted in major differences in diatom assemblages in varved sediment in different cores, particularly between L13-81-G117 and TT197-G330. Varves in L13-81-G117 contain an unusually well-preserved diatom record; similar sediments in L13-81-G145 are well-preserved, but less so than L13-81-G117. In contrast, laminated or varved sediment in TT197-G330 was deposited beneath the core of a strong upwelling center, and thus cannot be compared to L13-81-G117 or L13-81-G145. However, the anomalous diatom assemblage in TT197-G330 provides some insight into the occurrence and strength of coastal upwelling along the northern California continental margin during the late Quaternary.

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FLORAL LIST

The following is a list of the most common diatoms observed in late Quaternary sediments off northern California. I have divided the diatoms into 2 categories: (1) Marine Planktonic and Meroplanktonic Diatoms; and (2) Freshwater, Benthic, and Tychopelagic Diatoms. Within each category, species are listed alphabetically.

MARINE PLANKTONIC AND MEROPLANKTONIC DIATOMS

Actinocyclus Ehrenberg

Actinocyclus curvatulus Janisch *in* Schmidt, 1878
Description: Circular valve, 40-160 µm in diameter, coarsely areolate, about 5-6 areolae in 10 µm in the middle of the valve, 8-9 close to the margin, and much smaller, 11-12 in the submarginal zone. The margin is finely striate, about 18 in 10 µm. Areolae are fasciculate, with rows parallel to the longest row in the center of the fascicle. The epithet is based on the curvature of the rows. A small pseudonodule lies near the valve margin, but it is often indistinct. I follow Sancetta (1982) who named *Actinocyclus divisis*, *Coscinodiscus divisis*, and *C. curvatulus* as synonyms for *Actinocyclus curvatulus*.
References: Hustedt, 1930, Kieselalg. I, p. 538, fig. 307; Lohman, 1941, p. 76, pl. 15, fig. 2; Schrader, 1973, pl. 19, fig. 2; Koizumi, 1973, pl. 1, fig. 1-6; 1975, pl. 2, figs. 7-10; Sancetta, 1982, pl. 1, figs. 1-3.

As *Coscinodiscus curvatulus*: Hustedt, 1930, p. 406, fig. 214; Gran and Angst, 1931, p. 442, fig. 18; Cupp, 1943, p. 55, fig. 17, pl. 1, fig. 2; Rizynk, 1973, p. 120, pl. 6, fig. 6.
Distribution and Ecology: Cupp (1943, p. 55): "Neritic. Reported occasionally off California. Found in all the oceans." Common pelagic diatom north of the Subarctic Front (Sancetta, 1982).

Actinocyclus ochotensis Jousé, 1961
Description: Schrader (1973, p. 701): "Valve discoid, almost flat, 20-48 µ in diameter. Areolae hexagonal to round, 4-8 in 10 µ near the center, becoming smaller towards the margin. Central hyaline area usually present, 2.5-12 µ in diameter. Areolae tend to make fascicles in the inner half of the radius. The structure is interrupted near the margin by an irregular narrow hyaline zone. Fascicles not developed when pores are sparse and irregularly distributed. Pseudonodule filled with small areolae, present on the margin outside the hyaline zone. Margin 1.5-2 µ wide, radially striated, 14-15 striae in 10 µ."

Specimens off northern California more closely approximate those of Schrader, 1973, pl. 19, fig. 6, and the figures in Koizumi (1973). These species are not strongly fasciculated as in *A. curvatulus*, but may be closely related.
References: Jousé, 1968, fig. 2, no. 2,5; Koizumi, 1968, pl. 32, fig. 7-10; Donahue, 1970, p. 135, pl. 2, fig. 2-5; Jousé, 1971, pl. 31.3, fig. 4-6; Schrader, 1973, p. 701, pl. 18, fig. 8, 17, pl. 19, fig. 6; Koizumi, 1973. p. 831, pl. 2, fig. 3-7; 1975, pl. 2, fig. 11,12; Sancetta, 1982, p. 224, pl. 1, fig. 4-6; Akiba and Yanagisawa, 1985, pl. 46, fig. 14.
Distribution and Ecology: Cold-water pelagic species. Reported by Sancetta (1982) in pelagic settings of the northwestern Pacific, Bering Sea, Sea of Okhotsk. Reported by Kanaya and Koizumi (1966) as a subarctic pelagic species.

Actinocyclus spp.

Includes stratigraphically rare occurrence of *A. octonarius* and poorly-preserved diatoms assigned to the genus *Actinocyclus* but not identifiable to species.

Azpeitia M. Pergallo

Azpeitia tabularis (Grunow) Fryxell and Sims in Fryxell et al., 1986
Description: Valve diameter 16-59 µm, areolae are subquadrate, 5-6 in 10 µm, arranged initially in a spire then in radial rows; marginal processes spaced 7 to 12 µm apart. Central labiate process slightly off-center; areolae do not extend to the margin, leaving a distinctive hyaline zone. This species is distinguished by the sub-quadrate areolae and the hyaline space between the valvar areolae and the marginal areolae (Fryxell et al., 1986).
References: Fryxell et al., 1986, p. 16, fig. 14, 15, 30;
As *Coscinodiscus tabularis*: Hustedt, 1930, Kieselalg. I, p. 427, fig. 230; Koizumi, 1968, pl. 33, fig. 10; Schrader, 1973, p. 704, pl. 20, fig. 3,4; Koizumi, 1975b, p. 876, pl. 2, fig. 14-15; Koizumi and Tanimura, 1984, p. 290, pl. 5, fig. 13-14; Barron, 1985, pl. 3, fig. 4.
Distribution and Ecology: A cold-water diatom. Fryxell et al. (1986, p. 18): "...it appears that the species can be classified as extremely cold-tolerant but with a preference for subantarctic conditions."

Coscinodiscus Ehrenberg

Coscinodiscus marginatus Ehrenberg, 1843
Description: Sancetta (1987, p. 240): "Valve circular, flat or slightly depressed in center, falling more or less steeply at the mantle which may have a slight constriction about halfway down. Valves 35-145 µm in diameter. Areolae loculate, circular on valve face and elongated on mantle, surrounded on outer surface by ridges and nodes which produce a polygonal effect in LM. Areolae irregularly arranged, 1.5 to 2 in 10 µm at the center, 2.5 to 3 in 10 µm at the margin. Mantle areolae elongated in pervalvar direction, their walls resting on a broad (3-6 µm) hyaline band. One ring of marginal labiate processes, 2-3 in 10 µm, with two larger labiate processes among them, broadened and curled in a mushroom shape. Valve surface slightly depressed at locations of larger labiate processes." A robust diatom. The horizontally-arranged mantle areolae (in valve view) give the valve the appearance of having coarse marginal radial striae, which is a distinctive feature of this diatom (Sancetta, 1987).
References: Hustedt, 1930, Kieselalg. I, p. 416, fig. 223; Cupp, 1943, p. 55, fig. 19, pl. 1, fig. 3; Hendey, 1964, p. 78, pl. 22, fig. 2; Sheshukova-Poretzkaya, 1967, p. 156, pl. 11, fig. 9, pl. 17, fig. 4, pl. 18, fig. 1-2; Koizumi, 1968, p. 211, pl. 33, fig. 3; Jousé, 1971, pl. 31.1, fig. 5-6; Barron, 1973, pl. 1, fig. 2; Koizumi, 1973, p. 833, pl. 3, fig. 12-14; Schrader, 1973, pl. 20, fig. 7, 10; Rizynk, 1973, 120, pl. 6, fig. 5; Koizumi, 1975a, p. 798, pl. 3, fig. 7; Sancetta, 1982, p. 228, pl. 2, fig. 10; Maruyama, 1984, pl. 14, fig. 5; Akiba, 1985, p. 442, pl. 1, fig. 1-4; Whiting and Schrader, 1985, pl. 4, fig. 1-2; Kim and Barron, 1986, p. 177, pl. 3, fig. 3,5; Sancetta, 1987, p. 231, pl. 1, fig. 1-13; Laws, 1988, p. 157, pl. 6, fig. 6, pl. 35, fig. 4;
Distribution and Ecology: A coldwater species. Cupp (1943, p. 56): "Of wide distribution. Found in all oceans sporadically. Not common off California." Kanaya and Koizumi (1966) and Jousé (1962) reported *C. marginatus* as common in the North Pacific and Sea of Okhotsk; Sancetta (1982) reported it as averaging less than 5% of samples from similar areas, noting that higher percentages are found in areas of intense winnowing. Rare off northern California; often found with other resistant forms indicative of sediment winnowing or reworking.

Coscinodiscus oculus-iridis Ehrenberg, 1841
Description: Sancetta (1987, p. 240): "Valves circular with depressed central region and elevated crest dropping steeply to mantle. Valve 105-180 µm in diameter. Areolae loculate, circular, surrounded on outer surface by thickened ridges and nodes, producing hexagonal appearance in LM. Areolae radially arranged, with secondary spirals. Rosette,

if present, about 10 µm wide, consisting of 4-7 elongated central areolae. Areolae increase outward in size, 2 to 2.5 in 10 µm in center, 1 to 1.5 in 10 µm on crest, then decreasing abruptly to 3 in 10 µm on mantle, where they are arranged in quincunx rows. One ring of marginal labiate processes, 2 in 10 µm, with two larger labiate processes among them, broadened and curled in a mushroom shape." This species is distinguished by the central rosette, the depressed center, and areolae that increase in size for the inner two thirds of the valve, and then decrease in size the rest of the distance towards the margin.
References: Hustedt, 1930, Kieselalg. I, p. 452, fig. 252; Hendey, 1964, p. 78, pl. 24, fig. 1; Sheshukova-Poretzkaya, 1967, p. 160, pl. 21, fig. 1; Sancetta, 1982, p. 229, pl. 2, fig. 2; Sancetta, 1987, p. 235, pl. 2, fig. 11-14, pl. 3, fig. 1-12
Distribution and Ecology: Sancetta (1987, p. 238): "It occurs throughout the subarctic zone and into the deep basin of the Bering Sea, but is absent from the Sea of Okhotsk, the continental shelf, and south of 40° N." Hendey (1964, p. 78): "An oceanic, pelagic species found all over the world. Common in North Atlantic water. Frequent in the North Sea." Cupp (1943, p. 63): "A widely distributed species. Not common off California but reported occasionally. Oceanic." Rare in Pleistocene sediments off northern California.

Coscinodiscus radiatus Ehrenberg, 1841
Description: Sancetta (1987, p. 240): "Valve circular, flat, with short vertical mantle. Valves 13-100 µm in diameter. Areolae loculate, circular to polygonal on valve face and elongated on the mantle. Areolae more or less regularly arranged in radial rows, 3.5 to 5 in 10 µm on the valve face, 6-8 in 10 µm on the mantle. Labiate processes scattered over valve face at the ends of some shorter radial rows, their number greater in larger and more regularly radial specimens. One ring of marginal labiate processes, 3 in 10 µm, with two slightly larger labiate processes among them, not of different shape. Outer valve surface slightly depressed at location of the larger processes." Sancetta (1987) reported that both *C. obscurus* and *C. perforatus* (including varieties of *C. perforatus* discussed by Cupp, 1943) are junior synonyms of *C. radiatus*. The species is variable in the overall shape of the areolae, the occurrence of a hyaline central area, and the number and orientation of small labiate processes on the valve surface. *Coscinodiscus* cf. *radiatus* in Akiba (1985) is probably an example of smaller specimens of *C. radiatus* that do not have well-developed radial areolation patterns.
References: Gran and Angst, 1931, p. 445, fig. 21; Cupp, 1943, p. 56, fig. 20, pl. 1, fig. 4; Hendey, 1964, p. 76, pl. 22, fig. 7; Barron, 1973, pl. 2, fig. 1; Rizynk, 1973, p. 17, pl. 7, fig. 1; Rao and Lewin, 1976, p. 177, fig. 37; Barron, 1980a, pl. 5, fig. 2, 5, 7; 1985, pl. 3, fig. 7; Whiting and Schrader, 1985, pl. 4, fig. 3; Sancetta, 1987, p. 234, pl. 2, fig. 1-10; Laws, 1988, p. 158, pl. 5, fig. 7, pl. 6, fig. 2-4.

As *Coscinodiscus perforatus*: Cupp, 1943, p. 61, fig. 25-A,B, pl. 3, fig. 1; Hendey, 1964, p. 77; Whiting and Schrader, 1985, pl. 4, fig. 7-8.
Distribution and Ecology: Sancetta (1987, p. 235): "In the North Pacific *C. radiatus* is only consistently present in surface sediment underlying the subtropical gyre, south of 40°N... This distribution suggests a preference for waters warmer than those of the subarctic Pacific." Hendey (1964, p. 76): "Common on all North European coasts, North Sea, English Channel." Cupp (1943, p. 56): "Oceanic and neritic. Ubiquitous. Never in large numbers off California but not uncommon. Recorded by Gran as an oceanic, temperate species." Common in sediments off northern California, particularly associated with other subtropical diatoms in Holocene sediments.

Coscinodiscus spp.

Includes rare and/or poorly-preserved diatoms assigned to the genus *Coscinodiscus* but not identifiable to species level.

Delphineis Andrews

Delphineis karstenii (Boden) Fryxell in Fryxell and Miller, 1978
Description: Fryxell and Miller (1978, p. 116): "Valve in valve view linear with rounded apices to slightly inflated in center and ends with rounded apices, 27-86 µm in length seen, (6-) 7 µm in width. Rows of two or three areolae at the margin, 8-9 (-10) in 10 µm. Blunt spines resembling teeth on margin between areolae. No apical pore field, but two small holes in valve near labiate process; rows of areolae continue around apices. Double labiate process taking place of one areola internally at each apex, either same or opposite side at each pole of one cell.
References: Fryxell and Miller, 1978, p. 116, fig. 1-10; Whiting and Schrader, 1985, pl. 6, fig. 11-13; Andrews, 1988, pl. 1, fig. 3.
Distribution and Ecology: Fryxell and Miller (1978, p. 116): "Planktonic, continental shelf species." Used as an indicator of coastal upwelling off southwest Africa (Schuette and Schrader, 1981 a,b).

Delphineis surirella (Ehrenberg) G.W. Andrews, 1981
Description: Andrews (1981, p. 83): "Frustules observed only as solitary specimens, but details of the valve structure suggest a growth habit of weakly linked chains. Valves broadly elliptical to elliptical lanceolate with very slightly produced bluntly rounded apices. Surface of valves smoothly flat to slightly concave externally, smoothly rounded at margin to a narrow mantle. Length 17 to 53 µm; width 12 to 17 µm. Transverse striae made up of rows of large round poroid areolae, about 7-10 rows in 10 µm and about 7-8 areolae in wavy longitudinal rows. Outermost row of areolae on the mantle and one submarginal row of areolae continue around the apices of the valve; these radial areolae around the apices are slightly smaller and more closely spaced than the areolae along the lateral margins of the valve. Sieve plates near the inside of the valve, simple, apparently attached to the walls of the areolae by two strut-like thickenings parallel to the margin of the valve. Hyaline axial area distinct, narrow, widening slightly near the apices. The transverse rows of areolae are aligned across the hyaline axial area. Two extremely small pores penetrate the valve at the apices a short distance inside the row of submarginal areolae. A single labiate process is found in each end of the valve, and the pair is usually arranged diagonally to the longitudinal axis, but rarely on the same side of the axis."
References: Andrews, 1981, p. 83, pl. 1-2, fig. 1-7; 1986, p. 198, pl. 1, fig. 1.
As *Raphoneis surirella*: Lohman, 1941, p. 82, pl. 17, fig. 6; Hustedt, 1959, Kieselag. II, p. 173, fig. 679; Hendey, 1964, p. 155, pl. 26, fig. 11-13; Schrader, 1973, p. 709, pl. 25, fig. 4,6; Andrews, 1975, p. 212-213, pl. 3, fig. 35-37; Jensen, 1985, p. 162, fig. 679.
Distribution and Ecology: Temperate shallow marine and brackish coastal environments (Andrews, 1981). Hustedt (1959, translated in Jensen, 1985, p. 162): "Distributed on all European coasts, also in harbors and river mouths with brackish water. Very common on the coasts of the southern North Sea to the Atlantic coasts of west Europe; rare in the Mediterranean."

Denticulopsis Simonsen

Denticulopsis seminae (Simonsen et Kanaya) Simonsen, 1979
Description: Sancetta (1982, p. 231): "Valves linear to linear-elliptical with broadly rounded ends, 10-60 µm long, 5-10 µm wide. Pseudosepta 3-4 in 10 µm, broadened at each marginal end to form an apically-directed ridge. One to three shallow secondary pseudosepta between every pair of pseudosepta. Pseudosepta and secondary pseudosepta transapical and parallel across most of valve, curving slightly toward apices in apical region. Transapical striae not visible in LM, 40 or more in 10 µm, with decussate puncta. Canal raphe marginal, near valve mantle." Akiba and Yanagisawa (1985, p. 491): "Pseudosepta have well-

developed crossbars, but in some cases these are less conspicuous or absent. Secondary pseudosepta are well developed and curved near the apices. Branching of secondary pseudosepta is inconspicuous and only discernible by careful inspection. Both the valve face and mantle are generally furnished with transapical striae..." Akiba and Yanagisawa (1985) reported that *D. seminae* and 2 other late Neogene species show several morphological characters (an asymmetry formed by branching of pseudoseptae on the raphe margin, a continuous raphe slit, fine areolation of valve surface and margin) that may indicate an evolutionary lineage separate from *Denticulopsis*, and proposed the new genus *Neodenticula*. However, for this report I use the widely-accepted nomenclature of *Denticulopsis seminae* .
References: Simonsen, 1979, p. 65; Sancetta, 1982, p. 230, pl. 3, fig. 1-3; Whiting and Schrader, 1985, p. 256, text fig. 2.

As *Denticula seminae*: Simonsen and Kanaya, 1961, pl. 1, fig. 26-30; Koizumi, 1973, pl. 5, fig. 1-13; Schrader, 1973, p. 705, pl. 1, fig. 1-11, 36, 47; Koizumi, 1975a, p. 802, pl. 1, fig. 1-3; Barron, 1980, p. 672, pl. 1, fig. 1.

As *Neodenticula seminae*: Akiba, 1985, p. 443, pl. pl. 25, fig. 28-32; Akiba and Yanagisawa, 1985, p. 491, pl. 24, fig. 1-11; pl. 26, fig. 1-10.

Distribution and Ecology: Pelagic, common in subarctic Pacific. Sancetta (1979, 1982) reports that it forms a sharp distributional boundary with the Subarctic Front at 42°N, not being found south of this boundary. It is most common in the northeast Pacific in areas of low productivity, and is abundant in the Gulf of Alaska and along the Aleutian Arc. It is a resistant diatom, capable of surviving reworking. Found in Pleistocene sediments off northern California, though never in large numbers.

Hemidiscus Wallich

Hemidiscus cuneiformis Wallich, 1860

Description: Hendey (1964, p. 94): "Valves almost semicircular; dorsal margin strongly convex, ventral margin weakly so, often almost straight, or with a slight median inflation. Apices rounded, sometimes projecting very slightly on the ventral side. Valve surface covered with a fine areolation arranged in irregularly radiating fascicles; areolae in short parallel lines, particularly towards the middle of the valve, irregular or in tangential sectors towards the margin and the apices. Central area and rosette absent. Upon the ventral margin of the valve is a row of fine spinulae, and a small pseudo-ocellus occupies a position half-way between the apices." Valve 80-120 µm long, 40-70 µm broad.
References: Hustedt, 1930, Kieselalg. I, p. 904, fig. 543; Hendey, 1964, p. 94, pl. 22, fig. 9; Koizumi, 1968, p. 215, pl. 34, fig. 17-18; Schrader, 1974b, p. 914, pl. 19, fig. 20-25; Barron, 1980, p. 529, pl. 3, fig. 13; Fryxell et al., 1986, p. 25, fig. 26.
Distribution and Ecology: Hendey (1964, p. 94): "An oceanic species, with a wide distribution in tropical and sub-tropical waters, but frequent in the North Sea and English Channel." Fryxell et al. (1986, p. 25): "a marine, warm water species. In sediments, it is most likely warm-temperate, found in the North Pacific (Koizumi, 1973; Barron, 1981), the tropical eastern Pacific (Barron, 1980), and the tropical Indian Ocean (Schrader, 1974b)."

Nitzschia Hassall

Nitzschia spp.

Includes miscellaneous rare diatoms of the genus *Nitzschia*. As noted by Hendey (1964), *Nitzschia* is a large genus found in freshwater, brackish and marine environments. Finely-silicified *Nitzschias* in colonies and filaments are common in nearshore plankton off northern California (Hemphill-Haley, unpublished data; Cupp, 1943) but are rarely preserved in sediments. Examples include *N. delicatissima* and *N. seriata*, and occasionally estuarine forms like *N. navicularis*, *N. tryblionella*, and *N. communis*.

Pseudopodosira Jousé

Pseudopodosira elegans Sheshukova-Poretzkaya, 1964

Description: Sheshukova-Poretzkaya (1964, translated in Sancetta, 1982, p. 236): "Valves 12-28 µm in diameter, with flat median part 10-26 µm in diameter, raised above flat narrow hyaline margin 2 µm wide. Raised part of valve has serrated edge, at each prong of which are single small nodules, 4-7 in 10 µm; between the nodules 2-3 concentric rows of points of different size or short weak striae, about 30 striae in 10 µm, occasionally a ring of nodules displaced inward of the shaded zone. In center of valve a group of somewhat small but distinct points." The group of central pores on the hyaline valve surface is a distinctive feature of this species.

References: Sheshukova-Poretzkaya, 1964, p. 75, pl. 2, fig. 4-5; 1967, p. 178, pl. 24, fig. 3, pl. 25, fig. 4; Koizumi, 1973, p. 833, pl. 4, fig. 14; Sancetta, 1982, p. 236, pl. 4, fig. 1-2; Koizumi and Tanimura, 1984, p. 291, pl. 4, fig. 10.

Distribution and Ecology: A cold water diatom. Sancetta (1982) reported that *P. elegans* is absent from modern North Pacific sediments, but comprises up to 2% of diatom assemblages from the shelf and deeper basins of the Bering Sea , and 1% from deep basins of the Sea of Okhotsk. Rare in Pleistocene sediments off northern California.

Pseudoeunotia Grunow

Pseudoeunotia doliolus (Wallich) Grunow in Van Heurck, 1880

Description: Hustedt (1959, translated in Jensen, 1985, p. 235): "Valves half-lanceolate with bluntly rounded ends; straight, slightly concave or rarely slightly convex ventral margin and strongly convex dorsal margin, gradually sloping from the middle toward the ends and often somewhat retracted, 30-70 µm long, 5-8 µm wide. Transapical ribs 9-14 in 10 µm, in between which are found double rows of delicate areolae in quincunx, about 22 oblique rows in 10 µm. Pseudoraphe and central area absent.

References: Lohman, 1941, p. 83, pl. 17, fig. 12-13; Hustedt 1959, Kieselalg. II, p. 258, fig. 737; Cupp, 1943, p. 190, fig. 140; Schrader, 1973, p. 708, pl. 4, fig. 1-8; Koizumi, 1975a, p. 802, pl. 1, fig. 41-45; 1975b, p. 877, pl. 4, fig. 1-4; Hasle, 1976, fig. 29-31; Barron, 1980a, pl. 6 fig, 1-3, 9; 1980b, p. 672, pl. 2 fig. 5; Koizumi and Tanimura, 1984, p. 291, pl. 1, fig. 17, pl. 6, fig. 5; Akiba, 1985, p. 444, pl. 22, fig. 1-2; Jensen, 1985, p. 235, fig. 737; Laws, 1988, p. 172, pl. 31, fig. 1;

Distribution and Ecology: A subtropical species. Hustedt (1959, translated in Jensen, 1985, p. 235): "Predominantly in the littoral and in coastal plankton of warmer oceans; in the European area is found only in the Mediterranean." Cupp (1943, p. 191): "Neritic (and littoral) species. Most common in warmer seas. Moderately abundant in Gulf of California..." Laws (1988, p. 172): "Marine, oceanic, planktonic." Schrader (1973, p. 708): "This species is found in transitional to equatorial biocoenoses. Not found in arcto-boreal sediments." An important marker for the Pleistocene-Holocene boundary off northern California, as it is only found in Holocene-age sediments.

Rhizosolenia (Ehrenberg) Brightwell

Rhizosolenia hebetata form *hiemalis* (Bailey) Gran, 1904

Description: Cupp (1943, p. 88): "Cells straight, 18-20 µm in diameter, valves longitudinally drawn out; apical process thick, solid, except for small, hollow, rounded spine. Junction between scale-like intercalary bands distinct. Intercalary bands in two dorsiventral rows alternating. Cell wall strongly siliceous, with distinct structure. Intercalary bands finely punctate, puncta in quincunx, 24-26 in 10 µm. On valves punctation coarser, 19-20 puncta in 10 µm near base, in broken lines and coarser

near apex." *Rhizosolenia hebetata* is apparently dimorphic, with a cold-water form *hebetata* and a warmer-water, more finely-silicified form *semispina*. Sancetta (1982) reported both forms in the Bering Sea and North Pacific, with the more robust form *hiemalis* being more common.
References: Cupp, 1943, p. 88, fig. 50-A; Hendey, 1964, p. 150, pl. 3, fig. 6; Koizumi, 1973, p. 833, pl. 5, fig. 34-35; 1975a, p. 802, pl. 1, fig. 31-32, 34; Barron, 1980b, p. 672, pl. 2, fig. 15; Sancetta, 1982, p. 237, pl. 4, fig. 5-6; Akiba, 1985, p. 444, pl. 17, fig. 10-11, pl. 18, fig. 9-10.
Distribution and Ecology: A cold-water pelagic species. Cupp (1943, p. 88): "Usually a winter and cold-water form. Rarely seen more southerly than Alaska." Hendey (1964, p. 150): "Probably a cold-water or winter form. Common in all parts of the North Sea, North Atlantic coasts, English Channel and Arctic seas." Sancetta (1982) points out that as Venrick (1971) recorded this form from both winter and summer plankton, its distribution is probably not seasonal, but more likely temperature-controlled.

Rhizosolenia hebetata form *semispina* (Hensen) Gran, 1904
Description: Hendey (1964, p. 150): "Cells cylindrical, valves conical, very finely striate and produced to terminate in a long slender spine. Spine usually straight or only slightly curved, and possessing an internal basal cavity. Girdle composed of two dorsiventral lines of intercalary scale-like plates."
References: Gran and Angst, 1931, p. 460, fig. 43; Cupp, 1943, p. 88, fig. 50-B; Hendey, 1964, p. 150, pl. 3, fig. 5; Akiba, 1985, p. 444, pl. 18, fig. 8.
As *R. styliformis*: Schrader, 1973, pl. 10, fig 1, 20, 21.
Distribution and Ecology: Hendey (1964, p. 150): "An oceanic form common in all sub-tropical and temperate waters. Common in North Sea and English Channel, where it appears as a summer form." Only parts of the valves adjacent to the terminal processes are recovered from sediments off northern California; more common than form *hiemalis*.

Rhizosolenia styliformis Brightwell, 1858
Description: Hendey (1964, p. 150): "Valves deeply conical, oblique, ventral margin almost a straight line, dorsal margin ending in an apical spine. Spine usually short, hollow and furnished with two small lateral wings at the base, which reach down and fuse with the valve. Opposite the spine and appearing almost as a mirror-image of it, is a depression which corresponds to the spine of the contiguous cell. Girdle composed of two dorsiventral rows of imbricate scale-like plates." This species distinguished by the lateral wings of the apical process.
References: Hustedt, 1930, Kieselalg. I, p. 584, fig. 334; Hendey, 1937, p. 320, pl. 11, fig. 15-17; Lohman, 1941, p. 81, pl. 17, fig. 3-4; Cupp, 1943, p. 87, fig 48-A; Hendey, 1964, p. 150, pl. 2, fig. 1; Jousé, 1971, pl. 31.3, fig. 11; Schrader, 1973, p. 710, pl. 10, fig. 18-21; Koizumi, 1975a, p. 802, pl. 1, fig. 33; Barron, 1980a, pl. 7, fig. 13; Sancetta, 1982, p. 238, pl. 4, fig. 7-8; Akiba, 1985, p. 444, pl. 18, fig. 4; Whiting and Schrader, 1985, pl. 7, fig. 12-13;
Distribution and Ecology: Cupp (1943, p. 87): "North temperate species. Common off California, sometimes fairly numerous. Reported from Gulf of California." Hendey (1964, p. 150): "An oceanic species widely spread throughout the world. Common in the North Sea, English Channel, and all North Atlantic seas and off European coasts. Perhaps the most abundant and most important species of *Rhizosolenia* in British waters." Gran and Angst (1931, p. 460): "An oceanic species, in the Puget Sound only a rare guest." Lohman (1941, p. 82): "This is an oceanic species of world-wide distribution, common in both tropical seas and in the colder sub-Arctic and sub-Antarctic waters."

Roperia Grunow

Roperia tesselata (Roper) Grunow in Van Heurck, 1883

Description: Hendey (1964, p. 85): "Valves circular, surface flat, valve mantle abrupt. Valve surface covered with hexagonal areolations arranged in transverse decussating lines in the middle part of the valve up to about half radius; from thence to the margin in radiating fascicles. Marginal pseudonodule distinct. Girdle simple. Diameter of valve 50µm-70 µm."

References: Hustedt, 1930, Kieselalg. I, p. 321, fig. 157; Hendey, 1964, p. 86, pl. 22, fig. 3; Schrader, 1973, pl. 19, fig. 3-4, 8-9; Koizumi, 1975b, p. 877, pl. 2, 3-4; Barron, 1980a, pl. 3, fig. 8, 10; Koizumi and Tanimura, 1984, p. 291, pl. 5, fig. 5-6; Akiba, 1985, p. 444, pl. 16, fig. 7; Fryxell et al., 1986, p.24.

Distribution and Ecology: Hendey (1964, p. 85): "Frequent in the plankton of the Irish Sea, North Sea, English Channel." Fryxell et al. (1986, p. 25): "*Roperia tesselata* is a warm water, planktonic species in the modern oceans (Hasle, 1976). In sediments, this species was recorded by Fenner et al. (1976) from the southern Pacific Ocean, but only in samples north of the Antarctic Convergence. Barron (1980b) reports *R. tesselata* in tropical Eastern Pacific sediments beginning in the upper subzone 'c' of the *Rhizosolenia praebergonii* Zone (late Pliocene)." Common in Holocene sediments off northern California.

Skeletonema Greville

Skeletonema costatum (Greville) Cleve, 1878

Description: Hendey (1964, p. 91): "Valves mostly convex, but sometimes almost flat. Cells united to form filaments by means of a marginal ring of long spines; spines straight, filaments straight, sometimes slightly spiral, weakly siliceous. Owing to the length of the spines the spaces between the individual cells are frequently larger than the cells themselves. The striation of the valves is extremely fine, if anything it is a little more pronounced upon the peripheral zone or valve mantle; but on the face of the valve it is almost invisible... Diameter of valve 8µm-15µm, pervalvar axis 4µm-12 µm. Length of spines usually 6µm-10µm."

References: Hustedt, 1930, Kieselalg. I, p. 311, fig. 149; Gran and Angst, 1931, p. 434, fig. 8; Cupp, 1943, p. 43, fig. 6; Hendey 1964, p. 91, pl. 7, fig. 3; Rizynk, 1973, p. 132, pl. 15, fig. 8; Schrader, 1978, p. 863, pl. 18, fig. 17; Bérard-Therriault et al., 1987, p. 87, fig. 22.

Distribution and Ecology: Hendey (1964, p. 92): "A very common pelagic diatom, frequently associated with a coastal flora; when present it is usually found in large numbers. Common around all North Sea coasts, English Channel, Baltic Sea." Cupp (1943, p. 43): "Neritic. Widely distributed in all seas. One of our most abundant species, particularly from February through April." Because it is so finely-silicified, *S. costatum* does not preserve well, and is rare is sediments below the mixed layer. It may be used to indicate recovery of surface sediments in gravity cores, as it typically dissolves upon burial of a few tens of centimeters. It is associated with older sediments in only rare instances, and may indicate unusually high accumulation of diatoms, thereby raising the concentration of dissolved silica in interstitial waters and facilitating the preservation of a few (rather than no) diatom valves (Donegan and Schrader, 1981; Hemphill-Haley et al., in press).

Stellarima Hasle and Sims

Stellarima stellaris (Roper) Hasle and Sims, 1986

Description: Hustedt (1930, translated in Sancetta, 1982, p. 229): "Cells with convex valves about 60-175 µm in diameter, thin-walled. Disk surface areolate, areolae in more less wide radial fascicles, in which the rows run parallel to the middle rows, and tangential secondary rows concave outward. In the outermost part of the disk the areolae are 10-20 in 10 µm, toward the center they become somewhat larger. In the center of the valve a dark, irregularly

jagged, star-shaped design. Marginal spines absent." Distinguished by finely-silicified valve, and star-shaped cluster of central labiate processes. Usually found broken.
References: Hasle and Sims, 1986, p. 111 (not figured).

As *Coscinodiscus stellaris*: Hustedt, 1930, Kieselalg. I, p. 396, fig. 207; Lohman, 1941, p. 68, pl. 13, fig. 2; Cupp, 1943, p. 53, fig. 16, Hendey, 1964, p. 81, not figured; Koizumi, 1968, p. 212, pl. 33, fig. 11; Jousé, 1971, pl. 31.2, fig. 12; Barron, 1973, pl. 2, fig. 3; Schrader, 1973, p. 704, pl. 26, fig. 7; Sancetta, 1982, p. 229, pl. 2, fig. 12; Whiting and Schrader, 1985, pl. 3, fig. 7.

As *Coscinodiscus stellaris* var. *symbolophorus*: Koizumi, 1973, p. 832, pl. 4, fig. 5-6.

As *Coscinodiscus symbolophorus*: Sheshukova-Poretzkaya, 1967, p. 167, pl. 9, fig. 1; Akiba, 1985, p. 442, pl. 2, fig. 1.

Distribution and Ecology: Temperate to cold-water species. Occurs in low abundances in the Bering Sea and Sea of Okhotsk (Sancetta, 1982). Hendey (1964, p. 81): "An oceanic plankton species with a world-wide distribution, from the tropics to the poles." Cupp (1943, p. 55): "Oceanic. Temperate species. Rare off California." Part of the South-boreal and subtropical complex of Jousé (1971). Rare in sediments off northern California.

Stephanopyxis Ehrenberg

Stephanopyxis dimorpha Schrader, 1973
Description: Schrader (1973, p. 711): "Cells single, dimorphic, 30-50 µm in diameter, about 20 µm high. Upper valve flat, cylindrical, with 2-5 spines centrally arranged. Valve margin with a thin hyaline edge. Areolae hexagonal, in tangential rows, areolae becoming gradually smaller away from the center of the valve, 5 in 10 µm in the middle of the valve, 5-6 near the margin. Lower valve slightly convex with indented central part, 3-6 mucous pores near the center of the valve. Areolae hexagonal in tangential rows becoming gradually smaller toward the margin, 4-5 in 10 µm." Schrader did not provide ecologic information for this species, so it is not clear what category it should be included under. It was collected in a sediment trap deployed in 1980-81 off northern California, thus is not extinct. It is very robust, a fact which suggests that it readily produces resting spores that are retained in the sedimentary record. It is included in the planktonic diatom category because of its association with the planktonic species *S. turris*, but future environmental studies may show it to be tychopelagic like the common species *Paralia sulcata*.
References: Schrader, 1973, p. 711, pl. 15, fig. 9-11, 19-20; pl. 16, fig. 1-3, 8-11; pl. 24, fig. 10; Akiba, 1985, p. 445, pl. 4, fig. 13.
Distribution and Ecology: Found in the northeast Pacific, probably a cool-water to temperate species. Stratigraphic range from NPD Zone IX (correlates in part to the Pliocene *Rhizosolenia praebergonii* Zone of Burckle, 1972) to Holocene. Robust valves may be resting spores. This species comprises a large percentage of some Pleistocene-age samples off northern California, and the sturdy valves may be remnants from sediment winnowing or reworking.

Stephanopyxis kulmii Schrader, 1973
Description: Schrader (1973, p. 711): "Cells single, dimorphic; 16-19 µm in diameter, about 13-15 µm high. Upper valve with numerous trumpet-like spines, arranged at some distance from the center. Spines have a wide central canal. Structure consists of hexagonal areolae, about 9 in 10 µm, gradually becoming smaller (9-10 in 10 µm) towards the margin, in tangential rows. Lower valve convex with a slightly depressed center. Areolae hexagonal to circular, arranged in tangential rows, about 15 in 10 µm." I observed the upper-valve spines in a ring of either 7 or 14 spines, plus a central spine, all with clearly-defined central canals.
Distribution and Ecology: Distribution similar to *S. dimorpha*, which suggests that this species is ecologically similar.

Stephanopyxis turris (Greville and Arnott) Ralfs, 1861
Description: Cupp (1943, p. 40): "Cells circular, oblong, or ellipsoidal. Spines 12-16 at each end of cell, with distinct line of fusion midway between neighboring cells. Spines slightly thickened at the tips. Diameter of cells 36-57 µm. Areolations coarse, 3.5-5 in 10 µm, all about the same size, not smaller or only very slightly smaller at the valve margin. Girdle between two cells leaving a space between the halves of two alternate cells. Resting spores with thick walls and strong spines at two consecutive ends of adjacent cells."
References: Hustedt, 1930, Kieselalg. I, p. 304, fig. 140; Cupp 1943, p. 40, fig. 3; Koizumi, 1968, p. 218, pl. 35, fig. 7; 1973, p. 833, pl. 6, fig. 13-16; Schrader, 1973, p. 711, pl. 15, fig. 1-7; Sancetta, 1982, p. 238, pl. 4, fig. 9-10; Maruyama, 1984, pl. 12, fig. 20; Whiting and Schrader, 1985, pl. 7, fig. 4-5;
Distribution and Ecology: A pelagic species. Cupp (1943, p.40): "Neritic. Temperate and subtropical species. Fairly common, but never abundant off southern California and in Gulf of California." Sancetta (1982, p. 238): "It occurs only as rare individuals in a few samples from the Bering basins, Sea of Okhotsk and North Pacific." Rare in sediments off northern California; robust valves are probably resting spores.

Thalassiosira Cleve

Thalassiosira decipiens (Grunow ex Van Heurck) Jörgensen, 1905
Description: Mahood et al. (1986, p. 138): "Cell diameter 9-29 µm; areolae across valve face 8-12 in 10 µm, much smaller on mantle; single ring of marginal strutted processes four to six in 10 µm; one central strutted process; labiate process located between two marginal strutted process, closer to one than the other." Diatoms placed in the *T. decipiens* category may also include specimens of *T. angulata*, a small marine diatom with affinities for *T. decipiens*. As Hasle (1978, p. 100) noted: "*T. angulata* may be more closely related morphologically to *T. decipiens* than to any other species." Laws (1988) also grouped different small, morphologically similar diatoms together in a *T. decipiens* category.
References: Cupp, 1943, p. 48, fig. 10; Hendey, 1964, p. 87, pl. 1, fig. 5; Mahood et al., 1986, p. 138, fig. 62-67, 97-98.
Distribution and Ecology: Hendey (1964, p. 87): "Widely distributed in temperate seas." Cupp (1943, p. 48): "Neritic. North temperate species. Reported in the Gulf of California. Present but never abundant off southern California." Common in brackish-water environments in San Francisco Bay (Mahood et al., 1986).

Thalassiosira eccentrica (Ehrenberg) Cleve, 1904
Description: Mahood et al. (1986, p. 137): "Cell diameter 12-101 µm; areolae 5-8 in 10 µm in central area, 7-10 in 10 µm toward margin; scattered strutted processes across valve face; irregular spines around margin, three to four in 10 µm; central areola surrounded by seven areolae with single strutted process next to the central areola; two to three rings of strutted processes in 10 µm near margin; one prominent labiate process. Valve face relatively flat."
References: Jousé, 1971, pl. 31.1, fig. 1; Fryxell and Hasle, 1972, p. 300, pl. 1, fig. 1a-2, pl. 2, fig. 3-10, pl. 3, fig. 11-15; Schrader, 1973, p. 712, pl. 16, fig. 5-6, pl. 25, fig. 17; Hasle, 1976, fig. 36; Rao and Lewin, 1976, p. 177, fig. 47-48; Barron, 1980a, pl. 9, fig. 1, pl. 11, fig. 1; Akiba, 1985, p. 445, pl. 14, fig. 13; Barron, 1985, pl. 5, fig. 1; Mahood et al. 1986, p. 137, fig. 30-35, 102; Laws, 1988, p. 176, pl. 10, fig. 6-7, pl. 11, fig. 1-9.

As *Coscinodiscus eccentricus* (or *excentricus*): Gran and Angst, 1931, p. 441, fig. 17; Lohman, 1941, p. 67, pl. 12, fig. 7, pl. 13, fig. 8; Cupp, 1943, p. 52, fig 14, pl. 1, fig. 1; Hendey, 1964, p. 80, pl. 24, fig. 7; Sheshukova-Poretzkaya, 1967, p. 141, pl. 14, fig. 1; Koizumi, 1968, p. 211, pl. 32, fig. 23-24; 1973, p. 831, pl. 2, fig. 11-12;

Barron, 1973, pl. 1, fig. 4; Rizynk, 1973, p. 120, pl. 6, fig. 2.
Distribution and Ecology: This is a ubiquitous marine species. Cupp (1943, p. 52): "Oceanic, but often found near the coast. Wide distribution. Common but never abundant off California." Mahood et al. (1986, p. 137): "Possibly brackish to definitely saline waters, common in central San Francisco Bay." Hendey (1964, p. 80): "One of the most common and widespread diatoms in the neritic plankton, with a world-wide distribution."

Thalassiosira ferelineata Hasle and Fryxell, 1977
Description: Hasle and Fryxell (1977, p. 27): "Valve circular in outline, Valve face flattened; valve mantle shallow, slightly slanting; border between valve face and mantle rounded. Valve margin consisting of horizontal, fairly broad brim. Diameter 20-43 µm. Hexagonal loculate areolae in mostly straight rows. External foramina circular in outline with thick radial threads. Internal cribra hexagonal to circular in outline, porelli in straight rows; 6-7 areolae in 10 µm on valve face, somewhat smaller areolae, 15-20 in 10 µm on valve mantle. Valve mantle areolated to horizontal brim. One labiate process on edge of valve face, with internal slit parallel to tangent, without external tube and discernible on outer valve surface as deep, circular to oval hole, larger in outline than areola or outer opening of strutted process. One marginal ring of strutted processes close to valve margin, about 3-4 in 10 µm, separated by about 6 areolae. One centrally located strutted process. All processes with long internal extensions and nor external tubes. Strutted processes with minimum of four struts and satellite pores." This species distinguished by the single central process, the mostly linear but slightly irregular areolae array, the lack of strong ribbing, and by the arrangement of smaller areolae at the edge of the valve face and on the mantle in curved rows.
References: Hasle and Fryxell, 1977, p. 27, fig. 46-53.
Distribution and Ecology: Hasle and Fryxell (1977, p. 27): "Marine planktonic species. Type locality: South Pacific Ocean." Specimens off northern California match the description of this species in all respects except for marginal strutted processes. Northern California specimens appear to have about 10 processes in 10 µm rather than 3-4 in 10 µm.

Thalassiosira gravida Cleve, 1896
Description: Hendey (1964, p. 86): "Valves circular, united to form chains by a thick mucous thread exuded from a central pore, thread short, but often undulating. Valves flat or nearly so, edges slightly rounded. Structure of the valve very faint, composed of radial striae, moniliform. Valves furnished with small spinulae irregularly disposed, and one fairly stout apiculus, usually marginal. Resting spores are frequently observed and are characterized by their strongly convex valves, convexity unequal, and large areolate structure... Diameter of valve 20µm-58µm, mostly 50µm; pervalvar axis 8µm; length of unicellular thread 30µm-40µm." Sancetta (1982) combined *T. gravida* and *T. antarctica* together under *T. antarctica*, stating that both diatoms are typically found as morphologically indistinguishable convex resting spores. Akiba (1985, p. 445) noted that the epithet *gravida* should be retained because of chronostratigraphic morphological variability of the species in addition to morphological differences between vegetative cells and resting spores.
References: Hendey, 1937, p. 239, pl. 11, fig. 10; Cupp, 1943, p. 48, fig. 11; Hendey, 1964, p. 86, pl. 1, fig. 7.
Distribution and Ecology: Hendey (1964, p. 87): "A common and widely spread boreal species; North Sea, Norwegian and Danish Seas, North Atlantic." Cupp (1943, p. 49): "Neritic. Northern species, but not so northern as *T. nordenskoldii*. Never common off California."

Thalassiosira hendeyi Hasle and Fryxell, 1977
Description: Mahood et al. (1986, p. 130): "Cell diameter 38-120 µm; areolae, regularly linear, five to six in 10 µm; prominent central strutted process set to one side of central areola; two closely adjacent rings of marginal strutted processes alternating in orientation, not easily resolved with LM; wavy mantle ridge; two labiate processes; labiate process with two adjacent strutted processes; valve slightly concentrically undulated.
References: Hasle and Fryxell, 1977, p. 25, fig. 35-45; Whiting and Schrader, 1985, pl. 3, fig. 8-9; Mahood et al., 1986, p. 130, fig. 6-11, 86.
Distribution and Ecology: Hasle and Fryxell (1977, p. 26): "...a coastal, apparently warm water species." Rare in sediments off northern California.

Thalassiosira leptopus (Grunow) Hasle and Fryxell, 1977
Description: Valve 26-165 µm in diameter, valve face flattened without a sharp angle between valve face and mantle. Areolae are hexagonal, 4-7 in 10 µm on valve face in straight rows, with the central areolae distinctly larger than the others. Areolae on the margin are much smaller and irregularly arranged. Marginal processes include "one large labiate process located in the slanting valve mantle, numerous small marginal strutted processes arranged in zig-zags in 2-3 rings, and one marginal ring of irregularly spaced larger occluded process." (Hasle and Fryxell, 1977, p. 21). This species is distinguished by the larger central areolae without a central process, the linear areolae array, and the distinctive marginal processes.
References: Hasle and Fryxell, 1977, p. 20, fig. 1-14, 94-96; Barron, 1980a, pl. 9, fig. 6; Maruyama, 1984, pl. 14, fig. 12; Akiba, 1985, p. 446, pl. 14, fig. 12; Barron, 1985, pl. 5, fig. 5; Whiting and Schrader, 1985, pl. 3, fig. 10-11.
As *Coscinodiscus lineatus*: Hustedt, 1930, Kieselalg. I, p. 292, fig. 204.
Distribution and Ecology: A subtropical species. Hasle and Fryxell (1977, p. 22): "...wide distribution and apparent absence from colder waters."

Thalassiosira nordenskoldii Cleve, 1873
Description: Mahood et al. (1986, p. 138): "Cell diameter 10-50 µm; areolae 14-18 in 10 µm across valve face; marginal strutted processes three in 10 µm; separated from margin by ca. 6-8 areolae. Single strutted process in center of valve; one labiate process in same ring as marginal strutted processes but not in a constant position relative to a strutted process; marginal striae 18-20 in 10 µm in mantle rim." The large submarginal strutted processes help to distinguish this species.
References: Hustedt, 1930, Kieselalg. I, p. 321, fig. 157; Cupp, 1943, p. 46, fig. 8; Hendey, 1964, p. 85, pl. 1, fig. 8; Hasle, 1978, p. 79, fig. 1, 5-20, 35-37; Mahood et al., 1986, p. 138, fig. 106.
Distribution and Ecology: Hendey (1964, p. 85): "An Arctic species. One of the most important and abundant neritic diatoms, often occurring in enormous masses. North Atlantic, North Sea, Norwegian Sea, Arctic seas." Cupp (1943, p. 47): "Neritic. Boreal or arctic species. Reported only occasionally off southern California." Hasle (1978, p. 83) "...a cold water species of the northern hemisphere."

Thalassiosira oestrupii var. *venrickae* Fryxell and Hasle, 1980
Description: Fryxell and Hasle (1980, p. 810): "Drum-shaped cells, with diameters from 5.5-39 µm observed... Valves with eccentric areola array 6-9 in 10 µm in the center, 7-11 in 10 µm near the margin. One strutted process nearly centrally located; single labiate process 2-3 (1-5) areolae distant. Marginal strutted processes 4-7 µm apart. Strutted processes with reduced tri-columnar supports providing contact with basal siliceous layer." Mahood et al. (1986, p. 137): "May

be confused with *T. decipiens* but marginal strutted processes internal rather than external. Dominant characteristics: labiate process away from margin and marginal strutted processes with internal projection seen in same plane of focus." Differs from the type (*T. oestrupii* var. *oestrupii*) in the following ways: 1) var. *venrickae* has an eccentric areolae pattern, whereas var. *oestrupii* has a linear pattern; 2) var. *venrickae* has central areolae that are much larger than other areolae on the valve face, whereas for var. *venrickae* the central areolae are only slightly larger.
References: Fryxell and Hasle, 1980, p. 810, fig. 15-17; Mahood et al., 1986, p. 137 (not figured).
Distribution and Ecology: Mahood et al. (1986, p. 137): "Coastal, temperate waters. Central San Francisco Bay, rare." Fryxell and Hasle (1980, p. 813): "Found in tropical and subtropical waters, mostly on continental shelves."

Thalassiosira pacifica Gran and Angst, 1931
Description: Mahood et al. (1986, p. 138): "Cell diameter 7-46 µm; areolae 10-18 in 10 µm in central area; 20 in 10 µm at margin; one labiate process; pronounced, regular marginal strutted process, four to seven in 10 µm; single central strutted process adjacent to central areolae. Areolae usually fasciculated rows with areolae parallel to radius." Hasle (1978, p. 92): "The areola array varies from linear to eccentric to fasciculated, independent of size of valve diameter. When fasciculated, the sectors of *T. pacifica* are much wider than those of *T. nordenskoldii* and *T. aestivalis*, usually including five to six marginal processes." This category may also include specimens of *T. aestivalis*, which has ecological distribution similar to *T. pacifica*.
References: Gran and Angst, 1931, p. 437, fig. 12; Hasle, 1978, p. 88, fig. 3, 40, 42-69; Barron, 1980, pl. 5, fig. 3-4; Mahood et al., 1986, p. 138, fig. 49-55, 105.
Distribution and Ecology: Hasle (1978, p. 93): "According to present information, *T. pacifica* may... be classified as a cold to temperate water species restricted of the northern hemisphere."

Thalassiosira punctigera (Castracane) Hasle, 1983
Description: Mahood et al. (1986, p. 137): "Cell diameter 43-145 µm; areolae across valve face 15 in 10 µm; areolae fasciculated with areolae arranged parallel to center of fascicle; strutted processes four to five in 10 µm along margin; single central process; one labiate process; large occluded processes irregularly arranged around margin, although some specimens lack large occluded processes entirely." The finely-silicified valve face and prominent closely-spaced marginal processes help to distinguish this species.
References: Mahood et al., 1986, p. 137, fig. 42-48, 92; Laws, 1988, p. 177, pl. 9, fig. 7,8.
As *T. angstii*: Gran and Angst 1931, p. 443, fig. 19-20..
Distribution and Ecology: Coastal planktonic. Laws (1988, p. 177): "Planktonic, marine to brackish water, originally described from Puget Sound."

Thalassiosira tenera Proschkina-Lavrenko, 1961
Description: Mahood et al. (1986, p. 130): "Cell diameter 10-29 µm; areolae 9-16 in 10 µm; marginal strutted processes three to five in 10 µm, one central strutted process; one labiate process; arrangement of areolae linear or fasciculated; marginal strutted processes often with siliceous overgrowths and flattened." This species distinguished by the small size, fine areolation and distinctive marginal processes.
References: Hasle and Fryxell, 1977, p. 28, fig. 54-65; Mahood et al., 1986, p. 130, fig. 18-23, 103-104.
Distribution and Ecology: Hasle and Fryxell (1977, p. 30): "..a cosmopolitan species evidently with a preference for coastal waters." Collected in Monterey Bay, Puget Sound.

Thalassiosira trifulta Fryxell, 1979
Description: Fryxell and Hasle (1979, p.16): "Valves often heavily silicified, disk-shaped, diameter 16-58 µm. Areolae usually 5-6 in 10 µm in center, 6-7 in 10 µm near edge, sublinear arrangement. Labiate process away from margin, often 8-9 areolae from central process on large valves. Strutted process with longer extension inwards 1-4 (-8) in center of valve in 1-2 lines; in marginal ring 4-5 (3.5-6) µm apart; with three columnar supports, connecting processes to basal siliceous layer. Wide margin with external knurled ring."
References: Fryxell and Hasle, 1979, p. 16, pl. 1-5, fig. 1-24; Sancetta, 1982, p. 244, pl. 5, fig. 10-12; Koizumi and Tanimura, 1984, p. 292, pl. 3, fig. 7; Akiba, 1985, p. 446, pl. 10, fig. 5-7.
As *Thalassiosira pacifica*: Schrader, 1973, pl. 14, fig. 13, 14, pl. 25, fig. 18, 21.
As *Coscinodiscus excentricus* var. *jousei*: Koizumi, 1973, p. 832, pl. 3, fig. 1-6.
Distribution and Ecology: Sancetta (1982, p. 245): "*Thalassiosira trifulta*... appears not to be neritic, and thrives in cold productive waters of the basinal gyres, perhaps preferring the intermediate salinities of the basins relative to the shelf and the open ocean."

Thalassiosira cf. *lineata*
Description: Valve flat, about 20-30 µm in diameter, areolae 14-15 in 10 µm, arranged linearly, sometimes in wavy rows; no distinct central processes or central areolae, no scattered strutted processes visible on valve surface. Two rings of marginal processes, the outer ring with about 15 processes in 10 µm, the inner ring with about 7 processes in 10 µm. Differs from *T. lineata* Jousé by the lack of scattered strutted processes on the valve surface, and by more closely-spaced marginal processes.
Distribution and Ecology: Usually rare, but is one of the small *Thalassiosira* spp. found in higher frequencies in varved sediment on the continental slope off northern California.

Thalassiosira sp. 1
Description: Similar to *T. decipiens*. Valve small, slightly convex, about 10-25 µm in diameter; areolae about 10 in 10 µm, arranged in an irregular eccentric pattern. No distinctive central or marginal processes observed.
Distribution and Ecology: Similar to *T. decipiens* in sediments off northern California, which supports the possibility of this being a closely related diatom.

Thalassiosira sp. E
Description: Valve flat, about 50-70 µm in diameter, areolae arranged in irregular eccentric pattern, 5-7 in 10 µm; no central processes observed. Valve has overall similar appearance to *T. trifulta* which sometimes shows areolae in an irregular eccentric array, but does not show the line of processes on the valve face.
Distribution and Ecology: Rare in Pleistocene sediments off northern California.

Thalassiosira spp.
Includes poorly-preserved diatoms of the genus *Thalassiosira* not identifiable to species.

Thalassionema Grunow

Thalassionema nitzschioides (Grunow) H. and M. Pergallo, 1901
Description: Cupp (1943, p. 182): "Valves narrow linear with parallel sides and blunt-rounded ends. Length 30-80 µm; width 2-3.5 µm. Marginal spines small, 10-12 in 10 µm. Valves otherwise without sculpturing." Sancetta (1982, p. 239) noted that SEM investigations have shown that the "marginal spines" discussed by earlier workers (Cupp, 1943, Hustedt, 1959) are in fact thin strings of silica on the external surface of marginal cavities.
References: Cupp, 1943, p. 182, fig. 133; Hustedt , 1959, Kieselalg. II, p. 245, fig.

725; Koizumi, 1968, p. 218, pl. 35, fig. 9-10; Rizynk, 1973, p. 135, pl. 17, fig. 6; Barron, 1973, pl. 2, fig. 6; Schrader, 1973, p. 712, pl. 23, fig. 2,6, 8-10, 12-13, 26, 29, 34; 1974a, p. 556, fig. 5, no. 1-2, 4-6; Koizumi, 1975a, p. 803, pl. 1, fig. 50-51; Barron, 1980a, pl. 6, fig. 15, 21; Sancetta, 1982, p. 239, pl. 4, fig. 11-13; Koizumi and Tanimura, 1984, p. 291, pl. 6, fig. 10; Maruyama, 1984, pl. 11, fig. 1-2; Poulin et al., 1984, p. 363, fig. 92, 93; Jensen, 1985, p. 223, fig. 725; Akiba, 1985, pl. 21, fig. 11; Akiba and Yanagisawa, 1985, pl. 48, fig. 15-16; Whiting and Schrader, 1985, pl. 6, fig. 28-30; Barron, 1985, pl. 8, fig. 13, 15; Laws, 1988, p. 175, pl. 16, fig. 9.

As *Thalassiothrix nitzschioides*: Gran and Angst, 1931, p. 496, fig. 83.

Distribution and Ecology: Cupp (1943, p. 183): "Neritic. North temperate species. Very common and often abundant off southern California and Lower California, in the Gulf of California, and north to Scotch Cap, Alaska." Hustedt (1959, in Jensen, 1985, p. 223): "Pelagic in coastal plankton of European oceans, very widely distributed and common; often massive blooms in the northern Atlantic area." Sancetta (1979, 1982) found this species distributed most abundantly south of the subarctic front in the North Pacific. One of the most common diatoms found in sediments off northern California. Most abundant in surface sediments past the shelf break (Hemphill-Haley, unpublished data).

Thalassiosira nitzschioides var. *parva* Heiden and Kolbe, 1928

Description: Length of valve less than 30 µm, otherwise similar to type.

References: Heiden and Kolbe, 1928, p. 564, pl. 35, fig. 118; Koizumi and Tanimura, 1984, p. 291, pl. 6, fig. 11; Whiting and Schrader, 1985, pl. 6, fig. 27.

Distribution and Ecology: The ecology of this diatoms is uncertain. It may be indicative of high productivity of the species, being the small end member of successive doublings. This is supported by its occurrence with high numbers of the type.

Thalassiothrix Cleve and Grunow

Thalassiothrix longissima Cleve and Grunow, 1880

Description: Hustedt (1959, translated in Jensen, 1985, p. 224): "Valves very narrow-linear, somewhat narrowed on the bluntly rounded ends, but more narrowed on one end than on the other end of the same valve, about 1.5-4 mm long, but only about 3-4 µm wide (whole cells lie, therefore, on the wider girdle band side, as a rule!). Valve edges possess delicate spines, about 3 in 10 µm in the middle part of the cell, more scattered or completely absent toward the ends. Occasionally one finds valve edges completely without marginal spines. Membrane structured with short ribs on the margins, 11-13 in 10 µm; gelatin (mucous) pores near the apices." This species usually found in fragments; only apices were counted (as one-half each). May be distinguished from *T. frauenfeldii* by blunter apices and more closely-spaced marginal spines, when visible.

References: Gran and Angst, 1931, p. 496, fig. 82; Lohman, 1941, p. 82, pl. 17, fig. 5; Cupp, 1943, p. 184, fig. 134; Hustedt, 1959, Kieselalg. II, p. 247, fig. 726; Sheshukova-Poretzkaya, 1967, p. 250, pl. 42, fig. 11; Koizumi, 1968, p. 219, pl. 35, fig. 29; Barron, 1973, pl. 1, fig. 9; Schrader, 1973, pl. 23, fig. 7, 17-18; Koizumi, 1973, p. 834, pl. 8, fig. 16; Barron, 1980a, pl. 6, fig. 17. Sancetta, 1982, p. 245, pl. 6, fig. 3-4; Maruyama, 1984, pl. 11, fig. 17; Akiba, 1985, p. 446, pl. 21, fig. 18; Barron, 1985, pl. 8, fig. 16; Jensen, 1985, p. 224, fig. 726.

Distribution and Ecology: Hustedt (1959, translated in Jensen, 1985, p. 225): "Oceanic plankton form; distributed, often massively, from the northern Atlantic to the northern Arctic. Cupp (1943, p. 184): "Oceanic. Arctic-boreal to north temperate species. Not uncommon off California but never in large numbers." Sancetta (1982, p. 245): "*Thalassiothrix longissima* has been reported from most areas of the World Ocean, and appears to be almost cosmopolitan. It seems to thrive in productive areas of upwelling."

Miscellaneous Marine Planktonic Diatoms

Includes planktonic diatoms such as *Azpeitia africanus* and *Porosira glacialis*, etc., with occurrences too rare to make them useful for paleoecological interpretations.

Miscellaneous Reworked Diatoms

Includes extinct species such as Thalassiosira *antiqua*, *Actinocyclus ingens*, *Denticulopsis hustedtii*, and Rhizosolenia *curvirostris*.

FRESHWATER, BENTHIC AND TYCHOPELAGIC DIATOMS

Actinocylus Ehrenberg

Actinocyclus normanii (Gregory) Hustedt, 1957
Description: Valve circular, 30-110 µm in diameter, concentrically undulated. Areolae about 10-12 in 10 µm, arranged in fascicles, with rows parallel to central row of fascicle; marginal ring of prominent labiate processes with each process positioned in middle of sector.
References: Hustedt, 1957, p. 218, fig. 5,6; Hasle, 1977, p. 322, figs. 2, 11-17, 20, 21; Schrader, 1978, p. 859, pl. 13, fig. 3; Laws, 1988, p. 153, pl. 8, fig. 1-3, 7, 9, 11, 12.
Distribution and Ecology: Marine and brackish water (Brockmann, 1914). Planktonic, ß-mesohalobous with pH around 7 (Schrader, 1978).

Actinoptychus Ehrenberg

Actinoptychus senarius (Ehrenberg) Ehrenberg, 1838
Description: Sancetta (1982) provides an excellent discussion of the epithet priority for *A. senarius*. Cells discoid, 20-150 µm in diameter, with six radial sectors in alternating planes. Central area hexagonal, distinct. Areolae abut 7 in 10 µm, loculate, forming radial rows near the margin. Marginal processes that are positioned in the central part of raised sectors are shown by SEM studies (Sancetta, 1984; Hasle and Sims, 1986) to be external extensions of labiate processes.
References: Hendey, 1964, p. 95, pl. 23, fig. 1-2; Rao and Lewin, 1976, p. 179, fig. 42; Sancetta, 1982, p. 225, pl. 1, fig. 7; 1984, p. 758, pl. 3, fig. 1-4; Akiba, 1985, p. 447, pl. 29, fig. 2; Whiting and Schrader, 1985, p. 251, pl. 1, fig. 15-16; Hasle and Sims, 1986, fig. 37, 38; Laws, 1988, p. 153, pl. 13, fig. 1-4, 7.

As *Actinoptychus undulatus*: Hustedt, 1930, p. 475, fig. 264; Gran and Angst, 1931, p. 483, fig. 30; Cupp, 1943, p. 67, fig. 29, pl. 5, fig. 1; Schrader, 1973, pl. 22, fig. 4, 5, 12, 15; Maruyama, 1984, pl. 15, fig. 4.
Distribution and Ecology: Reported by Cupp (1943) as a widely-distributed, neritic benthic diatom, but often found in the plankton. Sancetta (1984) refers to *A. senarius* as a "cosmopolitan neritic form," that has been reported from the Bering Sea, South Atlantic, and Gulf of California.

Actinoptychus splendens (Shadbolt) Ralfs, 1861
Description: From Hendey (1964, p. 67): "Valves circular, divided into usually 18-20 sectors that are alternately raised and depressed. Valve structure complex and composed of a lamina of coarse hexagonal areolae and one of fine areolae. Alternate sectors differ in structure. In one, narrow hyaline line radiates from the central space to the margin where it terminates in an apiculus, dividing the sector in two, whereas the other does not possess the line, but the areolation breaks down near the margin leaving a hyaline space. Central space often large, circular or stellate. Valve margin narrow, striate." Diameter ranges from about 80 to 180 µm. Distinguishing features of this species are its large size, the

ornamentation of the raised and lowered sectors, and the hyaline line dividing the raised sectors.
References: Cupp, 1943, p. 67, fig. 30; Hendey, 1964, p. 95, pl. 22, fig. 1.
Distribution and Ecology: Hendey (1964, p. 95): "Common littoral form, frequent on English Channel coasts." Cupp (1943, p. 67): "Neritic, littoral. Found occasionally in the plankton. Not common off southern California. North or south temperate species." Rare in sediments off northern California.

Actinoptychus vulgaris Schumann, 1867
Description: Sheshukova-Poretzkaya (1967, translated in Sancetta, 1982, p. 225): "Valves round, diam. 45-75 µm, divided into 10-16 sectors. Structure of valve compound, no hyaline rays. On raised sectors hexagonal areolae... form radial rows, 4-6 in 10 µm, at bases of every sector one row of elongate areolae and one spinose process; puncta arranged radially and in obliquely crossing rows, 12-15 in 10 µm. On depressed sectors indistinct spots, 4-6 in 10 µm, and puncta in the same rows as on the raised sectors; in center of depressed sectors puncta occasionally somewhat discontinuous and irregularly arranged; at base of sectors a narrow bracket-shaped hyaline area. Margin width 1-3 µm, with fine striae, 20-22 in 10 µm, and short spines, 12 in 10 µm; inner contour of margin slightly undulating, raised sectors projecting and depressed sectors sunken. Central area large, polygonal, thickly strewn with puncta, occasionally distinguished with difficulty.

The distinction between this species and *Actinoptychus bipunctatus* Lohman is not clear (as figured in Barron, 1980, pl. 10, fig. 1,2). Schrader (1973, pl. 22, fig. 10, 11, 13, 14) refers to this species as "*Actinoptychus* cf. *splendens*."
References: Sheshukova-Poretzkaya, 1967, pl. 28, fig. 2a-d; Sancetta, 1982, p. 225, pl. 1, fig. 8; Akiba, 1985, p. 447, pl. 29, fig. 1.
Distribution and Ecology: Sheshukova-Poretzkaya (1967) reports *A. vulgaris* as a warm-water species. Sancetta (1982) recorded it from the Bering Sea, indicating that it may be eurythermal. Akiba (1985) lists it under "Marine Tychopelagic and Benthic Diatoms."

Aulacoseira Thwaites

Aulacoseira granulata (Ehrenberg) Simonsen, 1979
Description: Diameter of valves 5-21 µm, 5-18 µm high (usually seen in girdle view). Valves are distinctly areolate, with areolae linearly arranged on the mantle, 8-10 in 10 µm. Terminal valves with long, robust spines, a distinguishing character of the species.
References: Hustedt, 1930, Kieselalg. I, p. 248, fig. 104; Akiba, 1985, pl. 29, fig. 6-9; Laws, 1988, p. 154, pl. 1, fig. 11-15; Fourtanier and Gasse, 1988, p. 1404, pl. 1, fig. 1.
Distribution and Ecology: A freshwater diatom. Pankow (1976): Oligohalobous, meioeuryhaline. Associated with salinities below 5‰. This is a robust diatom that comprises large percentages of some Pleistocene samples from the upper slope off northern California, and is interpreted to represent reworking of shelf deposits.

Aulacoseira islandica (O. Müller) Simonsen, 1979
Description: Diameter of valves 7-27 µm, and 4-21 µm high (usually seen in girdle view). Valve mantle punctate, striate, with striae parallel to pervalvar axis.
References: Hustedt, 1930, Kieselag. I, p. 252, fig. 106, 107; Laws, 1988, p. 154, pl. 2, fig. 2-4.
Distribution and Ecology: A freshwater diatom. Pankow (1976): Oligohalobous, meioeuryhaline. Associated with salinities below 5‰. Distribution similar to *A. granulata*, although less common.

Aulacoseira italica (Ehrenberg) Simonsen, 1979
Description: Diameter 5-28 µm, 8-21 µm high. Mantle surface punctate, with

puncta arranged in striae that wrap around the valve.
References: Hustedt, 1930, Kieselalg. I, p. 257, fig. 109; Laws, 1988, p. 155, pl. 1, fig. 9-10.
Distribution and Ecology: A freshwater diatom. Hustedt (1930, translated in Laws, 1988, p. 155): "Littoral of freshwater streams and lakes." Distribution similar to *A. granulata*, although less common.

Aulacoseira spp.

Includes diatoms of the genus *Aulacoseira* not identifiable to species level.

Cocconeis Ehrenberg

Cocconeis spp.

These are freshwater to brackish benthic diatoms, typically epilithic and epiphytic. Occurrences presumably indicate deposition of coastal river sediments. Most common species include *C. placentula, C. fasciculata, C. costata, C. decipiens, C. scutellum, C. vitrea.*

Cyclotella Kützing

Cyclotella spp.

These are freshwater to brackish planktonic diatoms, presumably associated with coastal rivers. Most common species are *C. striata C. stylorum, C. compta.*

Endictya Ehrenberg

Endictya sp. 1
Description: Robust valve, diameter about 15-25 µm, areolae large, linearly arranged, 4-5 in 10 µm across valve surface, with elongate terminal areolae adjacent to the mantle. No pores or processes visible on valve surface. Mantle sharp, about 5-7 µm high, with regularly spaced spines that give an appearance of a scalloped margin in LM. Differs from *Endictya oceanica* by the smaller size, and linear areolae.
References: As *Endictya oceanica*: Schrader, 1973, p. 705, pl. 20, fig. 11.

As *Stephanopyxis* ? sp. 1: Laws, 1988, p. 174, pl. 6, fig. 5.
Distribution and Ecology: A very robust diatom, occurs in silty sediments suggesting reworking of shelf deposits. Distribution similar to *S. dimorpha*. Commonly found in estuarine sediments with *Paralia sulcata*.

Odontella Agardh

Odontella aurita (Lyngbye) Argardh, 1830

Description: Cupp (1943, p. 162, as *Biddulphia aurita*): "Valves elliptical-lanceolate, with obtuse processes inflated at the base. Center part of valve convex, more or less flattened at the top from which usually more or less long spines project. Spines sometimes absent or several. Girdle zone sharply differentiated from the valve zone by a clear depression. Cell wall strongly siliceous, areolated-punctated. Areolae 8-10 in 10 µm, on the valve in radial rows. On the girdle band in pervalvar rows, 7-10 rows in 10 µm, with 8-14 puncta or areolae in 10 µm. A very variable species. Length of apical axis 12-97 µm."
References: Sancetta, 1982, p. 234, pl. 3, fig. 11-12; Akiba, 1985, p. 444, pl. 17, fig. 2-3.

As *Biddulphia aurita*: Hustedt, 1930, p. 846, fig. 501; Gran and Angst, 1931, p. 491, fig. 76; Cupp, 1943, p. 161, fig. 112-A; Hendey, 1964, p. 103, pl. 24, fig. 6; Barron, 1973, pl. 1, fig. 5; Schrader, 1973, pl. 13, fig. 1-3; Riznyk, 1973, p. 118, pl. 3, fig. 9; Whiting and Schrader, 1985, pl. 5, fig. 13-14; Laws, 1988, p. 155, pl. 14, fig. 2.
Distribution and Ecology: Cupp (1943, p. 162): "Neritic and littoral species. Widely distributed, but most abundant in northern (arctic and boreal) seas. Very common at Scotch Cap, Alaska (Cupp, 1937) especially during April and May. Common off southern California but never in large numbers." Hendey (1964, p. 103): "A neritic and littoral species, sometimes found free, but usually in long chains attached to a substratum. Common in all parts of the North Sea, Baltic, English Channel." According to various authors in Sancetta (1982), *O. aurita* is a North Boreal species, planktonic and neritic. A distinctive member of the early spring bloom. Rhiznyk (1973, p. 118): "Very common in sediment at all intertidal levels... Appears to be filtered out from the phytoplankton." However, Bérard-Therriault et al. (1987) report its distribution as "Estuaire maritime, rives nord et sud; Côte-Nord; Basse-Cîte-Nord; Anticosti; baie des Chaleurs (trés commun, benthique)." Finally, Gran and Angst (1931) reported it as "Littoral and occasionally in the plankton." It is here regarded as a neritic tychopelagic diatom, possibly as an accidental part of the phytoplankton. Rare in sediments off northern California; resistant valves may be prone to reworking.

Odontella (Biddulphia) longicruris Greville, 1859
Description: Cupp (1943, p. 154): "Valves broad elliptical-lanceolate. Length of apical axis 15-110 µm; average of 144 specimens, 47 µm. Surface with a rounded conical elevation in the center from which usually two (sometimes one or three) long spines project obliquely upward and extend past on either side of the adjacent valve of the neighboring cell. Spines often bent to run nearly parallel to pervalvar axis... Processes situated at ends of apical axis, usually long and slender, with rounded ends, slightly inflated at base. Cells joined into chains by ends of processes. Usually a deep indentation or concavity on valve mantle above junction with girdle zone. Girdle zone with straight sides. Valves with puncta radiating from small hyaline central area, forming concentric ellipses on each half of the valve, in nearly parallel rows near base of valve mantle. Puncta on valve 12-17 in 10 µm. Girdle zone with fine, parallel, vertical rows of puncta, 18-21 puncta in 10 µm." Distinguishing features include the elongate valve, the long slender apical processes, and the long thickened spines protruding outward in a "V" from the central elevation.
References: Gran and Angst, 1931, p. 491, fig. 75; Cupp, 1943, p. 154, fig. 111-A; Rizynk, 1973, p. 118, pl. 4, fig. 2.
Distribution and Ecology: Cupp (1943, p. 156): "Neritic. Temperate to subtropical species. Reported north to Straits of Juan de Fuca. Most abundant in warmer waters." Rare in sediments off northern California. Gran and Angst (1930, p. 491): "Neritic in the Puget Sound, sometimes abundant."

Odontella spp.

Includes miscellaneous rare members of the genera *Odontella* and *Biddulphia*, including *O. mobilensis*, *O. pulchella*, and B. *alternans*.

Paralia Heiberg

Paralia sulcata (Ehrenberg) Cleve, 1873
Description: Hendey (1964, p. 73): "Cells discoid, often united valve to valve to form long, straight chains. Frustules with a robust margin and strongly formed valve mantle bearing coarse granular markings. Valves circular, central area slightly convex, hyaline. Valve surface bearing a ring of short, radiating lines which may be reduced to coarse, irregular puncta... Diameter of valve 36-60 µm." Valve size, and development of radiating lines, is quite variable. Hustedt (1930) noted a range in valve diameter of 8-80 µm. Attached chains only rarely observed in Pleistocene sediments off northern California.
References: Gran and Angst, 1931, p. 430, fig. 4; Hendey, 1964, p. 73, pl. 23, fig. 5; Barron, 1973, pl. 1, fig. 3; Sancetta, 1982, p. 235, pl. 3, fig. 13-15; Akiba, 1985, p. 447, pl. 29, fig. 4-5; Laws, 1988, p. 170, pl. 2, fig. 5-17.

As *Melosira sulcata*: Hustedt, 1930, Kieselalg. I, p. 276, fig. 118-120; Lohman, 1941, p. 64, pl. 12, fig. 1; Cupp, 1943, p. 40, fig. 2; Sheshukova-Poretzkaya, 1967, pl. 10, fig. 5; Rizynk, 1973, p. 124, pl. 10, fig. 8; Schrader, 1973, p. 706, pl. 20, fig. 9; Maruyama, 1984, pl. 11, fig. 12-14.
Distribution and Ecology: Hendey (1964 p. 73): "A true bottom form, found in neritic plankton, particularly after winter gales. Very common along the southeastern shores of the North Sea." Cupp (1943, p. 40): "Very common in littoral zone. Occurs in plankton accidentally (tychopelagic). Cold-water species. Not reported off southern California."

Raphoneis Ehrenberg

Raphoneis amphiceros (Ehrenberg) Ehrenberg, 1844
Description: Hendey (1964, p. 154): "Valves lanceolate or lanceolate-rhombic, somewhat broad, with produced apices. Valve bearing a pseudoraphe, narrow, linear; valve surface punctate, puncta in curved radiating lines, about 6 in 10 µm. A very variable species... Length of valve 40 µm - 45 µm; length/breadth ratio range from 1.3:1 to 3:1.
References: Hustedt, 1959, Kieselalg. II, p. 174, fig. 680; Hendey, 1964, p. 154, pl. 26, fig. 1-4; Andrews, 1975, p. 204, pl. 1, fig. 9-12; Akiba, 1985, p. 447, pl. 20, fig. 19; Whiting and Schrader, 1985, pl. 6, fig. 4-5; Jensen, 1985, p. 162, fig. 680; Laws, 1988, p. 172, pl. 16, fig. 7.
Distribution and Ecology: Hendey (1964, p. 154): "A widely distributed species, particularly along English Channel coasts." Hustedt (1959, translated in Jensen, 1985, p. 163): "Distributed on all European coasts; common; likewise found in harbors and river mouths with brackish water."

Raphoneis margaritalimbata Mertz, 1966
Description: Valve small, oval, 8-12 µm long, with oval pseudoraphe. Margin marked by regular punctae forming short rows normal to valve margin, about 12-14 rows in 10 µm.
References: Mertz, 1966, p. 27, pl. 6, fig. 1-3; Schrader, 1973, p. 709, pl. 25, fig. 13; Whiting and Schrader, 1985, pl. 6, fig. 9-10; Laws, 1988, p. 172, pl. 16, fig. 7.
Distribution and Ecology: A marine benthic diatom, distributed in Recent and Sangammon sediments in San Francisco Bay (Laws, 1988). Originally described by Mertz (1966) from Pliocene deposits in Peru; common in Pliocene sediments in DSDP Site 173 (Schrader, 1973).

Raphoneis psammicola Rizynk, 1973
Description: Rizynk (1973, p. 131): "Valves elliptical, 15-30 µm long, 10-17 µm wide, with transapical rows of striae strongly radiate, about 7 in 10 µm, coarsely punctate. Pseudoraphe more or less broad, enlarged in the middle of the valve to a large irregularly defined central area."
References: Rizynk, 1973, p. 131, pl. 15, fig. 3, pl. 20, fig. 4; Whiting and Schrader, 1985, pl. 6, fig. 6-8.
As *Raphoneis cocconeides*: Schrader, 1973, p. 709, pl. 25, fig. 9-10.
Distribution and Ecology: Benthic diatom, common on tidal flats (Rizynk, 1973). Indicative of transport of neritic sediments to upper slope off northern California.

Stephanodiscus

Stephanodiscus spp.

Includes brackish-water planktonic species such as *S. carconensis*, *S. astrea*, *S. niagarae*.

Thalassiosira Cleve

Thalassiosira lacustris (Grunow) Hasle and Fryxell, 1977
Description: Mahood et al. (1986, p. 146): "Cell diameter 20-75 µm; areolae 10-14 in 10 µm in central area; valve face tangentially undulated; areolae fine, arranged in dichotomous branching radiating rows, five to seven strutted processes in ring ca. one-third radius from center of valve; also ring on edge of mantle. Labiate process large, with slit parallel to the margin. This species marked by tangentially undulated structure of the valve face and areolar pattern." As noted by Laws (1988), two morphs of this species are known, with the more robust variety *hyperborea* Grunow (Hustedt, 1930, p. 433, fig. 235c) found in sediments off northern California.
References: John, 1983, p. 323, fig. 1-14; Mahood et al., 1986, p. 146, fig. 68-73, 88; Laws, 1988, p. 176, pl. 6, fig 7-8, pl. 7, fig. 1-2; Hasle and Lange, 1989, p. 121, fig., 1, 2, 8-13, 19.

As *Coscinodiscus lacustris*: Hustedt, 1930, Kieselalg. I, p. 432, fig. 235a; Schrader, 1973, p. 702, pl. 6, fig. 24.
Distribution and Ecology: Brackish waters of San Francisco Bay (Mahood et al., 1986); Hasle and Lange (1989, p. 123): "...distribution in waters of various salinity from fresh water to brackish..." Probably transported from estuarine areas along the northern California coast.

Miscellaneous Benthic Diatoms

Includes the benthic genera *Pinnularia*, *Diploneis*, *Cymbella*, *Cymatosira*, *Navicula*, *Stauroneis*, *Grammatophora*, *Rhopalodia*, *Epithemia*, *Achnanthes*. Benthic diatoms comprise a small percentage of most upper and lower slope sediment samples.

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TABLE CAPTIONS

Table 1. Locations (latitude/longitude) and uncorrected water depths for gravity cores L13-81-G117, L13-81-G138, L13-81-G145, and TT197-G330.

Table 2. Conventional and AMS ^{14}C ages for gravity cores L13-81-G117, L13-81-G138, L13-81-G145, and TT197-G330.

Table 3. Abbreviations for diatom species listed in tables 4-7.

Table 4. Counts for diatoms, *Chaetoceros* spp. resting spores, and silicoflagellates in L13-81-G138.

Table 5. Counts for diatoms, *Chaetoceros* spp. resting spores, and silicoflagellates in L13-81-G117.

Table 6. Counts for diatoms, *Chaetoceros* spp. resting spores, and silicoflagellates in L13-81-G145.

Table 7. Counts for diatoms, *Chaetoceros* spp. resting spores, and silicoflagellates in TT197-G330.

Table 1: Core locations.

CORE	LATITUDE	LONGITUDE	UNCORRECTED WATER DEPTH (m)
L13-81-G138	38° 28.7' N	123° 58.2' W	2531
L13-81-G117	38° 17.2' N	123° 36.4' W	695
L13-81-G145	38° 27.1' N	123° 40.8' W	698
TT197-G330	38° 57.0' N	124° 04.0' W	700

Table 2: Conventional and Acclerator Mass Spectrometer ^{14}C Ages.

CORE	DEPTH (cm)	CONVENTIONAL ^{14}C AGE (yr B.P.)	AMS ^{14}C AGE (yr B.P.)
L13-81-G138	4-12	2,550 ± 80	
	84-92	11,320 ± 120	
	150-158	16,210 ± 150	
	250-258	20,490 ± 620	
	394-402	27,370 ± 440	
L13-81-G117	0-8	4,110 ± 110	
	12-13		16,710 ± 160
	22-30	34,430 ± 660	
	60-68	37,190 ± 1000	
	70-78	41,900 ± 1400	
	100-108	43,300 ± 1800	
L13-81-G145	11-12		25,160 ± 380
	49-50		25,160 ± 380
	122-123		27,750 ± 530
TT197-G330	55-56		32,730 ± 1000
	65-66		38,400 ± 1800
	77-78		38,700 ± 1500
	85-86		35,700 ± 1300
	92-93		42,200 ± 2600

TABLE 3: ABBREVIATIONS FOR DIATOMS LISTED IN TABLES 4-7

Marine Planktonic and Meroplanktonic species		Freshwater, benthic, and tychopelagic species	
ACTCRV	Actinocyclus curvatulus	ACTNOR	Actinocyclus normanii
ACTOCH	Actinocyclus ochotensis	ACPSEN	Actinoptychus senarius
ACTSPP	Actinocyclus spp.	ACPSPL	Actinoptychus splendens
AZPTAB	Azpeitia tabularis	ACPVUL	Actinoptychus vulgaris
COSMAR	Coscinodiscus marginatus	AULGRN	Aulacoseira granulata
COSOCU	Coscinodiscus oculus-iridis	AULISL	Aulacoseira islandica
COSRAD	Coscinodiscus radiatus	AULITL	Aulacoseira italica
COSSPP	Coscinodiscus spp.	AULSPP	Aulacoseira spp.
DELKAR	Delphineis karstenii	COCTOT	Cocconeis spp.
DELSUR	Delphineis surirella	CYCSPP	Cyclotella spp.
DENSEM	Denticulopsis seminae	ENDsp1	Endictya sp. 1
HEMCUN	Hemidiscus cuneiformis	ODTAUR	Odontella aurita
NITSPP	Nitzschia spp.	ODTLON	Odontella longicruris
PSDELG	Pseudopodosira elegans	ODTSPP	Odontella spp.
PSNDOL	Pseudoeunotia doliolus	PARSUL	Paralia sulcata
RHZHIE	Rhizosolenia hebetata f. hiemalis	RAPAMP	Rhaponeis amphiceros
RHZSEM	Rhizosolenia hebetata f. semispina	RAPMRG	Rhaponeis cf. margaritalimbata
RHZSTY	Rhizosolenia styliformis	RAPPSA	Rhaphoneis psammicola
SLKCOS	Skeletonema costata	STDSPP	Stephanodiscus spp.
STESTE	Stellarima stellaris	THALAC	Thalassiosira lacustris
STPDIM	Stephanopyxis dimorpha	BENTHIC	Misc. benthic diatoms
STPKUL	Stephanopyxis kulmii		
STPTUR	Stephanopyxis turris		
THADEC	Thalassiosira decipiens		
THAECC	Thalassiosira eccentrica		
THAFER	Thalassiosira ferelineata		
THAGRA	Thalassiosira gravida		
THAHEN	Thalassiosira hendeyi		
THALEP	Thalassiosira leptopus		
THANOR	Thalassiosira nordenskioldii		
THAOES	Thalassiosira oestrupii		
THAPAC	Thalassiosira pacifica		
THAPUN	Thalassiosira punctigera		
THATEN	Thalassiosira tenera		
THATRI	Thalassiosira trifulta		
THALIN	Thalassiosira lineata		
THAsp1	Thalassiosira sp. 1		
THAspE	Thalassiosira sp. E		
THASPP	Thalassiosira spp.		
THLNIT	Thalassionema nitzschioides		
THLPRV	Thalassionema nitzschioides v. parva		
THXLON	Thalassiothrix longissima		
MSCMPD	Misc. marine planktonic diatoms		
REWRKD	Reworked diatoms		

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Valves Counted):								
DEPTH (CM)	ACTCRV	ACTOCH	ACTSPP	AZPTAB	COSMAR	COSOCU	COSRAD	COSSPP
1	9	5	1			1	17	1
12	7	5		1	2	2	12	2
20		5		3	4		17	
30	11	8	1	1	2		21	
10	6	6	2	1	3		11	2
50	9	3	2	4	1		11	2
60	3	2		2			16	5
70	6	6	1	3	1	1	17	
80	4		1	1			6	
90	7	2		4		3	26	3
100				3	1		7	
110	1	1	1	6			34	1
120	2	2	1	1	2	1	10	2
130	4		2		1		21	1
140					4		4	
150	4	2		7			30	1
160	1				3		2	
170	2		1	5	3	2	8	1
180	2	1		3	4		16	2
190	11	1	2	4	1	5	20	
200	1	6	1	9	2		8	1
210	8	3		11	3		19	3
220	2	3	2	8			6	3
230	17	10		7			14	
240	17	3		1	1			
250	14	7		5	2		8	1
260	1	1					1	
270		1		1			1	1
280	2	1		1			3	1
290	3	1		3			1	1
300		1		2				2
310	9	3		7			5	1
320		1						
330	8	2		1	1		3	1
340	3	2		1			5	2
350	3	2		8			5	2
360		1	1	2			3	1
370	2	1		5			3	1
380	2			1				
395	9		1	6			3	
400	1		1	1	1			1
410	6	2		3			2	3
420	5	1	2				3	
430	4		1	4			4	2
440	3	1	1	1	1		3	1

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Percent of Total):								
DEPTH (CM)	ACTCRV	ACTOCH	ACTSPP	AZPTAB	COSMAR	COSOCU	COSRAD	COSSPP
1	2.61%	1.45%	0.29%			0.29%	4.93%	0.29%
12	1.83%	1.31%		0.26%	0.52%	0.52%	3.14%	0.52%
20		1.55%		0.93%	1.24%		5.26%	
30	3.29%	2.40%	0.30%	0.30%	0.60%		6.29%	
10	1.82%	1.82%	0.61%	0.30%	0.91%		3.33%	0.61%
50	2.80%	0.93%	0.62%	1.24%	0.31%		3.42%	0.62%
60	0.77%	0.51%		0.51%			4.10%	1.28%
70	1.68%	1.68%	0.28%	0.84%	0.28%	0.28%	4.75%	
80	2.76%		0.69%	0.69%			4.14%	
90	2.50%	0.71%		1.43%		1.07%	9.29%	1.07%
100				0.99%	0.33%		2.30%	
110	0.27%	0.27%	0.27%	1.60%			9.09%	0.27%
120	0.57%	0.57%	0.28%	0.28%	0.57%	0.28%	2.85%	0.57%
130	1.60%		0.80%		0.40%		8.40%	0.40%
140					2.96%		2.96%	
150	1.20%	0.60%		2.10%			8.98%	0.30%
160	0.56%				1.67%		1.11%	
170	0.88%		0.44%	2.20%	1.32%	0.88%	3.52%	0.44%
180	0.86%	0.43%		1.29%	1.72%		6.87%	0.86%
190	2.97%	0.27%	0.54%	1.08%	0.27%	1.35%	5.41%	
200	0.42%	2.53%	0.42%	3.80%	0.84%		3.38%	0.42%
210	2.42%	0.91%		3.33%	0.91%		5.76%	0.91%
220	0.62%	0.93%	0.62%	2.49%			1.87%	0.93%
230	4.96%	2.92%		2.04%			4.08%	
240	7.30%	1.29%		0.43%	0.43%			
250	4.65%	2.33%		1.66%	0.66%		2.66%	0.33%
260	0.80%	0.80%					0.80%	
270		0.47%		0.47%			0.47%	0.47%
280	0.58%	0.29%		0.29%			0.87%	0.29%
290	0.74%	0.25%		0.74%			0.25%	0.25%
300		0.30%		0.60%				0.60%
310	2.22%	0.74%		1.72%			1.23%	0.25%
320		0.28%						
330	1.99%	0.50%		0.25%	0.25%		0.74%	0.25%
340	0.67%	0.44%		0.22%			1.11%	0.44%
350	0.90%	0.60%		2.40%			1.50%	0.60%
360		0.31%	0.31%	0.61%			0.92%	0.31%
370	0.63%	0.32%		1.58%			0.95%	0.32%
380	0.63%			0.32%				
395	2.45%		0.27%	1.63%			0.82%	
400	0.55%		0.55%	0.55%	0.55%			0.55%
410	1.83%	0.61%		0.92%			0.61%	0.92%
420	1.31%	0.26%	0.52%				0.79%	
430	1.20%		0.30%	1.20%			1.20%	0.60%
440	0.94%	0.31%	0.31%	0.31%	0.31%		0.94%	0.31%

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Valves Counted): DEPTH (CM)	DELKAR	DELSUR	DENSEM	HEMCUN	NITSPP	PSDELG	PSNDOL	RHZHIE
1			1	6			41	
12			1	2		1	53	2
20			12	1			15	1
30		1	2	3			5	
10			3				26	1
50			9		1	1	53	
60			16		1		61	
70	1		2				4	1
80			1					
90	1		4	3	1			2
100		2					2	2
110			7				2	
120			1	4	3			
130	3	1	1					1
140	3	2	2					
150	8	3			1			1
160			1					
170	2		1					
180	4		6					
190	5	1	7		2			
200	5		2					
210	5	3	4					1
220	3		3					
230	4	1	3					
240	4	2	1					
250	4	4	1			1		
260	1	2	3					
270	1	2			1			
280	2	1						
290	1	1	1					
300	2	1						
310	7	2						
320		1						
330		2	3					
340	6	2						
350	10		9		1	2		
360	3	1	7	1	2	1		
370	5		1			1		
380		1	2		2			
395	2		6		1	1		
400	1	2	7					
410	6	5	6		1	2		
420	5	4	9			1		1
430	6	3	1			6		
440	1	2	9		1	3		

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Percent of Total):								
DEPTH (CM)	DELKAR	DELSUR	DENSEM	HEMCUN	NITSPP	PSDELG	PSNDOL	RHZHIE
1			0.29%	1.74%			11.88%	
12			0.26%	0.52%		0.26%	13.87%	0.52%
20			3.72%	0.31%			4.64%	0.31%
30		0.30%	0.60%	0.90%			1.50%	
10			0.91%				7.88%	0.30%
50			2.80%		0.31%	0.31%	16.46%	
60			4.10%		0.26%		15.64%	
70	0.28%		0.56%				1.12%	0.28%
80			0.69%					
90	0.36%		1.43%	1.07%	0.36%			0.71%
100		0.66%					0.66%	0.66%
110			1.87%				0.53%	
120			0.28%	1.14%	0.85%			
130	1.20%	0.40%	0.40%					0.40%
140	2.22%	1.48%	1.48%					
150	2.40%	0.90%			0.30%			0.30%
160			0.56%					
170	0.88%		0.44%					
180	1.72%		2.58%					
190	1.35%	0.27%	1.89%		0.54%			
200	2.11%		0.84%					
210	1.52%	0.91%	1.21%					0.30%
220	0.93%		0.93%					
230	1.17%	0.29%	0.87%					
240	1.72%	0.86%	0.43%					
250	1.33%	1.33%	0.33%			0.33%		
260	0.80%	1.60%	2.40%					
270	0.47%	0.93%			0.47%			
280	0.58%	0.29%						
290	0.25%	0.25%	0.25%					
300	0.60%	0.30%						
310	1.72%	0.49%						
320		0.28%						
330		0.50%	0.74%					
340	1.33%	0.44%						
350	2.99%		2.69%		0.30%	0.60%		
360	0.92%	0.31%	2.15%	0.31%	0.61%	0.31%		
370	1.58%		0.32%			0.32%		
380		0.32%	0.63%		0.63%			
395	0.54%		1.63%		0.27%	0.27%		
400	0.55%	1.10%	3.85%					
410	1.83%	1.53%	1.83%		0.31%	0.61%		
420	1.31%	1.05%	2.36%			0.26%		0.26%
430	1.80%	0.90%	0.30%			1.80%		
440	0.31%	0.63%	2.83%		0.31%	0.94%		

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Valves Counted): DEPTH (CM)	RHZSEM	RHZSTY	ROPTES	SKLCOS	STESTE	STPDIM	STPKUL	STPTUR
1	14	4		10	1	3		1
12	33	4	3	8		5		
20	4			8		9		2
30	3	1	1	6		3		2
10	1		2			7		
50	8	12	11			4		2
60	11	26	10	3				3
70	5	27	3	4		4		
80		1				8		
90	2	2				4		1
100	1	1				4		
110	3	2		1	1	7		4
120	2	1		4		10		4
130						4		
140								
150		1				12		
160						10	2	1
170		1	1			26	2	
180						26		
190	2	1	1			16		
200						20	2	
210	3	1				47		
220						34		
230	1					50		
240	2					32	10	
250	1				1	80	7	
260						51		
270						61		
280						260	10	
290						260	20	
300					1	230	20	
310					1	168	21	1
320	2					240	11	
330			1			170	10	1
340						169	12	
350	2					108	10	5
360	1					113	13	8
370	3	1				127	20	6
380						200	27	1
395						160	12	3
400						91		2
410	3					150	13	4
420					1	112	32	2
430				1		104	11	6
440		1				98		3

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Percent of Total):								
DEPTH (CM)	RHZSEM	RHZSTY	ROPTES	SKLCOS	STESTE	STPDIM	STPKUL	STPTUR
1	4.06%	1.16%		2.90%	0.29%	0.87%		0.29%
12	8.64%	1.05%	0.79%	2.09%		1.31%		
20	1.24%			2.48%		2.79%		0.62%
30	0.90%	0.30%	0.30%	1.80%		0.90%		0.60%
10	0.30%		0.61%			2.12%		
50	2.48%	3.73%	3.42%			1.24%		0.62%
60	2.82%	6.67%	2.56%	0.77%				0.77%
70	1.40%	7.54%	0.84%	1.12%		1.12%		
80		0.69%				5.52%		
90	0.71%	0.71%				1.43%		0.36%
100	0.33%	0.33%				1.32%		
110	0.80%	0.53%		0.27%	0.27%	1.87%		1.07%
120	0.57%	0.28%		1.14%		2.85%		1.14%
130						1.60%		
140								
150		0.30%				3.59%		
160						5.56%	1.11%	0.56%
170		0.44%	0.44%			11.45%	0.88%	
180						11.16%		
190	0.54%	0.27%	0.27%			4.32%		
200						8.44%	0.84%	
210	0.91%	0.30%				14.24%		
220						10.59%		
230	0.29%					14.58%		
240	0.86%					13.73%	4.29%	
250	0.33%				0.33%	9.97%	2.33%	
260						40.80%		
270						28.50%	#VALUE!	
280						75.36%	2.90%	
290						64.04%	4.93%	
300					0.30%	68.86%	5.99%	
310					0.25%	41.38%	5.17%	0.25%
320	0.55%					66.48%	3.05%	
330			0.25%			42.18%	2.48%	0.25%
340						37.47%	2.66%	
350	0.60%					32.34%	2.99%	1.50%
360	0.31%					34.66%	3.99%	2.45%
370	0.95%	0.32%				40.19%	6.33%	1.90%
380						63.09%	8.52%	0.32%
395						43.48%	3.26%	0.82%
400						50.00%		1.10%
410	0.92%					45.87%	3.98%	1.22%
420					0.26%	29.40%	8.40%	0.52%
430				0.30%		31.23%	3.30%	1.80%
440		0.31%				30.82%		0.94%

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Valves Counted): DEPTH (CM)	THADEC	THAECC	THAFER	THAGRA	THAHEN	THALEP	THANOR	THAOES
1	4	16	10		1	1	1	1
12	2	15	5	2	1	2		4
20	4	5	3			1	2	2
30	1	7	2	2		1		5
10	1	15	3	3	3		3	6
50		13	8	2	2	4	1	4
60	1	14	2	10			1	9
70	2	15	15	3	1	2		5
80		12	4	1				1
90	1	8	13	1	1	1		1
100		9	7	2	1		1	1
110		30	20	4	3	3		1
120		13	10	1	2	2		6
130	1	16	5	2	1	1	1	2
140	1	7	3			1		2
150	1	15	24	2		4		4
160	1	2	3					1
170	1	10	3	3		1		1
180	2	7	5	3	1	2		4
190	2	38	8			2		2
200	1	16	4		3	3	1	2
210	1		19	2		2		4
220	2	17	5	1	1	3		1
230	3	29	18	5		3		3
240	6	24	6		2	1		4
250		18	15	2	3	4		2
260	2	3				2		1
270		7		1		3		2
280	1	4	1	2				
290		12	1	1		2		1
300		13	1					2
310		11	5	2		1		2
320	2	9	1			1		1
330		14	7	4	2	1		3
340		12	1			4		15
350		13	6	4		2		6
360	1	11	5	3		2	2	8
370	2	16	11	2		2	1	8
380		3	3		1	1		1
395	2	12	5	9		3		3
400	1	3	1					6
410	3	10	8	1	4			7
420	3	13	6	3	1	1	1	7
430	2	24	7	1	3	1		15
440		20	4		4	2		2

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Percent of Total):								
DEPTH (CM)	THADEC	THAECC	THAFER	THAGRA	THAHEN	THALEP	THANOR	THAOES
1	1.16%	4.64%	2.90%		0.29%	0.29%	0.29%	0.29%
12	0.52%	3.93%	1.31%	0.52%	0.26%	0.52%		1.05%
20	1.24%	1.55%	0.93%			0.31%	0.62%	0.62%
30	0.30%	2.10%	0.60%	0.60%		0.30%		1.50%
10	0.30%	4.55%	0.91%	0.91%	0.91%		0.91%	1.82%
50		4.04%	2.48%	0.62%	0.62%	1.24%	0.31%	1.24%
60	0.26%	3.59%	0.51%	2.56%			0.26%	2.31%
70	0.56%	4.19%	4.19%	0.84%	0.28%	0.56%		1.40%
80		8.28%	2.76%	0.69%				0.69%
90	0.36%	2.86%	4.64%	0.36%	0.36%	0.36%		0.36%
100		2.96%	2.30%	0.66%	0.33%		0.33%	0.33%
110		8.02%	5.35%	1.07%	0.80%	0.80%		0.27%
120		3.70%	2.85%	0.28%	0.57%	0.57%		1.71%
130	0.40%	6.40%	2.00%	0.80%	0.40%	0.40%	0.40%	0.80%
140	0.74%	5.19%	2.22%			0.74%		1.48%
150	0.30%	4.49%	7.19%	0.60%		1.20%		1.20%
160	0.56%	1.11%	1.67%					0.56%
170	0.44%	4.41%	1.32%	1.32%		0.44%		0.44%
180	0.86%	3.00%	2.15%	1.29%	0.43%	0.86%		1.72%
190	0.54%	10.27%	2.16%			0.54%		0.54%
200	0.42%	6.75%	1.69%		1.27%	1.27%	0.42%	0.84%
210	0.30%		5.76%	0.61%		0.61%		1.21%
220	0.62%	5.30%	1.56%	0.31%	0.31%	0.93%		0.31%
230	0.87%	8.45%	5.25%	1.46%		0.87%		0.87%
240	2.58%	10.30%	2.58%		0.86%	0.43%		1.72%
250		5.98%	4.98%	0.66%	1.00%	1.33%		0.66%
260	1.60%	2.40%				1.60%		0.80%
270		3.27%		0.47%		1.40%		0.93%
280	0.29%	1.16%	0.29%	0.58%				
290		2.96%	0.25%	0.25%		0.49%		0.25%
300		3.89%	0.30%					0.60%
310		2.71%	1.23%	0.49%		0.25%		0.49%
320	0.55%	2.49%	0.28%			0.28%		0.28%
330		3.47%	1.74%	0.99%	0.50%	0.25%		0.74%
340		2.66%	0.22%			0.89%		3.33%
350		3.89%	1.80%	1.20%		0.60%		1.80%
360	0.31%	3.37%	1.53%	0.92%		0.61%	0.61%	2.45%
370	0.63%	5.06%	3.48%	0.63%		0.63%	0.32%	2.53%
380		0.95%	0.95%		0.32%	0.32%		0.32%
395	0.54%	3.26%	1.36%	2.45%		0.82%		0.82%
400	0.55%	1.65%	0.55%					3.30%
410	0.92%	3.06%	2.45%	0.31%	1.22%			2.14%
420	0.79%	3.41%	1.57%	0.79%	0.26%	0.26%	0.26%	1.84%
430	0.60%	7.21%	2.10%	0.30%	0.90%	0.30%		4.50%
440		6.29%	1.26%		1.26%	0.63%		0.63%

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Valves Counted): DEPTH (CM)	THAPAC	THAPUN	THATEN	THATRI	THALIN	THAsp1	THAspE	THASPP
1	5			1	2	2		15
12	6				7	5		3
20	1			1	1	13	1	8
30	5			1	3	4	1	5
10	3		1		6	5		10
50	2		1		3	2		4
60	1				8	7		11
70	8			1	4	2		5
80	2			1	4			11
90	1				1	3		1
100	1				2	5		4
110	2			3	9	4		1
120	2			1	7	4	1	17
130	1				1	2		
140	2				3			4
150					2	2	1	8
160	1		1		2	1		1
170	4		1	1		2		2
180	1				1	5		9
190	1		1		5	5	1	4
200	2		2	1	7	9		11
210	2	1		1	3	4	1	34
220	2		1		1	4		6
230	7			2	3	8	1	4
240	6				2	7		6
250	2			3	3	8	3	8
260	1				4	2		5
270				1				1
280					1	2	2	2
290	1				2		1	1
300				1		1	1	2
310	2			2		3	3	2
320	3				3	2		8
330	6			1	2	3		
340	3				3	4		6
350	1			1	6	2	2	
360	4				8	7		11
370	3				4	1	1	2
380	2				1	2		6
395	3			3	6	2		4
400	4			1	6	6		10
410	5				3	2		1
420	1		2		4	1		7
430	4		1	1	5	1	3	2
440	2		1		1	1		8

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Percent of Total):								
DEPTH (CM)	THAPAC	THAPUN	THATEN	THATRI	THALIN	THAsp1	THAspE	THASPP
1	1.45%			0.29%	0.58%	0.58%		4.35%
12	1.57%				1.83%	1.31%		0.79%
20	0.31%			0.31%	0.31%	4.02%	0.31%	2.48%
30	1.50%			0.30%	0.90%	1.20%	0.30%	1.50%
10	0.91%		0.30%		1.82%	1.52%		3.03%
50	0.62%		0.31%		0.93%	0.62%		1.24%
60	0.26%				2.05%	1.79%		2.82%
70	2.23%			0.28%	1.12%	0.56%		1.40%
80	1.38%			0.69%	2.76%			7.59%
90	0.36%				0.36%	1.07%		0.36%
100	0.33%				0.66%	1.64%		1.32%
110	0.53%			0.80%	2.41%	1.07%		0.27%
120	0.57%			0.28%	1.99%	1.14%	0.28%	4.84%
130	0.40%				0.40%	0.80%		
140	1.48%				2.22%			2.96%
150					0.60%	0.60%	0.30%	2.40%
160	0.56%		0.56%		1.11%	0.56%		0.56%
170	1.76%		0.44%	0.44%		0.88%		0.88%
180	0.43%				0.43%	2.15%		3.86%
190	0.27%		0.27%		1.35%	1.35%	0.27%	1.08%
200	0.84%		0.84%	0.42%	2.95%	3.80%		4.64%
210	0.61%	0.30%		0.30%	0.91%	1.21%	0.30%	10.30%
220	0.62%		0.31%		0.31%	1.25%		1.87%
230	2.04%			0.58%	0.87%	2.33%	0.29%	1.17%
240	2.58%				0.86%	3.00%		2.58%
250	0.66%			1.00%	1.00%	2.66%	1.00%	2.66%
260	0.80%				3.20%	1.60%		4.00%
270				0.47%				0.47%
280					0.29%	0.58%	0.58%	0.58%
290	0.25%				0.49%		0.25%	0.25%
300				0.30%		0.30%	0.30%	0.60%
310	0.49%			0.49%		0.74%	0.74%	0.49%
320	0.83%				0.83%	0.55%		2.22%
330	1.49%			0.25%	0.50%	0.74%		
340	0.67%				0.67%	0.89%		1.33%
350	0.30%			0.30%	1.80%	0.60%	0.60%	
360	1.23%				2.45%	2.15%		3.37%
370	0.95%				1.27%	0.32%	0.32%	0.63%
380	0.63%				0.32%	0.63%		1.89%
395	0.82%			0.82%	1.63%	0.54%		1.09%
400	2.20%			0.55%	3.30%	3.30%		5.49%
410	1.53%				0.92%	0.61%		0.31%
420	0.26%		0.52%		1.05%	0.26%		1.84%
430	1.20%		0.30%	0.30%	1.50%	0.30%	0.90%	0.60%
440	0.63%		0.31%		0.31%	0.31%		2.52%

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Valves Counted):						
DEPTH (CM)	THLNIT	THLPRV	THXLON	MCSMPD	REWRKD	
1	100	11	8	1	11	
12	115		5	1	29	
20	139	9	11	1	9	
30	142	11	21		21	
10	111	10	11		38	
50	95	3	11		12	
60	109	11	4	5	3	
70	137	2	5	1	6	
80	44	1	3	4	1	
90	57	2	11		9	
100	156		8		1	
110	93		21		2	
120	96	3	19		2	
130	47		13	1	12	
140	12		1		3	
150	60		2		4	
160	8				6	
170	14		1		8	
180	39				5	
190	59	1	2		13	
200	52	3	3		3	
210	71	2	1		4	
220	155				1	
230	78		3		1	
240	41				3	
250	100	11	1		3	
260	10		1			
270	24	2	1		3	
280	21					
290	32	3	2			
300	32		1			
310	92	2			2	
320	47	4	2		1	
330	125		1		2	
340	144	3	1			
350	84	2	3		3	
360	62	2	1			
370	60	3	4		1	
380	14	1				
395	74	3			1	
400	18		1			
410	39		1			
420	89		2			
430	66	3	3		1	
440	115	4	2			

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Percent of Total):						
DEPTH (CM)	THLNIT	THLPRV	THXLON	MCSMPD	REWRKD	
1	28.99%	3.19%	2.32%	0.29%	3.19%	
12	30.10%		1.31%	0.26%	7.59%	
20	43.03%	2.79%	3.41%	0.31%	2.79%	
30	42.51%	3.29%	6.29%		6.29%	
10	33.64%	3.03%	3.33%		11.52%	
50	29.50%	0.93%	3.42%		3.73%	
60	27.95%	2.82%	1.03%	1.28%	0.77%	
70	38.27%	0.56%	1.40%	0.28%	1.68%	
80	30.34%	0.69%	2.07%	2.76%	0.69%	
90	20.36%	0.71%	3.93%		3.21%	
100	51.32%		2.63%		0.33%	
110	24.87%		5.61%		0.53%	
120	27.35%	0.85%	5.41%		0.57%	
130	18.80%		5.20%	0.40%	4.80%	
140	8.89%		0.74%		2.22%	
150	17.96%		0.60%		1.20%	
160	4.44%				3.33%	
170	6.17%		0.44%		3.52%	
180	16.74%				2.15%	
190	15.95%	0.27%	0.54%		3.51%	
200	21.94%	1.27%	1.27%		1.27%	
210	21.52%	0.61%	0.30%		1.21%	
220	48.29%				0.31%	
230	22.74%		0.87%		0.29%	
240	17.60%				1.29%	
250	33.22%	3.65%	0.33%		1.00%	
260	8.00%		0.80%			
270	11.21%	0.93%	0.47%		1.40%	
280	6.09%					
290	7.88%	0.74%	0.49%			
300	9.58%		0.30%			
310	22.66%	0.49%			0.49%	
320	13.02%	1.11%	0.55%		0.28%	
330	31.02%		0.25%		0.50%	
340	31.93%	0.67%	0.22%			
350	25.15%	0.60%	0.90%		0.90%	
360	19.02%	0.61%	0.31%			
370	18.99%	0.95%	1.27%		0.32%	
380	4.42%	0.32%				
395	20.11%	0.82%			0.27%	
400	9.89%		0.55%			
410	11.93%		0.31%			
420	23.36%		0.52%			
430	19.82%	0.90%	0.90%		0.30%	
440	36.16%	1.26%	0.63%			

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Valves Counted): DEPTH (CM)	ACTNOR	ACPSEN	ACPSPL	ACPVUL	AULGRN	AULISL	AULITL	AULSPP
1		7		3	1	5		
12		2		4	1			1
20				1	5			
30		2		1	7			
10		2		1	8			
50		5			4			
60		4			6	1		
70		3		1	14	1	1	1
80		4			17		1	
90		10			27	3	9	
100		4			35	3		1
110					31	5		1
120		6			43	13	3	2
130	1	6			24	12	17	1
140					31	6	2	3
150		12			52	6	3	1
160		1			91	6	2	1
170	1	9			45	14	6	5
180		7			40	8		2
190		31	2		39	11	3	
200				1	25	3	4	1
210		15			18	1	1	1
220		10			20	4	1	2
230		17			23	2	2	1
240		11			14	5	3	2
250				2	5	4		2
260		7			18	4		
270		11		1	19	8	1	
280		4			8	2		
290		13			6			
300		4			6			
310		13			2	1		
320		8			8			
330		9				3		
340		10			6		2	2
350		15				1		
360		20			1	4	2	
370		9			2			1
380		3			8		2	
395		13			3			
400		2			2	2	2	
410		13			3	3	3	
420		3			2	5	1	
430		15			3	1		
440		6				3		

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Percent of Total): DEPTH (CM)	ACTNOR	ACPSEN	ACPSPL	ACPVUL	AULGRN	AULISL	AULITL	AULSPP
1		2.03%		0.87%	0.29%	1.45%		
12		0.52%		1.05%	0.26%			0.26%
20				0.31%	1.55%			
30		0.60%		0.30%	2.10%			
10		0.61%		0.30%	2.42%			
50		1.55%			1.24%			
60		1.03%			1.54%	0.26%		
70		0.84%		0.28%	3.91%	0.28%	0.28%	0.28%
80		2.76%			11.72%		0.69%	
90		3.57%			9.64%	1.07%	3.21%	
100		1.32%			11.51%	0.99%		0.33%
110					8.29%	1.34%		0.27%
120		1.71%			12.25%	3.70%	0.85%	0.57%
130	0.40%	2.40%			9.60%	4.80%	6.80%	0.40%
140					22.96%	4.44%	1.48%	2.22%
150		3.59%			15.57%	1.80%	0.90%	0.30%
160		0.56%			50.56%	3.33%	1.11%	0.56%
170	0.44%	3.96%			19.82%	6.17%	2.64%	2.20%
180		3.00%			17.17%	3.43%		0.86%
190		8.38%	0.54%		10.54%	2.97%	0.81%	
200				0.42%	10.55%	1.27%	1.69%	0.42%
210		4.55%			5.45%	0.30%	0.30%	0.30%
220		3.12%			6.23%	1.25%	0.31%	0.62%
230		4.96%			6.71%	0.58%	0.58%	0.29%
240		4.72%			6.01%	2.15%	1.29%	0.86%
250				0.66%	1.66%	1.33%		0.66%
260		5.60%			14.40%	3.20%		
270		5.14%		0.47%	8.88%	3.74%	0.47%	
280		1.16%			2.32%	0.58%		
290		3.20%			1.48%			
300		1.20%			1.80%			
310		3.20%			0.49%	0.25%		
320		2.22%			2.22%			
330		2.23%				0.74%		
340		2.22%			1.33%		0.44%	0.44%
350		4.49%				0.30%		
360		6.13%			0.31%	1.23%	0.61%	
370		2.85%			0.63%			0.32%
380		0.95%			2.52%		0.63%	
395		3.53%			0.82%			
400		1.10%			1.10%	1.10%	1.10%	
410		3.98%			0.92%	0.92%	0.92%	
420		0.79%			0.52%	1.31%	0.26%	
430		4.50%			0.90%	0.30%		
440		1.89%				0.94%		

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Valves Counted): DEPTH (CM)	COCSPP	CYCSPP	ENDsp1	ODTAUR	ODTLON	ODTSPP	PARSUL	RAPAMP
1	3	6		2	1		6	1
12	3	10	2	1	2		1	
20	3	13	1	1			4	
30		11			3		4	1
10	3	6	1		5		2	
50		3	1		3	1	1	1
60	4	9	3		1		2	
70	5	12		2	4		1	1
80	2	6		2				
90	5	7	8	1			9	
100	4	4					11	1
110	4	3	3		2		28	2
120	2	17			1		10	
130	3	7		1			15	
140	6	7	6	2			6	
150	4	8		2			5	7
160		6	4	1	1		15	
170	4	5		2	1		11	2
180	4	7					5	2
190	3	3	14	1	3		8	5
200	2		2				4	5
210	8	2					2	6
220	1				1		7	3
230	2	2			5		2	5
240	1				1		2	4
250	1	3			1			5
260	1	3						
270	1	2	40	1			6	2
280			10				2	
290	1		30	1			1	
300	1	1	7				1	1
310	3	1	21	1	2		4	1
320							3	2
330	2		10	1	1		3	
340	1		10	1	2		12	3
350	1	2	2				5	
360	1	1					8	
370	2				1		2	1
380			12				18	1
395	1	1		1	1		12	
400							7	
410					2		7	1
420			16	1	1		29	
430		1	11		1		2	
440				2			9	

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Percent of Total):								
DEPTH (CM)	COCSPP	CYCSPP	ENDsp1	ODTAUR	ODTLON	ODTSPP	PARSUL	RAPAMP
1	0.87%	1.74%		0.58%	0.29%		1.74%	0.29%
12	0.79%	2.62%	0.52%	0.26%	0.52%		0.26%	
20	0.93%	4.02%	0.31%	0.31%			1.24%	
30		3.29%			0.90%		1.20%	0.30%
10	0.91%	1.82%	0.30%		1.52%		0.61%	
50		0.93%	0.31%		0.93%	0.31%	0.31%	0.31%
60	1.03%	2.31%	0.77%		0.26%		0.51%	
70	1.40%	3.35%		0.56%	1.12%		0.28%	0.28%
80	1.38%	4.14%		1.38%				
90	1.79%	2.50%	2.86%	0.36%			3.21%	
100	1.32%	1.32%					3.62%	0.33%
110	1.07%	0.80%	0.80%		0.53%		7.49%	0.53%
120	0.57%	4.84%			0.28%		2.85%	
130	1.20%	2.80%		0.40%			6.00%	
140	4.44%	5.19%	4.44%	1.48%			4.44%	
150	1.20%	2.40%		0.60%			1.50%	2.10%
160		3.33%	2.22%	0.56%	0.56%		8.33%	
170	1.76%	2.20%		0.88%	0.44%		4.85%	0.88%
180	1.72%	3.00%					2.15%	0.86%
190	0.81%	0.81%	3.78%	0.27%	0.81%		2.16%	1.35%
200	0.84%		0.84%				1.69%	2.11%
210	2.42%	0.61%					0.61%	1.82%
220	0.31%				0.31%		2.18%	0.93%
230	0.58%	0.58%			1.46%		0.58%	1.46%
240	0.43%				0.43%		0.86%	1.72%
250	0.33%	1.00%			0.33%			1.66%
260	0.80%	2.40%						
270	0.47%	0.93%	18.69%	0.47%			2.80%	0.93%
280			2.90%				0.58%	
290	0.25%		7.39%	0.25%			0.25%	
300	0.30%	0.30%	2.10%				0.30%	0.30%
310	0.74%	0.25%	5.17%	0.25%	0.49%		0.99%	0.25%
320							0.83%	0.55%
330	0.50%		2.48%	0.25%	0.25%		0.74%	
340	0.22%		2.22%	0.22%	0.44%		2.66%	0.67%
350	0.30%	0.60%	0.60%				1.50%	
360	0.31%	0.31%					2.45%	
370	0.63%				0.32%		0.63%	0.32%
380			3.79%				5.68%	0.32%
395	0.27%	0.27%		0.27%	0.27%		3.26%	
400							3.85%	
410					0.61%		2.14%	0.31%
420			4.20%	0.26%	0.26%		7.61%	
430		0.30%	3.30%		0.30%		0.60%	
440				0.63%			2.83%	

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Valves Counted): DEPTH (CM)	RAPMRG	RAPPSA	STDSPP	THALAC	BENTHIC	TOTAL VALVES
1		1			4	345
12	1		6		3	382
20					3	323
30	1				1	334
10			2			330
50					3	322
60	2		1		2	390
70	1		5		6	358
80					2	145
90	1		6		18	280
100	1	1	5		13	304
110		1	4		23	374
120		1	9		8	351
130	1	1	9		7	250
140	2		5		5	135
150	1	7	10		17	334
160		1	4		1	180
170	1	4	10			227
180		7	3			233
190	3	15	6		9	370
200	3	3	4		4	237
210		12	1		8	330
220	1	7			7	321
230		5	2		3	343
240		5	4		11	233
250		3	3		7	301
260		1			2	125
270		4	4		3	214
280		2				345
290		1	2		3	406
300					1	334
310		1	2		2	406
320	1					361
330					2	403
340	1		3		1	451
350	1	3	2			334
360	1		2		1	326
370			1		5	316
380			2		2	317
395	1	1			2	368
400	1				5	182
410	2		3			327
420	3	1			1	381
430	2		1		1	333
440	1	1	1			318

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency						
(Percent of Total):						
DEPTH (CM)	RAPMRG	RAPPSA	STDSPP	THALAC	BENTHIC	TOTAL
1		0.29%			1.16%	100.00%
12	0.26%		1.57%		0.79%	100.00%
20					0.93%	100.00%
30	0.30%				0.30%	100.00%
10			0.61%			100.00%
50					0.93%	100.00%
60	0.51%		0.26%		0.51%	100.00%
70	0.28%		1.40%		1.68%	100.00%
80					1.38%	100.00%
90	0.36%		2.14%		6.43%	100.00%
100	0.33%	0.33%	1.64%		4.28%	100.00%
110		0.27%	1.07%		6.15%	100.00%
120		0.28%	2.56%		2.28%	100.00%
130	0.40%	0.40%	3.60%		2.80%	100.00%
140	1.48%		3.70%		3.70%	100.00%
150	0.30%	2.10%	2.99%		5.09%	100.00%
160		0.56%	2.22%		0.56%	100.00%
170	0.44%	1.76%	4.41%			100.00%
180		3.00%	1.29%			100.00%
190	0.81%	4.05%	1.62%			100.00%
200	1.27%	1.27%	1.69%		1.69%	100.00%
210		3.64%	0.30%		2.42%	100.00%
220	0.31%	2.18%			2.18%	100.00%
230		1.46%	0.58%		0.87%	100.00%
240		2.15%	1.72%		4.72%	100.00%
250		1.00%	1.00%		2.33%	100.00%
260		0.80%			1.60%	100.00%
270		1.87%	1.87%		1.40%	100.00%
280		0.58%				100.00%
290		0.25%	0.49%		0.74%	100.00%
300					0.30%	100.00%
310		0.25%	0.49%		0.49%	100.00%
320	0.28%					100.00%
330					0.50%	100.00%
340	0.22%		0.67%		0.22%	100.00%
350	0.30%	0.90%	0.60%			100.00%
360	0.31%		0.61%		0.31%	100.00%
370			0.32%		1.58%	100.00%
380			0.63%		0.63%	100.00%
395	0.27%	0.27%			0.54%	100.00%
400	0.55%				2.75%	100.00%
410	0.61%		0.92%			100.00%
420	0.79%	0.26%			0.26%	100.00%
430	0.60%		0.30%		0.30%	100.00%
440	0.31%	0.31%	0.31%			100.00%

TABLE 4: DIATOM DATA FOR L13-81-G138

Frequency (Valves Counted): DEPTH (CM)	S/D RATIO	CHT SPORES	SILICOS
1	0.77	264	22
12	0.87	333	16
20	0.72	232	6
30	0.51	170	8
10	0.70	232	22
50	0.46	147	7
60	0.35	135	7
70	0.79	284	10
80	0.34	49	1
90	0.69	194	2
100	0.28	84	2
110	0.53	200	19
120	0.64	223	7
130	0.63	157	3
140	0.47	63	2
150	0.48	161	9
160	0.17	31	5
170	0.41	94	2
180	0.48	112	5
190	0.29	107	11
200	0.57	135	2
210	0.47	156	5
220	0.37	118	5
230	0.40	138	6
240	0.44	102	7
250	0.59	178	5
260	0.17	21	
270	0.03	6	6
280	0.05	17	5
290	0.20	81	3
300	0.10	32	
310	0.37	152	4
320	0.15	55	
330	0.30	120	4
340	0.48	218	5
350	0.90	301	10
360	0.48	157	15
370	0.35	110	9
380	0.20	63	3
395	0.18	68	4
400	0.45	81	1
410	0.83	273	1
420	0.52	199	6
430	0.73	242	13
440	0.44	141	5

TABLE 5: DIATOM DATA FOR L13-81-G117

Frequency: (Valves Counted)												
DEPTH (cm)	ACTCRV	ACTOCH	ACTSPP	AZPTAB	COSMAR	COSOCU	COSRAD	COSSPP	DELKAR	DELSUR	DENSEM	HEMCUN
1	9		2	1	3		17			1		1
5	3			1			3					
8	5	1		1			3			4	4	
15	6	1		4	2		13				3	2
18	3	1		2	1		2	1	1	2	2	
25	1		1		1		2					
28	5			1	1			1		5	2	
38		1					1					
52					1		1				1	
55		1		1			1					
65			1				1			1	1	
67				1			5		2	3		
75	16	2	3		1		27	1		4		
83	9	6	2		2		3		1	3		
85	22	10					22			5		
92	8	5		1			6	2	1	6	1	
95	9	10		2			12			2		

Frequency: (Percent of Total)												
DEPTH (cm)	ACTCRV	ACTOCH	ACTSPP	AZPTAB	COSMAR	COSOCU	COSRAD	COSSPP	DELKAR	DELSUR	DENSEM	HEMCUN
1	2.17%		0.48%	0.24%	0.72%		4.11%			0.24%		0.24%
5	2.56%			0.85%			2.56%					
8	1.42%	0.28%		0.28%			0.85%			1.13%	1.13%	
15	1.68%	0.28%		1.12%	0.56%		3.63%				0.84%	0.56%
18	0.87%	0.29%		0.58%	0.29%		0.58%	0.29%	0.29%	0.58%	0.58%	
25	0.29%		0.29%		0.29%		0.59%					
28	1.28%			0.26%	0.26%			0.26%		1.28%	0.51%	
38		0.32%					0.32%					
52					0.31%		0.31%				0.31%	
55		0.29%		0.29%			0.29%					
65			0.32%				0.32%			0.32%	0.32%	
67				0.33%			1.63%		0.65%	0.98%		
75	4.52%	0.56%	0.85%		0.28%		7.63%	0.28%		1.13%		
83	2.73%	1.82%	0.61%		0.61%		0.91%		0.30%	0.91%		
85	5.19%	2.36%					5.19%			1.18%		
92	2.48%	1.55%		0.31%			1.86%	0.62%	0.31%	1.86%	0.31%	
95	2.49%	2.77%		0.55%			3.32%			0.55%		

TABLE 5: DIATOM DATA FOR L13-81-G117

Frequency: (Valves Counted)												
DEPTH (cm)	NITSPP	PSDELG	PSNDOL	RHZHIE	RHZSEM	RHZSTY	ROPTES	SKLCOS	STESTE	STPDIM	STPKUL	STPTUR
1			23		9	1	6	3		48	2	3
5		3	1		1		2			21	3	
8	4	1	7	1	2	5		3		14	2	1
15		5					1			134	8	3
18		4			2			7		39	6	
25		12								134	5	
28		3		1	2					142	6	2
38										241	2	2
52	1	2								150	10	
55		1								248	4	
65		1								224	2	1
67	1	2								114	8	1
75	6					1				68	3	3
83	5				1	1				35		
85	3									105	10	5
92	1				1					17		
95		1								41	1	2

Frequency: (Percent of Total)												
DEPTH (cm)	NITSPP	PSDELG	PSNDOL	RHZHIE	RHZSEM	RHZSTY	ROPTES	SKLCOS	STESTE	STPDIM	STPKUL	STPTUR
1			5.56%		2.17%	0.24%	1.45%	0.72%		11.59%	0.48%	0.72%
5		2.56%	0.85%		0.85%		1.71%			17.95%	2.56%	
8	1.13%	0.28%	1.98%	0.28%	0.57%	1.42%		0.85%		3.97%	0.57%	0.28%
15		1.40%					0.28%			37.43%	2.23%	0.84%
18		1.17%			0.58%			2.04%		11.37%	1.75%	
25		3.52%								39.30%	1.47%	
28		0.77%		0.26%	0.51%					36.32%	1.53%	0.51%
38										77.00%	0.64%	0.64%
52	0.31%	0.62%								46.30%	3.09%	
55		0.29%								72.09%	1.16%	
65		0.32%								72.26%	0.65%	0.32%
67	0.33%	0.65%								37.13%	2.61%	0.33%
75	1.69%					0.28%				19.21%	0.85%	0.85%
83	1.52%				0.30%	0.30%				10.61%		
85	0.71%									24.76%	2.36%	1.18%
92	0.31%				0.31%					5.26%		
95		0.28%								11.36%	0.28%	0.55%

TABLE 5: DIATOM DATA FOR L13-81-G117

Frequency; (Valves Counted)												
DEPTH (cm)	THADEC	THAECC	THAFER	THAGRA	THAHEN	THALEP	THANOR	THAOES	THAPAC	THAPUN	THATEN	THATRI
1	4	23	6			1	1	3	13	2	2	
5		8	5					2	6			
8	7	21	12	3	2	3	1	1	17		1	
15		25	9	1					19		1	
18	5	15	19	4	1	3		1	11		1	
25		7	3	1		1		3				
28	1	9	1	7		1			2			
38		2	1									
52	2	11	4	2				1	1		3	
55	4	3	2	1		1			6			
65		2	2	1								
67		6	2	5		1			1			
75	2	42	1	3	4			11	21			
83	1	44	1	1	19			10	77	2	3	
85	2	60	2	2	4	1		26	32	3		
92	5	36	7	5	22			5	71	1		1
95	1	32			2		2	8	109	5		

Frequency; (Percent of Total)												
DEPTH (cm)	THADEC	THAECC	THASIM	THAGRA	THAHEN	THALEP	THANOR	THAOES	THAPAC	THAPUN	THATEN	THATRI
1	0.97%	5.56%	1.45%			0.24%	0.24%	0.72%	3.14%	0.48%	0.48%	
5		6.84%	4.27%					1.71%	5.13%			
8	1.98%	5.95%	3.40%	0.85%	0.57%	0.85%	0.28%	0.28%	4.82%		0.28%	
15		6.98%	2.51%	0.28%					5.31%		0.28%	
18	1.46%	4.37%	5.54%	1.17%	0.29%	0.87%		0.29%	3.21%		0.29%	
25		2.05%	0.88%	0.29%		0.29%		0.88%				
28	0.26%	2.30%	0.26%	1.79%		0.26%			0.51%			
38		0.64%	0.32%									
52	0.62%	3.40%	1.23%	0.62%				0.31%	0.31%		0.93%	
55	1.16%	0.87%	0.58%	0.29%		0.29%			1.74%			
65		0.65%	0.65%	0.32%								
67		1.95%	0.65%	1.63%		0.33%			0.33%			
75	0.56%	11.86%	0.28%	0.85%	1.13%			3.11%	5.93%			
83	0.30%	13.33%	0.30%	0.30%	5.76%			3.03%	23.33%	0.61%	0.91%	
85	0.47%	14.15%	0.47%	0.47%	0.94%	0.24%		6.13%	7.55%	0.71%		
92	1.55%	11.15%	2.17%	1.55%	6.81%			1.55%	21.98%	0.31%		0.31%
95	0.28%	8.86%			0.55%		0.55%	2.22%	30.19%	1.39%		

TABLE 5: DIATOM DATA FOR L13-81-G117

Frequency:										
(Valves Counted)										
DEPTH (cm)	THALIN	THAsp1	THAspE	THASPP	THLNIT	THLPRV	THXLON	MSCMPD	REWRKD	
1	5	7		11	57	4	1	2	6	
5		2		2	12	1			2	
8	9	11	4	3	147	3	3	2	7	
15	2	2		5	14	4		3		
18	3	6	3	3	150	8				
25	1	1		3	20				1	
28	3	1	4	2	122	4	1			
38		1			2					
52	3	2	1	7	70	3	1		2	
55				6	12	1	1		2	
65				1	8					
67	1	4		5	50	3	1		1	
75	3	8	6	3	12		2			
83	2	15		17	22		2	2		
85	7	4	1	7	16					
92		22		12	40		2	3	4	
95	10	10		20	20					
Frequency:										
(Percent of Total)										
DEPTH (cm)	THALIN	THAsp1	THAspE	THASPP	THLNIT	THLPRV	THXLON	MSCMPD	REWRKD	
1	1.21%	1.69%		2.66%	13.77%	0.97%	0.24%	0.48%	1.45%	
5		1.71%		1.71%	10.26%	0.85%			1.71%	
8	2.55%	3.12%	1.13%	0.85%	41.64%	0.85%	0.85%	0.57%	1.98%	
15	0.56%	0.56%		1.40%	3.91%	1.12%		0.84%		
18	0.87%	1.75%	0.87%	0.87%	43.73%	2.33%				
25	0.29%	0.29%		0.88%	5.87%				0.29%	
28	0.77%	0.26%	1.02%	0.51%	31.20%	1.02%	0.26%			
38		0.32%			0.64%					
52	0.93%	0.62%	0.31%	2.16%	21.60%	0.93%	0.31%		0.62%	
55				1.74%	3.49%	0.29%	0.29%		0.58%	
65				0.32%	2.58%					
67	0.33%	1.30%		1.63%	16.29%	0.98%	0.33%		0.33%	
75	0.85%	2.26%	1.69%	0.85%	3.39%		0.56%			
83	0.61%	4.55%		5.15%	6.67%		0.61%	0.61%		
85	1.65%	0.94%	0.24%	1.65%	3.77%					
92		6.81%		3.72%	12.38%		0.62%	0.93%	1.24%	
95	2.77%	2.77%		5.54%	5.54%					

TABLE 5: DIATOM DATA FOR L13-81-G117

Frequency: (Valves Counted)												
DEPTH (cm)	ACTNOR	ACPSEN	ACPSPL	ACPVUL	AULGRN	AULISL	AULITL	AULSPP	COCSPP	CYCSPP	ENDsp1	ODTAUR
1	1	23		7	8			1	4	31	2	5
5		8			6					6		1
8		4		1	1	4			3	10		
15		12		2	5				1		7	
18		4			2		1				2	
25		35			3						5	
28		15			2			1			6	1
38		19			6						3	
52		4			8	2		1	3		14	
55		8			16	2				2	3	2
65		14			16		1	2		2	7	1
67		16			8	4		2	2		16	1
75	1	11		1	9	5	1		8	5	5	1
83		6			3	1			4	3		1
85	2	10			7	1		3	7	9	4	
92		5			2				8	1		
95	1	15		2	9				2	3	7	

Frequency: (Percent of Total)												
DEPTH (cm)	ACTNOR	ACPSEN	ACPSPL	ACPVUL	AULGRN	AULISL	AULITL	AULSPP	COCSPP	CYCSPP	ENDsp1	ODTAUR
1	0.24%	5.56%		1.69%	1.93%			0.24%	0.97%	7.49%	0.48%	1.21%
5		6.84%			5.13%					5.13%		0.85%
8		1.13%		0.28%	0.28%	1.13%			0.85%	2.83%		
15		3.35%		0.56%	1.40%				0.28%		1.96%	
18		1.17%			0.58%		0.29%				0.58%	
25		10.26%			0.88%						1.47%	
28		3.84%			0.51%			0.26%			1.53%	0.26%
38		6.07%			1.92%						0.96%	
52		1.23%			2.47%	0.62%		0.31%	0.93%		4.32%	
55		2.33%			4.65%	0.58%				0.58%	0.87%	0.58%
65		4.52%			5.16%		0.32%	0.65%		0.65%	2.26%	0.32%
67		5.21%			2.61%	1.30%		0.65%	0.65%		5.21%	0.33%
75	0.28%	3.11%		0.28%	2.54%	1.41%	0.28%		2.26%	1.41%	1.41%	0.28%
83		1.82%			0.91%	0.30%			1.21%	0.91%		0.30%
85	0.47%	2.36%			1.65%	0.24%		0.71%	1.65%	2.12%	0.94%	
92		1.55%			0.62%				2.48%	0.31%		
95	0.28%	4.16%		0.55%	2.49%				0.55%	0.83%	1.94%	

TABLE 5: DIATOM DATA FOR L13-81-G117

Frequency: (Valves Counted)										
DEPTH (cm)	ODTLON	ODTSPP	PARSUL	RAPAMP	RAPMRG	RAPPSA	STDSPP	THALAC	BENTHIC	TOTAL VALVES
1	1	1	42	1		1	1	1	7	414
5			17						1	117
8	1		5	2	1	2	1		3	353
15	1		57	1	1		1		3	358
18			24		2				2	343
25			96	2		1			2	341
28	1		28	2	2	1	1		2	391
38			31				1			313
52			6	4	2		1			324
55			5	1		3	3		4	344
65			19	2						310
67			32	3	1	3			2	307
75		1	11	2	2	20	3	1	14	354
83	2			1	6	11	2		4	330
85		1	7	1	1	10	2	1	9	424
92	2		3	2	6	4	3		2	323
95	1		6	1		2	1	4	8	361

Frequency: (Percent of Total)										
DEPTH (cm)	ODTLON	ODTSPP	PARSUL	RAPAMP	RAPMRG	RAPPSA	STDSPP	THALAC	BENTHIC	TOTAL
1	0.24%	0.24%	10.14%	0.24%		0.24%	0.24%	0.24%	1.69%	100.00%
5			14.53%						0.85%	100.00%
8	0.28%		1.42%	0.57%	0.28%	0.57%	0.28%		0.85%	100.00%
15	0.28%		15.92%	0.28%	0.28%		0.28%		0.84%	100.00%
18			7.00%		0.58%				0.58%	100.00%
25			28.15%	0.59%		0.29%			0.59%	100.00%
28	0.26%		7.16%	0.51%	0.51%	0.26%	0.26%		0.51%	100.00%
38			9.90%				0.32%			100.00%
52			1.85%	1.23%	0.62%		0.31%			100.00%
55			1.45%	0.29%		0.87%	0.87%		1.16%	100.00%
65			6.13%	0.65%						100.00%
67			10.42%	0.98%	0.33%	0.98%			0.65%	100.00%
75		0.28%	3.11%	0.56%	0.56%	5.65%	0.85%	0.28%	3.95%	100.00%
83	0.61%			0.30%	1.82%	3.33%	0.61%		1.21%	100.00%
85		0.24%	1.65%	0.24%	0.24%	2.36%	0.47%	0.24%	2.12%	100.00%
92	0.62%		0.93%	0.62%	1.86%	1.24%	0.93%		0.62%	100.00%
95	0.28%		1.66%	0.28%		0.55%	0.28%	1.11%	2.22%	100.00%

TABLE 5: DIATOM DATA FOR L13-81-G117

Frequency:			
(Valves Counted)			
DEPTH (cm)	S/D RATIO	CHT SPORES	SILICOS
1	0.71	294	12
5	0.56	65	3
8	0.62	219	1
15	0.32	116	4
18	0.98	336	4
25	0.03	10	1
28	0.16	62	
38	0.01	4	
52	0.35	115	
55	0.12	41	
65	0.07	22	
67	0.23	71	1
75	1.82	646	49
83	5.79	1911	24
85	3.13	1327	47
92	4.49	1450	29
95	3.45	1245	25
Frequency:			
(Percent of Total)			
DEPTH (cm)			
1			
5			
8			
15			
18			
25			
28			
38			
52			
55			
65			
67			
75			
83			
85			
92			
95			

TABLE 6: DIATOM DATA FOR L13-81-G145

Frequency (Valves Counted):												
DEPTH (cm)	ACTCRV	ACTOCH	ACTSPP	AZPTAB	COSMAR	COSOCU	COSRAD	COSSPP	DELKAR	DELSUR	DENSEM	HEMCUN
1	4						4			2		
10	4		1	3			4		4		4	
20	3	1			1	1	2			1		
30					1							
40	1			1			2					
50	30	1	1	1			4		5	7		
60	38	7	1			1	14	1	5	1	1	
70	7	2			1		4		1	4		
80	1				1						1	
90	5					1	4		1	8	14	
100	13	1					5			2	23	
110	27	3				1	12		2	10	24	
120	42	1					20		1	4	19	1
129	62	17			1		94		1	1	5	
Frequency (Percent of Total):												
DEPTH (cm)	ACTCRV	ACTOCH	ACTSPP	AZPTAB	COSMAR	COSOCU	COSRAD	COSSPP	DELKAR	DELSUR	DENSEM	HEMCUN
1	4.00%						4.00%			2.00%		
10	1.00%		0.25%	0.75%			1.00%		1.00%		1.00%	
20	0.88%	0.29%			0.29%	0.29%	0.59%			0.29%		
30					1.35%							
40	0.97%			0.97%			1.94%					
50	7.92%	0.26%	0.26%	0.26%			1.06%		1.32%	1.85%		
60	10.47%	1.93%	0.28%			0.28%	3.86%	0.28%	1.38%	0.28%	0.28%	
70	2.15%	0.62%			0.31%		1.23%		0.31%	1.23%		
80	1.72%				1.72%						1.72%	
90	1.36%					0.27%	1.09%		0.27%	2.17%	3.80%	
100	3.59%	0.28%					1.38%			0.55%	6.35%	
110	6.38%	0.71%				0.24%	2.84%		0.47%	2.36%	5.67%	
120	11.11%	0.26%					5.29%		0.26%	1.06%	5.03%	0.26%
129	16.23%	4.45%			0.26%		24.61%		0.26%	0.26%	1.31%	

TABLE 6: DIATOM DATA FOR L13-81-G145

Frequency (Valves Counted):												
DEPTH (cm)	NITSPP	PSDELG	PSNDOL	RHZHIE	RHZSEM	RHZSTY	ROPTES	SKLCOS	STESTE	STPDIM	STPKUL	STPTUR
1		2	1			1		1		4	2	
10										95	3	3
20							1			116	2	
30					1					41	2	
40							1			55	3	1
50	4	1			3					94	4	2
60					2	1	2			100	4	1
70		1					2			174	3	1
80										16	1	
90	1	6			19	1	6			71	5	3
100		5			1	1	1			54	10	1
110		41			2	2	3			77	7	
120	1				4		6			58	8	3
129							15			16	5	4
Frequency (Percent of Total):												
DEPTH (cm)	NITSPP	PSDELG	PSNDOL	RHZHIE	RHASEM	RHZSTY	ROPTES	SKLCOS	STESTE	STPDIM	STPKUL	STPTUR
1		2.00%	1.00%			1.00%		1.00%		4.00%	2.00%	
10										23.63%	0.75%	0.75%
20							0.29%			34.22%	0.59%	
30					1.35%					55.41%	2.70%	
40							0.97%			53.40%	2.91%	0.97%
50	1.06%	0.26%			0.79%					24.80%	1.06%	0.53%
60					0.55%	0.28%	0.55%			27.55%	1.10%	0.28%
70		0.31%					0.62%			53.54%	0.92%	0.31%
80										27.59%	1.72%	
90	0.27%	1.63%			5.16%	0.27%	1.63%			19.29%	1.36%	0.82%
100		1.38%			0.28%	0.28%	0.28%			14.92%	2.76%	0.28%
110		9.69%			0.47%	0.47%	0.71%			18.20%	1.65%	
120	0.26%				1.06%		1.59%			15.34%	2.12%	0.79%
129							3.93%			4.19%	1.31%	1.05%

TABLE 6: DIATOM DATA FOR L13-81-G145

Frequency (Valves Counted):												
DEPTH (cm)	THADEC	THAECC	THAFER	THAGRA	THAHEN	THALEP	THANOR	THAOES	THAPAC	THAPUN	THATEN	THATRI
1	2	4	1					2	9		1	
10	1	15	4		2	1		1	7			
20	1	6	7		1	1		4	1			
30												
40												
50	2	15	6					3	12			
60	6	15	5					5	7		1	
70		4	2						1			
80		1	1					1				
90		14	2					5	5			
100	2	22	10	2	1	1		1	21			
110		14	8		2	1		7	8		1	1
120	1	16	5		3	2		11	9			1
129	2	19	7	3	2			7	9			
Frequency (Percent of Total):												
DEPTH (cm)	THADEC	THAECC	THAFER	THAGRA	THAHEN	THALEP	THANOR	THAOES	THAPAC	THAPUN	THATEN	THATRI
1	2.00%	4.00%	1.00%					2.00%	9.00%		1.00%	
10	0.25%	3.73%	1.00%		0.50%	0.25%		0.25%	1.74%			
20	0.29%	1.77%	2.06%		0.29%	0.29%		1.18%	0.29%			
30												
40												
50	0.53%	3.96%	1.58%					0.79%	3.17%			
60	1.65%	4.13%	1.38%					1.38%	1.93%		0.28%	
70		1.23%	0.62%						0.31%			
80		1.72%	1.72%					1.72%				
90		3.80%	0.54%					1.36%	1.36%			
100	0.55%	6.08%	2.76%	0.55%	0.28%	0.28%		0.28%	5.80%			
110		3.31%	1.89%		0.47%	0.24%		1.65%	1.89%		0.24%	0.24%
120	0.26%	4.23%	1.32%		0.79%	0.53%		2.91%	2.38%			0.26%
129	0.52%	4.97%	1.83%	0.79%	0.52%			1.83%	2.36%			

TABLE 6: DIATOM DATA FOR L13-81-G145

Frequency										
(Valves Counted):										
DEPTH (cm)	THALIN	THAsp1	THAspE	THASPP	THLNIT	THLPRV	THXLON	MSCMPD	REWRKD	
1	7			2	28					
10	4		1		203	5				
20	1				40	4	1			
30					2					
40	1				4					
50	7	2		6	59	1				
60	2			1	56	5			1	
70	3	2			16					
80					8					
90	1	1			106	1		2		
100	12	2		1	96	2	1	1		
110	7	1	1	1	84		1			
120	6	2		1	76	5	3			
129	7	2		3	36		1	2	1	
Frequency										
(Percent of Total):										
DEPTH (cm)	THALIN	THAsp1	THAspE	THASPP	THLNIT	THLPRV	THXLON	MSCMPD	REWRKD	
1	7.00%			2.00%	28.00%					
10	1.00%		0.25%		50.50%	1.24%				
20	0.29%				11.80%	1.18%	0.29%			
30					2.70%					
40	0.97%				3.88%					
50	1.85%	0.53%		1.58%	15.57%	0.26%				
60	0.55%			0.28%	15.43%	1.38%			0.28%	
70	0.92%	0.62%			4.92%					
80					13.79%					
90	0.27%	0.27%			28.80%	0.27%		0.54%		
100	3.31%	0.55%		0.28%	26.52%	0.55%	0.28%	0.28%		
110	1.65%	0.24%	0.24%	0.24%	19.86%		0.24%			
120	1.59%	0.53%		0.26%	20.11%	1.32%	0.79%			
129	1.83%	0.52%		0.79%	9.42%		0.26%	0.52%	0.26%	

TABLE 6: DIATOM DATA FOR L13-81-G145

Frequency (Valves Counted):												
DEPTH (cm)	ACTNOR	ACPSEN	ACPSPL	ACPVUL	AULGRN	AULISL	AULITL	AULSPP	COCSPP	CYCSPP	ENDSP1	ODTAUR
1		5		1	1					1	1	1
10		1			9				1		3	
20		24			8				1	1	5	
30		1			10		2				1	
40		1			13		1				8	
50		12			12			2	3		5	2
60		19			5				4		7	1
70		18		1	11				3	1	12	
80		1			3	1			1	1	5	
90		9		1					2		3	1
100		14		1	2				1		4	
110		9							4		8	
120		17		2					1			
129		5							1			
Frequency (Percent of Total):												
DEPTH (cm)	ACTNOR	ACPSEN	ACPSPL	ACPVUL	AULGRN	AULISL	AULITL	AULSPP	COCSPP	CYCSPP	ENDSP1	ODTAUR
1		5.00%		1.00%	1.00%					1.00%	1.00%	1.00%
10		0.25%			2.24%				0.25%		0.75%	
20		7.08%			2.36%				0.29%	0.29%	1.47%	
30		1.35%			13.51%		2.70%				1.35%	
40		0.97%			12.62%		0.97%				7.77%	
50		3.17%			3.17%			0.53%	0.79%		1.32%	0.53%
60		5.23%			1.38%				1.10%		1.93%	0.28%
70		5.54%		0.31%	3.38%				0.92%	0.31%	3.69%	
80		1.72%			5.17%	1.72%			1.72%	1.72%	8.62%	
90		2.45%		0.27%					0.54%		0.82%	0.27%
100		3.87%		0.28%	0.55%				0.28%		1.10%	
110		2.13%							0.95%		1.89%	
120		4.50%		0.53%					0.26%			
129		1.31%							0.26%			

TABLE 6: DIATOM DATA FOR L13-81-G145

Frequency (Valves Counted):										
DEPTH (cm)	ODTLON	ODTSPP	PARSUL	RAPAMP	RAPMRG	RAPPSA	STDSPP	THALAC	BENTHIC	TOTAL VALVES
1			8	2			1		2	100
10	1		21						1	402
20			103			1	1			339
30			8			1	1		3	74
40			6			3	1		1	103
50		1	27	10	2	31	1		1	379
60			12	4	2	19	2		5	363
70			11	1	1	31	1		6	325
80			13			2				58
90	1		50	2	3	10	1		3	368
100	1		36	2	2	3			4	362
110	2		45	1	3	2	1			423
120	1	1	28	1	4	7		1	6	378
129			48	2		4				382
Frequency (Percent of Total):										
DEPTH (cm)	ODTLON	ODTSPP	PARSUL	RAPAMP	RAPMRG	RAPPSA	STDSPP	THALAC	BENTHIC	TOTAL
1			8.00%	2.00%			1.00%		2.00%	100.00%
10	0.25%		5.22%						0.25%	100.00%
20			30.38%			0.29%	0.29%			100.00%
30			10.81%			1.35%	1.35%		4.05%	100.00%
40			5.83%			2.91%	0.97%		0.97%	100.00%
50		0.26%	7.12%	2.64%	0.53%	8.18%	0.26%		0.26%	100.00%
60			3.31%	1.10%	0.55%	5.23%	0.55%		1.38%	100.00%
70			3.38%	0.31%	0.31%	9.54%	0.31%		1.85%	100.00%
80			22.41%			3.45%				100.00%
90	0.27%		13.59%	0.54%	0.82%	2.72%	0.27%		0.82%	100.00%
100	0.28%		9.94%	0.55%	0.55%	0.83%			1.10%	100.00%
110	0.47%		10.64%	0.24%	0.71%	0.47%	0.24%			100.00%
120	0.26%	0.26%	7.41%	0.26%	1.06%	1.85%		0.26%	1.59%	100.00%
129			12.57%	0.52%		1.05%				100.00%

TABLE 6: DIATOM DATA FOR L13-81-G145

Frequency			
(Valves Counted):			
DEPTH (cm)	S/D RATIO	CHT SPORES	SILICOS
1	0.63	63	2
10	0.73	293	4
20	0.21	72	4
30	0.05	4	
40	0.07	7	5
50	0.25	94	23
60	0.42	151	25
70	0.10	31	9
80	0.17	10	
90	0.21	78	5
100	0.58	209	17
110	0.22	92	19
120	0.21	78	21
129	0.21	82	39
Frequency			
(Percent of Total):			
DEPTH (cm)			
1			
10			
20			
30			
40			
50			
60			
70			
80			
90			
100			
110			
120			
129			

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency: (Valves Counted): DEPTH (cm)	ACTCRV	ACTOCH	ACTSPP	AZPTAB	COSMAR	COSOCU	COSRAD	COSSPP	DELKAR	DELSUR	DENSEM	HEMCUN
1	8		1	3	2		14			1		7
5	1	1		1				1		1		
10												
15					1		1					
20					3							
25												
30										1		
35												
40	1	2	1		1							
45												
50	(no diatoms recovered from this sample)											
55												
60	1				3		2		1	4	1	
65	1				1						3	
70	4										8	
75	1											1
80	2						1			1	1	
85	2				1						1	
90	1									1		1
95			1								3	
100							1			8	9	
105	2				2				1	1	2	
110	1				1						5	
115	2		2								4	
120							1					
125			3								4	
130					1				1		6	
135			4							2	14	
140	1	2			1		1			1	3	
145	1								2		14	
150	3	1								1	6	

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency (Percent of Total):												
DEPTH (cm)	ACTCRV	ACTOCH	ACTSPP	AZPTAB	COSMAR	COSOCU	COSRAD	COSSPP	DELKAR	DELSUR	DENSEM	HEMCUN
1	2.69%		0.34%	1.01%	0.67%		4.71%			0.34%		2.36%
5	Diatoms too rare in this sample for comparison of percent frequency.											
10	"											
15	"											
20	"											
25	"											
30	"											
35	"											
40	"											
45	"											
50	(no diatoms recovered from this sample)											
55												
60	0.35%				1.05%		0.70%		0.35%	1.40%	0.35%	
65	0.28%				0.28%						0.85%	
70	1.25%										2.51%	
75	0.26%											0.26%
80	0.66%						0.33%			0.33%	0.33%	
85	0.65%				0.33%						0.33%	
90	0.29%									0.29%		0.29%
95			0.28%								0.85%	
100							0.30%			2.42%	2.73%	
105	0.62%				0.62%				0.31%	0.31%	0.62%	
110	0.29%				0.29%						1.45%	
115	0.56%		0.56%								1.11%	
120							0.31%					
125			0.81%								1.08%	
130					0.30%				0.30%		1.78%	
135			1.27%							0.63%	4.43%	
140	0.29%	0.57%			0.29%		0.29%			0.29%	0.86%	
145	0.24%								0.48%		3.37%	
150	0.90%	0.30%								0.30%	1.79%	

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency: (Valves Counted): DEPTH (cm)	NITSPP	PSDELG	PSNDOL	RHZHIE	RHZSEM	RHZSTY	ROPTES	SKLCOS	STESTE	STPDIM	STPKUL	STPTUR
1	6		17			20	1	2				1
5	2									3		
10												
15												
20						1						
25												
30												
35												
40												
45										2		
50												
55										266	41	1
60										142		8
65										117	7	
70										146	13	
75										202	20	
80										66	7	
85										145	8	2
90										214	14	
95	1									169	6	2
100										210	14	
105										185		
110	3									170	15	1
115										195		
120										249	26	
125										161		
130										143	12	
135	2									88		
140										184	15	
145										205		
150										247	15	2

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency (Percent of Total): DEPTH (cm)	NITSPP	PSDELG	PSNDOL	RHZHIE	RHZSEM	RHZSTY	ROPTES	SKLCOS	STESTE	STPDIM	STPKUL	STPTUR
1	2.02%		5.72%			6.73%	0.34%	0.67%				0.34%
5												
10												
15												
20												
25												
30												
35												
40												
45												
50												
55										76.88%	11.85%	0.29%
60										49.65%		2.80%
65										33.14%	1.98%	
70										45.77%	4.08%	
75										52.47%	5.19%	
80										21.93%	2.33%	
85										47.23%	2.61%	0.65%
90										62.76%	4.11%	
95	0.28%									48.15%	1.71%	0.57%
100										63.64%	4.24%	
105										56.92%		
110	0.87%									49.13%	4.34%	0.29%
115										54.32%		
120										76.85%	8.02%	
125										43.28%		
130										42.31%	3.55%	
135	0.63%									27.85%		
140										52.72%	4.30%	
145										49.40%		
150										73.73%	4.48%	0.60%

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency: (Valves Counted): DEPTH (cm)	THADEC	THAECC	THAFER	THAGRA	THAHEN	THALEP	THANOR	THAOES	THAPAC	THAPUN	THATEN	THATRI
1	2	10	9			1		1	20			
5											1	
10												
15												
20												
25												
30												
35												
40												
45												
50												
55												
60		2	1			1						
65		2						1				1
70		20							1			
75				1								
80		1						2				
85		2										
90		3						1				
95												
100		13										4
105												
110												
115												
120												
125												
130												
135		2		1								
140		2										
145	1	4							1			
150		1										

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency (Percent of Total):												
DEPTH (cm)	THADEC	THAECC	THAFER	THAGRA	THAHEN	THALEP	THANOR	THAOES	THAPAC	THAPUN	THATEN	THATRI
1	0.67%	3.37%	3.03%			0.34%		0.34%	6.73%			
5												
10												
15												
20												
25												
30												
35												
40												
45												
50												
55												
60		0.70%	0.35%			0.35%						
65		0.57%						0.28%				0.28%
70		6.27%							0.31%			
75				0.26%								
80		0.33%						0.66%				
85		0.65%										
90		0.88%						0.29%				
95												
100		3.94%										1.21%
105												
110												
115												
120												
125												
130												
135		0.63%		0.32%								
140		0.57%										
145	0.24%	0.96%							0.24%			
150		0.30%										

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency: (Valves Counted): DEPTH (cm)	THALIN	THAsp1	THAspE	THASPP	THLNIT	THLPRV	THXLON	MSCMPD	REWRKD	
1	3	1		4	57	32	7			
5		1			3		1	1	2	
10										
15				1						
20					2					
25									1	
30							1			
35										
40					1					
45										
50										
55										
60					77		3			
65					4			8	4	
70				1	28		2		4	
75								16		
80								8	5	
85					1			4	2	
90					8		2		3	
95								20	7	
100					19				1	
105					1			4	25	
110					3			6	3	
115					3			7	19	
120								3	2	
125					3			7	33	
130					3			5		
135					13			7		
140					7			2	9	
145					12	3		8	19	
150					5			3	2	

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency (Percent of Total):										
DEPTH (cm)	THALIN	THAsp1	THAspE	THASPP	THLNIT	THLPRV	THXLON	MSCMPD	REWRKD	
1	1.01%	0.34%		1.35%	19.19%	10.77%	2.36%			
5										
10										
15										
20										
25										
30										
35										
40										
45										
50										
55										
60					26.92%		1.05%			
65					1.13%			2.27%	1.13%	
70				0.31%	8.78%		0.63%		1.25%	
75								4.16%		
80								2.66%	1.66%	
85					0.33%			1.30%	0.65%	
90					2.35%		0.59%		0.88%	
95								5.70%	1.99%	
100					5.76%				0.30%	
105					0.31%			1.23%	7.69%	
110					0.87%			1.73%	0.87%	
115					0.84%			1.95%	5.29%	
120								0.93%	0.62%	
125					0.81%			1.88%	8.87%	
130					0.89%			1.48%		
135					4.11%			2.22%		
140					2.01%			0.57%	2.58%	
145					2.89%	0.72%		1.93%	4.58%	
150					1.49%			0.90%	0.60%	

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency; (Valves Counted); DEPTH (cm)	ACTNOR	ACPSEN	ACPSPL	ACPVUL	AULGRN	AULISL	AULITL	AULSPP	COCSPP	CYCSPP	ENDsp1	ODTAUR
1		12		2	5	1			4	18		4
5					13				1	9		1
10										2		
15	1				5					1		
20		2			33				1	1		
25					5	1				1		1
30					24	1				2		
35					1			1		1		
40		2			24				1	3		
45					1			1				
50												
55					28	2		4			3	
60		8			18	2				2		1
65		3	1		139	9	3	13	1	1	15	
70		4			60	3		3	1		6	
75		9			91	6		6	1	5	16	
80		9			136	4	4	9	2	4	9	1
85		17			81	16	4	4		2	4	
90		24			38	2		5	1		9	1
95		16			66	6	2	5		1	34	2
100		17			14	2		2			8	
105	1	4			45	3	3	5		3	22	1
110		3			70	10	3	3	1	3	25	
115		1			78	2		8			24	
120					24			1			11	1
125					92	3	4	5	2	7	22	
130					105	3	3	4	2	2	18	
135		1			138	3	5	3		6		1
140		1			68	7	3	4	1	1	5	2
145		1			68		9	1		4	53	
150	1				27		2	1		2	8	1

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency (Percent of Total):												
DEPTH (cm)	ACTNOR	ACPSEN	ACPSPL	ACPVUL	AULGRN	AULISL	AULITL	AULSPP	COCSPP	CYCSPP	ENDsp1	ODTAUR
1		4.04%		0.67%	1.68%	0.34%			1.35%	6.06%		1.35%
5												
10												
15												
20												
25												
30												
35												
40												
45												
50												
55					8.09%	0.58%		1.16%			0.87%	
60		2.80%			6.29%	0.70%				0.70%		0.35%
65		0.85%	0.28%		39.38%	2.55%	0.85%	3.68%	0.28%	0.28%	4.25%	
70		1.25%			18.81%	0.94%		0.94%	0.31%		1.88%	
75		2.34%			23.64%	1.56%		1.56%	0.26%	1.30%	4.16%	
80		2.99%			45.18%	1.33%	1.33%	2.99%	0.66%	1.33%	2.99%	0.33%
85		5.54%			26.38%	5.21%	1.30%	1.30%		0.65%	1.30%	
90		7.04%			11.14%	0.59%		1.47%	0.29%		2.64%	0.29%
95		4.56%			18.80%	1.71%	0.57%	1.42%		0.28%	9.69%	0.57%
100		5.15%			4.24%	0.61%		0.61%			2.42%	
105	0.31%	1.23%			13.85%	0.92%	0.92%	1.54%		0.92%	6.77%	0.31%
110		0.87%			20.23%	2.89%	0.87%	0.87%	0.29%	0.87%	7.23%	
115		0.28%			21.73%	0.56%		2.23%			6.69%	
120					7.41%			0.31%			[illegible]	0.31%
125					24.73%	0.81%	1.08%	1.34%	0.54%	1.88%	[illegible]	
130					31.07%	0.89%	0.89%	1.18%	0.59%	0.59%	[illegible]	
135		0.32%			43.67%	0.95%	1.58%	0.95%		1.90%	[illegible]	0.32%
140		0.29%			19.48%	2.01%	0.86%	1.15%	0.29%	0.29%	1.43%	0.57%
145		0.24%			16.39%		2.17%	0.24%		0.96%	12.77%	
150	0.30%				8.06%		0.60%	0.30%		0.60%	2.39%	0.30%

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency; (Valves Counted); DEPTH (cm)	ODTLON	ODTSPP	PARSUL	RAPAMP	RAPMRG	RAPPSA	STDSPP	THALAC	BENTHIC	TOTAL VALVES
1	1	1	6		2		1		10	297
5			13				1			57
10										2
15			3							13
20			5				4		1	53
25							1			10
30			6				1			36
35										3
40			7				3			46
45										4
50										
55									1	346
60				3		1	3		2	286
65				4		1	6		8	353
70				5			3		7	319
75						1	4		5	385
80			2	6			12		9	301
85							8		3	307
90	1			3			1		8	341
95							7		3	351
100				2			2		4	330
105			1				7		7	325
110			3	1			12		4	346
115			1	1			4		8	359
120				1			3		2	324
125			2				14		10	372
130	1		5				10		14	338
135			2		2		8		14	316
140	1		6	1			6		15	349
145	1		1	1			6			415
150							1		6	335

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency (Percent of Total):										
DEPTH (cm)	ODTLON	ODTSPP	PARSUL	RAPAMP	RAPMRG	RAPPSA	STDSPP	THALAC	BENTHIC	TOTAL
1	0.34%	0.34%	2.02%		0.67%		0.34%		3.37%	100.00%
5										
10										
15										
20										
25										
30										
35										
40										
45										
50										
55									0.29%	100.00%
60				1.05%		0.35%	1.05%		0.70%	100.00%
65				1.13%		0.28%	1.70%		2.27%	100.00%
70				1.57%			0.94%		2.19%	100.00%
75						0.26%	1.04%		1.30%	100.00%
80			0.66%	1.99%			3.99%		2.99%	100.00%
85							2.61%		0.98%	100.00%
90	0.29%			0.88%			0.29%		2.35%	100.00%
95							1.99%		0.85%	100.00%
100				0.61%			0.61%		1.21%	100.00%
105			0.31%				2.15%		2.15%	100.00%
110			0.87%	0.29%			3.47%		1.16%	100.00%
115			0.28%	0.28%			1.11%		2.23%	100.00%
120				0.31%			0.93%		0.62%	100.00%
125			0.54%				3.76%		2.69%	100.00%
130	0.30%		1.48%				2.96%		4.14%	100.00%
135			0.63%		0.63%		2.53%		4.43%	100.00%
140	0.29%		1.72%	0.29%			1.72%		4.30%	100.00%
145	0.24%		0.24%	0.24%			1.45%			100.00%
150							0.30%		1.79%	100.00%

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency: (Valves Counted):			
DEPTH (cm)	S/D RATIO	CHT SPORES	SILICOS
1	0.44	132	23
5	0.51	29	1
10		6	
15			
20	0.08	4	
25	0.30	3	
30			
35	0.33	1	
40	0.22	10	1
45	0.25	1	
50			
55			
60	0.32	92	27
65	0.04	13	8
70	0.34	110	7
75	0.01	5	5
80	0.03	10	1
85	0.02	5	
90	0.20	67	4
95	0.04	14	
100	1.20	396	1
105	0.03	10	
110	0.10	34	1
115	0.03	9	1
120	0.01	2	
125	0.09	32	
130	0.03	11	2
135	0.08	25	
140	0.06	22	1
145	0.11	47	1
150	0.03	10	2

TABLE 7: DIATOM DATA FOR TT197-G330

Frequency			
(Percent of Total):			
DEPTH (cm)			
1			
5			
10			
15			
20			
25			
30			
35			
40			
45			
50			
55			
60			
65			
70			
75			
80			
85			
90			
95			
100			
105			
110			
115			
120			
125			
130			
135			
140			
145			
150			

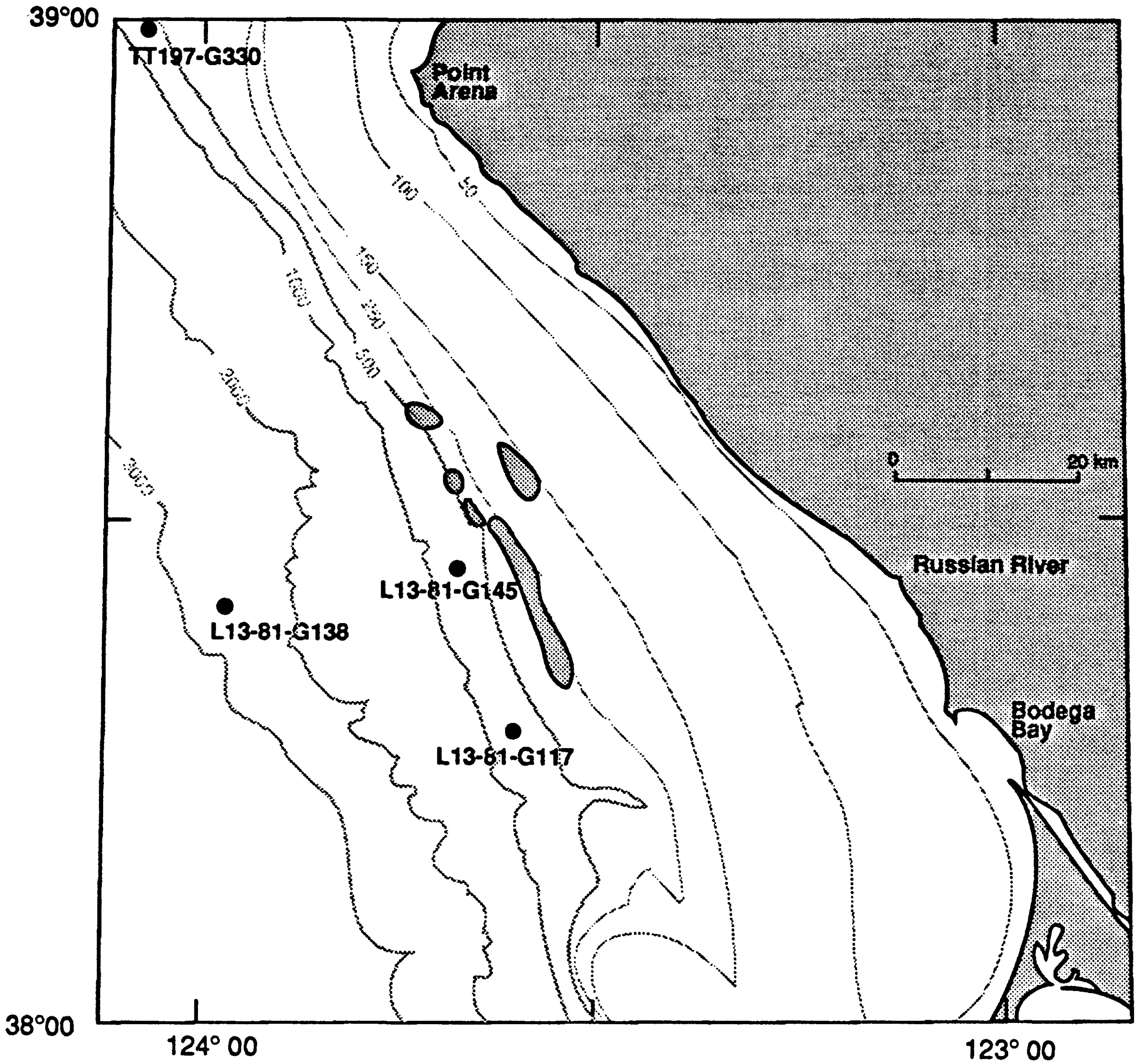

Figure 1. Locations of gravity cores L13-81-G117, L13-81-G138, L13-81-G145, and TT197-G330.

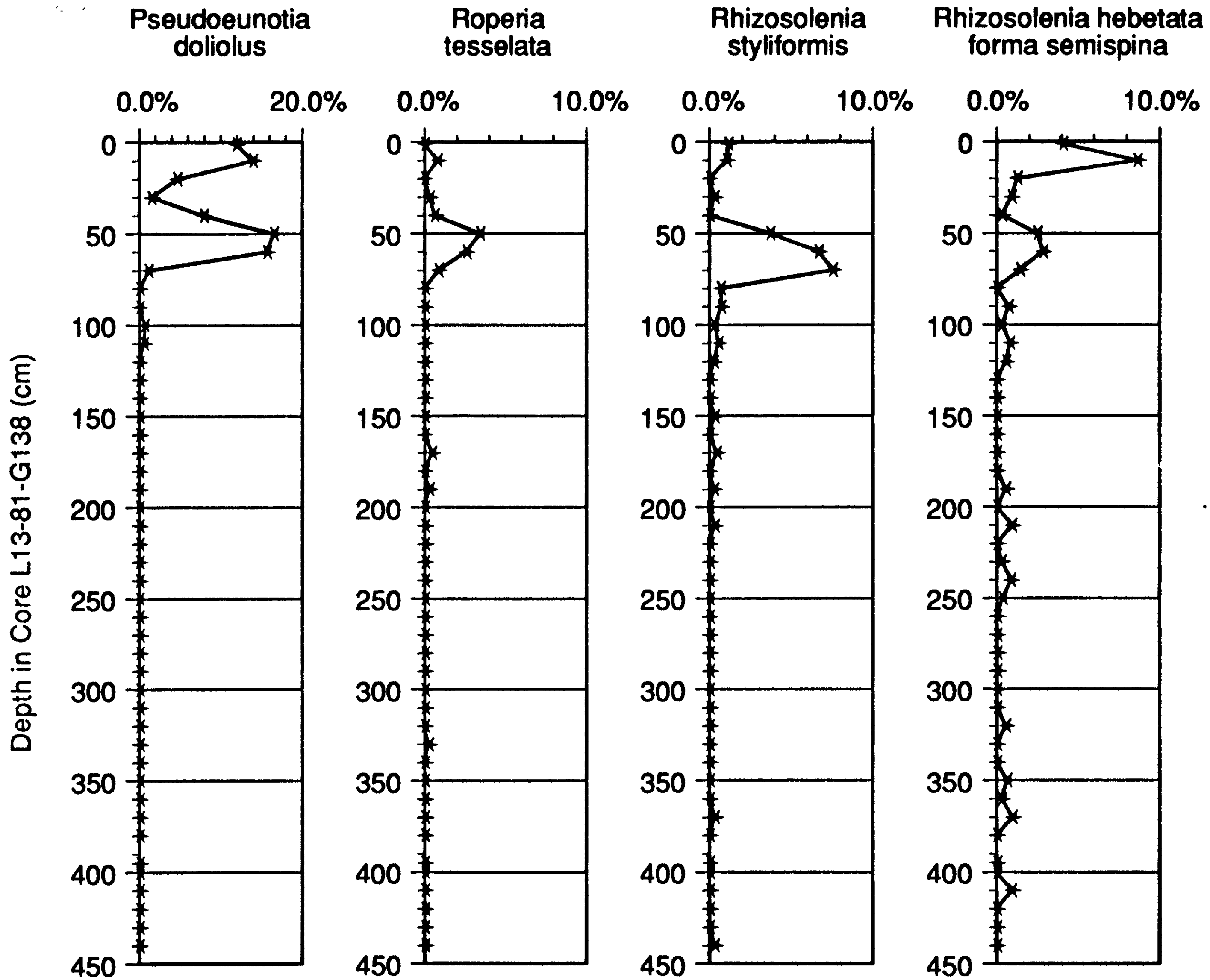

FIGURE 2. Relative frequencies of diatoms associated with Holocene sediments in L13-81-G138.

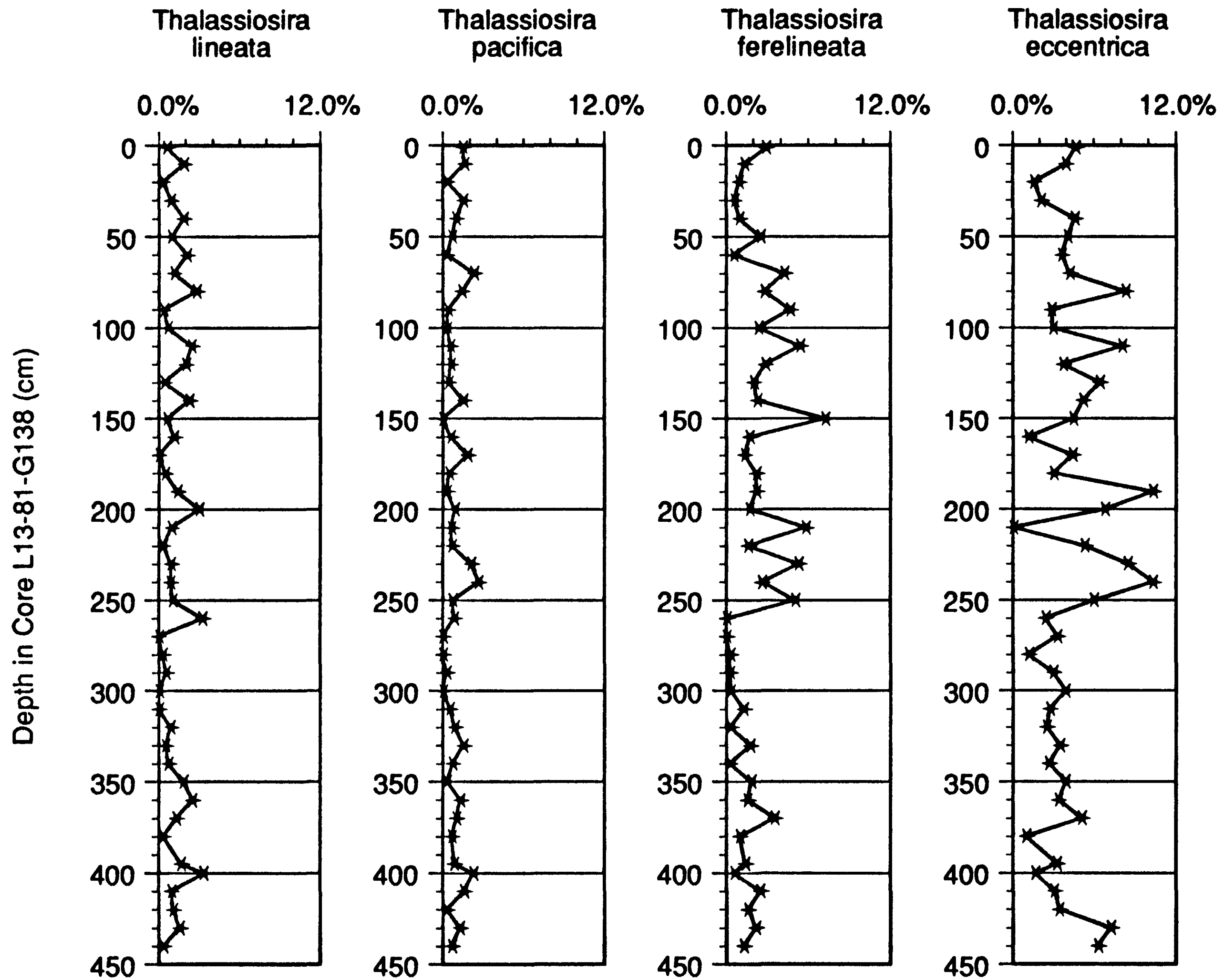

Figure 3. Relative frequencies of four species of *Thalassiosira* in core L13-81-G138.

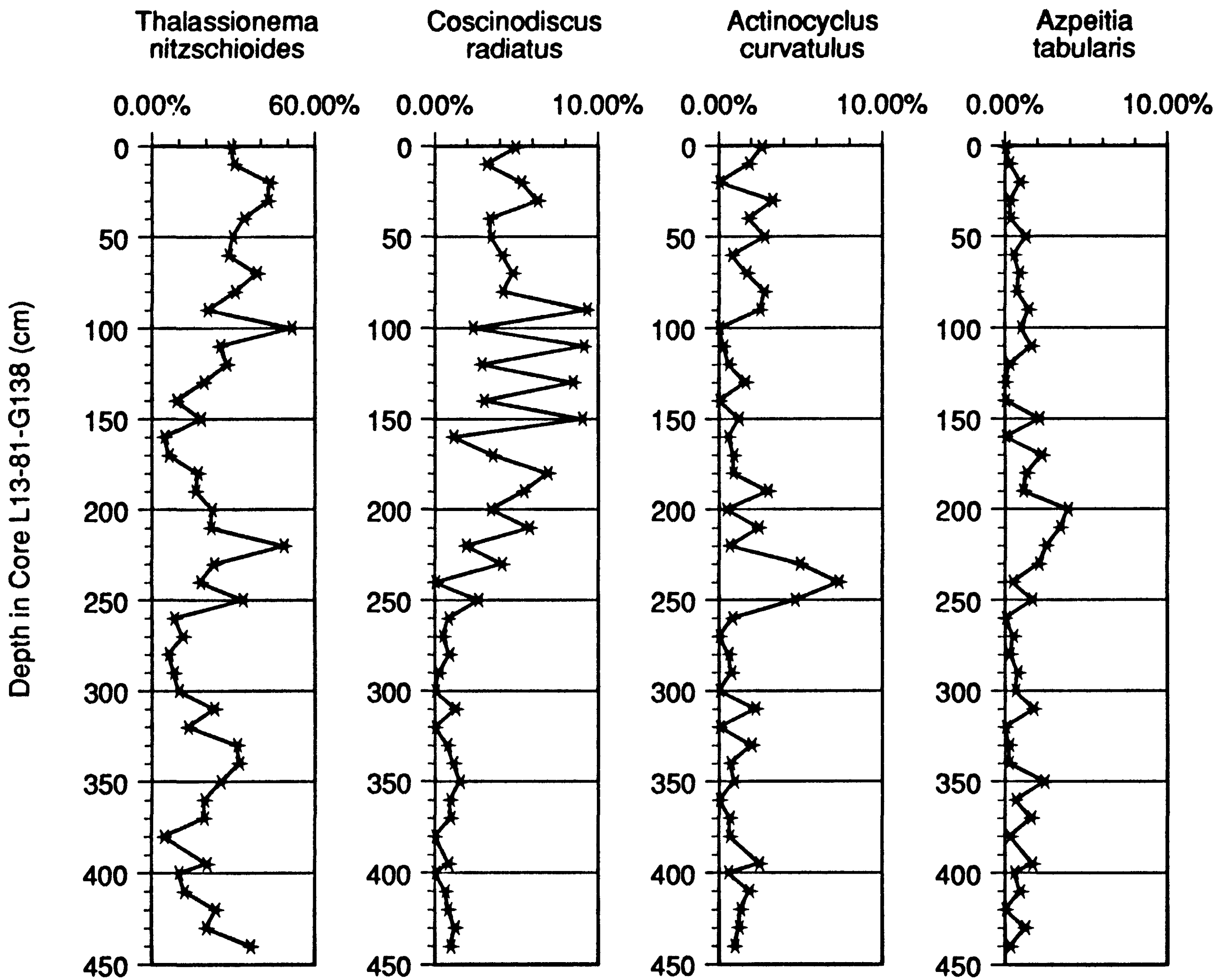

Figure 4. **Relative freqencies of diatoms in core L13-81-G138.** ***Thalassionema nitzschioides*** **is a dominant species in Holocene and Pleistocene sediment.**

oldest age first

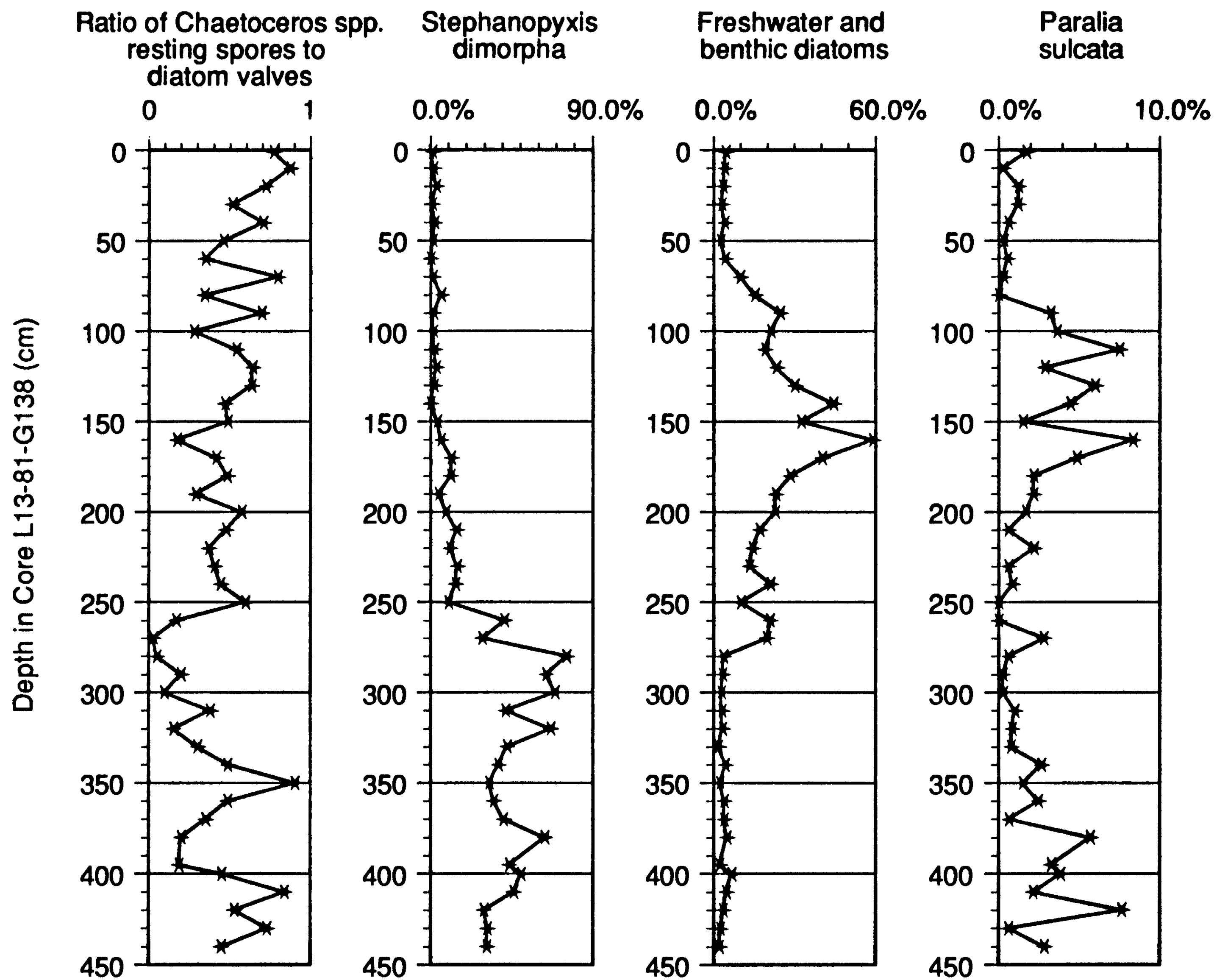

Figure 5. Ratio of *Chaetoceros* spp. resting spores to total diatom valves, and relative frequencies of tychopelagic, freshwater, and benthic species in core L13-81-G138.

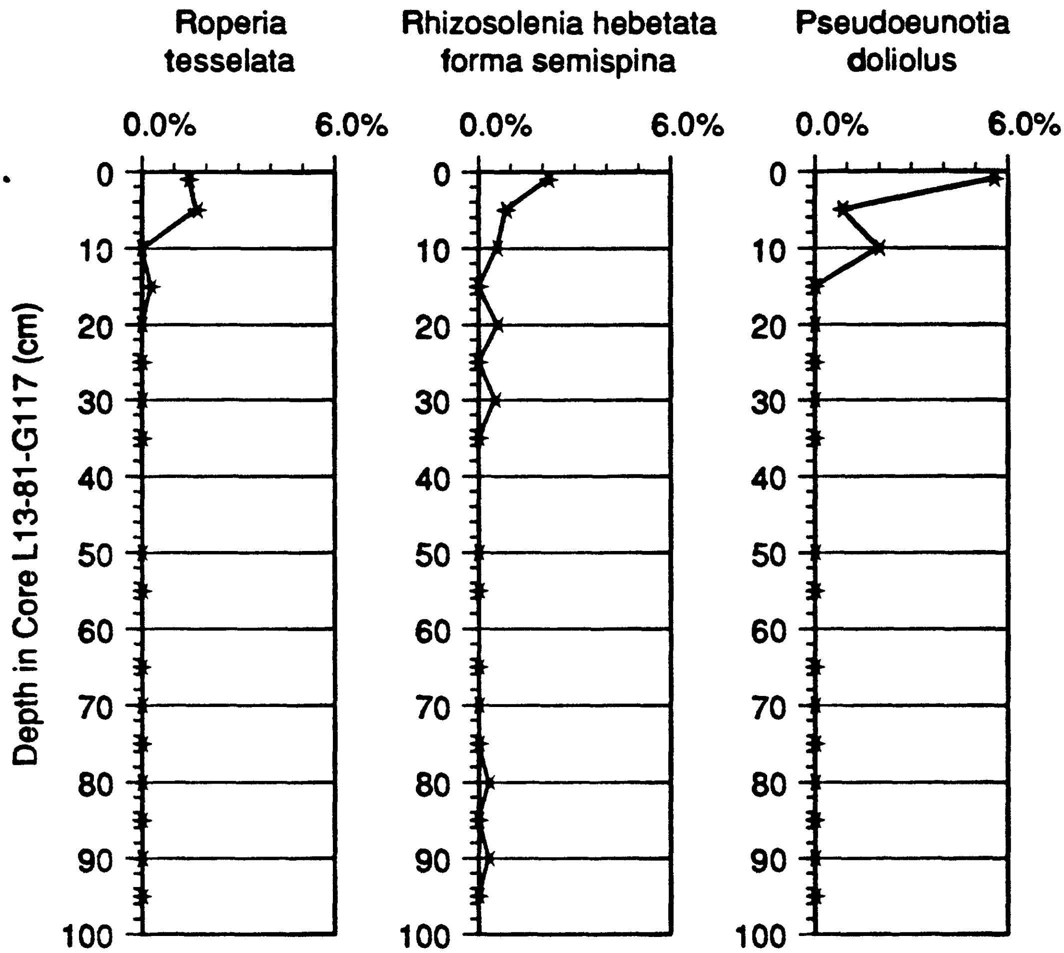

Figure 6. Relative frequencies of species associated with Holocene sediment in L13-81-G117, particularly *Pseudoeunotia doliolus*.

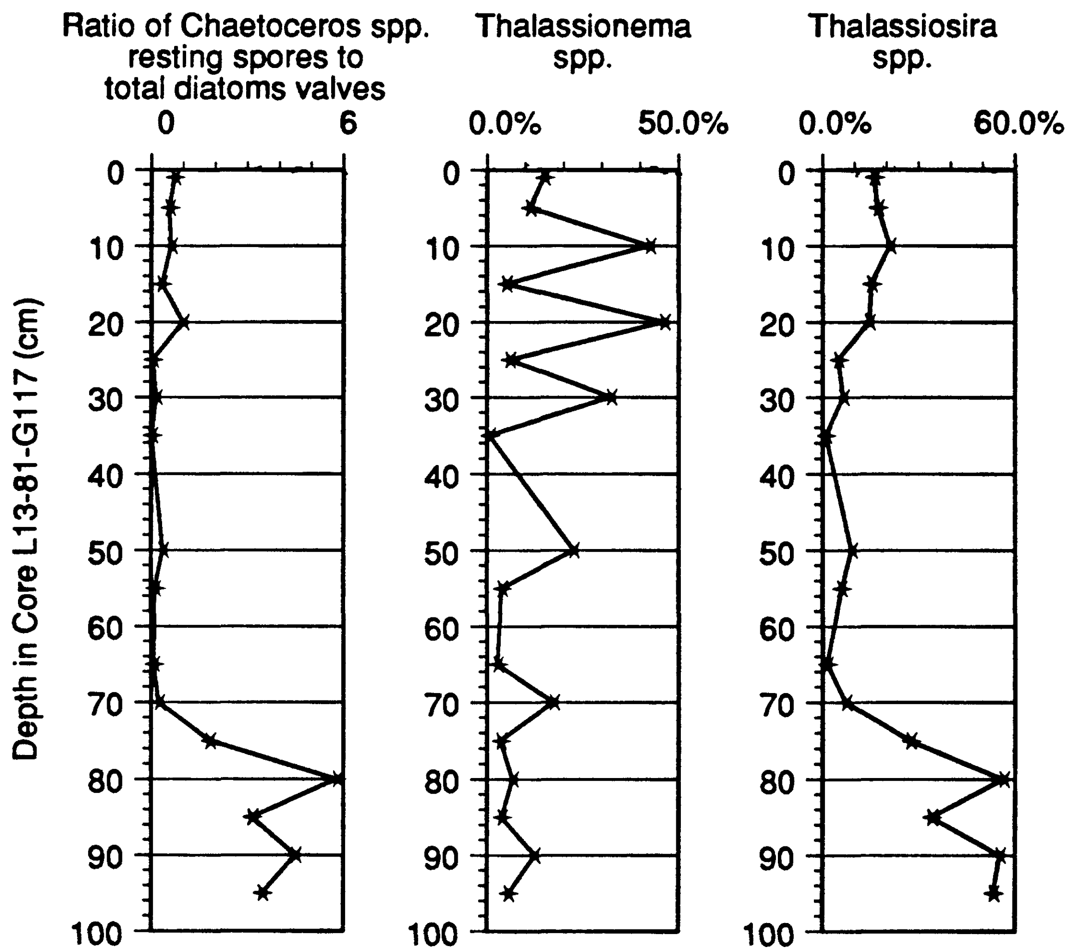

Figure 7. Ratio of *Chaetoceros* spp. resting spores to total diatom valves, showing large increase in varved sediment below 70 cm. *Thalassionema* spp. are more abundant in bioturbated sediment above 70 cm, and *Thalassiosira* spp. are more abundant in varved sediment below 70 cm.

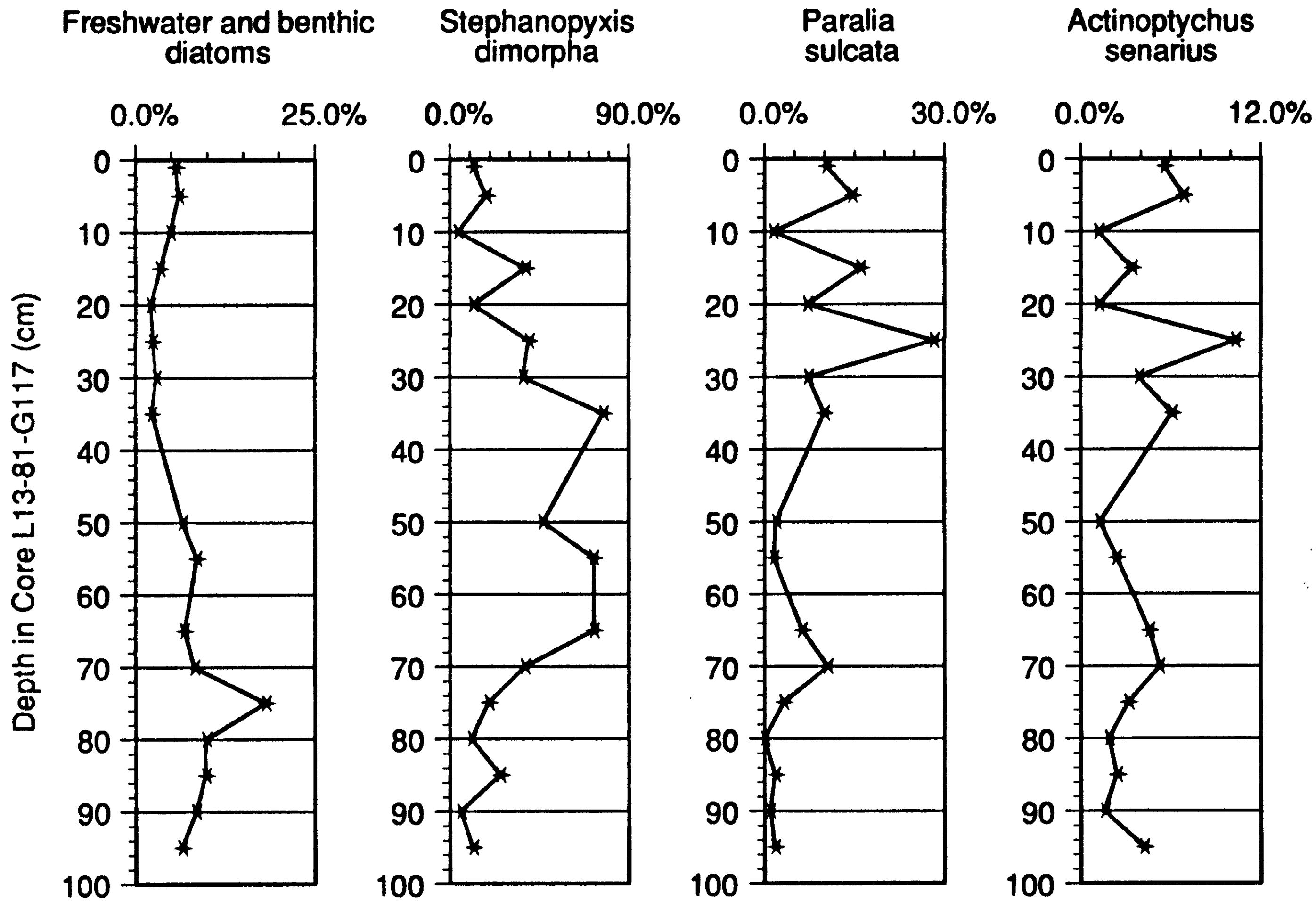

Figure 8. Freshwater, benthic, and tychopelagic diatoms in core L13-81-G117. *Stephanopyxis dimorpha* is the dominant species in sediment between 30 cm and 70 cm. *Actinoptychus senarius* and *Paralia sulcata* show parallel distributions.

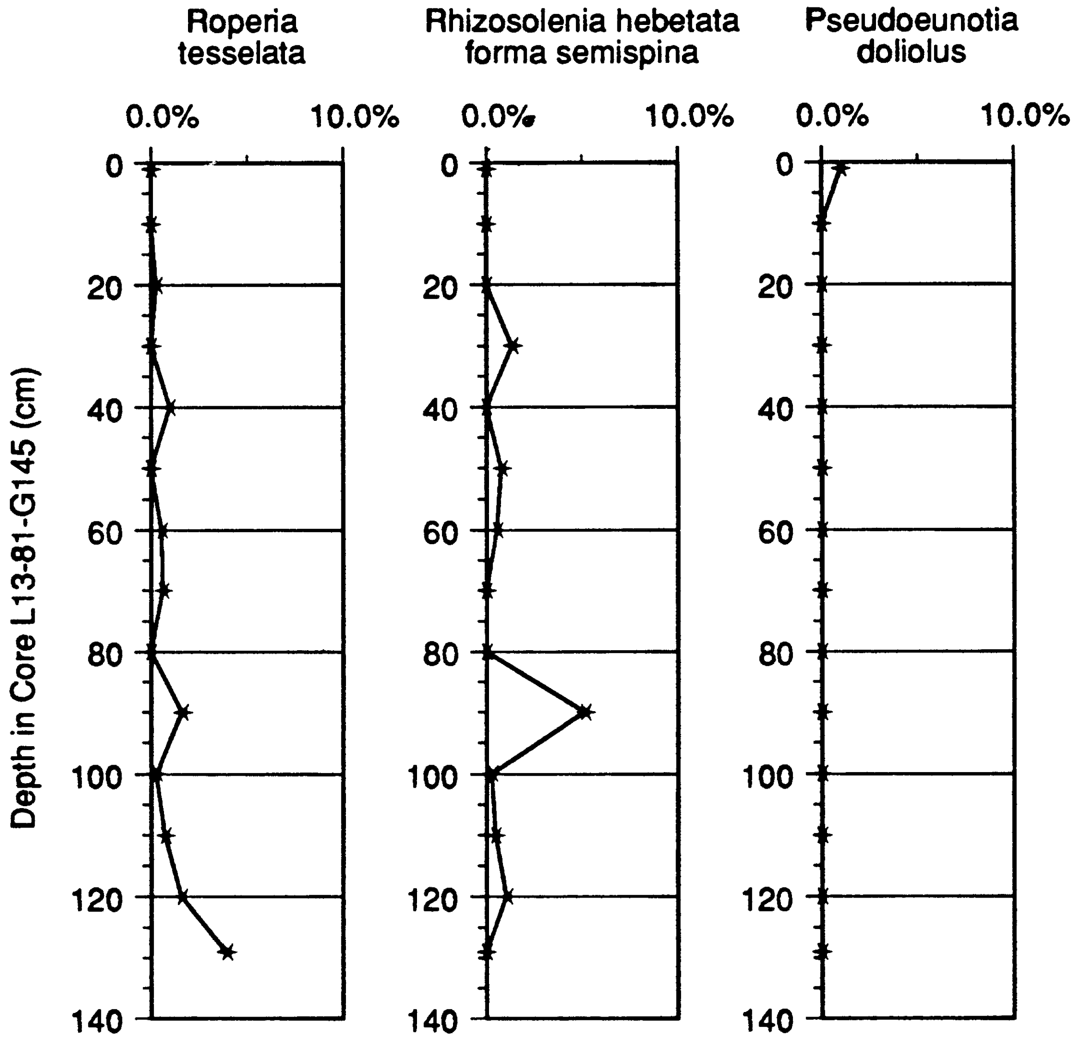

Figure 9. **Relative frequencies of diatoms in core L13-81-G145. Only *Pseudoeunotia doliolus* is restricted to Holocene sediment at the top of the core.**

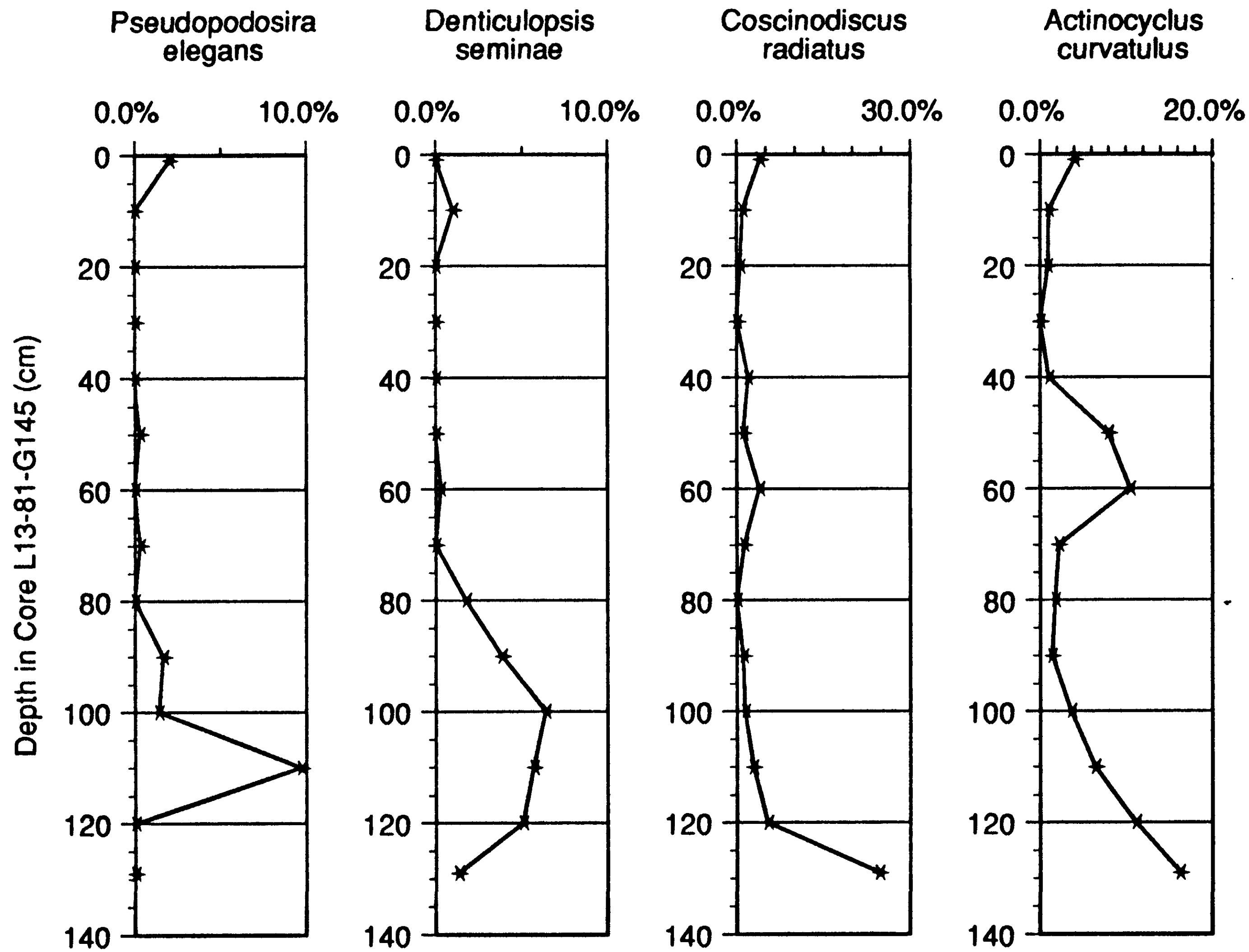

Figure 10. Relative frequencies of diatoms in gravity core L13-81-G145.

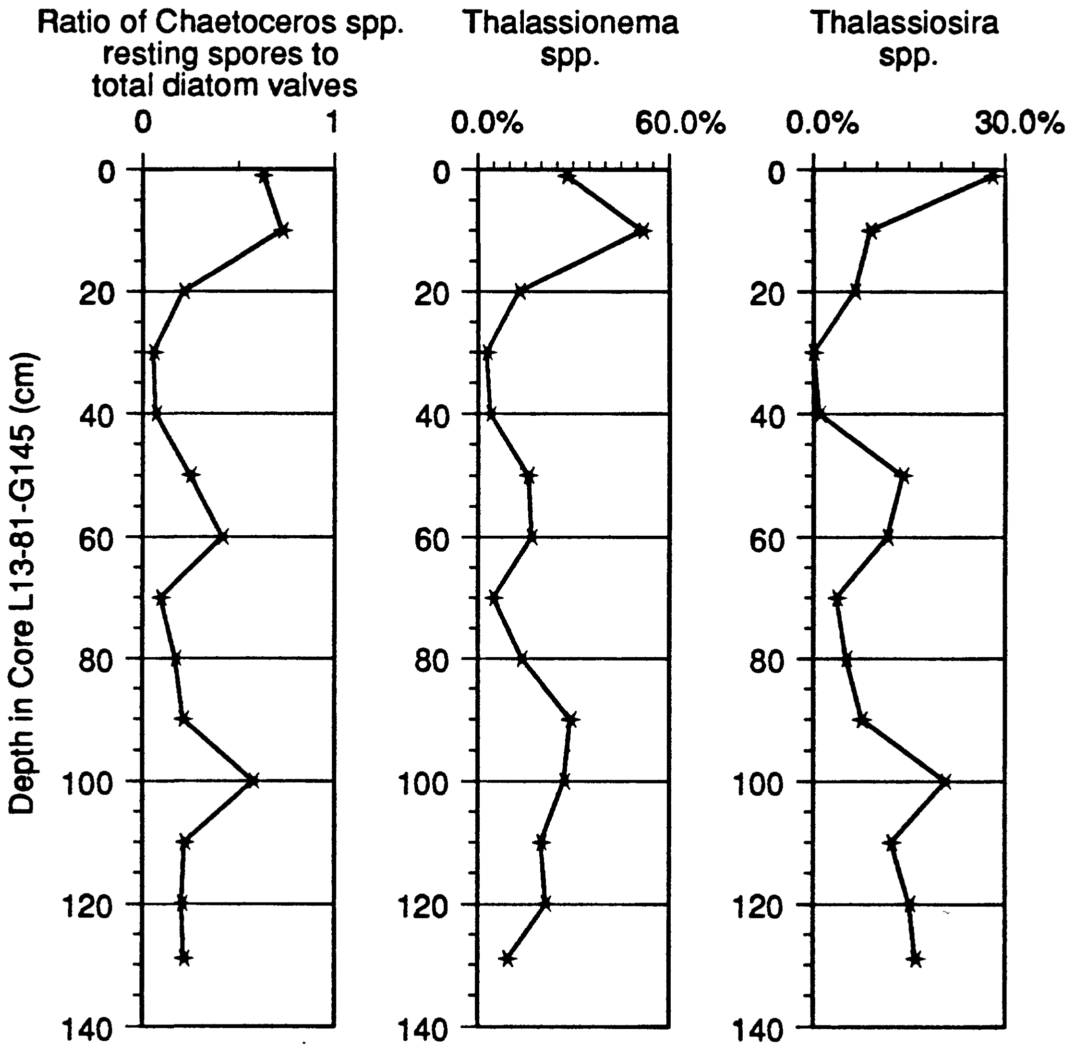

Figure 11. Ratio of *Chaetoceros* spp. resting spores to total diatom valves, and relative frequencies of *Thalassionema* spp. and *Thalassiosira* spp. in core L13-81-G145.

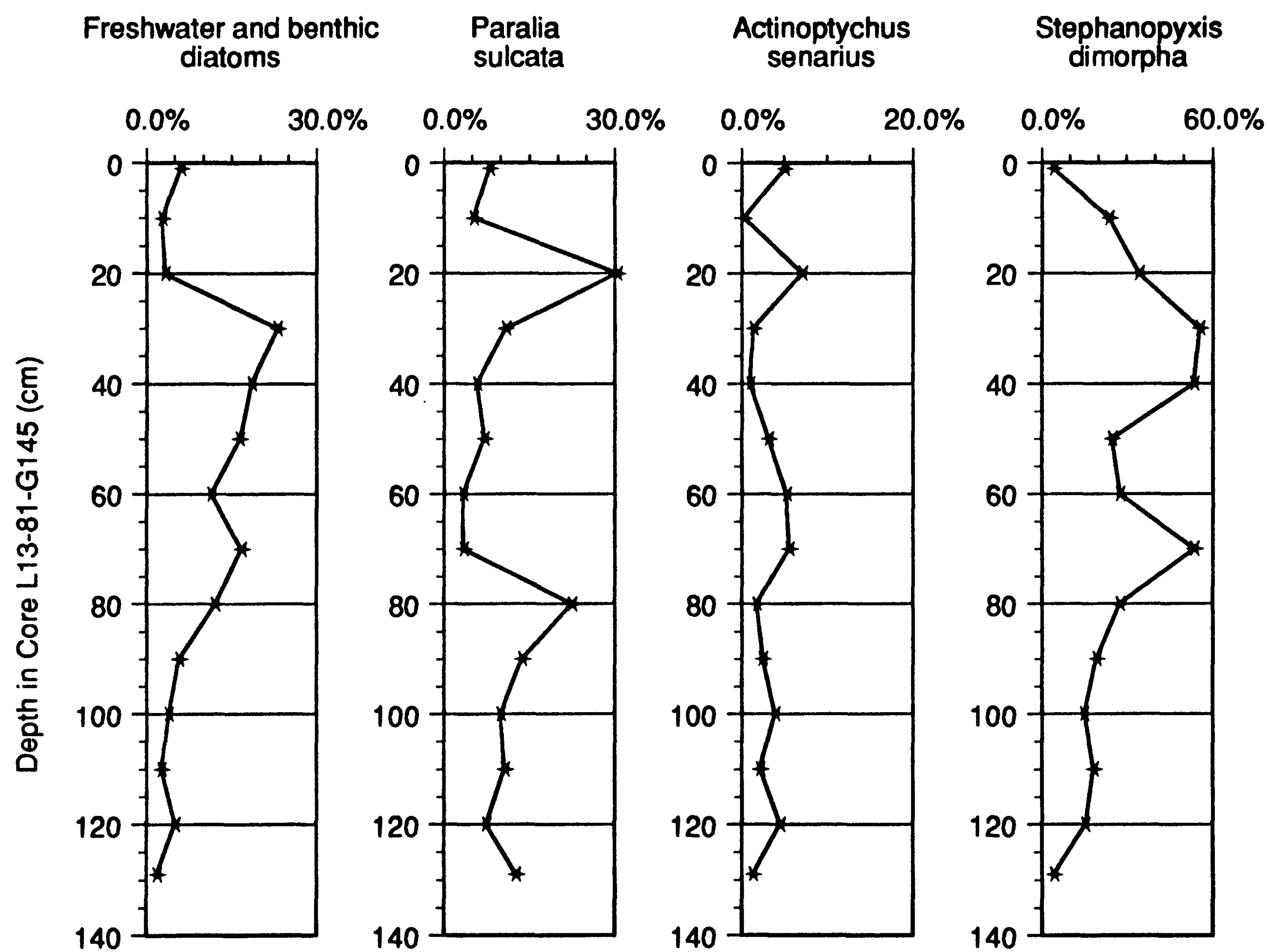

Figure 12. **Freshwater, benthic and tychopelagic diatoms in core L13-81-G145. Freshwater and benthic diatoms, and *Stephanopyxis dimorpha* are most abundant in coarser-grained sediment at 30-40 cm and 70 cm.**

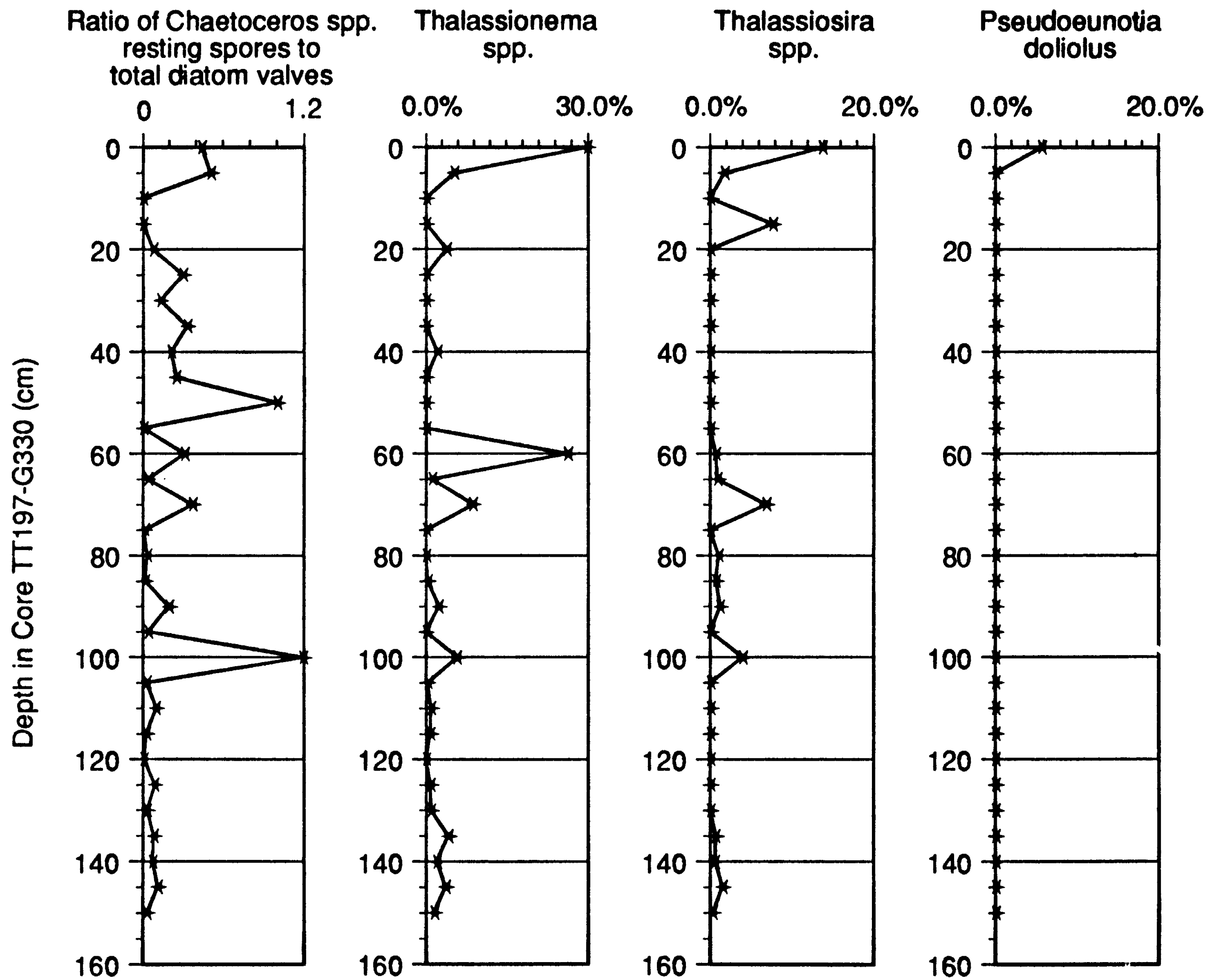

Figure 13. **Ratio of *Chaetoceros* spp. resting spores to total diatom valves, and relative frequencies of *Thalassionema* sspp., *Thalassiosira* spp., and *Pseudoeunotia doliolus*.**

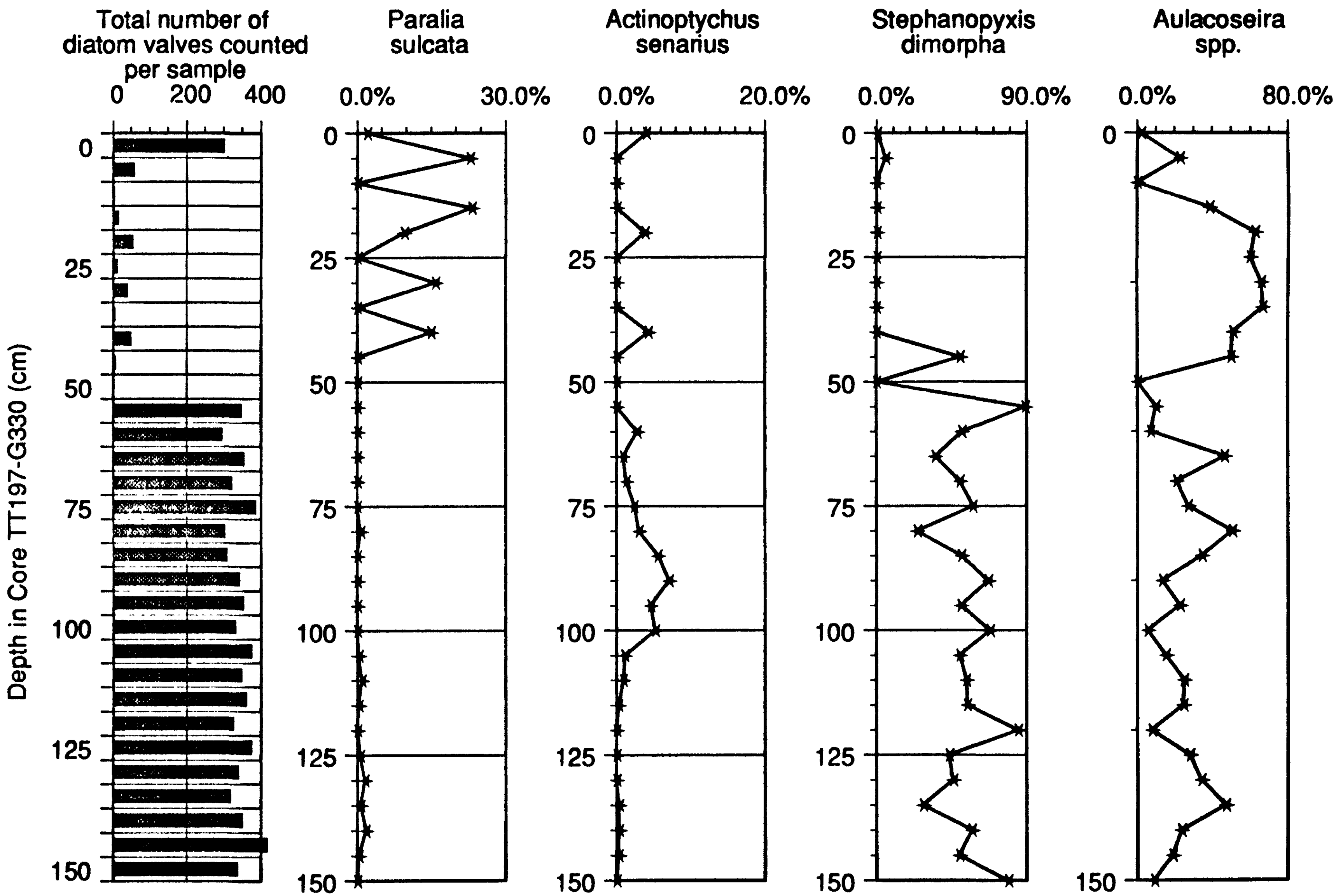

Figure 14. Total number of diatom valves counted in TT197-G330, showing very low values in upper sandy unit. Freshwater diatoms (*Aulacoseira* spp.) and *Stephanopyxis dimorpha* are abundant throughout the core, including varved sediment below 55 cm.