Diatoms and Siliceous Flagellates (Silicoflagellates, Ebridians, and Endoskeletal Dinoflagellate Actiniscus) from the Subarctic Pacific

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Diatoms and Siliceous Flagellates (Silicoflagellates, Ebridians, and Endoskeletal Dinoflagellate *Actiniscus*) from the Subarctic Pacific

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Abstract

The one hundred seventy two photomicrographs for major diatoms and siliceous flagellates in the pelagic northwestern subarctic Pacific are presented here as supplemental information for our previous publication on diatom and silicoflagellate flux studies at Stations 50N, KNOT, and 40N in the subarctic Pacific. As the siliceous flagellates, silicoflagellates, endoskeletal dinoflagellate *Actiniscus pentasterias*, and ebridian *Ebria tripartita* were observed in the samples.

Keywords: diatom, silicoflagellate, *Actiniscus*, *Ebria*, subarctic Pacific

1. Introduction

In the pelagic subarctic Pacific, the siliceous plankton, especially diatoms, plays a significant role in the carbon cycle as the major component of sinking particles (HONDA *et al.*, 2002; TAKAHASHI *et al.*, 2002). Among the diatom flux studies in the subarctic Pacific, there are several publications for the relatively long-term monitoring studies (longer than one year) at Stations PAPA and C (TAKAHASHI, 1986; 1997) in the eastern subarctic Pacific, SA and AB in the northern central subarctic and the Bering Sea (KURIHARA and TAKAHASHI, 2002; TAKAHASHI *et al.*, 2002), and 50N, KNOT, and 40N in the western subarctic Pacific (ONODERA *et al.*, 2005). ONODERA *et al.* (2005) were not able to include the flux data and photomicrographic plates of the observed diatoms due to the limited space and so as ONODERA and TAKAHASHI (2005) for silicoflagellates. As the supplemental information of these publications, photomicrographs of diatoms and siliceous flagellates are presented here. The flux data for the major diatoms presented in ONODERA *et al.* (2005) are also included here as three appendix tables.

2. Materials and Methods

The studied samples were obtained by sediment traps deployed at Stations 50N, KNOT, and 40N during December 1997 through May 2000 in the subarctic Pacific (Fig.1). The deployment depth of sediment trap was approximately 3,000 m at each of the station. The preparing method of

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filter slide for specimen counts was explained in ONODERA *et al.* (2005). The mounting media of filter slide was Cargile® immersion oil Type B or Canada Balsam (Refractive Index = 1.53). For newly preparing another slide, the split sample was treated by 30% H₂O₂, 10% HCl, and Calgon as surfactant. After the deacidification by decantation with distilled water, the sample slurry was dried on a cover slip, and then was mounted on a slide glass with Pleurax or Naphrax (R.I. = 1.73). This new method with the better mounting media improved on previously unrecognized thin-silicified taxa. The cleaned valves and skeletons on cover slips were observed on SEM. The prepared slides were observed on Light Microscope Olympus BX-50. The LM photomicrographs were taken with the mounted digital camera Fujifilm HC-300Z. The SEM photomicrographs were taken using Shimazu SS-550 at the Center of Advanced Instrumental Analysis, Kyushu University.

The species identification was mainly based on the following references: CUPP (1943); HENDEY (1964); SIMONSEN (1974, 1992); POELCHAU (1976); FRYXELL and HASLE (1979); HARGRAVES (1979); SYVERTSEN (1979); SANCETTA (1982); TAKAHASHI (1987, 1991); RINES and HARGRAVES (1988); PITCHER (1990); TAKANO (1990); TAKAHASHI *et al.* (1994); HASLE and SYVERTSEN (1996).

Station 50N is located near the center of the Western Subarctic Gyre (WSG). Diatom and silicoflagellate assemblages at this station are mainly composed of the subarctic pelagic taxa. Station KNOT is located in the mixed water region of the subarctic waters, the Oyashio waters, and the subtropical waters. The coastal water advection from coastal to Station KNOT below upper waters was occasionally significant (ONODERA *et al.*, 2005). Therefore, the diversities of diatom and siliceous flagellate assemblages at Station KNOT were relatively high. Station 40N is located near the Subarctic Boundary, and thus it is covered by the subtropical waters as well as the subarctic waters. The characteristics of the water masses at Station 40N reflect the diversified siliceous microplankton assemblages (OKAZAKI *et al.*, 2005; ONODERA *et al.*, 2005).

Fig. 1. The locations for sediment trap Stations 50N, KNOT, and 40N (black triangles) in the western subarctic Pacific with the general surface circulation (modified from ONODERA *et al.*, 2005); OSG: the Okhotsk Sea Gyre; WSG: the Western Subarctic Gyre. Coordinates, water depth, deployed sediment trap depth, and the sampled duration for each station are presented.

Table 1. The mean abundances of major diatom and siliceous flagellate fluxes at Stations 50N, KNOT, and 40N. The mean abundances for diatoms and siliceous flagellates were separately calculated.

	50N	KNOT	40N		50N	KNOT	40N
Diatoms				Pennales			
Centrales				Diatomaceae			
Thalassiosiraceae				<i>Thalassionema nitzschioides</i>	T	P	R
<i>Bacterosira bathyomphala</i>		T		<i>Thalassiothrix longissima</i>	T	+	T
<i>Thalassiosira eccentrica</i>	+	P	P	Nitzschiaceae			
<i>Thalassiosira gravida</i>	+	+		<i>Fragilariopsis doliolus</i>		P	C
<i>Thalassiosira hyalina</i>	+	+		<i>Fragilariopsis oceanica</i>		+	
<i>Thalassiosira lineata</i>	P	P	T	<i>Fragilariopsis</i> spp.	+	+	
<i>Thalassiosira nordenskiöldii</i>	+	P		<i>Neodenticula seminae</i>	A	F	R
<i>Thalassiosira oestrupii</i>	P	P	P	<i>Nitzschia bicapitata</i>			P
<i>Thalassiosira pacifica</i>		P		<i>Nitzschia sicula</i>	+	+	+
<i>Thalassiosira trifurcata</i> Group	P	P	P				
Melosiraceae				Diatom Resting Spores			
<i>Corethron</i> sp.	P	+	P	<i>Chaetoceros furcellatus</i>	P	R	
<i>Palaria sulcata</i>		+		Total <i>Chaetoceros</i> resting spores	P	F	
<i>Stephanopyxis</i> sp.		+	+				
Coscinodiscaceae				Siliceous Flagellates			
<i>Coscinodiscus marginatus</i>	P	+	R	Silicoflagellates			
<i>Coscinodiscus ocellus-iridis</i>		+	+	<i>Dictyocha mandrai</i>	T	R	R
<i>Coscinodiscus radiatus</i>	+	+	P	<i>Dictyocha messanensis</i>	+	P	C
<i>Stellarima stellaris</i>		T	T	<i>Dictyocha pseudofibula</i>		+	
Hemidiscaceae				<i>Distephanus speculum</i>	A	A	C
<i>Actinocyclus curvatus</i>	P	T	T	<i>Distephanus boliviensis</i>	F	R	+
<i>Actinocyclus</i> sp.		+		<i>Distephanus septenarius</i>	P	P	
<i>Azpeitia neocrenulata</i>			T	<i>Distephanus octangulatus</i>	P	P	+
<i>Azpeitia tabularis</i>	P	+	+	<i>Distephanus crux</i>		+	
<i>Ropelia tessellata</i>			P	<i>Distephanus quinquangellus</i>	+	+	+
Asterolampraceae				<i>Distephanus pulchrus</i>		+	T
<i>Asteromphalus heptactis</i>		+	+				
<i>Asteromphalus hyalinus</i>	P	+	+	Siliceous Dinoflagellates			
Heliopeltaceae				<i>Actiniscus pentasterias</i>	R	P	P
<i>Actinoptychus senarius</i>		+	+				
Rhizosoleniaceae				Ebridians			
<i>Rhizosolenia bergonii</i>			+	<i>Ebria tripartita</i>		+	
<i>Rhizosolenia hebetata</i> f. <i>hebetata</i>	P	T					
<i>Rhizosolenia hebetata</i> f. <i>semispina</i>	+	T	+				
<i>Proboscia alata</i>			T				
<i>Proboscia subarctica</i>	+	T	P				
Chaetoceraeae							
<i>Chaetoceros atlanticum</i>	P	T	+				
<i>Chaetoceros concavicornis</i>	+	+					
<i>Chaetoceros pervianum</i>	T	+	R				
<i>Chaetoceros compressum</i>		T					
<i>Chaetoceros radicans</i>		T					
Subgenus <i>Hyalochaete</i> spp.	T	F	P				

Abundances
<0.1% (blank)
0.1≤%<0.5
0.5≤%<1
1≤%<5
5≤%<10
10≤%<30
30≤%<50
≥50%
A

3. Diatoms from the pelagic subarctic Pacific

The major diatoms occurred in the studied samples are listed. The system for the diatom taxonomy in this study is essentially based on HASLE and SYVERTSEN (1996). The references for each taxon are selected from some pertinent papers including photomicrographs. The synonyms and reference of original description for each taxon are omitted due to space limitations.

CENTRIC DIATOMS

Bacterosira bathyomphala (CLEVE) SYVERTSEN and HASLE, 1993, p. 298; HASLE and SYVERTSEN, 1996, p. 31, pl. 1. (Plate 1, figs. 1 and 2).

Thalassiosira sp. cf. *binata* FRYXELL in HASLE and FRYXELL, 1977a, p. 244, figs. 24-38; TAKANO, 1990, p. 186-187; **Remarks:** The central annule of this taxon is smaller than that of typical a *T. binata*. (Pl. 1, fig. 3).

Thalassiosira nordenskiöldii CLEVE, 1873:

- SYVERTSEN, 1979, p. 49, figs. 6-14; TAKANO, 1990, p. 214-215; HASLE and SYVERTSEN, 1996, p. 36, pl. 5. (Pl. 1, figs. 4-6).
- Thalassiosira eccentrica* (EHRENBERG) CLEVE, 1904: RIVERA, 1981, p. 64, figs. 129-140; HASLE and SYVERTSEN, 1996, p. 62, pl. 6; **Remarks:** The count data for *T. eccentrica* in ONODERA *et al.* (2005) probably included *Thalassiosira symmetrica*. The latter taxon was newly recognized in Pleurax slide. (Pl. 2, figs. 1-3).
- Thalassiosira symmetrica* FRYXELL *et al.* HASLE, 1972: FRYXELL and HASLE, 1972, p. 312, figs. 37-46; SIMONSEN, 1974, p. 11, pl. 6, figs. 1-2; **Remarks:** This taxon occurred at Stations KNOT and 40N. The count data for this taxon in ONODERA *et al.* (2005) was included as a part of *T. eccentrica*. The revised taxonomy here represents splitting of the previous one taxon into two taxa. (Pl. 1, figs. 11-13).
- Thalassiosira gravida* CLEVE, 1896: FRYXELL, 1989, figs. 19-21, HASLE and SYVERTSEN, 1996, p. 69, pl. 8. (Pl. 2, figs. 4, 5).
- Thalassiosira hyalina* (GRUNOW) GRAN, 1880: TAKANO, 1990, pp. 202-203; HASLE and SYVERTSEN, 1996, p. 69, pl. 8. (Pl. 2, fig. 6).
- Thalassiosira anguste-lineata* (A. SCHMIDT) G. FRYXELL and HASLE: FRYXELL and HASLE, 1977, p. 73, figs. 22-34; TAKANO, 1990, p. 182-183. (Pl. 2, figs. 7-9).
- Thalassiosira lineata* JOUSÉ, 1868, p.13, pl. 1, figs. 1-2; HASLE and FRYXELL, 1977b, p.22, figs. 15-25. (Pl. 2, figs. 10-12).
- Thalassiosira* sp. cf. *bioculata* (GRUNOW) OSTENFELD, 1903: HASLE and SYVERTSEN, 1996, p. 69, pl. 8. (Pl. 3, figs. 1-3).
- Thalassiosira oestrupii* (OSTENFELD) HASLE, 1972: FRYXELL and HASLE, 1980; HASLE and SYVERTSEN, 1996, p. 83, pl. 12. (Pl. 3, figs. 4-7).
- Thalassiosira pacifica* GRAN and ANGST, 1931: RIVERA, 1981, p. 105, figs. 281-307. (Pl. 1, figs. 7-8).
- Thalassiosira punctigera* (CASTRACANE) HASLE, 1983: TAKANO, 1990, p. 224-225. (Pl. 1, figs. 9-10).
- Thalassiosira trifulta* Group; **Remarks:** *Thalassiosira trifulta* G. FRYXELL in FRYXELL and HASLE, *T. poroseriata* (RAMSFJELL) HASLE, and their affinities were lumped and counted as *T. trifulta* group in ONODERA *et al.* (2005). (Pl. 3, figs. 8-11).
- Palaria sulcata* (EHRENBERG) CLEVE, 1873: HENDEY, 1964, p. 73, pl. 23, fig. 5; HASLE and SYVERTSEN, 1996, p. 91, pl. 14. (Pl. 4, figs. 1-3).
- Stephanopyxis turris* (ARNOTT in GREVILLE) RALFS in PRITCHARD, 1861: CUPP, 1943, p.40, fig. 3. (Pl. 4, figs. 4-5).
- Leptocylindrus mediterraneus* (H. PERAGALLO) HASLE, 1892: CUPP, 1943, p.77, fig. 33; HASLE, 1975, p.124, figs. 121-130; HASLE, 1976, figs. 34-35; HASLE and SYVERTSEN, 1996, p.93-96. (Pl. 4, figs. 4-5).
- Corethron* sp.: **Remarks:** The species of *Corethron* is not identified under LM observation. ONODERA *et al.* (2005) dealt this taxon as *Corethron* sp. SEM microphotograph (Pl. 4, fig. 8) is *Corethron criophilum* CASTRACANE. (Pl. 4, figs. 6-9).
- Coscinodiscus marginatus* EHRENBERG, 1844: SANCETTA, 1987, p. 231, pl. 1, figs. 1-13. (Pl. 4, figs. 11-12).
- Coscinodiscus oculus-iridis* EHRENBERG, 1841: SANCETTA, 1982, p. 229, pl. 2, fig. 11; SEMINA, 2003, pp. 74 and 76, pl. 1-2.
- Coscinodiscus radiatus* EHRENBERG, 1841: HASLE and SIMS, 1986a, pp. 310 and 312, figs. 8-32 and 35-39; SANCETTA, 1987, p. 234, pl. 2, figs. 1-10. (Pl. 5, fig. 3).
- Stellarima stellaris* (ROPER) HASLE and SIMS, 1986b. (Pl. 5, figs. 4-5).
- Actinocyclus octonarius* EHRENBERG, 1838: VILLAREAL and FRYXELL, 1983, p. 453, figs. 1-14. (Pl. 6, fig. 1).
- Actinocyclus curvatulus* JANISCH in A. SCHMIDT, 1878: HUSTEDT, 1930, p. 538, fig. 307. (Pl. 7, figs. 1-4).
- Actinocyclus ochotensis* JOUSÉ, 1968: KOIZUMI, 1968, pl. 32, figs. 7-10; SANCETTA, 1982, p.224, pl. 1; figs. 4-6. (Pl. 7, figs. 5, 7-9).
- Azpeitia neocrenulata* (VANLANDINGHAM) G. FRYXELL and T.P. WATKINS in FRYXELL *et al.*, 1986, p. 18, figs. 16, 30-2. (Pl. 8, figs. 6-8).
- Azpeitia tabularis* (GRUNOW) G. FRYXELL and P.A. SIMS in FRYXELL *et al.*, 1986, p. 16, figs. 14-15, and 30-1; **Remarks:** The central labiate process is usually hard to discern under LM observation of the sample slide mounted with low refractive index medium such as Canada Balsam or immersion oil. *Azpeitia* sp. in Appendix Table 2 represents the specimens observed on the sample slide prepared with

- Canada Balsam or immersion oil, which looks like *A. tabularis* but a central labiate process is not discernible. Thus, there is a good chance that *Azpeitia* sp. is the same as *A. tabularis*. (Pl. 8, figs. 1-5).
- Hemidiscus cuneiformis* WALLICH, 1860: HENDEY, 1964, p. 94, p. 22, fig. 9; FRYXELL *et al.*, 1986, p. 25, fig. 26. (Pl. 8, fig. 9).
- Roperia tessellata* (ROPER) GRUNOW in VAN HEURCK, 1880-1885: FRYXELL *et al.*, 1986, p. 24, figs. 25, 32-3, 32-4. (Pl. 8, figs. 10, 11).
- Asteromphalus arachne* (BRÉBISSEON) RALFS in PRITCHARD, 1861: HERNÁNDEZ-BECERRIL, 1992, p. 279, figs. 1-14. (Pl. 9, fig. 3).
- Asteromphalus brookei* Bailey, 1856: SANCETTA, 1982, p. 226, pl. 1, fig. 9. (Pl. 9, figs. 1-2).
- Asteromphalus heptactis* (BRÉBISSEON) RALFS in PRITCHARD, 1861: HERNÁNDEZ-BECERRIL, 1991, p. 26, pl. 28-29. (Pl. 9, figs. 6-7).
- Asteromphalus hyalinus* KARSTEN, 1905: HASLE and SYVERTSEN, 1996, p. 139, pl. 25. (Pl. 9, figs. 4-5).
- Actinoptychus senarius* (EHRENBERG) EHRENBERG, 1843: HENDEY, 1964, p. 95, pl. 23, figs. 1-2; TAKANO, 1990, p. 258-259. (Pl. 10, figs. 1-2).
- Actinoptychus vulgaris* SCHUMANN, 1867: SANCETTA, 1982, p. 225, pl. 1, fig. 8. (Pl. 10, figs. 3-4).
- Rhizosolenia bergonii* H. PERAGALLO, 1892: CUPP, 1943, p. 81, fig. 43. (Pl. 10, fig. 5).
- Rhizosolenia hebetata* BAILEY, 1856: CUPP, 1943, p. 88, fig. 50a-b; **Remarks:** This taxon is counted as *R. hebetata* forma *hebetata* (Pl. 10, fig. 6) and *R. hebetata* forma *semispina* (Pl. 10, figs. 7-8) in ONODERA *et al.*, (2005). (Pl. 10, figs. 6-8).
- Rhizosolenia styliformis* BRIGHTWELL, 1858: HASLE, 1975, figs. 1-3. (Pl. 10, figs. 9-10).
- Proboscia alata* (BRIGHTWELL) SUNDSTRÖM, 1986: TAKAHASHI *et al.*, 1994, p. 413, figs. 2-7; JORDAN and LIGOWSKI, 2004, pp. 97-98, pl. I-III, and IV, figs. 1-4. (Pl. 11, fig. 1).
- Proboscia eumorpha* TAKAHASHI, JORDAN and PRIDDLE, 1994, p. 415, figs. 8-16. (Pl. 11, fig. 2).
- Proboscia subarctica* TAKAHASHI, JORDAN and PRIDDLE, 1994, p. 417, figs. 17-37. (Pl. 11, figs. 3-4).
- Pseudosolenia calcar-avis* (SCHULTZE) SUNDSTRÖM, 1986: CUPP, 1943, p. 89, fig. 51; HASLE and SYVERTSEN, 1996, p. 160, pl. 30. (Pl. 10, fig. 11).
- Bacteriastrium delicatulum* CLEVE, 1897: DREBES, 1974, p. 60, figs. 45-47; FRYXELL, 1978, p. 63, 1-17. (Pl. 11, fig. 5).
- Genus *Chaetoceros* EHRENBERG; Remarks:** The gender of generic name “*Chaetoceros*” is sometime erroneously treated as masculine noun. However, Ehrenberg who is the author of this genus defined this word as a neuter noun (HENDEY, 1964). Therefore, the specific names of *Chaetoceros* here are treated as a Latin neuter noun.
- Subgenus *Chaetoceros***
- Chaetoceros atlanticum* CLEVE, 1873: CUPP, 1943, p. 103, fig. 59; TAKANO, 1990, pp. 282-283. (Pl. 11, fig. 7).
- Chaetoceros concavicornis* MANGIN, 1917: HENDEY, 1964, p. 122, pl. 9, fig. 1; EVENSEN and HASLE, 1975, p. 158, figs. 15-22.
- Chaetoceros peruvianum* BRIGHTWELL, 1856: CUPP, 1943, p. 113, fig. 68; KOCH and RIVERA, 1984, p. 69, figs. 36-47. (Pl. 11, figs. 8-9).
- Subgenus *Hyalochaete*; Remarks:** Most *Hyalochaete* valves and their resting spores were countered as “*Hyalochaete* spp.” and “*Hyalochaete* resting spores”, respectively. The morphologically characteristic resting spores, however, were countered at species level.
- Chaetoceros compressum* LAUDER, 1864: HENDEY, 1964, p. 125, pl. 16, fig. 5; RINES and HARGRAVES, 1988, p. 64, figs. 131-134 and 218. (Pl. 12, figs. 1-3).
- Chaetoceros didymus* EHRENBERG, 1845: RINES and HARGRAVES, 1988, p. 77, figs. 154-163; TAKANO, 1990, pp. 288-289. (Pl. 12, figs. 4).
- Chaetoceros diadema* (EHRENBERG) GRAN, 1897: RINES and HARGRAVES, 1988, p. 76, figs. 150-151, 153. (Pl. 12, figs. 9-13).
- Chaetoceros furcellatum* BAILEY, 1856: HASLE and SYVERTSEN, 1996, p. 213, pl. 45. (Pl. 12, figs. 16-18).
- Chaetoceros radicans* SCHÜTT, 1895: HENDEY, 1964, p. 134, pl. 14, fig. 4; RINES and HARGRAVES, 1988, p. 90, figs. 192-198. (Pl. 12, figs. 5-7).
- PENNATE DIATOMS**
- Thalassionema nitzschioides* (GRUNOW) MERESCHKOWSKY, 1902: HASLE and SYVERTSEN, 1996, p. 257, pl. 56, fig. 4, pl. 57; SEMINA, 2003, pl. 133, figs. 3-4, pl. 134, fig. 4, pl. 136, figs. 1-4, pl. 137, figs. 1-4, pl. 138, figs. 1-4. (Pl. 13, figs. 2-9).
- Thalassiothrix longissima* CLEVE and GRUNOW, 1880: HASLE and SYVERTSEN, 1996, p. 108, pl. 18, fig. 5, pl.

- 23-25. (Pl. 13, figs. 10-13).
Fragilariopsis doliolus (WALLICH) MEDLIN and SIMS, 1993: HASLE, 1976, figs. 29-31; SEMINA, 2003, pl. 51. (Pl. 13, figs. 14-16).
Neodenticula seminae (SIMONSEN and KANAYA) AKIBA and YANAGISAWA, 1986, p. 491, pl. 24, figs. 1-11, pl. 26, figs. 1-10; YANAGISAWA and AKIBA, 1990, p. 263, pl. 7, figs. 45-49; SEMINA, 2003, p.40, 59-60, pl. 19-22. (Pl. 13, figs. 17-22).
Nitzschia bicapitata CLEVE, 1901: FRYXELL, 2000, p. 47, figs. 1-11. (Pl. 14, figs. 5-9).
Nitzschia braarudii HASLE, 1960, p. 22, text fig. 11, pl. 7, figs. 58-63; SIMONSEN, 1974, p. 50, pl. 35, fig. 2. (Pl. 14, fig. 10).
Nitzschia interruptestriata SIMONSEN, 1974, p. 52, pl.36, figs. 9-11, pl. 37, 38, figs. 1-7. (Pl. 14, figs. 11-14).
Nitzschia kolaczekii GRUNOW, 1867: HASLE, 1960, p. 24, pl. 5, figs. 50a-c. (Pl. 14, fig. 15).
Nitzschia sicula (CASTRACANE) HUSTEDT, 1958, p. 180, figs. 128-132; HASLE, 1960, p. 26, fig. 16; HASLE and SYVERTSEN, 1996, p. 327, pl. 74-75. (Pl. 13, figs. 23-24).
Alveus marinus (GRUNOW) KACZMARSKA et G.: KACZMARSKA and FRYXELL, 1996, p. 3, figs. 1-35; SEMINA, 2003, pl. 49-50. **Remarks:** This taxon was observed with rare abundances in many samples at Station 40N. (Pl. 14, figs.3-4).

4. Siliceous flagellates from the pelagic subarctic Pacific

The silicoflagellates, endoskeletal dinoflagellates, and ebridian in the studied samples are listed below. Other siliceous microflagellates are not found in the sediment trap samples. The count and flux data for *Actiniscus* and ebridians are not included here but they will be prepared in the near future.

4. 1. Siliceous Phytoflagellates

Among the marine siliceous phytoflagellates, silicoflagellate skeletons occurred at all of Stations 50N, KNOT, and 40N. The silicoflagellate taxonomy employed here is essentially based on TAKAHASHI (1987; 1991).

SILICOFLAGELLATE

Dictyocha mandrai LING, 1977, p. 209, pl. 1,

figs. 13-14; TAKAHASHI, 1991, p.11, pl. 1, figs. 8-11, pl. 2, fig. 1. (Pl. 15, figs. 1-2).

Dictyocha messanensis HAECKEL in PETERS, 1860: TAKAHASHI, 1991, p. 7, 9, pl.1, figs. 1-6; **Remarks:** POELCHAU (1976), TAKAHASHI(1991), and TAKAHASHI and BLACKWELDER (1992) suggested that the two varieties of this taxon showed the different habitats and different skeletal dimensions. ONODERA and TAKAHASHI (2005) did not identify the two varieties and dealt as one taxon *D. messanensis*. (Pl. 15, figs. 3-4).

Dictyocha pseudofibula (SCHULZ) TSUMURA, 1963, p. 55, pl. 11, figs. 1-3, pl. 24, fig. 2. (Pl. 15, fig. 5).

Distephanus boliviensis (FRENGUELLI) BUKRY and FOSTER, 1973, p. 827, pl. 4, figs. 1-3. (Pl. 15, fig. 6).

Distephanus speculum (EHRENBERG) HAECKEL, 1887: POELCHAU, 1976, pl. 2, figs. a-d. (Pl. 15, figs. 7-8).

Distephanus septenarius (EHRENBERG) FRENGUELLI, 1938: DESIKACHARY and PREMA, 1996, pp. 194-195, pl. 59, figs. 3, 5, 7-8, pl. 72, figs. 2, 4-5; **Remarks:** ONODERA and TAKAHASHI (2005) treated this taxon as *Distephanus speculum* (Heptagonal form). (Pl. 15, fig.9; Pl. 16 fig. 1).

Distephanus octangulatus WAILES, 1932: TAKAHASHI, 1987, pl. 1, figs. 6-7, pl. 2, fig. 3. (Pl. 16, figs. 2-3).

Distephanus quinquangellus BUKRY and FOSTER, 1973, p. 828, pl. 5, fig. 4; LING, 1973, p. 753, pl. 2, figs. 16-17. (Pl. 16, figs. 4-5).

Distephanus pulchrus (SCHILLER) LING and TAKAHASHI, 1985, p. 80, pl. 1, figs. 4-9, pl. 2, figs. 1-4, 7; TAKAHASHI, 1991, p. 12, 13, pl. 2, figs. 5-11. (Pl. 16, figs. 6-7).

DINOFLAGELLATE

Actiniscus pentasterias (EHRENBERG) EHRENBERG, 1854: ORR and CONLEY, 1976, p. 92, pl. 1, figs. 1-11, pl. 2, figs. 1-6; TAKAHASHI, 1991, pp. 13-14, pl. 2, figs. 12-15. (Pl. 16, figs. 8-10).

4. 2. Siliceous Zooflagellate

EBRIDIAN

Ebria tripartita (SCHUMANN) LEMMERMAN, 1899: VØRS, 1992, p. 76, figs. 34k-n; **Remarks:** The occurrences were recorded with very rare abundances at Station KNOT (ONODERA, unpublished data). (Pl. 16, figs. 11-13).

5. Acknowledgements

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6. References

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7. PLATES

LM and SEM photomicrographs of diatoms (Plates 1-14), silicoflagellates (Plates 15-16), and ebridians and *Actiniscus* (Pl. 16) at Stations 50N, KNOT, and 40N during 1998-2000. Whenever deemed appropriate "a" and "b" (and sometimes "c") figures representing different focal planes of the same specimens are illustrated. All scale bars = 10µm.

Plate 1. 1, 2. *Bacterosira bathyomphala* resting spore (Station KNOT, July 1999), **3. *Thalassiosira* sp. cf. *binata*** (KNOT, June 1999), **4-6. *Thalassiosira nordenskiöldii*** (4: 50N, Sept. 1999; 5: KNOT, June 1999; 6: KNOT, July 1999), **7, 8. *Thalassiosira pacifica*** (7: KNOT, July 1999; 8: KNOT, Apr. 1999), **9, 10. *Thalassiosira punctigera*** (KNOT, June 1999), **11-13. *Thalassiosira symmetrica*** (11, 12: KNOT, Jan. 1999; 13: 40N, Apr. 1998).

Plate 2. 1-3. *Thalassiosira eccentrica* (1, 3: KNOT, Apr. 1999; 2: 50N, Apr. 2000), **4, 5. *Thalassiosira gravida*** (KNOT, June 1999), **6. *Thalassiosira hyalina*** (50N, Apr. 1999), **7-9. *Thalassiosira anguste-lineata*** (KNOT, June 1999), **10-12. *Thalassiosira lineata*** (10, 11: KNOT, Apr. 1999; 12: 40N, Apr. 1998).

Plate 3. 1-3. *Thalassiosira* sp. cf. *bioculata* (1, 2: 50N, Jan. 1999; 3: 50N, Apr. 2000), **4-7. *Thalassiosira oestrupii*** (4, 5: 40N, Apr. 1999; 6, 7: 40N, July 1999), **8-11. *Thalassiosira trifulta* group** (8: 50N, May 1999; 9: KNOT, Apr. 1999; 10: 50N, Jan. 1999; 11: 40N, Apr. 1999).

Plate 4. 1-3. *Paralia sulcata* (1, 2: KNOT, Dec. 1997; 3: KNOT, Nov. 1999), **4, 5. *Stephanopyxis turris*** (4: KNOT, June 1998; 5: June 1999), **6-9. *Corethron* sp.** (6, 9: KNOT, May 1999; 7: KNOT, June 1999; 8: 50N, Apr. 2000), **10. *Leptocylindrus mediterraneus*** (KNOT, Apr. 1998), **11, 12. *Coscinodiscus marginatus*** (11: KNOT, Nov. 1999; 12: 40N, July 1999).

- Plate 5.** 1, 2. *Coscinodiscus* sp. cf. *oculus-iridis* (1: 50N, Apr. 2000; 2: 40N, Apr. 1998), 3. *Coscinodiscus radiatus* (KNOT, June 1999), 4, 5. *Stellarima stellaris* (4: KNOT, Apr. 1999; 5: KNOT, May 1998).
- Plate 6.** 1, 2?. *Actinocyclus octonarius* (1: KNOT, Apr. 1999; 2: KNOT, Apr. 1999), 3. *Actinocyclus subtilis* (3: 40N, Nov. 1999).
- Plate 7.** 1-4. *Actinocyclus curvatulus* (1: KNOT, June 1999; 2: 50N, Mar. 1998; 3, 4: 50N, Jan. 1999), 5-7, 8?, 9. *Actinocyclus ochotensis* (5, 7-9: 50N, Apr. 2000; 6: 50N, Apr. 1998), 10. *Actinocyclus* sp. (50N, Apr. 2000), 11. *Actinocyclus normanii*? (40N, Apr. 1998).
- Plate 8.** 1-5. *Azpeitia tabularis* (1, 5: 50N, Apr. 2000; 2, 3: 50N, Apr. 1998; 4: 50N, Jan. 1999), 6-8. *Azpeitia neocrenulata* (6: 40N, Apr. 1998; 7: 40N, Sept. 1999; 8: KNOT, Apr. 1999), 9. *Hemidiscus cuneiformis* (40N, Dec. 1999), 10, 11. *Roperia tessellata* (10: 40N, Dec. 1999; 11: KNOT, Apr. 1999).
- Plate 9.** 1, 2. *Asteromphalus brookei* (1: 50N, Jan. 1999; 2: 40N, Apr. 1998), 3. *Asteromphalus arachne* (40N, Dec. 1999), 4, 5. *Asteromphalus hyalinus* (4: 50N, Jan. 1999; 5: 50N, Apr. 2000), 6, 7. *Asteromphalus heptactis* (6: 40N, Apr. 1998; 7: 40N, July 1999).
- Plate 10.** 1, 2. *Actinoptychus senarius* (1: KNOT, Jan. 1998; 2: KNOT, June 1999), 3, 4. *Actinoptychus vulgaris* (3: KNOT, Sept. 1998; 4: KNOT, Apr. 1999), 5. *Rhizosolenia bergonii* (40N, Apr. 1998), 6-8. *Rhizosolenia hebetata* (6: KNOT, July 1999; 7: 40N, Dec. 1999; 8: 50N, Apr. 2000), 9, 10. *Rhizosolenia styliformis* (40N, Oct. 1998), 11. *Pseudosolenia carcaravis*, (40N, Nov. 1999).
- Plate 11.** 1. *Proboscia alata* (40N, Apr. 1998), 2. *Proboscia eumorpha* (KNOT, June 1998), 3, 4. *Proboscia subarctica* (3: KNOT, Apr. 1999; 4: 40N, Apr. 1998), 5. *Bacteriastrum delicatulum* (KNOT, Jan. 1999), 6. *Bacteriastrum furcatum*? (40N, Apr. 1998), 7. *Chaetoceros atlanticum* (KNOT, Dec. 1999), 8, 9. *Chaetoceros peruvianum* (8: KNOT, Nov. 1999; 9: KNOT, Apr. 1998).
- Plate 12.** 1-3. *Chaetoceros compressum* (1, 2: KNOT, June 1999; 3: July 1999), 4. *Chaetoceros didymum* resting spore (KNOT, Feb. 1998), 5-7. *Chaetoceros radicans* (KNOT, June 1999), 8. *Chaetoceros* sp. cf. *cinctum* (KNOT, June 1999), 9-13. *Chaetoceros diadema* resting spores (9, 10, 13: KNOT, June 1999; 11, 12: KNOT, Nov. 1999), 14, 15. *Hyalochaete* spp. and their resting spores (KNOT, June 1999), 16-18. *Chaetoceros furcellatum* resting spores (KNOT, June 1999).
- Plate 13.** 1. *Lioloma* sp. (KNOT, Apr. 1999), 2-7, 8?, 9? *Thalassionema nitzschioides* (2, 3, 5: KNOT, Apr. 1999; 4, 6, 7, 9: 40N, Apr. 1998; 8: KNOT, Sept. 1998), 10-13. *Thalassiothrix longissima* (10: 40N, Apr. 1998; 11: 50N, Apr. 2000; 12, 13: KNOT, Jan. 1998), 14-16. *Fragilariopsis doliolus* (14: KNOT, Sept. 1998; 15: 40N, July 1999; 16: KNOT, Apr. 1999), 17-22. *Neodenticula seminae* (17, 19: 50N, Apr. 1998; 18: 50N, Apr. 2000; 20: 50N, Apr. 2000; 21: KNOT, Apr. 1999; 22: 50N, Sept. 1999), 23, 24. *Nitzschia sicula* (40N, Apr. 1998).
- Plate 14.** 1, 2. *Nitzschia* spp. (1: 40N, Apr. 1998; 2: 40N, Nov. 1999), 3-4. *Alveus marinus* (3: 40N, Nov. 1999; 4: 40N, Apr. 1998), 5-9. *Nitzschia bicapitata* Group (40N, Sept. 1999), 10. *Nitzschia* sp. cf. *braarudii* (40N, Apr. 1998), 11-14. *Nitzschia interruptestriata* (11: 40N, Nov. 1999; 12, 14: 40N, Apr. 1998; 13: KNOT, Apr. 1999), 15. *Nitzschia kolaczekii* (40N, Apr. 1998).
- Plate 15.** 1, 2. *Dictyocha mandrai* (1: KNOT, Oct. 1998; 2: 40N, July 1999), 3, 4. *Dictyocha messanensis* (3: KNOT, Oct. 1998; 4: KNOT, Jan. 1999), 5. *Dictyocha pseudofibula* (KNOT, Mar. 1998), 6. *Distephanus boliviensis* (50N, May 1998), 7, 8. *Distephanus speculum* (7: KNOT, Jan. 1999; 8: KNOT, Jan. 1998), 9. *Distephanus septenarius* (KNOT, Jan. 1998).
- Plate 16.** 1. *Distephanus septenarius* (50N, May 1999), 2, 3 (lateral view). *Distephanus octangulatus* (2: 50N, May 1998; 3: 50N, Apr. 2000), 4, 5. *Distephanus quinquangellus* (4: KNOT, Jan. 1999; 5: KNOT, Apr. 1999), 6, 7. *Distephanus pulchrus* (6: KNOT, Oct. 1998; 7: 40N, Nov. 1999), 8-10. *Actiniscus pentasterias* (8: 50N, June 1999; 9, 10: 50N, May 1999), 11-13. *Ebria tripartita* (11: KNOT, Dec. 1999; 12: KNOT, Apr. 1999; 13: KNOT, Jan. 1998).

Plate 1

Plate 2

Plate 3

Plate 4

Plate 5

Plate 6

Plate 7

Plate 8

Plate 9

Plate 10

Plate 11

Plate 12

Plate 13

Plate 14

Plate 15

Plate 16

Station 50N		Initial Date																											
		No. Valves Counted																											
		1036	1467	1185	1113	1140	1585	1258	15 Mar. 1998	1 Apr. 1998	19 Apr. 1998	6 May 1998	23 May 1998	20 Jul. 1998	4 Aug. 1998	19 Aug. 1998	3 Sep. 1998	18 Sep. 1998	3 Oct. 1998	18 Oct. 1998	2 Nov. 1998	17 Nov. 1998	2 Dec. 1998	17 Dec. 1998	1 Jan. 1999	16 Jan. 1999	31 Jan. 1999	15 Feb. 1999	2 Mar. 1999
	<i>A. curvatulus</i>	439	102	115	166	205	235	310	307	809	160	311	242	367	1186	934	875	310	1283	1066	1231	886	1189	1327	974	993	1041	950	
	<i>A. c. ochotensis</i>	9	0	5	0	20	8	15	0	51	6	0	99	0	0	0	7	0	7	15	0	0	0	9	0	0	0	0	0
	<i>Actinocyclus senarius</i>	20	33	18	22	23	17	33	19	77	21	7	10	0	0	0	4	0	3	30	0	0	0	6	6	2	30	2	1
	<i>Asteromphalus brookei</i>	0	15	5	13	8	5	10	10	0	0	0	5	0	0	0	12	0	0	0	0	15	0	0	0	0	0	3	0
	<i>A. heptactis</i>	0	3	5	3	3	5	20	20	72	26	44	20	95	284	22	89	22	89	212	213	89	38	38	15	11	18	15	3
	<i>A. d. hyalinus</i>	0	14	6	6	21	38	86	118	2	74	35	41	36	18	0	36	39	107	59	36	22	24	9	9	9	0	0	0
	<i>A. d. robustus</i>	38	302	189	233	184	210	346	399	635	221	488	291	331	391	237	385	229	340	320	281	136	115	81	96	92	86	86	86
	<i>Azpeitia tabularis</i>	0	72	20	15	13	20	20	31	184	67	59	15	12	12	12	37	30	22	30	24	59	15	4	4	4	0	3	3
	<i>Az. sp.</i>	1	0	0	0	0	+	0	0	0	0	7	20	3	9	4	7	2	13	18	0	0	1	6	0	0	1	0	0
	<i>Bacterosira bathyomphala</i>	74	56	36	18	11	18	46	213	143	59	181	44	52	26	6	19	3	246	269	181	36	21	8	10	16	4	0	0
	<i>Chaetoceros atlanticum</i>	34	16	83	7	4	27	67	394	199	36	285	123	26	31	58	13	5	19	31	84	5	4	5	0	3	0	0	0
	<i>Ch. concavicornis</i>	87	130	114	38	15	11	40	112	179	64	39	0	31	52	45	65	13	16	65	16	6	11	6	1	6	1	0	0
	<i>Ch. pervianum</i>	43	52	60	29	12	17	36	118	296	157	790	316	254	150	84	45	23	52	83	45	39	14	5	8	0	3	0	0
	<i>Cocconeis sp.</i>	181	195	121	155	93	108	90	106	125	11	194	232	228	264	194	343	198	363	539	544	241	202	128	147	218	80	3	0
	<i>Cocconeis marginatus</i>	0	0	0	1	0	+	0	3	15	0	0	10	3	6	0	4	2	13	6	0	0	1	0	0	0	0	0	0
	<i>Cos. oculus-iridis</i>	0	0	0	0	0	0	0	0	3	10	2	37	35	53	36	78	67	16	32	24	52	59	47	37	46	34	30	0
	<i>Cos. radiatus</i>	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	4	4	5	19	0	0							

Appendix Table 1. (cont.)

Station 50N 3000 m		Initial Date																										
No. Valves Counted		17 Mar. 1999	1 Apr. 1999	16 Apr. 1999	1 May 1999	16 May 1999	19 May 1999	5 Jun. 1999	22 Jun. 1999	10 Jul. 1999	27 Jul. 1999	13 Aug. 1999	31 Aug. 1999	17 Sep. 1999	5 Oct. 1999	22 Oct. 1999	8 Nov. 1999	26 Nov. 1999	13 Dec. 1999	30 Dec. 1999	17 Jan. 2000	3 Feb. 2000	21 Feb. 2000	10 Mar. 2000	27 Mar. 2000	14 Apr. 2000	1 May 2000	
<i>Ac. curvatus</i>	157	148	740	1621	N.A.	1060	1157	916	1233	3105	2095	1995	1504	1283	949	2127	2311	1525	1148	1466	1606	1390	1386	1429	1409	1462		
<i>Ac. ochotensis</i>	0	6	133	130		32	0	0	10	166	10	13	72	26	38	9	13	9	16	0	3	3	0	11	0	272	1920	
<i>Actinoprychus senarius</i>	1	7	7	0		6	1	0	1	0	0	0	0	0	0	0	0	3	3	0	0	3	3	0	6	0	0	0
<i>Asteromphala brookeri</i>	12	9	59	41		11	0	4	7	51	0	16	92	45	45	46	33	18	51	15	6	20	13	58	141	154	0	0
<i>As. heptactis</i>	0	0	0	0		0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>As. hyalinus</i>	18	38	1184	2568		941	200	80	54	0	22	13	133	51	102	34	34	30	21	4	11	21	21	112	1344	1024	0	0
<i>As. robustus</i>	25	22	59	62		11	0	10	7	13	0	6	31	26	13	15	10	16	8	10	13	3	13	77	77	0	0	0
<i>Azpeitia tabularis</i>	89	124	414	509		147	120	96	87	154	58	32	205	205	90	179	128	94	75	102	91	55	117	288	960	896	0	0
<i>Az. sp.</i>	3	9	30	0		0	3	0	0	0	0	0	0	0	0	0	0	13	27	0	16	4	5	64	96	32	0	0
<i>Bacterostira bathyophala</i>	0	0	0	0		0	1	0	0	26	26	26	31	0	0	5	20	5	0	3	16	10	3	0	0	0	0	0
<i>Chaetoceros atlanticum</i>	10	6	194	176		190	9	3	4	102	17	11	67	140	11	108	87	76	22	54	22	7	96	2448	5343	2086	0	0
<i>Ch. concavicornis</i>	0	0	117	155		22	13	14	2	512	118	57	22	45	22	11	18	7	39	34	14	13	22	304	320	294	0	0
<i>Ch. pervianum</i>	3	25	414	1440		381	74	50	69	0	154	62	85	50	73	13	31	11	25	6	0	6	208	704	320	294	0	0
<i>Cocconeis</i> sp.	4	10	635	1979		403	76	28	22	64	20	14	9	17	45	7	7	11	3	0	14	0	32	1184	992	1318	0	0
<i>Cocconeis marginatus</i>	146	172	233	145		112	119	77	148	90	25	59	112	230	286	215	197	217	210	177	269	179	205	304	768	448	0	0
<i>Cos. oculis-iridis</i>	0	0	0	0		0	0	0	0	13	0	0	0	0	0	0	0	0	0	3	0	0	0	3	13	13	0	0
<i>Cos. radiatus</i>	30	15	37	26		6	3	0	2	0	2	0	0	20	19	6	8	5	15	10	26	6	10	3	13	0	64	0
<i>Ditylum</i> sp.	19	19	15	10		6	2	0	2	0	0	3	0	13	6	3	3	3	3	3	3	5	0	0	0	0	0	0
<i>Hydrochaete</i> spp.	97	0	194	65		0	14	0	56	560	84	168	504	224	392	168	224	0	84	224	140	140	98	168	0	0	336	0
<i>Proboscia alata</i>	0	0	0	0		0	0	0	0	13	0	0	0	0	0	5	8	3	6	0	0	0	0	0	0	0	0	0
<i>Pr. eumorpha</i>	0	0	22	10		11	0	0	0	0	0	0	0	6	6	3	0	8	3	0	0	0	0	13	38	0	0	0
<i>Pr. subarctica</i>	37	49	67	57		34	0	0	40	51	29	38	41	77	38	44	56	41	0	51	38	23	77	48	128	90	0	0
<i>Rhizosolenia hebetata</i> f. <i>hebetata</i>	44	81	355	212		106	0	48	53	333	208	234	532	531	320	322	246	202	198	195	285	118	330	432	1075	1165	0	0
<i>Rh. hebetata</i> f. <i>semispina</i>	4	7	192	202		101	32	17	17	141	80	26	41	64	58	10	28	18	3	5	19	3	13	29	77	179	0	0
<i>Stellarina stellaris</i>	3	3	0	26		56	4	6	6	0	6	0	6	0	10	0	6	0	0	0	0	0	0	0	0	13	26	0
<i>Thalassiosira eccentrica</i>	18	15	163	118		32	0	6	26	38	3	54	123	128	77	47	38	47	64	21	48	38	48	192	352	224	0	0
<i>Th. grossida</i>	12	12	0	0		6	0	0	3	51	93	195	287	26	38	384	537	192	59	124	368	166	101	64	256	160	0	0
<i>Th. hyalina</i>	24	21	118	189		70	15	22	20	10	10	38	92	51	38	130	68	60	75	128	107	43	112	256	864	1120	0	0
<i>Th. lineata</i>	41	98	769	970		256	84	54	64	51	86	83	235	218	230	68	68	60	75	128	107	43	112	256	864	1120	0	0
<i>Th. nordenskiöldii</i>	0	0	0	0		0	0	0	0	179	480	582	348	77	115	239	311	55	32	60	53	60	21	80	32	0	0	0
<i>Th. oestrupii</i>	281	308	562	734		243	207	160	184	410	125	186	645	781	448	307	243	401	453	299	256	299	533	1120	2527	3039	0	0
<i>Th. trifida</i> group	178	275	518	876		205	259	211	177	1062	358	483	1536	1293	691	499	333	503	400	303	235	183	256	736	1376	1504	0	0
TOTAL CENTRICS	1265	1492	7326	12354		4142	1589	1160	1448	4719	2478	2820	6153	5166	3936	3209	3151	2428	2181	2170	2384	1610	2633	9003	20444	16659	0	0
<i>Noodenticula seminiae</i>	5391	6395	20204	29918		12716	6036	5784	7548	30306	8921	11708	30418	29185	24144	14537	11007	9467	9495	13080	9187	5182	5448	18038	40557	35067	0	0
<i>Nitzschia stictica</i>	0	0	30	0		0	0	0	5	0	3	0	41	128	243	94	119	98	75	55	64	0	32	48	128	192	0	0
<i>Thalassiosira nitzeioides</i>	34	28	67	36		50	34	18	22	38	58	32	51	58	90	18	5	10	19	51	93	84	54	365	2432	2432	0	0
<i>Thalassiothrix longissima</i>	24	18	148	145		45	20	18	17	576	115	384	1403	793	403	292	195	243	173	123	125	38	93	179	512	371	0	0
TOTAL PENNATES	5456	6450	20522	30116		12817	6102	5822	7597	30920	9103	12159	31994	30203	24892	15028	11450	9875	9867	13439	9633	5479	5699	18646	44300	38350	0	0
TOTAL VEGETATIVE VALVES	6721	7941	27848	42470		16958	7691	6981	9045	35639	11581	14979	38147	35368	28829	18237	14601	12303	12048	15069	12017	7089	8332	27649	64744	55009	0	0
<i>Ch. furcellatum</i>	0	1	15	5		0	2	3	3	2982	1744	1564	2027	633	250	1408	2368	845	665	737	1964	1211	1113	656	896	1216	0	0
<i>Ch. sp.</i>	30	13	30	16		45	11	10	20	512	262	58	102	64	58	51	46	61	59	67	51	19	32	102	141	0	0	0
TOTAL RESTING SPORES	30	15	44	21		45	13	13	24	3494	2022	1660	2129	697	307	1459	2414	909	726	796	2032	1262	1133	688	998	1357	0	0
TOTAL DIATOM FLUXES	6798	7992	27928	42491	N.A.	17048	7749	6997	9073	39133	13603	16663	40301	36066	29136	19696	17015	13212	12774	16405	14048	8351	9465	28336	65742	56365	0	0

[illegible]

Appendix Table 3. The diatom fluxes ($\times 10^3$ valves $\text{m}^{-2} \text{d}^{-1}$) at Station 40N 3000 m during Dec. 1997 through Feb. 2000. The symbol "+" represent less than 1000 valves $\text{m}^{-2} \text{d}^{-1}$. N.A. represents no samples due to turn-around of the sediment traps or malfunction of the trap.

Station 40N																										
Initial Date		No. Valves Counted																								
1 Dec. 1997	18 Dec. 1997	4 Jan. 1998	22 Jan. 1998	8 Feb. 1998	25 Feb. 1998	15 Mar. 1998	1 Apr. 1998	19 Apr. 1998	6 May 1998	23 May 1998	10 Jun. 1998	27 Jun. 1998	14 Jul. 1998	4 Aug. 1998	19 Aug. 1998	3 Sep. 1998	18 Sep. 1998	3 Oct. 1998	18 Oct. 1998	2 Nov. 1998	17 Nov. 1998	2 Dec. 1998	17 Dec. 1998	16 May 1999	22 May 1999	
1565	1435	1169	1039	2041	1558	1741	1791	1712	1715	1352	1519	998	N.A.	1066	1473	1162	1908	1862	1942	1810	1440	1267	N.A.	N.A.	N.A.	2223
64	220	81	21	96	102	137	154	205	205	77	256	154		178	207	138	67	296	192	118	20	148			256	
9	3	0	4	0	10	0	51	0	0	0	0	0	17	30	0	0	0	0	0	0	7	20	30		26	
26	5	0	4	26	61	0	0	0	51	0	17	51	0	30	0	20	15	0	0	15	39	59			77	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0		
21	3	0	9	13	61	119	77	205	68	51	51	0	0	118	118	39	44	59	0	30	59	89			256	
4	3	9	0	0	34	0	0	0	0	0	0	0	0	0	89	0	15	0	0	0	0	0			51	
0	0	64	115	378	235	0	26	0	324	435	375	222		266	266	197	67	178	222	133	473	740			384	
277	77	34	13	32	51	102	282	102	102	128	119	102		237	89	99	126	118	44	126	79	89			26	
0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	
0	3	9	0	0	20	85	102	0	0	26	17	0	0	30	0	0	0	30	0	0	355	621			26	
0	3	3	5	13	10	20	41	31	61	41	20	31		36	12	0	9	0	0	6	12	12			31	
0	4	0	491	1655	2836	3222	3112	2949	2519	1894	952	1003		1101	1397	793	476	876	337	364	1089	2817			4054	
0	5	192	131	474	461	645	1126	921	461	471	450	328		355	864	367	210	414	272	163	237	379			502	
0	124	18	102	67	452	788	737	1024	1116	594	450	614		876	1905	1148	1089	1953	923	838	781	1089			1116	
9	5	4	4	0	10	0	0	0	0	77	205	119		0	0	59	0	0	0	15	20	0			128	
0	94	33	38	30	64	72	273	486	461	307	333	427	341	444	296	276	0	148	148	67	158	89			1049	
0	5	0	0	0	0	31	34	154	230	0	102	17		1154	2426	809	15	30	15	118	118				77	
0	0	0	0	0	20	17	0	0	0	0	17	0		59	207	99	7	0	0	0	59	118			0	
0	0	0	0	0	0	0	0	0	34	26	34	34	N.A.	59	740	256	229	118	104	111	39	89	N.A.		1075	
55	49	77	132	486	880	1706	1689	1510	836	537	1229	580		740	769	526	229	118	104	111	39	89			0	
0	0	0	0	0	6	0	0	26	0	0	0	34		59	178	118	22	0	74	37	0	0			26	
0	4	4	19	20	51	26	51	0	26	85	17	59	30	17	59	30	20	0	0	0	0	0			0	
0	0	0	0	10	34	0	51	34	0	34	51	0	31	0	30	20	0	0	0	0	0	0			0	
98	41	17	0	38	113	119	77	154	51	77	102	68		473	740	197	126	0	44	30	39	59			0	
0	0	5	4	10	10	10	10	10	10	10	10	0	10	12	24	24	6	12	9	24	24	24			20	
132	59	94	81	102	358	410	665	358	341	358	580	273		118	178	59	86	1154	947	185	651	592			819	
21	36	38	17	77	276	427	563	435	256	333	358	290		266	207	118	96	30	104	59	20	59			256	
0	4	13	6	0	0	0	102	128	17	0	85	34		118	30	59	0	0	0	15	0	0			0	
166	136	213	115	397	287	563	486	512	853	461	427	375		325	621	138	170	444	178	178	276	296			614	
38	18	94	30	64	174	239	256	230	205	307	444	290		148	385	217	104	385	207	111	355	266			179	
491	312	448	290	665	1423	1416	1740	2099	1399	1561	1928	1263		1539	1775	1124	547	828	414	355	592	888			2359	
137	72	132	34	36	184	132	282	102	222	307	973	171		237	444	237	170	325	148	126	158	148			307	
1826	1118	2284	1595	5535	9204	11903	14123	13099	9822	8569	13514	7661		10125	15918	8450	4481	17487	7400	4591	8368	12261			15280	
TOTAL CENTRICS																										
0	3	4	0	9	20	31	20	10	10	10	41	0		0	0	0	0	12	15	15	59	30			102	
819	691	840	934	1668	1792	2662	2703	2304	1085	1392	1208	880		1255	1657	1124	604	3598	3055	3129	14064	14350			55541	
2969	1313	1152	601	1088	1904	3092	3624	4535	7126	5354	3604	2314		4474	5160	4628	1542	2474	1871	2027	1775	1509			6092	
55	26	34	17	38	205	222	174	235	113	72	31	164		142	249	201	53	414	296	200	276	118			256	
17	5	26	4	13	31	20	72	51	20	31	20	20		36	59	12	6	24	22	22	39	178			51	
21	8	9	9	5	51	41	143	154	102	41	133	82		95	24	59	6	178	81	30	39	118			51	
751	361	38	806	1199	2590	2293	2416	1710	1618	1047	1413	1171		959	1030	1290	509	5574	2049	1080	1894	1953			3634	
115	90	17	21	68	113	133	133	61	61	82	20	51		83	71	59	27	450	15	79	59				51	
4850	2554	2167	2427	4146	6747	8692	9480	9235	10207	8682	6624	4822		7125	8545	7728	2775	13090	7582	6672	18601	18729			66035	
6676	3673	4451	4023	9681	15951	20595	23604	22334	20029	17251	20138	12491		17270	24464	16179	7257	30576	14982	11263	26969	30991			81362	
TOTAL RESTING SPORES																										
6676	3673	4451	4023	9681	15951	20595	23604	22334	20029	17251	20138	12491	N.A.	17270	24464	16218	7257	30576	14982	11263	26969	30991	N.A.	N.A.	81362	
TOTAL DIATOM FLUXES																										