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DIATOM COMMUNITIES IN WESTERN ALEUTIAN WATERS  
ON THE BASIS OF NET SAMPLES COLLECTED  
IN MAY-JUNE 1953\*

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The present studies are based on materials collected by the Training Ship "Oshoro Maru" of the Faculty of Fisheries, Hokkaido University, during her training and research cruise to the western Aleutian waters from May to June 1953. The main purpose of the studies is to get the figure of distribution of diatom communities in upper layers of these areas which are certainly bounded by particularities of the water system.

The plankton net used in samplings measures 20 cm in mouth diameter and 68 cm in length along the side; it is made of fine bolting silk, XX 16, i. e., 157 meshes a linear inch. Samplings were made by 50 metre approximately vertical hauls.

The positions and dates of the samplings were quite the same as those of zooplankton samplings (fig. 1 and appendix; cf. Anraku, 1954). The number of stations, however, is different from those given in the hydrographic studies by Mishima & Nishizawa (1955), so that in referring to their hydrographic data care is necessary to read degrees of latitude and longitude of the stations, but not the number of the stations.

In the areas investigated the diatom flora is comparatively rich in species including the following nine leading species:

<i>Chaetoceros atlanticus</i>	<i>Corethron hystrix</i>
Ch. <i>convolutus</i>	<i>Denticula</i> sp.
Ch. <i>debilis</i>	<i>Nitzschia seriata</i>
Ch. <i>decipiens</i>	<i>Rhizosolenia hebetata</i> f. <i>semispina</i>
Ch. <i>radicans</i>	

In addition to these species, *Coscinodiscus oculus iridis*, *Thalassiosira decipiens*, *Th. nordenskiöldii* and *Thalassiothrix longissima* are more or less abundant through the entire area, and *Nitzschia closterium* is also sometimes rather abundant though in restricted location. A few species of dinoflagellates and tintinnodes are present too but in very small quantities.

Although the quantitative values of the present samples are limited because of difficulty of exact estimation of filtration coefficient of the net, counting of the cell numbers of diatoms is made to get an approximate figure of density of population

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which, together with the composition of the population, might have bearing upon the hydrography of the areas.

Illustrated in figures 2-6 respectively is the quantitative distribution of diatoms as given by the cell numbers of total communities as well as by those in percentage of four major groups separately, i. e., *Chaetoceros-Hyalochaete*, *Chaetoceros-Phaeoceros*, *Nitzschia seriata* and *Rhizosolenia hebetata* f. *semispina*.

From the characteristics of the diatom communities in respect to their density as well as to their composition, the areas investigated may be divided into six regions: they are symbolized by A, B, C, D, E and F in figure 1 and table 1.

Table 1. Abridged table showing characteristics of diatom communities in six regions

Regions		A	B	C	D	E	F
Total number of diatom cells per m <sup>3</sup> per a station		3×10 <sup>7</sup>	3×10 <sup>4</sup>	6×10 <sup>4</sup>	3×10 <sup>5</sup>	8×10 <sup>4</sup>	4×10 <sup>5</sup>
Percentage of six major groups	<i>Chaetoceros-Hyalochaete</i>	82	41	0	7	17	2
	<i>Chaetoceros-Phaeoceros</i>	6	15	69	67	8	60
	<i>Corethron hystrix</i>	+	+	13	2	7	8
	<i>Denticula</i> sp.	1	6	16	5	2	4
	<i>Nitzschia seriata</i>	2	12	+	4	50	4
	<i>Rhizosolenia hebetata</i> f. <i>semispina</i>	2	24	+	11	13	19
	Diatoms miscellaneous	7	2	2	4	3	3

#### A Region

The A region covering St. 1, 4-8, 10 and 20 around the Near Islands and Rat Islands is densely populated with diatoms which are present to the number of more than one million cells per 1 m<sup>3</sup> of water. *Chaetoceros-Hyalochaete* group, mainly composed of *Chaetoceros constrictus*, *Ch. compressus*, *Ch. debilis*, *Ch. decipiens*, *Ch. radicans* and *Ch. teres*, are most prevalent. Every station in this region shows the occurrence of *Hyalochaete* in the bulk more than 60 per cent of the total numbers of diatoms; especially on the course from St. 4 to St. 8 this group is remarkably predominant, forming more than 80 per cent of the total. Other diatoms, such as *Chaetoceros convolutus*, *Nitzschia closterium*, *Nitz. seriata*, *Rhizosolenia hebetata* f. *semispina*, *Thalassiosira nordenskiöldii*, *Thalassiothrix longissima*, etc., are also found to be prevalent though to a less extent.

It is supposed from the fact of the richness in diatom population as well as of the nearly monotonous presence of fine species of Subgenus *Hyalochaete* that the waters in A region are much influenced by neritic elements. Low transparency and green colour of water have been reported in this region (Taguchi & Hirose, 1954).

It has been found that a warm water mass of low salinity moves westward along the southern side of the Aleutian Chain from far to the east and turns into the Bering

Sea passing through the channels between the Aleutian Islands (Barnes & Thompson, 1938; Sverdrup *et al.*, 1942; Watanabe, 1954; Mishima & Nishizawa, 1955). The communities found in A region resemble to certain extent those of the neritic waters in the Bering Sea on the coast of Alaska Peninsula which fact has been reported by Aikawa (1938).

### B Region

In the B region covering St. 11 and 12 the total population of diatoms is very small, less than 1000000 cells per 1 m<sup>3</sup> of water. The leading forms are *Hyalochaete*, among which *Chaetoceros decipiens* prevails, as in A region but in less percentage. On the other hand, *Phaeoceros* including *Chaetoceros convolutus*, *Nitzschia seriata* and *Rhizosolenia hebetata* f. *semispina*, become relatively abundant. Thus the B region is characterized by the paucity of total diatom population, the occurrence of *Phaeoceros* and relative decrease in number of *Hyalochaete*. These facts will indicate that warm water of low salinity from A region here contacts and mingles with the cold oceanic water from D region; that is the B region is an intermediate mixing area between A and D regions.

### C Region

The C region covers St. 2 and 4. Although the amount of total diatoms is very small as in B region, the simplicity of communities and the predominance of *Phaeoceros* clearly show that water of this region differs from neritic water. *Phaeoceros* including *Chaetoceros atlanticus*, *Ch. concavicornis*, *Ch. convolutus*, etc., of which the predominant species is *Ch. convolutus*, occupy more than 55 per cent of total number of diatoms, and in addition, typical cold water species, *Corethron hystrix* and *Denticula* sp. are present, while *Hyalochaete* is entirely absent. These facts indicate that the water in this region is purely oceanic. The water in this region has been reported to be very transparent, more than 20 metres of Secchi disc reading (Taguchi & Hirose, 1954). Although Taguchi & Hirose (1954) and also Mishima & Nishizawa (1955) have judged this region to be the continuation of Kuroshio extension, the diatom communities observed here suggest that the surface water of this region is more like to that of cold oceanic waters of D region.

### D Region

The D region covering St. 13, 15, 19 and 21, contains diatom cells varying from 7500 to 800000 per 1 m<sup>3</sup> of water, showing thus a more dense population than in B or C region. The communities are characterized by the predominance (60 per cent of total diatoms) of *Phaeoceros* mainly comprising *Chaetoceros atlanticus* and *Ch. convolutus*.

Together with these species, *Corethron hystrix*, *Denticula* sp. and *Rhizosolenia hebetata* f. *semispina* are also abundantly found here. These communities quite resemble those in C region far to the south-east, both reflecting the cold oceanic nature of the water. It has been suggested from the observations on the drift course of ice bergs that there might exist a surface current from the northern Bering Sea to near the western Aleutian Chain through the northeastern offing of Kamchatka (Hokkaido-Cho, 1906).

It is known that diatom communities in wide areas of the Bering Sea are represented by *Phaeo*-plankton associations (Aikawa, 1932, 1933, 1935, 1936a, 1936b, 1938, 1940; Kanno, 1936). The similarity of communities between D region and those in a large part of the Bering Sea and the suggestion of a surface current above mentioned will indicate that this region has a water mass very similar to that of the northern reaches of the Bering Sea. So far as the surface water is concerned the water mass in this region seems from the present data to be of different origin from that suggested by the results of the hydrographic studies of Mishima & Nishizawa (1955).

#### E Region

The E region covers St. 17, 18 and 23. The count of diatoms is relatively low, being only about 100000 cells per 1 m<sup>3</sup> of water. *Nitzschia seriata* is prevalent and *Chaetoceros debilis* is present in considerable number, while *Phaeoceros* remarkably decrease in occurrence. These communities are typically represented at St. 17 and 23, indicating the neritic nature of the water to certain extent, while at St. 18 certain effects of cold oceanic water are proved by the presence of *Nitzschia seriata* and *Chaetoceros convolutus* in about equal number and also by the abundant occurrence of *Rhizosolenia hebetata* f. *semispina*.

Although both A and E regions are shown to be of neritic nature in respect to diatom communities, there is a wide difference between the two in the composition of communities, indicating that the water comes from different origins. The presence of *Nitzschia seriata* in considerable number in E region suggests that the water in this region is influenced by the coastal waters near Kamchatka, because this species has been reported to be the most prevalent one in the neritic waters on both the east and the west coasts of Kamchatka (Aikawa, *loc. cit.*; Tsuruta & Chiba, 1954).

#### F Region

The F region covers St. 16 and 24. The water is populated with diatoms in considerable density. The most predominant species is *Chaetoceros convolutus*. *Corethron hystrix* and *Rhizosolenia hebetata* f. *semispina* are also fairly numerous. Curiously *Nitzschia seriata* is hardly observed, numbering only about 4 per cent of the total diatoms. Thus the communities in this region show a close resemblance with those of

C and D region reflecting the presence of cold oceanic water, but not with those of E region. The limitation of areas investigated leaves unsolved the origin of the water in F region.

There are certain facts of discord in diatom associations in the present areas between the results of the preceding investigators and the present data. That is, (1) *Thalassiothrix*, *Coscinodiscus* and *Thalassiosira* have been reported to be the most representative forms in the Aleutian waters, but in the present investigations they appear only in small quantities; (2) *Chaetoceros atlanticus* is known to be the most dominant and wide-spread species in these areas, but it is abundantly collected only at one station in the present cruise; (3) on the other hand, *Hyalochaete* group are widely found in the present cruise, while the previous investigators have reported that the distribution of this species is certainly localized.

#### Summary

1. The diatoms are comparatively abundant, as a whole, in the upper layers of the areas investigated, occurring about one hundred million cells per 1 m<sup>3</sup> of water in the maximum, about ten million in average and about several thousand in the minimum.
2. The leading species are *Chaetoceros atlanticus*, *Ch. convolutus*, *Ch. debilis*, *Ch. decipiens*, *Ch. radicans*, *Corethron hystrix*, *Denticula* sp., *Nitzschia seriata* and *Rhizosolenia hebetata* f. *semispina*.
3. From the characteristics of the diatom communities six regions are distinguishable in the investigated areas (fig. 1).
4. The A region is characterized by *Chaeto*-plankton associations, demonstrating the neritic nature of the water.
5. The B region presents mixed communities of *Chaeto*-plankton, *Phaeo*-plankton, *Rhizosolenia hebetata* f. *semispina* and *Nitzschia seriata*, indicating that the water is mixed with cold oceanic water to a certain extent.
6. The C region is also represented by *Phaeo*-plankton associations, indicating the purely cold and oceanic nature of the water.
7. The D region is also represented by *Phaeo*-plankton associations, indicating cold oceanic water like that in the C region.
8. The E region is mainly occupied by *Nitzschia seriata*, having similar communities to those of the neritic water off Kamchatka that have been reported by the preceding investigators.
9. The F region is indicated to be oceanic by diatom communities.

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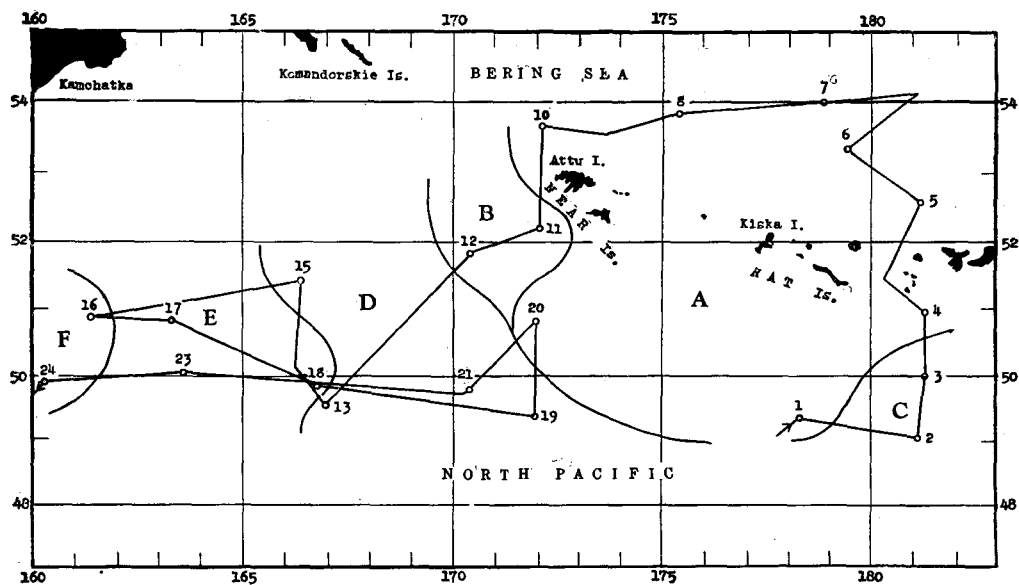


Fig. 1. Approximate sampling positions (1-8, 10-13, 15-21, 23-24) and demarcation of regions (A-F) which are set according to the characteristics of diatom communities

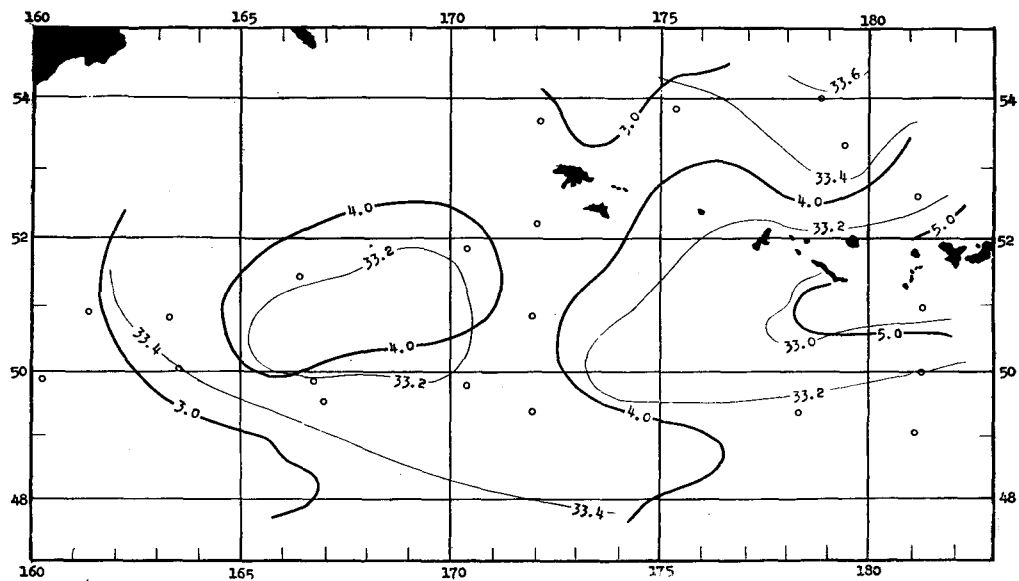


Fig. 2. Isotherms and isohalines at the surface (Mishima & Nishizawa, 1955)

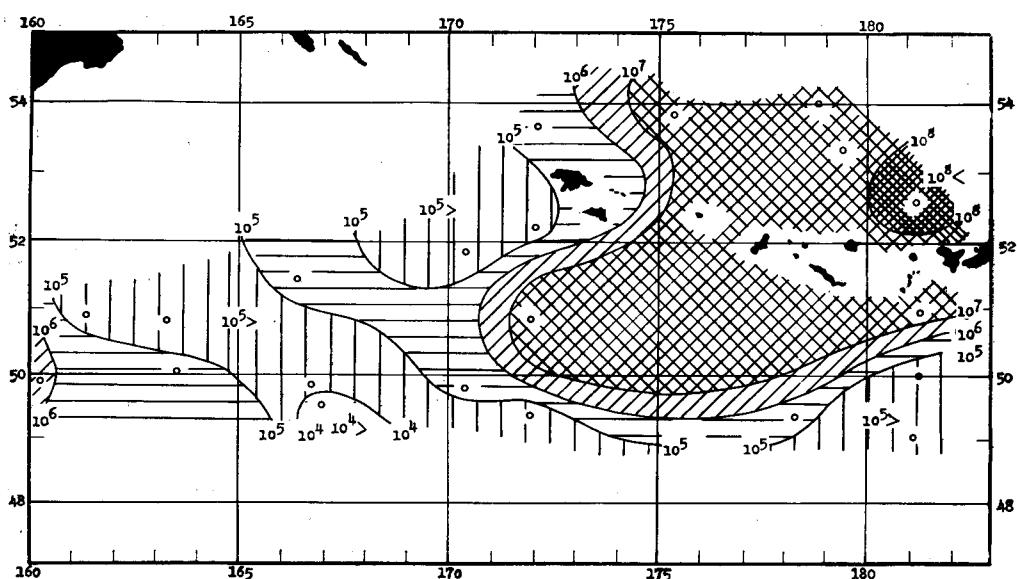


Fig. 3. Horizontal distribution of total numbers of diatoms

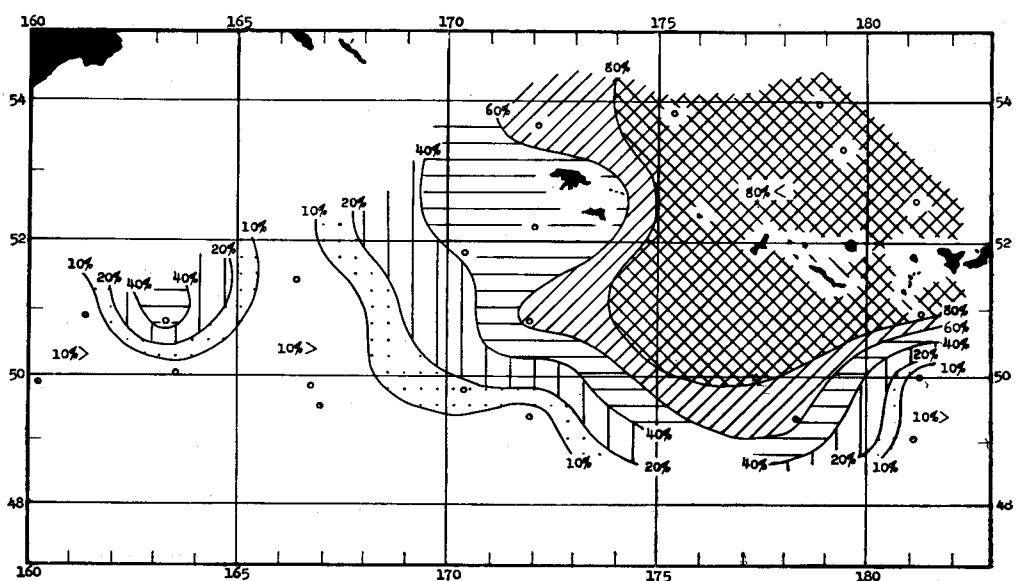


Fig. 4. Occurrence of *Chaetoceros-Hyalochaete* in percentage of total diatoms in each haul

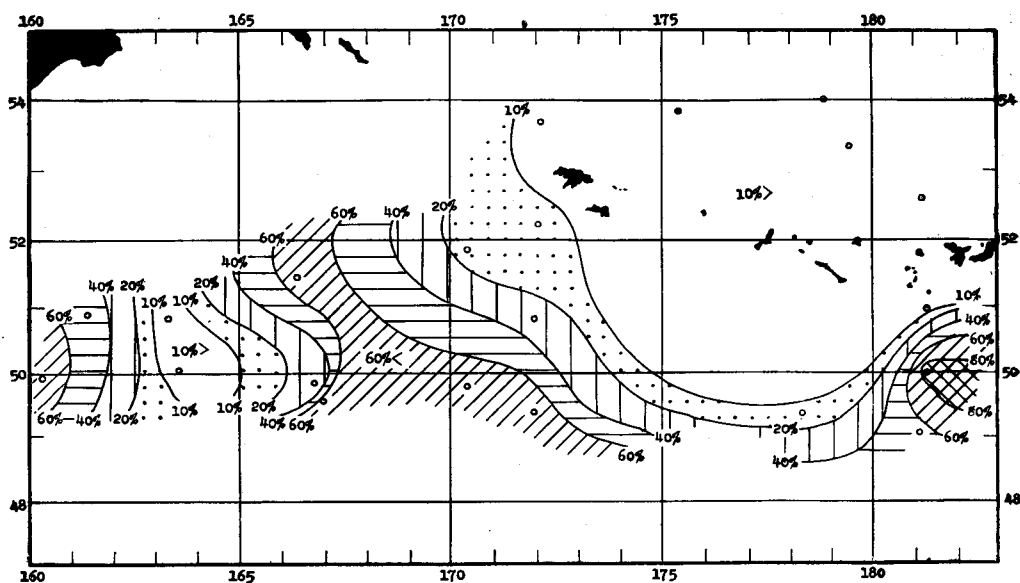


Fig. 5. Occurrence of *Chaetoceros-Phaeoceros* in percentage of total diatoms in each haul

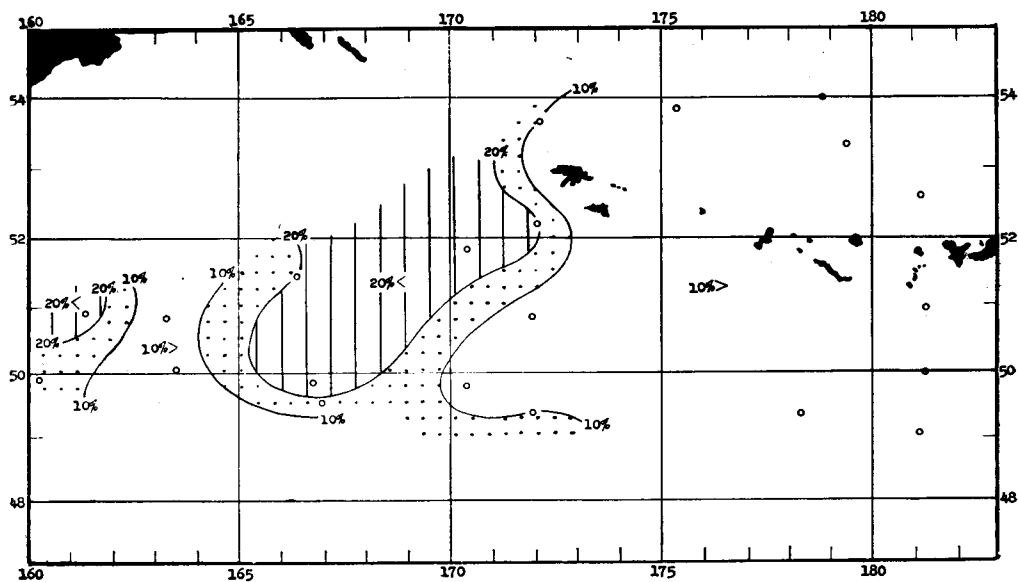


Fig. 6. Occurrence of *Rhizosolenia hebetata* f. *semispina* in percentage of total diatoms in each haul

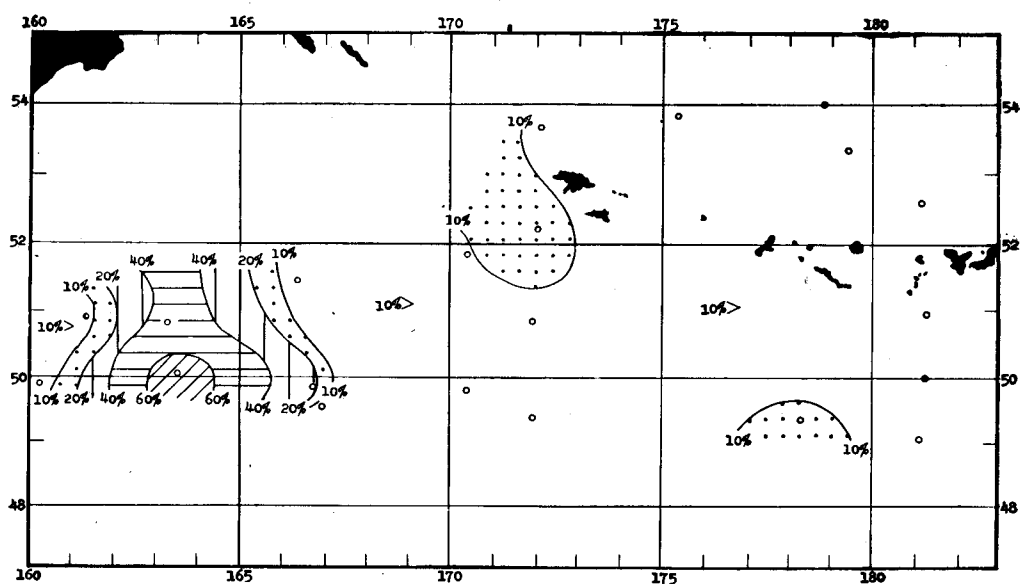


Fig. 7. Occurrence of *Nitzschia seriata* in percentage of total diatoms in each haul

Appendix: Full data of diatom count.

A Station	1		2		3		4		5		6		7		8		10		11		12		13		15		16		17		18		19		20		21		23		24		
B Location	Lat.	Long.	49°22'N 178°18'E	48°57'N 178°49'W	50°00'N 178°44'W	50°58'N 178°40.5'W	52°36'N 178°46'W	53°22'N 179°27'E	54°00'N 178°57'E	53°50.5'N 175°24.5'E	53°42'N 172°09'E	52°15'N 172°07'E	51°53'N 170°23'E	49°33'N 167°01'E	51°28'N 166°24'E	50°55.5'N 161°3'E	50°52'N 163°18'E	49°50.8'N 166°46.2'E	49°24'N 172°00'E	50°51.5'N 172°00'E	49°48'N 170°22'E	50°03'N 163°32'E	49°55'N 160°15'E																				
C Date	V-15		V-15		V-16		V-16		V-17		V-17		V-18		V-19		V-20		V-20		V-21		V-24		V-27		VI-1		VI-1		VI-2		VI-5		VI-6		VI-10		VI-16		VI-17		
D Time	1:20		14:00		2:00		10:30		3:00		14:45		8:30		10:30		8:00		20:30		19:00		14:30		17:00		8:00		20:00		20:00		16:00		13:00		19:30		19:00		19:00		
E Hauled distans (m)	0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		0-50		
F Settling volume of total sample (cc/m³)	0.9		4.0		3.5		20.8		52.5		15.4		11.3		12.5		0.8		0.3		—		1.3		4.7		1.2		0.6		—		2.9		8.4		5.0		0.3		3.2		
G Number of diatom cells/m³	141750		39900		73500		42800000		123540000		21210000		22000000		21890000		238000		41850		10500		7550		125600		17700		37250		28750		12700		18830000		777000		161700		1038000		
Diatomeae	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
		100		100		100		100		100		100		100		100		100		100		100		100		100		100		100		100		100		100		100		100		100	
<i>Amphora</i> sp.						+		+																																			
<i>Asteromphalus</i> sp.							+		+		+																																
<i>Biddulphia aurita</i>												+																															
<i>Chaetoceros</i> total	105350	74	22000	55	61800	84	40600000	95	119740000	97	20070000	95	19400000	88	20420000	93	187600	79	21980	53	6300	60	4650	62	90800	72	9500	54	16000	43	6150	21	9500	75	15960000	85	678000	87	17400	11	720000	69	
<i>Hyalochaete</i> total	88900	63	+				37400000	87	118360000	96	17910000	84	19100000	87	18880000	86	174300	73	16340	39	4500	43	50	0.7	4400	3.5	300	1.7	15750	42					11690000	62	126000	16	11400	7.0	18000	1.7	
<i>Chaetoceros compressus</i>							2200000	5.1	10010000	8.1	+		+				3500	1.5																									
<i>C. constrictus</i>							1600000	3.7	+		+		200000	0.9			700	0.3																									
<i>C. debilis</i>	49350	35					14400000	34	25190000	20	2640000	12	14300000	65	4720000	22	6300	2.6										15750	42							5950000	32	15000	1.9	11100	6.9	18000	1.7
<i>C. decipiens</i>	33950	24	+				+		1040000	0.8	14400000	68	1600000	7.3	13180000	60	147000	62	13520	32	4200	40	+		1600	1.3	300	1.7								980000	5.2	36000	4.6	300	0.2		
<i>C. decipiens</i> f. <i>singularis</i>									60000	0.3							2100	0.9	280	0.7														140000	0.7								
<i>C. radicans</i>	2450	1.7					17000000	40	79350000	64	480000	2.3	1900000	8.6	70000	0.3	6300	2.6	2540	6.1					2800	2.2									3395000	18	57000	7.3					
<i>C. seiracanthus</i>	3150	2.2					800000	1.9	+		120000	0.6	600000	2.7	910000	4.2																		1225000	6.5								
<i>C. socialis</i>									350000	0.3																																	
<i>C. teres</i>									690000	0.6	150000	0.7	+				5600	2.4			300	2.9																					
<i>Hyalochaete</i> miscs.							1400000	3.3	1730000	1.4	60000	0.3	500000	2.3			2800	1.2					50	0.7																			
<i>Phaeoceros</i> total	16450	12	22000	55	61800	84	3200000	7.5	1380000	1.1	2160000	10	300000	1.4	1540000	7.1	13300	5.6	5640	18	1800	17	4600	61	86400	69	9200	52	250	0.7	6150	21	9500	75	4270000	23	552000	71	6000	3.7	702000	68	
<i>Chaetoceros atlanticus</i>			300	0.8			200000	0.5	+		450000	2.1	+		350000	1.6	700	0.3	+		+		+		400	0.3	100	0.6						350000	1.9	282000	36	900	0.6	15000	1.4		
<i>C. atlanticus</i> f. <i>audax</i>																																											
<i>C. borealis</i>	+														+				280	0.7																							
<i>C. concavicornis</i>	2800	2.0	400	1.0			+								420000	1.9			990	2.4			+				200	1.1							945000	5.0			300	0.2	21000	2.0	
<i>C. convolutus</i>	13650	9.7	21300	54	61800	84	3000000	7.0	1380000	1.1	1710000	8.1	300000	1.4	770000	3.5	12600	5.3	4370	10	1800	17	4600	61	86000	68	8900	50	250	0.7	6150	21	9500	75	2975000	16	264000	34	4800	3.0	666000	64	
<i>C. densus</i>													+																														
<i>Corethron hystrix</i>	2100	1.5	8900	22	2400	3.3	+		+		+		+		+		+		+		100	1.0	200	2.7	2800	2.2	2300	13	1950	5.2	4100	14	1500	12	+		+		5100	3.2	27000	2.6	
<i>Coscinodiscus concinns</i>							+		+		+		+		+																												
<i>C. excentricus</i>									+		+		+		+																							+					
<i>C. gigas</i>																			140	0.3																							
<i>C. marginatus</i>			+																140	0.3																							
<i>C. oculus iridis</i>									+		+		+				700	0.3			100	1.0	100	1.3			400	0.3			50	0.1			150	0.5	50	0.4					
<i>Denticula</i> sp.	7000	4.9	8200	21	8100	11	400000	0.9	+		+		400000	1.8	+		5600	2.4	4230	10	100	1.0	950	13							600	2.1	200	1.6	1050000	5.6	30000	3.9	8100	5.0	84000	8.1	
<i>Ditylum brightwellii</i>							+		+		+		+																									</					