REPORT FROM THE "OSHORO MARU" ON OCEANOGRAPHIC AND BIOLOGICAL INVESTIGATIONS IN THE BERING SEA AND NORTHERN NORTH PACIFIC IN THE SUMMER OF 1955

IV. Diatom Standing Crops and the Major Constituents of the Populations as Observed by Net Sampling [1]

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I. Introduction

On the 1955 cruise of the training ship "Oshoro Maru" to the Bering Sea sampling of plankton by vertical haul for upper 50 meter zone with a fine mesh net (0.112 mm in mesh aperture) was carried out covering almost all parts of the Bering Sea except north of 60 degrees north latitude, though stations of sampling were distributed rather sparsely (Fig. 1). Detailed descriptions on gear, methods, sampling stations and other

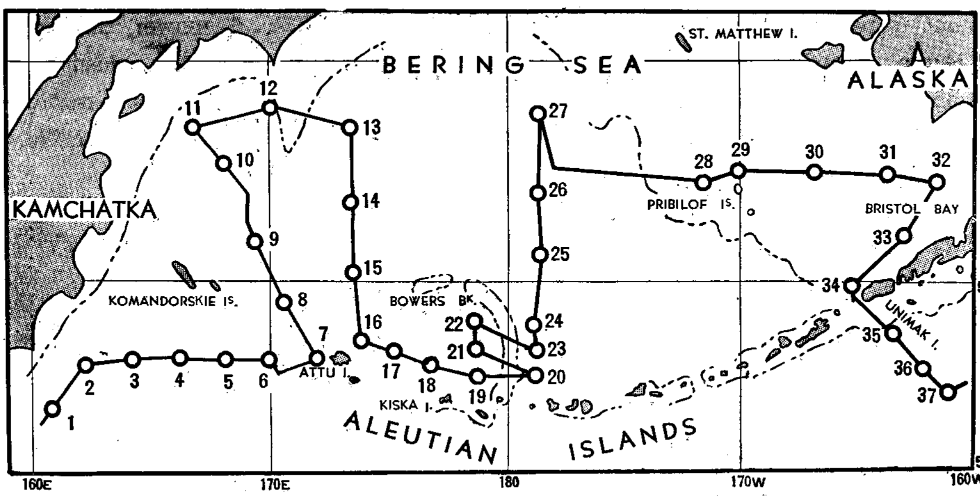

Fig. 1. Chart showing the location of the stations occupied by "Oshoro Maru" during June and July, 1955

records are given in the introductory notes of Motoda & Fujii (1956). The data of rough estimation on the displacement volume, weight and pigment content of the samples in these collections are presented in *Data Record of Oceanographic Observations and Exploratory Fishing*, No. 1, 1957 (pp. 88–92).

In the present studies the author intends to make more exact quantitative estimation of diatom standing crops by counting the cell number, and also to report the characteristic

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species which occupy the main constituents of populations.

The author is gratefully indebted to Prof. S. Motoda, Asst. Prof. T. Kawamura and Mr. M. Anraku for their painstaking guidance throughout the present studies. He expresses his sincere gratitude to Mr. Y. Kawarada, Hakodate Marine Observatory, for his kindness not only in making available his unpublished data but in giving valuable criticism on the present paper. He also sincerely thanks Captain T. Fujii and his crew members as well as the research staff aboard the "Oshoro Maru" on that cruise for their work in sampling at sea. Cordial thanks are also due to Asst. Prof. H. Koto for his generosity in offering his unpublished data on the hydrographic analysis of this cruise.

II. Standing Crops of Total Diatom Populations

As the net used was not equipped with a flow meter at its mouth, the exact quantity of water filtered by its cloth is unknown. All of the data on cell number presented in the present report are those which are multiplied by four on the basis of assumption that such type of the net would allow as little as 25 per cent of the water column to pass through the bolting cloth (Motoda *et al.*, 1957). Moreover, the increase of hauling distance due to the drift of the ship caused by wind may have added to the height of water column. This error was corrected on the basis of the actual records of revolutions of current meter which was attached near the net (see *Data Record*, No. 1, p. 89).

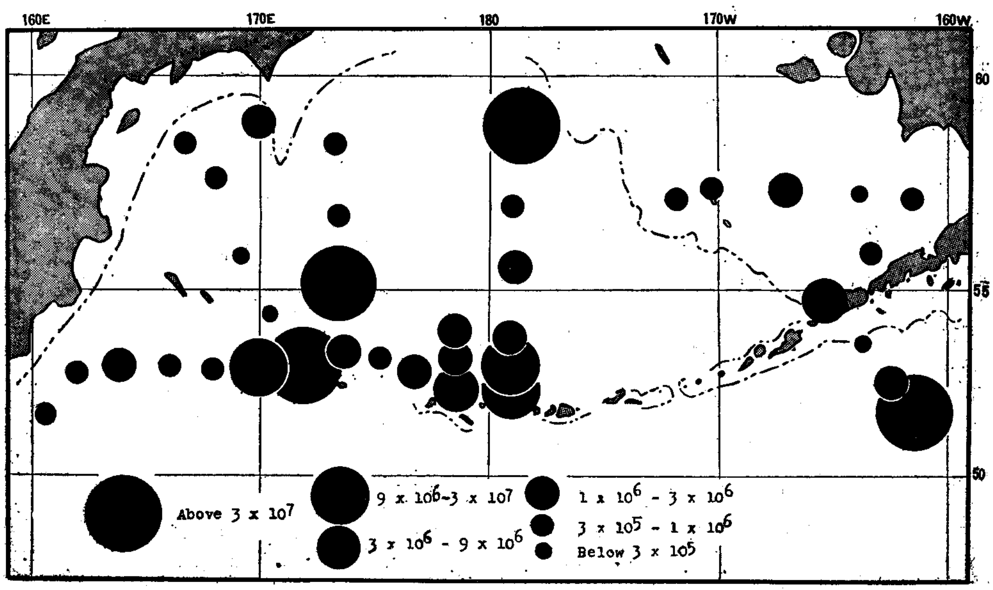

Fig. 2. Abundance of total diatom populations

The full data of the present studies are given in Table 2, among which abundance of total populations without regard to the species composition is illustrated in Fig. 2.

Throughout the whole areas investigated the quantity of diatoms vary from 100000 to 80000000 cells per 1 m^3 of water. Motoda & Kawarada (1955) gave an account of the quantity of diatoms on the basis of similar net samples in the western Aleutian waters taken on the cruise of May-June, 1953. Their data are not corrected either for errors due to filtration coefficient of the net nor for increase of hauling distance in rough weather. For comparison of size of populations between the 1953 and 1955 cruises the value 0.25 is tentatively adopted for filtration coefficient also to the data of 1953 cruise. Thus, the comparion of data from the two cruises shows that there were generally larger diatom populations in 1953 than in 1955.

	1953 cruise (Western Aleutian waters)	1955 cruise (Western Bering Sea: St. Os 1-Os 27)	1955 cruise (All stations)
Largest	494,160,000	79,600,000	79,600,000
Least	30,000	74,800	74,800
Mean	44,384,000	9,870,600	8,456,000

There are found rich populations of diatoms near Attu Island (St. Os 6 & Os 7), east of Bower's Bank (St. Os 20 & Os 23). Also diatoms are rich at St. Os 15, Os 27, Os 34 and at the south-easternmost station out of the Bering Sea (St. Os 37).

Locality	Cell number / m^3
Near Attu Island (St. Os 6 & Os 7)	14,056,000-79,600,000
East of Bower's Bank (St. Os 20 & Os 23)	19,700,000-20,880,000
St. Os 15	55,088,000
St. Os 27	31,920,000
St. Os 34	6,956,000
St. Os 37	33,324,000

Previous report also shows diatom-rich water in the east of Bower's Bank, and considerably too, near Attu Island (Motoda & Kawarada, 1955).

Quantitative data on the diatoms in the Aleutian waters have been presented by Aikawa (1932, 1935). His data are based upon the samples collected with Kitahara's fine mesh net, and no correction for the error regarding filtration coefficient is made. He reported cell number per 1 m^3 of water as follows:

Year		Largest	Mean
1928	Over	3,000,000	935,000
1933	〃	1,000,000	803,000

Although the comparison is very rough in exactness, the above data indicate far smaller populations than the present data. According to the dip-water samplings of Allen (1929, 1930), quantities of diatoms at the surface in Alaskan and Aleutian waters are as follows:

Locality and year	Cell number per m^3 in maximum catch among the stations
Alaskan waters (1923-24)	over 100,000,000
Mary I., Revillagigedo Channel, Alaska (1929)	40,000,000

Cupp (1937) recorded 28560000 cells per m^3 on average for five years (1927, 1929–32) at Scotch Cap Light, Unimak Island. In her summer collection the diatom cells were fairly abundant compared with the present data on St. Os 34 and Os 35 adjacent to Unimak Island.

III. Species Composition of Diatom Populations and its Regional Characteristics

The diatom species which most predominantly appear in the present samples are as follows:

Chaetoceros convolutus
Ch. debilis
Ch. seiracanthus
Ch. constrictus
Rhizosolenia hebetata f. *semispina*
Rh. heb. f. *hiemalis*
Denticula sp.
Ch. concavicornis
Ch. didymus
Ch. furcellatus
Nitzschia seriata
Fragilaria spp.
Thalassiothrix longissima

Table 1. Relative abundance of important diatoms in each region (In percent of cell number)

Main constituent \ Region	1	2	3	4	5	6	7	8	9	10	11	12	13
Station No.	6–9, 14,15	3,4, 10,11	12,13	1	4,5	16–19	21,22 24–26	20,23	27	30–32	28,29	33,34	35–37
Chaetoceros–Phaeoceros	3	1	5	2	45	9	6	9	6	57	35	3	2
Chaetoceros–Hyalochaete	13	2	31	83	4	26	2	6	40	1	25	82	9
Denticula sp.	+	9	2	1	15	17	3	2	+	1	2	3	1
Melosira sulcata										9		+	
Nitzschia seriata	84	18	14		28	21	4	4	47	9	25	2	30
Rhizosolenia hebetata* f. *semispina		+				3	2	68	+	+	1	4	58
Rhiz. heb.* f. *hiemalis	+	1	1			4	18	+		+	8	+	
Thalassiothrix longissima	+	62	33	5	4	19	63	10	1	11	4		
Other Diatoms	+	7	14	9	4	2	2	1	6	12	+	+	

Relative abundance of these species in percentage occurring in each catch is summarized in Table 1. The hydrographic observations in the present cruise have been analyzed by Asst. Prof. H. Koto, but not yet published. Through his courtesy the isotherms and isohalines at 25 meter depth are presented in Fig. 3.

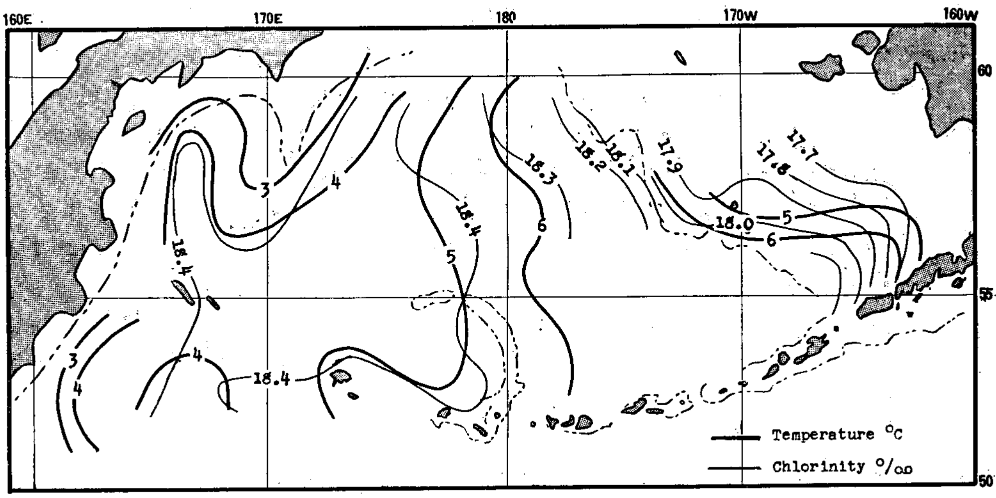

Fig. 3. Isotherms and isohalines at 25 meter depth (H. Koto)

Upon the basis of the characteristics in composition of diatom associations in upper 50 meter zone, the area investigated may be divided into thirteen regions (Fig. 4), and

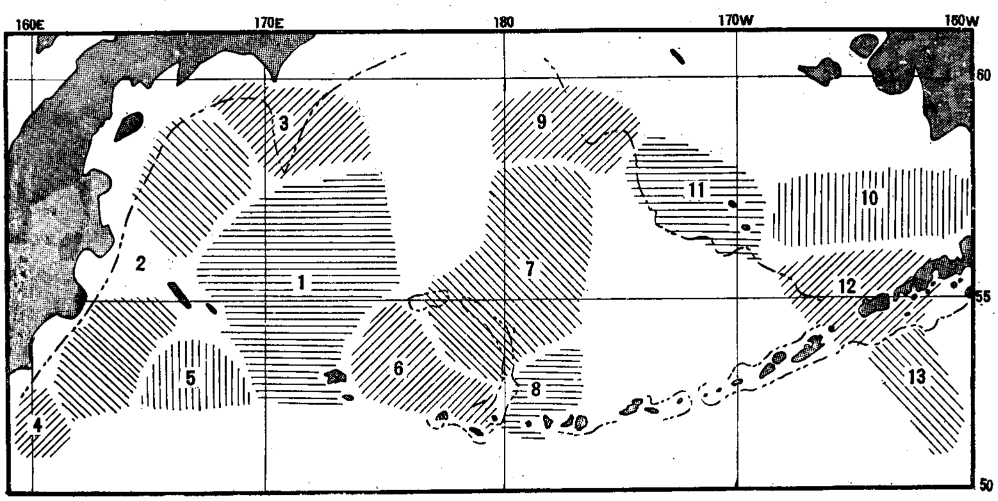

Fig. 4. Division of area according to the characteristics of diatom populations

the presentation of comments will be in order of these regions.

Region 1 (St. Os 6–Os 9, Os 14 & Os 15): In the area covering St. Os 6, Os 7 and Os 15, *Nitzschia seriata* is abundant, occupying more than three-fourths of total diatoms, and it is followed by *Chaetoceros–Hyalochaete*, mainly composed of *Ch. debilis, Ch. seiracanthus, Ch. decipiens, Ch. compressus* and *Ch. teres*, altogether which are less than 20% of total diatoms. It is indicated that the population generally includes neritic elements, except in the northern part (St. Os 8, Os 9 & Os 14) where such cold oceanic forms as *Chaetoceros convolutus, Thalassiothrix longissima* and *Denticula* sp. are present.

Region 2 (St. Os 2, Os 3, Os 10 & Os 11): In the western Bering Sea off the east coast of Kamchatka, cold-water species such as *Thalassiothrix longissima, Fragilaria* spp., *Denticula* sp. and *Nitzschia seriata* are widely distributed. The first species supplies more than a half of total diatoms. The dominance of these species may indicate the prevalence of cold water that flows southward along the coast of Kamchatka (Sverdrup *et al.*, 1942).

Region 3 (St. Os 12 & Os 13): Also *Thalassiothrix longissima* is dominant. *Hyalochaete* including *Chaetoceros debilis, Ch. compressus, Ch. decipiens, Ch. seiracanthus* and *Ch. furcellatus* is also numerous. This subgenus may indicates neritic influence in the southern offing of Cape Olyutorskii.

Region 4 (St. Os 1): In the offing to the southeast of Kamchatka, predominance of *Chaetoceros furcellatus* is observed, as abundant as about four-fifths of total diatoms. *Chaetoceros debilis, Ch. atlanticus, Fragilaria* spp. and *Thalassiothrix longissima* are found too, but very few in number. Predominance of such neritic forms has been also reported by previous workers in the area to the south of Kamchatka (Aikawa, 1938, 1940; Motoda & Kawarada, 1955; Marumo, 1956).

Region 5 (St. Os 4 & Os 5): Differing from the neighbouring stations, St. Os 4 and Os 5 are populated by somewhat peculiar composition, i. e., subgenus *Phaeoceros* (45%) containing *Chaetoceros convolutus, Ch. concavicornis* and *Ch. atlanticus*, and *Nitzschia seriata* (28%). In small quantities, *Thalassiothrix longissima, Corethron hystrix* and *Denticula* sp. are present. These diatom species reflect the cold oceanic nature of water in this area, agreeing with the results of previous investigations (Tsuruta & Chiba, 1954; Motoda & Kawarada, 1955). It is noted that the cold oceanic flora in this region is different in composition from that off east coast of Kamchatka (Region 2).

Region 6 (St. Os 16– Os 19): Along the northern side of Aleutian Islands, from Near Islands to Rat Islands, there are mixed associations, composed of *Hyalochaete* (26%), *Phaeoceros* (9%) and other oceanic forms. They are *Chaetoceros debilis, Ch. seiracanthus, Ch. atlanticus, Ch. convolutus, Denticula* sp. (17%), *Nitzschia seriata* (21%) and *Thalassiothrix longissima* (19%), but at St. Os 17 the last two species are considerably dominant. Predominance of *Hyalochaete* was reported by Motoda & Kawarada (1955) from the waters of western Aleutian Islands, but the present data show that considerable portions of populations in the same area are occupied by oceanic forms.

Region 7 (St. Os 21, Os 22, Os 24 – Os 26): Region 7 covers both sides of Bower's Bank and extends toward the north. *Thalassiothrix longissima* is a leading species, more than 60%, and next comes *Rhizosolenia hebetata* f. *hiemalis*. But at St. Os 26 the latter species is exceptionally numerous. *Chaetoceros atlanticus*, *Nitzschia seriata*, *Denticula* sp. and *Ch. debilis* occur in certain number at St. Os 25 and Os 26. The above dominant forms reflect the cold oceanic nature of the water.

Region 8 (St. Os 20 & Os 23): In the south of the east side of Bower's Bank, rich diatom populations are found, as many as more than 21 millions. The populations are characterized by the dominance of *Rhizosolenia hebetata* f. *semispina*, *Thalassiothrix longissima*, *Nitzschia seriata* and several species of *Hyalocheate*. It is shown that similar diatom floras are to be found between here and the south of Alaska Peninsula (St. Os 37); e. g., *Rhizosolenia hebetata* f. *semispina* is found to constitute a major portion of populations in both regions.

Region 9 (St. Os 27): This station is located close to the edge of the shallow shelf of the eastern Bering Sea. Diatoms are remarkably rich, and represented by *Nitzschia seriata* (47%) and *Hyalochaete* (40%) including *Chaetoceros debilis*, *Ch. seiracanthus*, *Ch. subsecundus*, etc. *Chaetoceros concavicornis*, *Fragilaria* spp. and *Thalassiosira decipiens* are also present in small number. These associations are generally resemblant to those in Region 1. The transparency of water measures only 6 meters, and the temperature falls from 6.7 °C at 25 meter depth to 2.4°C at 50 meter depth.

Region 10 (St. Os 30–Os 32): In Bristol Bay large portions of diatom populations are occupied by *Chaetoceros convolutus* and *Ch. concavicornis*, accompanying with *Coscinodiscus* spp., *Nitzschia seriata* and *Melosira sulcata*. Contrary to the expectation, neritic associations are not observed. General poverty of diatoms and predominance of *Phaeoceros* indicate that the central portion of Bristol Bay is much affected by cold oceanic water.

Region 11 (St. Os 28 & Os 29): This region is located on the shallow shelf of the eastern Bering Sea between Regions 9 and 10. There are present mixed associations of *Hyalochaete* (25%), mainly composed of *Chaetoceros debilis*. and *Phaeoceros* (35%), represented by *Ch. convolutus*, together with *Nitzschia seriata* (25%). Accordingly, this region may be the transitional area between Regions 9 and 10.

Region 12 (St. Os 33 & Os 34): Northwest coast of Alaska Peninsula is occupied by *Chaetoceros didymus*, *Ch. constrictus*, *Ch. debilis*, *Ch. radicans*, etc. These diatoms reflect the presence of warm water in the eastern Bering Sea. In poor number, *Rhizosolenia hebetata* f. *semispina*, *Melosira sulcata* and *Corethron hystrix* are present. It is noted that such a warm-water species as *Chaetoceros didymus* is dominant in the Bering Sea.

Region 13 (St. Os 35 – Os 37): On the Pacific side of the Alaska Peninsula, *Nitzschia seriata* and *Rhizosolenia hebetata* f. *semispina* are prevalent, especially rich in number and dominant in composition at St. Os 37. At St. Os 35 such *Hyalochaete* species as those found in Region 12 are numerously present, giving proof of neritic influence. Toward the south, *Chaetoceros concavicornis* and *Denticula* sp. occur in certain number, evidencing an indication of oceanic influence. *Rhizosolenia hebetata* f. *semispina* is also found which has been observed as a representative diatom on the east side of Bower's Bank.

There are found some inconstancies in the distributional feature of diatoms between the results of the present observations and the previous reports. In the present cruise the greater part of the Bering Sea is found to be dominated by such forms as *Thalassiothrix longissima, Nitzschia seriata, Rhizosolenia hebetata* f. *semispina* and *Rh. heb.* f. *hiemalis*. Such wide distribution of *Nitzschia seriata* has not been reported by previous worker (Aikawa, 1936, 1938, 1940). Also the dominant occurrence of *Chaetoceros didymus* which is known as a south temperate species, in the Bering sea is noted. The distribution of *Phaeo*-plankton is fairly localized in the present cruise. *Corethron hystrix* and *Coscinodiscus* spp., the representatives of cold oceanic diatoms, are very rare compared with the previous records (Kanno, 1935; Yanagisawa, 1942; Aikawa, 1936, 1938, 1940; Marumo, 1956).

The surface diatom data by water dipping method on the same cruise as the present studies are provided by Mr. Y. Kawarada, Hakodate Marine Observatory. The diatom cell numbers are generally larger in his data than in the present. He obtained the maximum occurrence of diatoms amounting to over 10^6 cells per liter (i. e., 10^9 cells per m^3) at St. Os 27, and also found abundance of diatoms in Regions 1, 3, 12, 13 and 6. The present studies show the maximum occurrence in Region 1 amounting to over 10^7 per m^3 and also abundant occurrence in Regions 8, 9 and 13. It must be kept in mind that his data are concerned with the surface dipping, while the present data are obtained by 0-50 meter hauls.

There are general agreements in distribution of dominant forms between the above vertical and the surface data. However, there are found remarkable differences of major constituents of diatoms between the two methods of sampling in the central portions of the Bering Sea (Regions 7 and 8). In Regions 7 and 8, *Thalassiothrix longissima, Rhizosolenia hebetata* f. *semispina* and *Rh. heb.* f. *hiemalis* are dominant in the upper 50 meters while *Denticula* sp. and *Hyalochate* are exclusively dominant at the surface. There are also some inconstancies between the above two samplings in other several localities: *Hyalochaete* is exclusively dominant at the surface in Regions 6, 7 and 9, whilst mixed associatons of *Hyalochaete, Thalassiothrix longissima, Nitzschia seriata* and *Phaeoceros* are found in the vertical haul.

In conclusion, the area investigated may be divided on the basis of certain peculiarities of diatom populations as follows: neritic areas are (1) off the east coast of Kamchatka, (2) Alaskan coast, (3) central Aleutian waters, and (4) a west portion of shallow shelf of the eastern Bering Sea. However, (1) and (2) are distinguished from (3) and (4), by the different representatives of diatom species. Oceanic areas are (5) almost all parts of the western Bering Sea and (6) portions of the eastern Bering Sea. In this demarcation, there is a disagreement between the present data and the results of observations by Johnson (1953) and Vinogradov (1956), e. g., the area (6), contrary to their cases, is indicated as an oceanic area by the present data. It has been reported that the water highly influenced by neritic elements from Alaskan coast prevails in the eastern Bering Sea and this water flows northward along the Alaskan coast (Barnes & Thompson, 1938; Goodman *et al.*, 1942; Sverdrup *et al.*, 1942). However, the diatom distribution observed on the present cruise does not confirm the above statements in the point that the eastern Bering Sea is indicated to be oceanic by the dominant presence of cold oceanic populations.

IV. Summary

Observations of the diatom populations in the Bering Sea in the summer of 1955 were made. The density of diatoms as a whole varies between 100000 and 80000000 cells per 1 m^3 of water.

Cold oceanic populations represented by *Thalassiothrix longissima*, *Rhizosolenia hebetata* f. *hiemalis*, *Fragilaria* spp. and *Denticula* sp. are widely distributed in the western Bering Sea (Regions 2 & 7) (Fig. 4). In Region 1 *Nitzschia seriata* is dominant, accompanying with subgenus *Hyalochaete*, which represents somewhat neritic nature.

In the eastern Bering Sea and southwestern part of the western Bering Sea an oceanic group, *Phaeoceros*, is distributed in certain restricted locations (Regions 5 & 10).

Neritic populations represented by *Hyalochaete* occur to the southeast of Kamchatka, in western Bering Sea and to the east of the shallow shelf of the eastern Bering Sea (Regions 4, 12 & 9).

Mixed associations of subgenus *Hyalochaete* and other oceanic forms are found in Aleutian waters (St. Os 16 - Os 19), to the south of Cape Olyutorskii and in the eastern Bering sea, suggesting the mixing of oceanic and neritic waters (Regions 3,6 & 11).

Rhizosolenia hebetata f. *semispina* and *Nitzschia seriata* are abundantly distributed in the offshore area of Pacific side of Alaska Peninsula, and the former species is also found in the east of Bower's Bank (Region 8 & 13).

Literature cited

Aikawa, H. (1932). On the summer plankton in the waters of the west Aleutian Islands in 1928. ***Bull. Jap. Soc. Sci. Fish.*** 1 (2), 70–74. (in Japanese).

———— (1935). On the quantitative analysis of the plankton associations in adjacent seas of Japan III. ***Jour Imp. Fish. Exp Sta.*** (6), 131–172. (in Japanese).

———— (1936). The planktological properties of the principal sea areas surrounding Japan. ***Bull. Jap. Soc. Sci. Fish.*** 5 (1), 33–41. (in Japanese).

———— (1938). On the quantitative analysis of the plankton associations in the adjacent seas of Japan V. ***Jour. Imp. Fish. Exp. Sta.*** (9), 67–86. (in Japanese).

———— (1940). On the plankton associations in the Bering Sea and the Okhotsk Sea. ***Kaiyô-Gyogyô*** 5 (1), 20–31. (in Japanese).

Allen, E. W. (1929). Surface catches of marine diatoms and dinoflagellates made by U. S. S. "Pioneer" in Alaskan waters in 1924. ***Bull. Scripps Inst. Oceanogr. Tech. Ser.*** 2 (2), 139–153.

———— (1930). Quantitative studies of surface catches of marine diatoms and dinoflagellates taken in Alaskan waters by the International Fisheries Commission in the fall and winter of 1927–1928 and 1929. ***Ibid.*** 2 (10), 389–399.

Anonymous (1957). ***Data record of oceanographic observations and exploratory fishing*** (1). 247p. Fac. Fish., Hokkaido Univ.

Barnes, C. A. & Thompson, T. G (1938). Physical and chemical investigations in Bering Sea and portions of the North Pacific Ocean. ***Univ. Wash. Publ. Oceanogr.*** 3 (2), 1–243.

Cupp, E. E. (1937). Seasonal distribution and occurrence of marine diatoms and dinoflagellates at Scotch Cap, Alaska. ***Bull. Scripps Inst. Oceanogr. Tech. Ser.*** 4 (3), 71–100.

Goodman, J. R., Lincoln, J. H., Thompson, T. G. & Zeusler, F. A. (1942). Physical and chemical investigations in Bering Sea, Bering Straits and Chukchi Sea during the summer of 1937 and 1938. ***Univ. Wash. Publ. Oceanogr.*** 3 (4), 105–169.

Johnson, M. W. (1953). Studies on plankton of the Bering Sea and Chukchi Sea and adjacent areas. ***Proc. Seventh Pac. Sci. Congr.*** 4, 480–500.

Kanno, R. (1935). The distribution of plankton during summer in the south Okhotsk Sea and on the coast of Kamchatka. ***Jour. Fish., Hakodate Coll. Fish.*** (38), 22–32. (in Japanese).

Marumo, R. (1956). Diatom communities in Bering Sea and its neighbouring waters in the summer of 1954. ***Oceanogr. Mag.*** 8 (1), 69–73.

Motoda, S. & Fujii, T. (1956). Report from the "Oshoro Maru" on oceanographic and biological investigations in the Bering Sea and northern North Pacific in the summer of 1955 I. ***Bull. Fac. Fish., Hokkaido Univ.*** 6 (4), 280–294.

———— & Kawarada, Y. (1955). Diatom communities in western Aleutian waters on the basis of net samples collected in May–June, 1953. ***Ibid*** 6 (3), 191–200.

Sverdrup, H. U., Johnson, M. W. & Fleming, R. H. (1942). ***The Oceans, their physics, chemistry and general biology.*** 1087 p. Prentice-Hall Inc., N. Y.

Tsuruta, A. & Chiba, T. (1954). On the distribution of plankton at the fishing ground of salmons in the North Pacific, 1952. ***Jour. Shimonoseki Coll. Fish.*** 3 (3), 39–45. (in Japanese).

Vinogradov, M. E. (1956). Distribution of zooplankton in the western regions of Bering Sea. ***Contr. Soviet Hydrobiol. Soc. Acad. Sci., U. S. S. R.*** 7, 173—203. (in Russian).

Yanagisawa, T. (1942). Plankton in the vicinity of Kurile Islands. ***Jour. Oceanogr., Kobe. Mar. Obs.*** 13 (3), 730–738. (in Japanese).

Table 2. Full Data of Diatom Observations (Cell number per cubic meter)

Station No.	1	2	3	4	5	6	7	8	9	10
Position	N 51-43 E160-30	N 52-52 E161-50	N 53-00 E164-00	N 53-01 E166-00	N 53-00 E168-00	N 53-02 E170-00	N 53-02 E172-00	N 54-30 E170-33	N 55-58 E169-11	N 57-41 E167-59
Species \ Transparency of water (m)	15.00	17.20	23.28	14.08	16.17	14.16	10.11	21.24	15.55	15.33
Achnanthes longipes										
Asteromphalus sp.									1200 (0.9)	
Biddulphia aurita										
Chaetoceros total	366000 (85)	26000 (2.8)	332000 (19.92)	236000 (50.8)	188000 (42.5)	1520000 (10.8)	19360000 (24.3)	16600 (22.2)	31600 (23.4)	19600 (3.7)
Phaeoceros total	10000 (2.3)	4000 (0.43)	312000 (18.72)	230000 (49.5)	158000 (34.7)	1040000 (7.4)	2720000 (3.5)	6600 (8.8)	10800 (8)	7600 (1.4)
Chaetoceros atlanticus	10000 (2.3)	4000 (0.43)	12000 (0.72)	10000 (2.1)	10000 (2.3)		320000 (0.5)	1800 (2.42)	1200 (0.9)	4800 (0.9)
Ch. convolutus			300000 (18)	200000 (43.1)	120000 (28)	1040000 (7.4)	2400000 (3)	4800 (6.4)	9600 (7.1)	2800 (0.5)
Ch. concavicornis				20000 (4.3)	18000 (4.2)					
Hyalochaete total	356000 (82.7)	22000 (2.4)	20000 (1.2)	6000 (1.3)	30000 (7.5)	480000 (3.4)	16640000 (20.8)	10000 (13.4)	19600 (14.5)	12000 (2.3)
Ch. decipiens					8000 (1.8)		160000 (0.2)	1800 (2.4)	1200 (0.9)	12000 (2.3)
Ch. compressus										
Ch. didymus										
Ch. constrictus										
Ch. subsecundus										
Ch. seiracanthus							480000 (0.6)			
Ch. debilis	16000 (3.7)	22000 (2.4)		6000 (1.3)	3600 (0.8)		16000000 (20)	5200 (7)	9600 (7.1)	
Ch. radicans										
Ch. furcellatus	340000 (79)									
Ch. teres					14000 (3)	320000 (2.3)		3000 (4)		
Hyalochaete spp.			20000 (1.2)		4400 (1.5)	160000 (1.1)			8800 (6.5)	
Corethron hystrix	6000 (1.4)		8000 (0.5)	24000 (5.1)	10000 (2.5)				1200 (0.9)	4000 (0.8)
Coscinodiscus spp.		20000 (2.1)	4000 (0.24)						600 (0.4)	
Denticula sp.	4000 (0.9)	68000 (7.6)	84000 (5)	98000 (21)	30000 (6.7)	96000 (0.7)	240000 (0.3)	1800 (2.4)	6000 (4.4)	50000 (9.5)
Fragilaria spp.	24000 (5.6)							6800 (9.5)		140000 (26.4)
Melosira sulcata										
Nitzschia seriata			600000 (36)	40000 (18.3)	201200 (46.7)	12320000 (87.6)	60000000 (75.3)	48000 (64)	90000 (67)	
Rhizosolenia hebetata f. *semispina*			10000 (0.6)							
Rh. heb. f. *hiemalis*		8000 (0.9)	10000 (0.6)					1200 (1.8)	600 (0.4)	2000 (0.4)
Stephanopyxis nipponica	2000 (0.5)									20000 (3.7)
Thalassiosira nordenskioldii	6000 (1.4)									2000 (0.4)
Thal. decipiens										
Thalassiothrix longissima	20000 (4.6)	800000 (86)	600000 (36)	26000 (5.6)	10000 (2.3)	120000 (0.9)			4800 (3.5)	280000 (54.4)
Total	429000	924000	1668000	424000	439000	14056000	79500000	74400	106000	520400

Station No.	11	12	13	14	15	16	17	18	19
Position	N 58-29 E166-32	N 59-00 E170-00	N 58-30 E173-15	N 56-54 E173-17	N 55-10 E173-17	N 53-25 E173-38	N 53-10 E175-04	N 52-50 E176-56	N 52-28 E178-40
Species \ Transparency of water (m)	15.00	10.03	13.22	9.00	10.45	10.18	10.20	9.40	12.51
Achnanthes longipes				6000 (1.6)					
Asteromphalus sp.									
Biddulphia aurita									
Chaetoceros total	14400 (2.2)	692000 (36.6)	170000 (33.8)	28000 (7.6)	8160000 (15.4)	452000 (31.8)	96000 (16.8)	788000 (36.8)	1360000 (38.2)
Phaeoceros total	4800 (0.7)	72000 (3.8)	26000 (5.1)	8000 (2.2)	120000 (0.2)	180000 (12.6)	58000 (10.2)	124000 (5.8)	360000 (10.1)
Chaetoceros atlanticus	4800 (0.7)	12000 (0.6)	14000 (2.7)		48000 (0.09)	180000 (12.6)	44000 (7.7)	16000 (0.8)	240000 (6.7)
Ch. convolutus		60000 (3.2)	12000 (2.4)	8000 (2.2)	72000 (0.14)		14000 (2.5)	108000 (5.0)	120000 (3.4)
Ch. concavicornis									
Hyalochaete total	9600 (1.5)	620000 (32.8)	134000 (28.1)	20000 (5.4)	8040000 (15.2)	232000 (19.2)	38000 (6.6)	664000 (31.0)	1000000 (28.1)
Ch. decipiens	9600 (1.5)	180000 (9.5)	34000 (6.6)	14000 (3.8)	120000 (0.2)	30000 (2.1)	4000 (0.7)		
Ch. compressus		60000 (3.2)	20000 (3.9)	6000 (1.6)	120000 (0.2)	8000 (0.5)			60000 (1.7)
Ch. didymus									
Ch. constrictus						40000 (2.8)		16000 (0.7)	100000 (2.8)
Ch. subsecundus		80000 (4.2)	4000 (0.8)						40000 (1.1)
Ch. seiracanthus		40000 (2.2)			5280000 (9.9)	40000 (2.8)	10000 (1.8)	240000 (11)	240000 (6.7)
Ch. debilis		100000 (5.3)	50000 (9.8)		2400000 (4.5)	100000 (7)	20000 (3.5)	380000 (17.7)	520000 (14.6)
Ch. radicans						16000 (1.1)	4000 (0.7)	16000 (0.8)	40000 (1.12)
Ch. furcellatus		20000 (1.05)	32000 (6.3)						
Ch. teres									
Hyalochaete spp.		140000 (7.4)	4000 (0.8)		120000 (0.2)	42000 (3.6)		12000 (0.8)	
Corethron hystrix			4000 (0.8)			24000 (1.7)		12000 (0.8)	
Coscinodiscus spp.	4800 (0.7)	10000 (0.5)					4000 (0.7)		
Denticula sp.	92000 (14)	20000 (1.1)	34000 (6.6)	50000 (13.7)	480000 (0.9)	260000 (18.3)	80000 (14)	280000 (22.4)	480000 (13.5)
Fragilaria spp.	24000 (3.6)	120000 (6.3)	12000 (2.3)	6000 (1.6)					
Melosira sulcata									
Nitzschia seriata	24000 (3.6)	300000 (15.8)	34000 (6.6)	200000 (54.6)	44400000 (83.6)	260000 (18.3)	140000 (24.5)	640000 (29.9)	600000 (16.9)
Rhizosolenia hebetata f. *semispina*						120000 (8.5)	14000 (2.5)	20000 (0.9)	80000 (2.2)
Rh. heb. f. *hiemalis*	14400 (2.3)	10000 (0.5)	4000 (0.7)			40000 (2.8)	52000 (9.1)	16000 (0.7)	180000 (5.1)
Stephanopyxis nipponica			4000 (0.7)			4000 (0.28)			
Thalassiosira nordenskioldii								8000 (0.4)	
Thal. decipiens	4800 (0.7)	180000 (9.5)	10000 (2.2)						20000 (0.5)
Thalassiothrix longissima	480000 (72.8)	560000 (29.6)	240000 (46)	76000 (20.7)	48000 (0.1)	260000 (18.3)	186000 (32.2)	176000 (8.1)	840000 (23.6)
Total	668000	1892000	512000	366000	53788000	1420000	572000	1412000	3560000

Station No.	20	21	22	23	24	25	26	27	27′
Position	N 52-30 W178-54	N 53-14 E178-40	N 53-54 E178-40	N 53-03 W178-52	N 53-50 W178-52	N 55-34 W178-48	N 57-00 W178-58	N 58-49 W178-43	N 58-49 W178-43
Species \ Transparency of water (m)		18.30		10.27	15.08	17.30	12.25	5.14	5.14
Achnanthes longipes									
Asteromphalus sp.									
Biddulphia aurita									
Chaetoceros total	2640000 (13.4)	280000 (9.8)	332000 (25.4)	3720000 (18.02)	156000 (5.8)	80000 (6.1)		21000000 (40.2)	8288000 (72.2)
Phaeoceros total	1880000 (9.5)	240000 (8.4)	212000 (16.2)	1960000 (9.4)	96000 (3.2)	80000 (6.1)		2840000 (5.4)	768000 (6.7)
Chaetoceros atlanticus	1480000 (7.5)	240000 (8.4)	212000 (16.2)	560000 (2.7)	96000 (3.2)	80000 (6.1)		160000 (0.3)	48000 (0.5)
Ch. convolutus	400000 (2.0)			1400000 (6.7)				1280000 (2.4)	40000 (0.3)
Ch. concavicornis					60000 (2.0)			1600000 (2.6)	680000 (5.4)
Hyalochaete total	760000 (3.9)	40000 (1.4)	120000 (9.1)	1800000 (8.6)				10160000 (34.8)	7520000 (65.5)
Ch. decipiens								1040000 (1.9)	320000 (2.8)
Ch. compressus									32000 (0.3)
Ch. didymus									
Ch. constrictus								160000 (0.3)	
Ch. subsecundus								320000 (0.6)	400000 (3.5)
Ch. seiracanthus	120000 (0.6)			120000 (0.6)	28000 (0.9)			2400000 (4.6)	1600000 (13.9)
Ch. debilis	200000 (1.0)	40000 (1.4)	120000 (9.1)	1600000 (7.7)	32000 (1.1)			12000000 (23)	5120000 (44.5)
Ch. radicans	440000 (2.23)			80000 (0.4)				160000 (0.3)	+
Ch. furcellatus									
Ch. teres									
Hyalochaete spp.								2080000 (3.9)	48000 (0.4)
Corethron hystrix	120000 (0.6)							720000 (1.4)	27200 (0.2)
Coscinodiscus spp.							20000 (2.4)		
Denticula sp.	200000 (1.0)		240000 (18.2)	720000 (3.5)			48000 (6.1)		64000 (0.6)
Fragilaria spp.								800000 (1.6)	560000 (4.9)
Melosira sulcata									
Nitzschia seriata	160000 (0.8)		80000 (6.1)	1600000 (7.7)	192000 (6.5)	48000 (3.7)	80000 (9.8)	28000000 (53.5)	2400000 (20.8)
Rhizosolenia hebetata f. *semispina*	13320000 (69.6)	120000 (4.2)	40000 (3.0)	13600000 (65.1)	48000 (1.6)	44000 (3.4)	10000 (1.2)	80000 (0.2)	
Rh. heb. f. *hiemalis*	140000 (0.7)	520000 (18.3)	144000 (10.9)		400000 (13.5)	180000 (13.7)	400000 (48.8)		
Stephanopyxis nipponica								80000 (0.2)	
Thalassiosira nordenskioldii									
Thal. decipiens								1200000 (2.4)	224000 (1.9)
Thalassiothrix longissima	2720000 (13.8)	1920000 (67.6)	480000 (36.3)	1200000 (5.8)	2160000 (73)	960000 (73.2)	260000 (31.7)	400000 (0.7)	
Total	19700000	2840000	1320000	20880000	2956000	1312000	818000	52280000	11563200

Station No.	28	29	30	31	32	33	34	35	36	37
Position	N 57-16 W171-50	N 57-27 W170-11	N 57-26 W167-05	N 57-23 W163-58	N 57-16 W161-40	N 56-04 W163-15	N 54-46 W165-19	N 53-40 W163-31	N 52-58 W162-19	N 52-15 W161-09
Species \ Transparency of water (m)	15.36	12.08	9.20	9.15	10.00	12.18	12.24		21.19	20.18
Achnanthes longipes										
Asteromphalus sp.										
Biddulphia aurita				3200 (1.8)	4000 (1.1)					
Chaetoceros total	256000 (47.1)	528000 (69.4)	728000 (69)	36800 (21.3)	143000 (40.8)	242400 (70.3)	6320000 (91.2)	48000 (34.8)	152000 (12.9)	3484000 (10.5)
Phaeoceros total	132000 (24.3)	320000 (42)	728000 (69)	24200 (14.9)	143000 (40.8)	12400 (3.6)	184000 (2.6)	8000 (5.8)	120000 (10.2)	380000 (1.1)
Chaetoceros atlanticus	8000 (1.5)						24000 (0.4)			80000 (0.2)
Ch. convolutus	100000 (18.4)	320000 (42)	728000 (69)	24200 (14.9)	3000 (0.8)					
Ch. concavicornis	24000 (4.4)				140000 (40)	12400 (3.6)	160000 (2.3)	8000 (5.8)	120000 (10.2)	300000 (0.9)
Hyalochaete total	124000 (22.8)	208000 (27.4)		12600 (6.4)		230000 (66.7)	6136000 (88.5)	40000 (29)	24000 (2.7)	3104000 (9.3)
Ch. decipiens	12000 (2.2)	8000 (1.1)								
Ch. compressus							136000 (2.1)			
Ch. didymus						80000 (23.2)	640000 (9.2)	6000 (4.3)	14000 (1.2)	104000 (0.3)
Ch. constrictus						120000 (34.8)	3360000 (48.4)	10000 (7.2)	18000 (1.5)	200000 (0.6)
Ch. subsecundus										
Ch. seiracanthus								4000 (2.9)		
Ch. debilis	92000 (16.9)	160000 (21)		12600 (6.4)		30000 (8.7)	400000 (5.7)	20000 (14.5)		2800000 (8.4)
Ch. radicans	20000 (3.7)						1600000 (23)			
Ch. furcellatus										
Ch. teres										
Hyalochaete spp.		40000 (5.3)								
Corethron hystrix						20000 (5.8)	40000 (0.5)			
Coscinodiscus spp.	12000 (2.2)	90000 (11.8)	136000 (12.9)	38000 (20.2)	4000 (1.1)					
Denticula sp.	20000 (3.7)	12000 (1.6)		13600 (7.6)	2000 (0.6)	40000 (11.6)	160000 (2.3)		80000 (6.8)	240000 (0.7)
Fragilaria spp.										
Melosira sulcata				77600 (43.2)	60000 (17)	6000 (1.7)				
Nitzschia seriata	200000 (36.8)	128000 (16.8)	8000 (0.7)	8000 (4.5)	130000 (37)	20000 (5.8)	128000 (1.8)	60000 (43.5)	900000 (76.1)	9600000 (28.8)
Rhizosolenia hebetata f. *semispina*	8000 (1.5)	10000 (0.3)			4000 (1.1)		272000 (3.9)	30000 (21.8)	48000 (4.4)	20000000 (60)
Rh. heb. f. *hiemalis*			8000 (0.7)	2000 (1.4)	4000 (1.1)	14000 (4.1)				
Stephanopyxis nipponica							16000 (0.23)			
Thalassiosira nordenskioldii						2400 (0.7)				
Thal. decipiens										
Thalassiothrix longissima	48000 (8.8)		176000 (16.7)							
Total	544000	768000	1056000	178800	351000	344800	6956000	134000	1180000	33324000