Diatom Communities in the Okhotsk sea, Principally on the West Coast of Kamchatka, Spring to Summer 1955*

Mamoru Ohwada**

During the cruise of the "Yōkō-maru", the factory ship of the Nihon Suisan Co., to and from crab-fishing grounds in the Okhotsk Sea in April and in August 1955 respectively, there was an opportunity to carry out a standard sampling of surface microplankton (Marumo, 1954) on board the ship. The present investigations are attempted to observe seasonal and regional variations of the diatom communities on the basis of the above samples. The diatom samples contained in 330 cc of surface water are concentrated by decanting and later centrifugalizing, and their subsamples are subjected to the cell count under microscope.

1. Result of Observations

In the southwestern part of the Okhotsk Sea, covering St. 1 to St. 9, the water temperature is as low as 0°C to -1°C, owing to the existence of the drift-ice in early April, that is, the lowest temperature throughout the present observations. The population of diatoms in these stations is generally small, showing, 5×10^2 to 10^4 cells per liter of water. The diatom communities, except St. 1, are characterized by the predominance of two genera, *Fragilaria* (*F. islandica*, *F. oceanica*, *F. oceanica* f. *circularis*) and *Thalassiosira* (*T. decipiens*, *T. hyalina*, *T. nordenskiöldii*).

From the presence of such cold neritic species, it is suggested that the waters here are much influenced by the cold neritic elements. These communities resemble quite to those in the drift-ice, which was reported by MATSUDAIRA (1933) on the shore

of Nemuro and KAWARADA (1955) on the neighbourhood of Abashiri. Moreover, above mentioned waters in the Okhotsk Sea are suggested to have certain relation to those in the "Neritic Oyashio Current" in the

Fig. 1. Observational station

southeastern part of Hokkaido (cf. Centr. Meteorol. Obs. 1955, Hakodate Mar. Obs. 1955b). On the contrary, at St. 1, *Chaetoceros debilis* is prevalent. In addition to this species, genus *Coscinodiscus* (*C. marginatus*, *C. stellaris*) and genus *Thalassiosira* (above-mentioned species) are more or less abundant.

At St. 10, although the total population of diatoms is fairly small as in the preced-

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** Oceanographical Section, Hakodate Marine Observatory.

ing stations, the nearly monotonous presence of genus *Nitzschia* (*N. closterium*, *N. eriata*) is observed differing from other stations. MARUMO (1956) stated that in the southern part of the northern Kurile Islands there also occurred genus *Nitzschia* in considerable numbers in August 1954, and therefore, the above fact might be considered as an evidence that the waters here resemble closely to those in St. 10.

In the area A, covering St. 11 to St. 16, the diatom population is not so different from the preceding stations, as well as the water temperature is, excepting St. 13, where the water temperature suddenly falls to -1°C , probably due to the approaching of the ice field. The following neritic cold water forms are important: subgenus *Hyalochaete* (*Chaetoceros compressus*, *Ch. constrictus*, *Ch. debilis*, *Ch. decipiens*, *Ch. radicans*), *Thalassionema nitzschioides*, genus *Thalassiosira*, genus *Nitzschia*, genus *Rhizosolenia* (*R. hebetata* f. *semispina*, *R. setigera*) and *Asterionella kariana*. The composition of such elements greatly varies even within a short duration (3-4 days), due to alternative tidal current (cf. SUDA 1934).

In the area B, including St. 17 to St. 23, the water temperature is generally low, but the cell number suddenly increases reaching 5×10^6 in the maximum at St. 21. This outburst of the population may be related to the neritic situations. At St. 17, genus *Thalassiosira* prevails, and in addition, genus *Fragilaria* is more or less important. From St. 18 to St. 23, genus *Thalassiosira* decreases gradually in number, accompanied with increase of genus *Fragilaria*. Finally at St. 23, genus *Fragilaria* shows the nearly monotonous presence. At St. 22 the temperature rises up to 3.5°C , while the population falls to 4×10^5 , with little change in the composition.

Between St. 24 and St. 28, in the area C, the population decreases gradually to 5×10^5 , but there is a remarkable mingling of subgenus *Hyalochaete* (*Chaetoceros constrictus*, *Ch. debilis*, *Ch. radicans*), and *Bacteriosira fragilis*. At St. 28, genus *Hyalochaete* occupies 95 per cent of the total diatoms. The gradu-

al decrease of the cell number accompanied with the gradual rise of the water temperature, may show that the spring growth in these coastal waters is finished.

From St. 29 to St. 46 in the area C, the population is generally small, showing 5×10^2 to 6×10^4 cells, except the Sts. 35 and 43, which are located at about 60 miles to the northern part of the area C, and contain fairly larger number of cells, 2×10^5 . Judging from the sudden decrease of the cell number and the prevalent appearance of subgenus *Phaeoceros* (*Chaetoceros atlanticus*, *Ch. convicorins*, *Ch. convolutus*), as well as occurrence of certain oceanic species the character of the water between St. 29 and St. 33 may be affected by the oceanic water. At St. 32 to St. 34, genus *Fragilaria* is predominant. The richness in the population of diatoms at St. 35 and St. 43, may be due to the shift of the sampling positions to the north, where the water temperature is still low, showing 4.5°C . It is probable that the period of the spring increase is delayed than in the southern part. It is supposed from the presence of subgenus *Phaeoceros* at Sts. 35 and 41 to 43, that the water in the northeastern part of the Okhotsk Sea had already been influenced by the oceanic elements.

Between Sts. 36 and 40, genus *Nitzschia* and *Leptocylindrus danicus* are predominantly distributed: at Sts. 36 and 40, there occurs the monotonous community of genus *Nitzschia*, while at Sts. 37 and 38, replaced with *Leptocylindrus danicus*, and at St. 39, in addition to these two forms, genus *Fragilaria* is more or less important.

At station 44 the population is small, 4×10^3 cells, forming the monotonous composition with *L. danicus*.

At Sts. 45 and 46, the total diatoms are slightly abundant, 2×10^4 to 6×10^4 , and the community is characterized by the presence of subgenus *Phaeoceros*, so that the waters here are possibly influenced by the cold oceanic water to a certain extent. This phenomenon may be brought out by approaching of the oceanic water to this coastal part, probably owing to the prevailing southward current as has been stated by

SUDA (1935).

At St. 47 near the central part of the Okhotsk Sea, the water temperature is the highest among the present observations, reaching 18°C. The population is small, 10^3 , containing the oceanic cold-water species, viz., subgenus *Phaeoceros*, and the neritic cold-water species, viz., *Rhizosolenia alata*, *R. fragilissima* and genus *Nitzschia*. These neritic species are thought to be carried from the southwest coast of the Kamchatka Peninsula with the drift of anticlockwise current (SUDA, 1953). In addition to these diatom species, *Parafavella logidentata*, which is one of the cold water indicators among tintinnids, appears in fairly high numbers, showing 30 per cent to the total microplankton.

At St. 48, the population is the least throughout the present investigation, 2×10^2 , showing the monotonous composition of subgenus *Phaeoceros*. These oceanic cold-water species, viz., *Phaeoceros*, frequently appear in so-called "Oceanic Oyashio Current" in the sea area east off Tōhoku District (Centr. Meteorol. Obs. 1955, Hakodate Mar. Obs. 1955 a,b). KANNO (1935) stated on the basis of the net sampling that such oceanic forms were populated more densely in the eastern part of the Okhotsk Sea in summer. However, in the present case, on the contrary they occur rather more densely in the western part.

At St. 49, the count of diatoms is low, 3×10^3 , and the community is characterized by the predominance of *Rhizosolenia alata*, as like as the description by AIKAWA (1933, 1936) as the "Styli-plankton"

2. Discussion

As the course of the ship was located along the west coast of the Kamchatka Peninsula, from south (area A) to north (area C), the samples contain the neritic cold-water forms predominantly throughout these regions. Thus, the variation in the diatom communities in the samples may involve the local variation in confusion of the seasonal variation.

In April, in the area A, there is no dominant species, but several diatom species appear in almost equal amount.

In May, in the area B, the chief components are genus *Thalassiosira* and genus *Fragilaria*.

In June, in the area C, subgenus *Hyalochoete* becomes predominant, but above-mentioned species are still present in considerable number for early ten days, while genus *Fragilaria* is again predominant for the last ten days of this month. The predominant occurrence of the oceanic cold-water species, viz., subgenus *Phaeoceros*, during the period from the middle to the end of this month, may give an evidence of approaching of the oceanic water to this coastal part; that is the fact, when the southward current prevails the oceanic cold water may invade in the coastal region (SUDA, 1934).

In July, in the area C, *Leptocylindrus danicus* and genus *Nitzschia* are important.

In August, in the area C, *L. danicus* is prevalent until 12th, but afterwards subgenus *Phaeoceros* and subgenus *Hyalochoete* are more or less important.

The vernal growth is observed chiefly in the areas B and C, starting from early May in the waters with low water temperature, about 1°C, and it seems to finish in the middle of June, when the water temperature is about 5°C. So far as the water temperature is concerned, it may be thought that the optimum temperature to induce or maintain the spring increase lies in the limits from 1°C to 5°C, in these areas.

In the waters with low water temperature, about 1°C, in May, genus *Thalassiosira* and genus *Fragilaria* are predominant. But in the waters with some higher water temperature, about 3°C to 5°C, subgenus *Hyalochoete* becomes predominant, but above-mentioned forms are still present in considerable number for early ten days of June.

When the water temperature is higher than 5°C, but not so high as about 7°C from the middle of June to July, the cell number decreases. When the water temperature is still low, 4.5°C, as at Sts. 35 and

43 situated in the northern part of the area C in July, the population is still numerous. This increase may be correspondent to the

vernal growth there. At St. 35 gubgenus *Hyalochaete* is prevalent, accompanied with subgenus *Phaeoceros* and genus *Thalassio-*

Fig. 2. Diagram showing the regional variation (corresponding to monthly variation) of total cells and composition of major constituents. The numerals attached in parentheses mean the power of 10^5 , for instance, 5(2) denotes 500.

A: Diatom components represented by the symbols.

- (1) *Chaetoceros atlanticus*, *Ch. concavicornis*, *Ch. convolutus*,
- (2) *Cheatoceeros compressus*, *Ch. constrictus*, *Ch. debilis*, *Ch. decipiens*, *Ch. radicans*,
- (3) *Fragilaria islandica*, *F. oceanica*, *F. ocea. f. circularis*, *F. striatula*,
- (4) *Thalassiosira decipiens*, *T. hyalina*, *T. nordenskiöldii*,
- (5) *Nitzschia closterium*, *N. frigida*, *N. seriata*,
- (6) *Leptocylindrus danicus*,
- (7) *Rhizosolenia alata*, *R. hebetata f. semispina*, *R. setigera*,
- (8) *Thalassionema nitzschioides*,
- (9) *Bacteriosira fragilis*,
- (10) *Coscinodiscus marginatus*, *C. stellaris*,
- (11) *Coscinosia polychorda*,
- (12) *Asterionella kariana*.

B: Number of station.

C: Day.

D: Month.

sira, while at St. 43 both genus *Nitzschia* and subgenus *Phaeoceros* are considerably important.

From the above facts, so far as this investigation is concerned, it is suggested that the spring growth in the sea area on the west coast of the Kamchatka Peninsula begins from the southern part in May, in which water temperature is about 1°C, and proceeds northward. It declines gradually with the rise of water temperature, and finally it ends when the water temperature becomes above 5°C.

Although Sts. 41 and 42, and Sts. 35. and 43 are all situated in the north part of the area C, the temperature is lower by 2.5 to 3°C in the latter two stations than in the former two. This difference of temperature is reflected upon the density of total population; the high concentration at Sts. 35 and 43 as contrast to the low concentration at Sts. 41 and 42. As the diatom species composing population do not differ with the above two groups of stations, the difference of population density with each other might indicate that this difference occurs due to the seasonal variation of growth in these areas.

3. Summary

(1) The density and composition of the plankton diatoms in the surface waters of the west coast of the Kamchatka Peninsula from April to August in 1955 are observed. In general, the leading forms are genus *Thalassiosira*, genus *Fragilaria*, subgenus *Hyalocheate*, subgenus *Phaeoceros*, genus *Nitzschia* and *Leptocylindrus danicus*.

(2) It is suggested that the vernal growth in the coastal waters on the west coast of the Kamchatka Peninsula begins in early May, with maximum cell number 5×10^6 per liter of water. There is, however, an alternation of the major components with succession of time. The vernal growth seems to end in the middle of June. The optimum temperature of the water for the spring increase in these coastal waters, may range from 1°C to 5°C.

(3) Near the drift-ice from St. 2 to St. 9, the water temperature is lower than 0°C,

and the population is fairly small, showing 5×10^2 to 10^4 , and composed of principally genus *Fragilaria* and genus *Thalassiosira*. The certain species in this community are possibly supplied to the waters in the so-called "Neritic Oyashio Current" in the eastern part of Hokkaido in May.

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