PLANKTON INVESTIGATION IN INLET WATERS ALONG THE COAST OF JAPAN

XVIII. SEASONAL SUCCESSION OF PLANKTON IN TAIZI BAY IN THE YEARS 1951–1953[1]

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With Plates XXI–XXII and 12 Text-figures

With the object of studying the stability and the seasonal succession of plankton in inlet waters, the routine works have been started since July, 1951 and are now going on in bays of Taizi, Moriura and Tanabe along Kii Peninsula. In these works our special attention was paid to the following points: (1) How the plankton communities differ regionally from the innermost part of the inlet to the open sea being influenced by topographical and hydrographical conditions, (2) the relation between the predominance of oceanic or neritic plankton and the movements of water masses, and (3) the correlation between the fishery and the hydrological environment, of which the physical and chemical factors were referred to together with the plankton as the synthetic indicator. The last point has a concern in the fishery of yellowtail *Seriola quinqueradiata* TEMMINCK et SCHLEGEL (Japanese name "Buri"), one of the highly appreciated food fishes in our country, which are captured by kiddle net on the fishing ground near the entrance of Taizi Bay in the season from December to May; and this fishery seems certainly to be influenced by hydrological condition of the coastal waters.

There are many works reporting the seasonal succession of plankton in inlets and bays along the coast of Japan (KOKUBO, 1930–1952; KOKUBO and TAMURA, 1934 and 1938) MATSUDAIRA, 1939; UEDA, 1949; FUJIYA, 1952; OKITSU, 1953; SHIMOMURA, 1953; KADO, 1954). They are, however, chiefly dealing with only the phytoplankton in detail. Moreover the plankton occurring along the Kii Peninsula is left nearly unstudied, excepting a few works by MIYADI (1940) dealing with the benthic community of the bay. Here the results of the works in Taizi Bay are described.

1) Contributions from the Seto Marine Biological Laboratory, No. 263.

Publ. Seto Mar. Biol. Lab., IV (2-3), 1955. (Article 26)

Plankton and water samples were collected monthly from July, 1951 to June, 1953 at the stations indicated in Fig. 1, besides one station at the innermost area was added since April, 1952. For the meteorological data quoted in this article we are indebted wholly to the Sionomisaki Meteorological Observatory. Plankton samples

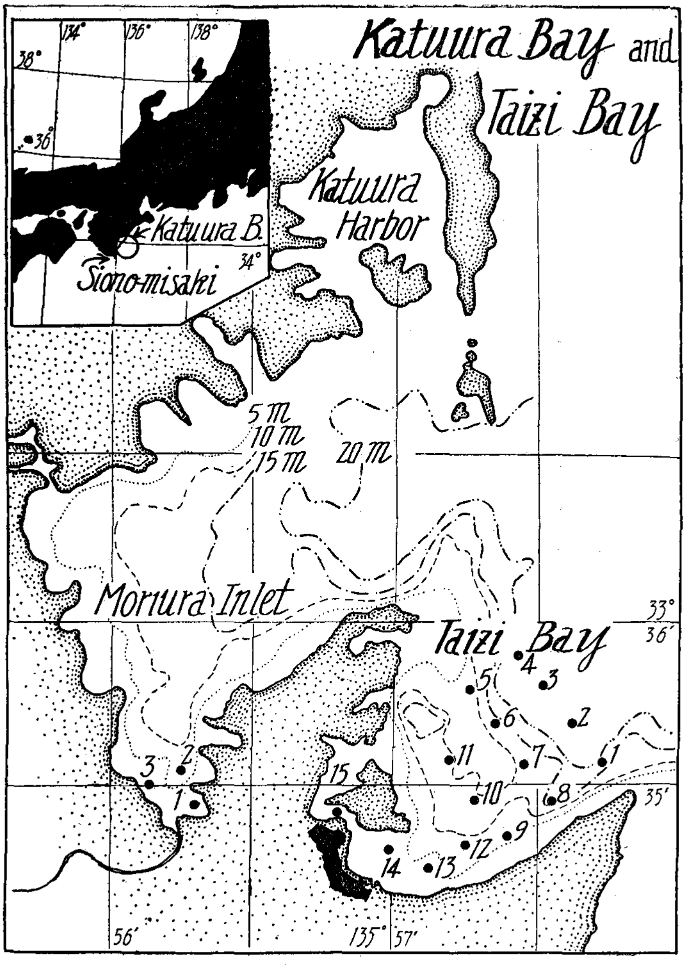

Fig. 1. Map of Taizi and Katuura Bay, showing the stations and bathymetric contours.

were hauled vertically from the bottom to the surface at each station in the daytime by KITAHARA's quantitative tow net stretched with No. 13 MÜLLER gauze. The size of the net is 22.5 cm in diameter of the mouth and 100 cm in length; therefore the mouth of the net cut off a water column of 50 liters at each one meter haul. All data and figures about the plankton imply the volume or number per one meter haul.

Samples were settled for 24 hours in a measuring cylinder and volumes were recorded in cc.

Before going further, we express here our sincere thanks to Mr. K. OKA, the director of the Sionomisaki Meteorological Observatory and to Mr. K. OGURA, a member of the same Observatory, for their kindness in allowing to use the meteorological data obtained by the Observatory.

Environmental Conditions

Of the hydrological and meteorological conditions, temperature, chlorinity, transparency, phosphates, silicates, catalytic activity of sea water, temperature, wind direction, rainfall and sunshine in the atmosphere are here concerned.

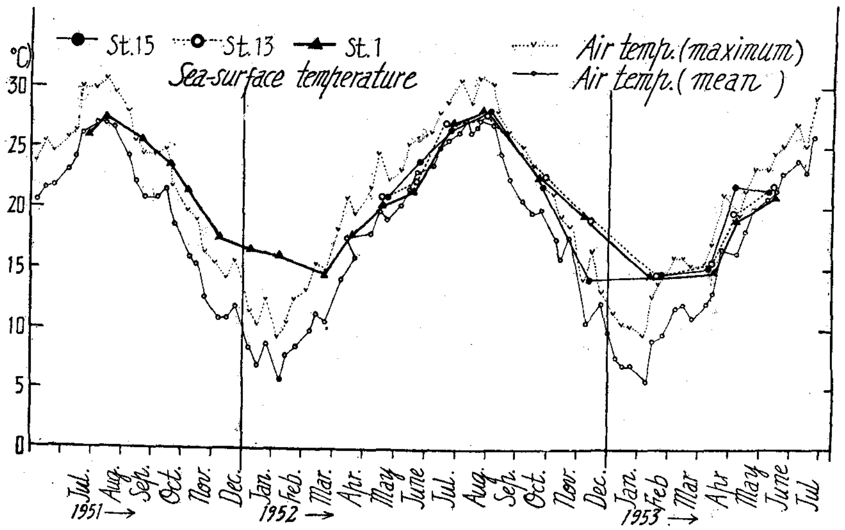

Fig. 2. Variations of the air and sea-surface temperature in Taizi Bay during the period from July, 1951 to July, 1953.
The plotted points represent 10-day averages.

Temperature (Fig. 2): Surface water temperature observed monthly and air temperature in ten-day averages and the maximum value for ten days are plotted in Fig. 2. The maximum of surface water temperature occurred during the period from late August to early September, while the minimum in February or March, and these are generally in accordance with the extremes of the air temperature. As shown clearly in the figure, the surface water temperature is generally higher than the average air temperature and the difference between the water and air temperatures is markedly large during the cold season from late autumn to early spring, while during the warmer season from early spring to autumn it is very small. The rapid

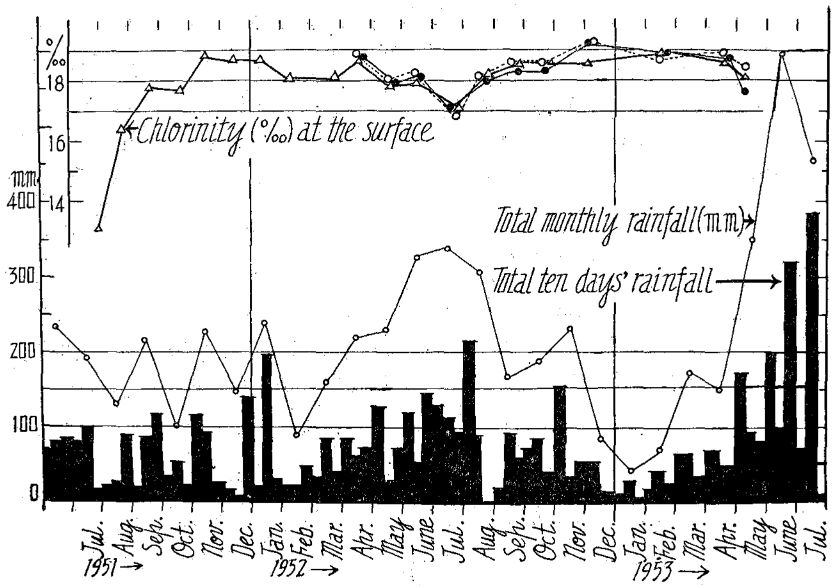

Fig. 3. Variations of the surface chlorinity (above), total monthly rainfall (middle) and total ten-days' rainfall at Siono-misaki from July, 1951 to July, 1953.

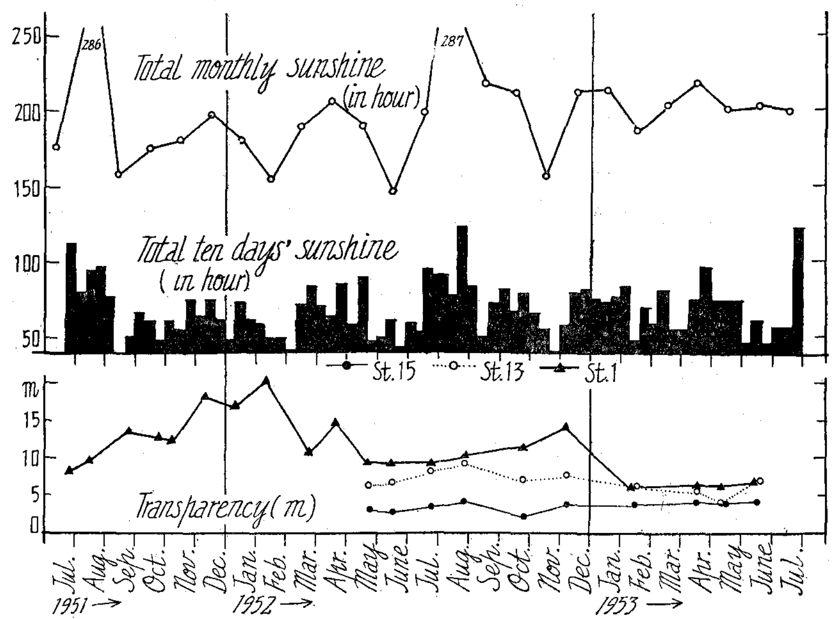

Fig. 4. Variations of the total monthly sunshine (in hour) (above), total ten days' sunshine at Siono-misaki (middle) and transparency of the sea water in Taizi Bay (below) from July, 1951 to July, 1953.

fall of the air temperature in autumn induces the gradual cooling of the surface water. The temperature at three stations situated respectively at different parts of the bay somewhat differs one another, namely the temperature in the inner region is higher during the warm season and lower during the cold season than in the outer region of the bay. This phenomenon is correlated distinctly with the stagnation of the water. During the present observations the diatom increase in winter was found in the lowest water temperature and the summer diatom maximum occurred before the temperature reached the climax.

Chlorinity (Fig. 3): The chlorinity of the surface water shows the range of variation from 17 to 19‰ throughout the year, except in early summer when it may show extraordinarily low values. The highest value is found in the coldest season from autumn to winter, while the lowest value in early summer as mentioned above. The seasonal fluctuation of chlorinity corresponds well with that of the rainfall as shown

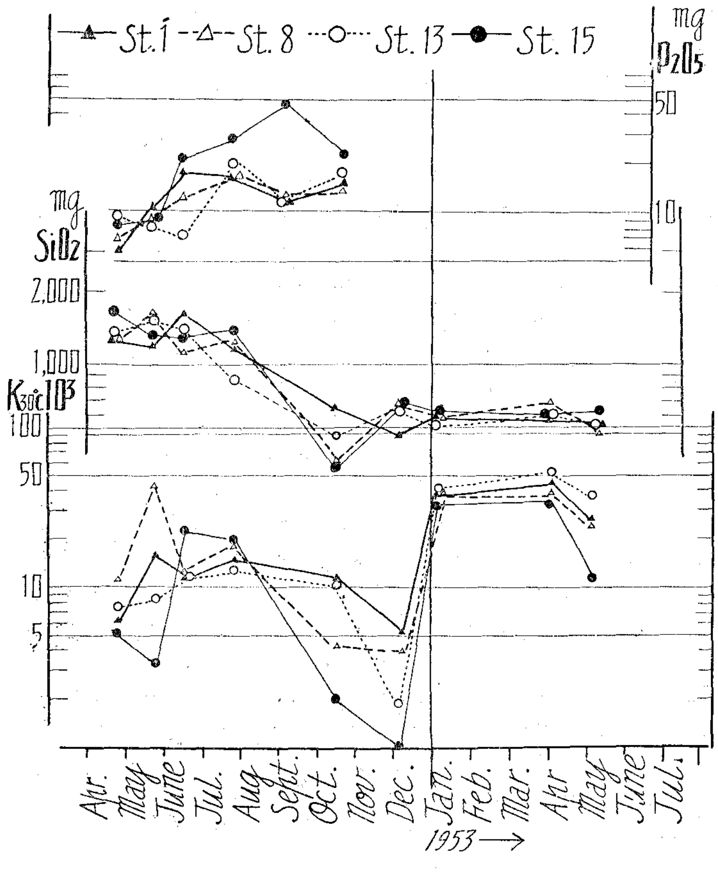

Fig. 5. The seasonal variations of the hydrological conditions in Taizi Bay. Phosphates (P_2O_5, mg/m^3) (above), silicates SiO_2, mg/m^3) (middle), and catalytic activity of sea water ($K_{30°C} \cdot 10^3$) (below).

in Fig. 3. The summer maximum of diatoms is accompanied by the decrease of chlorinity, which is brought by rich land drainage containing an amount of nutrient salts, although the winter propagation seems entirely not to depend upon the decrease of chlorinity.

Transparency (Fig. 4): The transparency ranged seasonally between 2 and 20 meters. The water is less transparent in the inner region than in the outer region, chiefly because of the existence of suspending debris. It was generally larger in the later half of 1951 and the early half of 1952 than in other periods. In the outer region, the lowest reading 6 m was found in the spring of 1951, while the higher readings more than 12 m were observed in late autumn in 1951 and 1952, and in the winter of 1952. These higher values may be accepted as a sign of richer inflow of oceanic water mass in these periods than in others.

Other enviromental factors are shown in Figs. 4 and 5, and the correlation between the hydrological condition and the plankton will be discussed later on.

Volume and Number of Plankton

Four stations (Sts. 1, 8, 13 and 15) were selected as representatives of the inner and outer parts of the bay and two intermediate regions between them, when we treated the data stationally. Volume and number of plankton varied seasonally and regionally, although the fluctuations seem to belong to a regular cyclic one at least in years of our observations. We found two maxima of each volume and number in a year; one was in winter and the other was in summer (Figs. 6 and 7) as in cases observed by UEDA (1949) in Uranouti Bay of Kôti Prefecture and by KADO (1954) near Mukaizima in the Inland Sea.

During July and August, 1951, the quantity of plankton and the number of species were very large, and the volume and number reached the maximum. This was induced by rich population of a few species of *Chaetoceros*, *Bacteriastrum* and zooplankton, chiefly copepods and their nauplii. The enormous abundance of typical oceanic plankton in this year is probably due to the strong inflow of "Kurosio". A small peak occurred in early November; this was induced chiefly by local flourishing of Pennatae diatoms: *Thalassiothrix*, *Thalassionema* and *Nitzschia*. This autumnal flourishing of diatoms was not found in the next year, 1952. From December, 1951 to February, 1952 and in January, 1953, the volume of plankton and the number of species declined, but soon followed by the vernal flourishing of some neritic diatoms. The vernal propagation in 1953 consisted of neritic diatoms of boreal temperate water and abundant tintinnids being associated with some neritic zooplankton of warm water and continued from January till the end of April relatively larger than in 1952; in 1952 the quantity of plankton reached the minimum during the period from the end of April to nearly the end of May. The increase of the number of warm water species began in early summer and the association changed gradually to the summer phase.

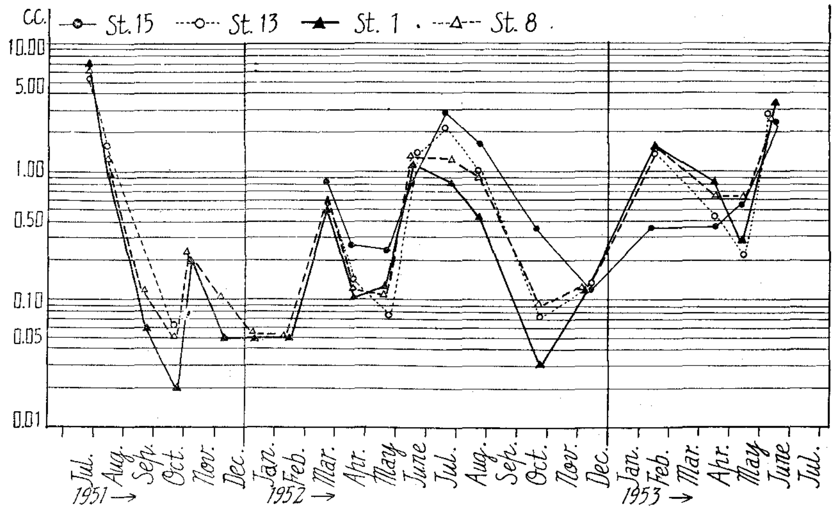

Fig. 6. Settling volume at the four stations of Taizi Bay during the period of July, 1951 to July, 1953. Unit of volume is cubic millimeter of plankton per one meter haul.

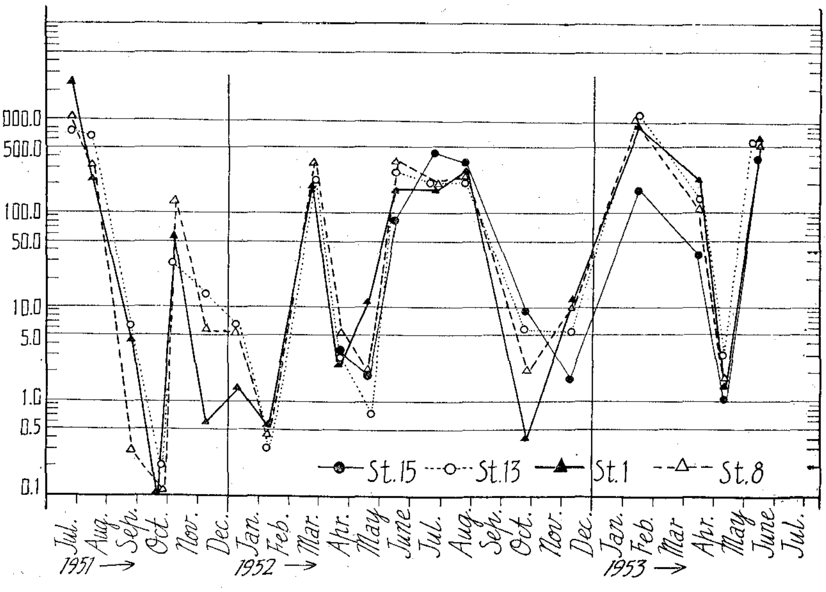

Fig. 7. The total number of plankton from the inner to the outer region of the bay per one meter haul. Unit of number is thousand.

As mentioned above, the differences in the time of occurrence of maxima of volume and number of plankton may be attributable partly to the difference of stations; the rich population was found generally at stations in the inner part of the bay more frequently than at those in the outer part, although the richest catch throughout the whole period of our observations was recorded in the outer part of the bay in 1953.

Proportion of Zooplankton to Phytoplankton

The total quantities and the percentages of zoo- and phytoplankton varies seasonally and stationally as shown in Fig. 8. Phytoplankton shows two distinct peaks, one

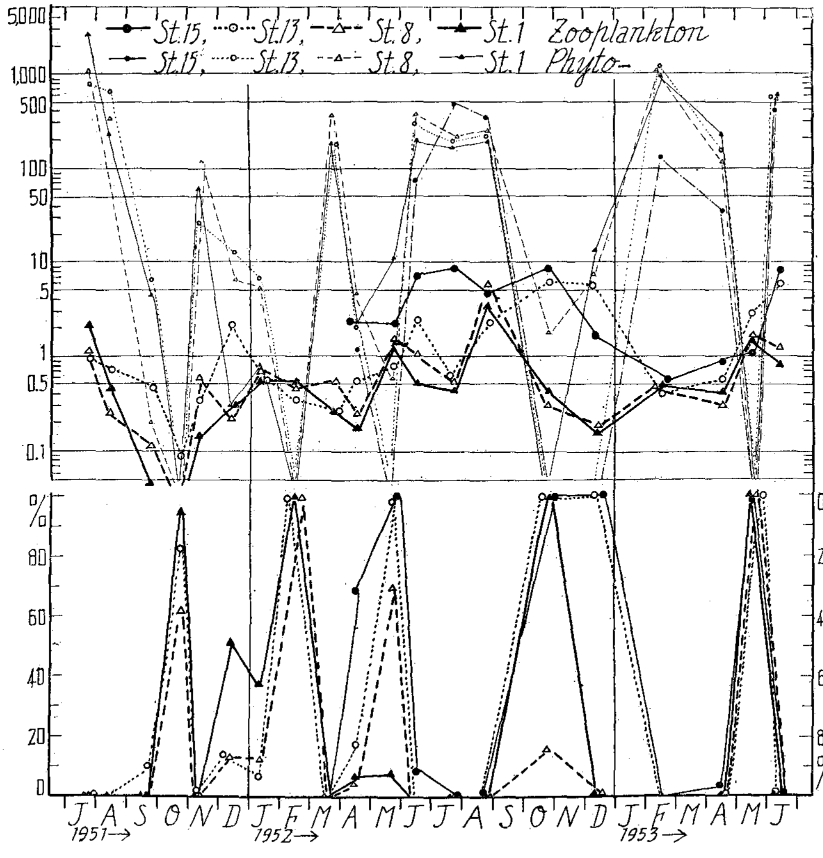

Fig. 8. Seasonal variations of the total number of zoo- and phytoplankton per one meter haul, and their percentage composition.

from late winter to early spring and the other in summer, and a temporary and indistinct one in autumn as seen in 1952, while zooplankton population is generally occupied by some special organisms.

Qualitative Succession of Plankton

Although the components of plankton in this bay is very complicated, ecologically and economically important ones in inlet waters may be summarized as follows (Fig. 9):

(1) Copepod population: *Oithona nana, Acartia clausi, Acartia spinicauda, Paracalanus parvus, Oithona similis* and *Oithona rigida* were the important species.

(2) Larval forms, including copepod nauplii, gastropod and pelecypod veligers, polychaete larvae, pluteus, besides the sporadic appearance of larvae of other benthic animals.

(3) Protozoans, including a large number of *Tintinnopsis radix, Favella taraikaensis, Poroecus apiculatus* and radiolarians.

(4) Other animals, consisting of neritic and oceanic forms excepting the preceding groups. *Sagitta delicata, Oikopleura dioica, Penilia schmackeri, Evadne tergestina* and hydromedusae of neritic waters and *Sagitta enflata, Oikopleura longicauda, Fritillaria,* and *Doliolum* of oceanic waters were the important forms.

(5) Phytoplankton including diatoms, both neritic and oceanic, and dinoflagellates. Of diatoms *Chaetoceros, Thalassiothrix, Thalassionema, Nitzschia, Bacteriastrum* and *Rhizosolenia* occurred most numerously.

Figs. 9–12 show the seasonal succession of important zoo- and phytoplankton groups or species in number and percentage.

From July to August in 1951: The plankton was composed of rich local stock and a small number of open sea species. The copepods were represented dominantly by *Paracalanus parvus, Oithona similis, Oithona nana,* and partly by a small number of *Acartia spinicauda, Microsetella rosea,* and *Oncaea media.* A large number of larval forms, consisting of abundant copepod nauplii, a considerable number of cirripedian nauplii and pelecypod veligers, were also observed. *Tintinnopsis radix* occurred abundantly in July, but this species and also *Rhabdonella elegans, Rh. spiralis* and *Favella campanulla* were found sparsely in August. *Penilia schmackeri, Evadne tergestina, Oikopleura dioica, Oikopleura longicauda, Fritillaria* sp. and *Doliolum tritonis* were also met with frequently. Diatoms consist of *Chaetoceros Lorenzianus, Ch. affinis, Bacteriastrum hyalinum, Ch. compressus, Ch. didymus, Ch. laciniosus,* a small number of *Thalassionema nitzschioides, Thalassiothrix Frauenfeldii* and significant amount of oceanic forms. The dominant forms are all distinct neritic or inlet-water species and their appearance reflects the warm water condition.

From September to October in 1951: The plankton community differed from that of the preceding period in quantity and quality. Important copepods decreased remarkably and the percentage composition varied considerably as shown in the figures, although the occurring members were almost unchanged. *Oithona similis, Microsetella rosea, Paracalanus parvus* and *Oithona nana* were important species and accompanied by *Oncaea, Corycaeus, Calanus darwinii, Calanus helgolandicus, Calo-*

calanus sp., *Eucalanus attenuatus, Lucicutia flavicornis, Paracalanus aculeatus, Centropages yamadai, Oithona plumifera, Setella gracilis, Euterpe acutifrons, Oithona falax* of copepods, *Sagitta enflata, Oikopleura longicauda* and a tintinnid *Epiplocylis undilla* var. *blonda.* Of diatoms *Chaetoceros coarctatus, Ch. diversus, Ch. messanensis, Ch. peruvianus, Ch. dadayi, Ch. pseudocurvisetus, Bacteriastrum commosum, Rhizosolenia robusta, Rh. bergonii, Rh. cylindrus, Rh. calcar avis,* etc. were tropical members, and the tropical feature of plankton was maintained distinctly till November. The occurrence of neritic and inlet-water copepods, *Oithona rigida* and *Acartia spinicauda,* was also noticeable in this period. As mentioned previously the dominancy of oceanic plankton in the autumn of 1951 was very remarkable.

From November to December in 1951: The tropical forms gradually decreased and attained to the minimum at the end of December. The plankton was composed of local stocks consisting chiefly of *Oithona nana, Oithona rigida, Acartia spinicauda* and a small number of *Paracalanus parvus.* The associated forms with these copepods were almost similar to those in the preceding period.

From January to February in 1952: The plankton, especially phytoplankton, was very poor in quantity and also in number of species, here the occurrence of a cold water-form *Chaetoceros socialis* was noticeable. Copepods were dominated by *Oithona nana, Acartia clausi, Oithona similis* and *Paracalanus parvus,* although some oceanic forms still remained. Tintinnids, *Favella taraikaensis* and *Tintinnopsis radix* occurred in this period.

From March to May in 1952: The plankton was characterized by the dominant copepods: *Acartia clausi* and *Oithona nana* at the inner stations, and *Oithona similis* and *Paracalanus parvus* at the outer. *Favella taraikaensis* was widely distributed, but especially it was numerous at the inner stations. Cirripedian nauplii, *Penilia schmackeri* and *Evadne tergestina* occurred in the middle of May. The diatoms were represented chiefly by *Ch. Van Heurcki* and *Ch. didymus, Nitzschia seriata* began to increase in March, showed a small peak of spring flourishing and decreased rapidly in April, attaining to the minimum in May. The decrease of diatoms seems to show the period when the quantitative change of plankton is going on.

From June to August in 1952: The plankton showed a clear summer association. Zooplankton was characterized by the dominance of copepods as yet, namely by *Oithona* at the inner stations and by *Oithona* and *Paracalanus* at the outer stations. Other important forms were *Oithona similis, Acartia spinicauda, Microsetella rosea, Oncaea media, O. venusta, Corycaeus* spp., *Setella gracilis* and *Euterpe acutifrons* of copepods, *Penilia schmackeri, Evadne tergestina* and *Podon* sp. of Cladocera, *Sagitta delicata,* a large number of *Oikopleura dioica* and *Tintinnopsis radix* and *Tintinnus lusus-undae.* Larval forms occurred considerably. Many warm oceanic forms accompanied to them. Diatoms were most abundant in this period throughout the year as in the preceding year. Important species were *Chaetoceros laciniosus, Ch. didymus, Ch. affinis, Ch. compressus* and *Ch. Lorenzianus.* Other neritic and oceanic diatoms were similar to those occurred in 1951.

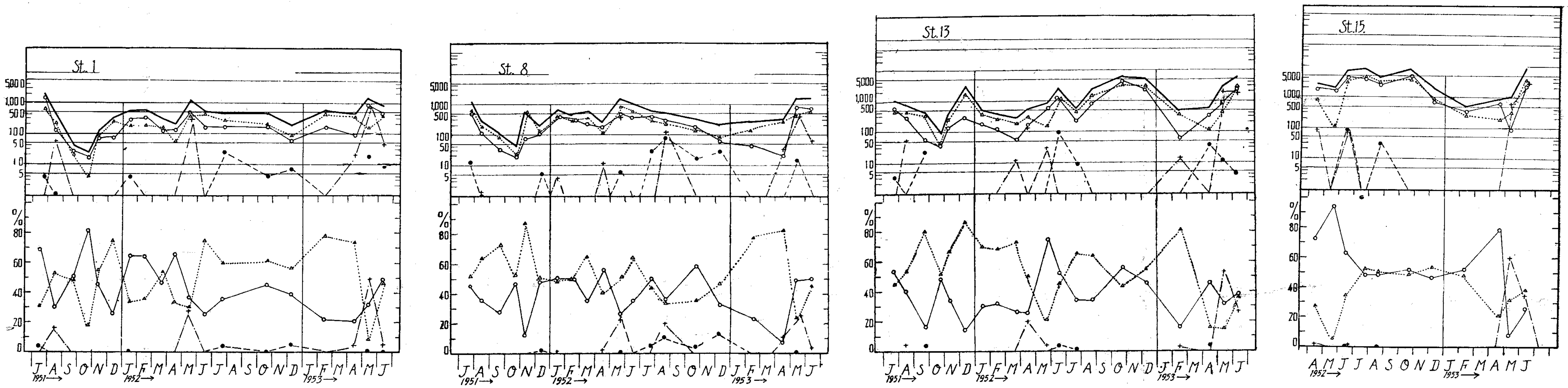

Fig. 9. Seasonal variations of number of zooplankton groups at Stations 1, 8, 13 and 15 from the inner to the outer part of the bay (above) and their percentage composition (below).

—— Total number of zooplankton; —○— Copepods; —+— Protozoans; ···△··· Larvae; ···●··· Other animals

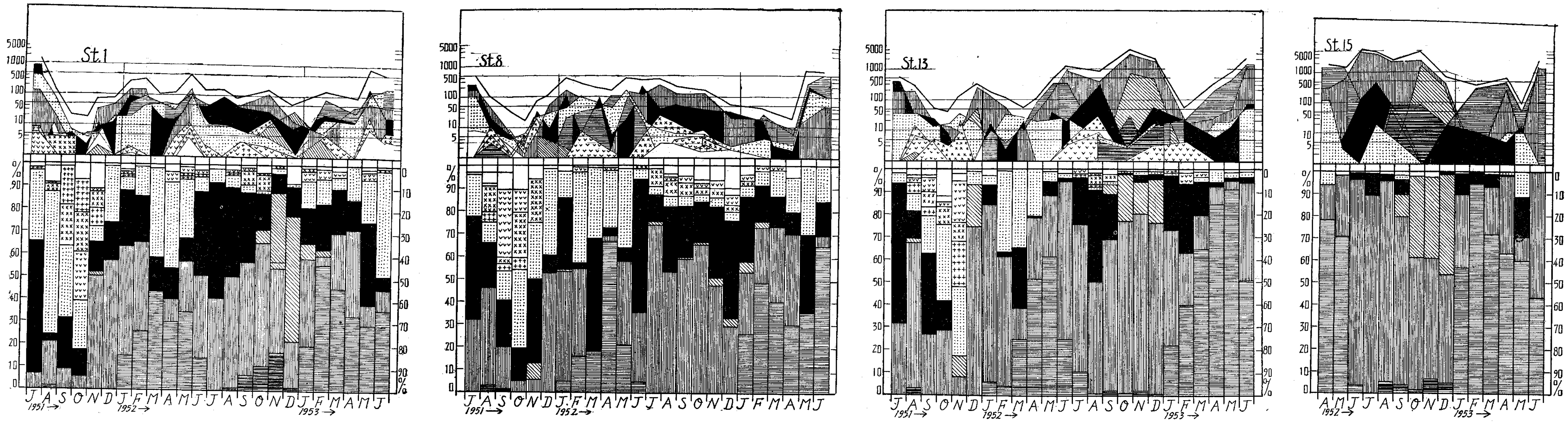

Fig. 10. Seasonal variations of abundance of the important copepods per one meter haul at Stations 1, 8, 13 and 15 from the inner to the outer part of the bay (above) and their percentage composition (below).

Acartia clausi; *Acartia spinicauda*; *Oithona nana*; *Paracalanus parvus*; *Oithona rigida*; *Oithona similis*; *Microsetella*; *Oncaea*; *Corycaeus*; —— Total number of copepods

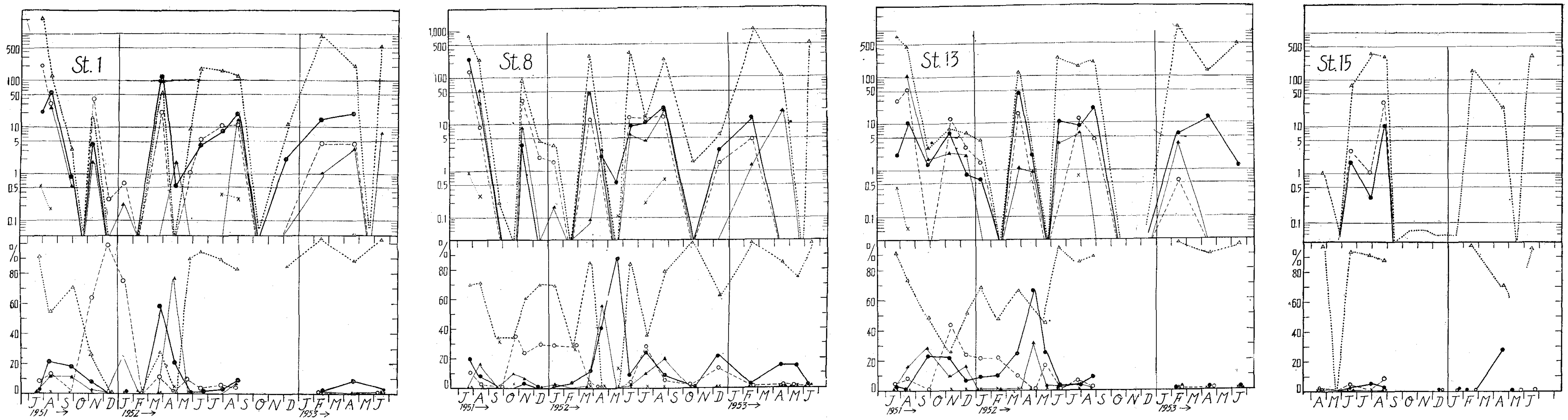

Fig. 11. Seasonal variations of the number of phytoplankton of the main groups per one meter haul at Stations 1, 8, 13 and 15 from the inner to the outer part of the bay (above) and their percentage composition. Unit of number is thousand.

···△··· *Chaetoceros*; —▲— *Rhizosolenia*; ···×··· Dinoflagellata; —●— Pennales; ···○··· Other Centrales

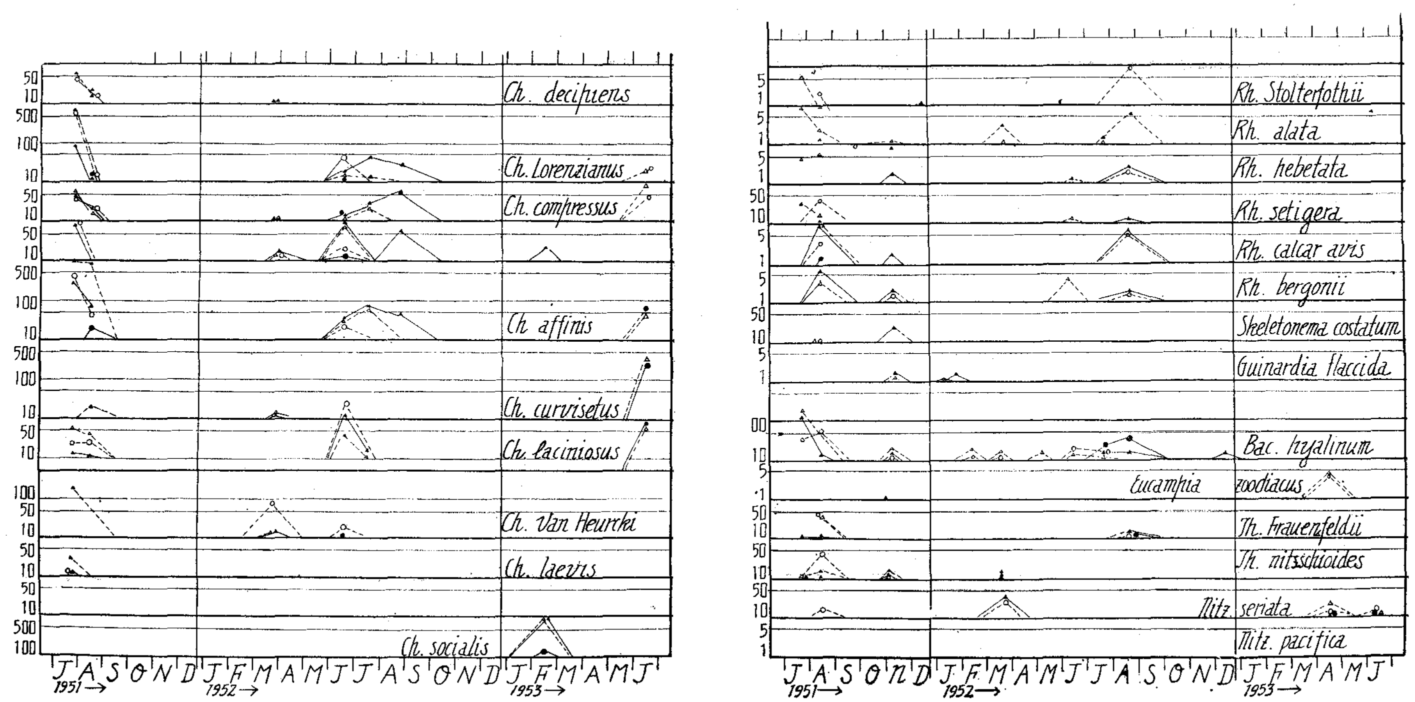

Fig. 12. Seasonal variations of number of the important diatoms per one meter haul from the inner to the outer stations of the bay. Unit of number is thousand.

···△··· St. 1; —▲— St. 8; ···○··· St. 13; —●— St. 15

The plankton composition is more stable throughout the year at the inner stations than at the outer stations. In the summer of 1951 the oceanic influx was larger than in 1952, therefore populations was larger than in 1952; therefore populations of inlet water forms, such as *Oithona nana*, *Acartia* and *Paracalanus*, in 1951 were reached the maxima as compared with those in the latter year. On the other hand, the percentages of oceanic and neritic copepods such as *Oithona similis*, *Microsetella rosea*, *Oncaea media* and *Corycaeus* sp. showed comparatively higher values than those of inlet copepods. Diatoms varied remarkably in their composition year by year. In the winter of 1952 the leading species were *Thalassiothrix*, *Thalassionema* and *Nitzschia*, while they were *Chaetoceros socialis* and a small number of *Ch. affinis*, *Ch. didymus* and *Ch. compressus* in the winter of 1953. Main component of copepods seems to be constant, but the percentage composition was more or less variable year after year. For instance, *Oithona nana*, *Acartia clausi*, *Paracalanus* and *Oithona similis* were widely found in winters of both 1952 and 1953, but *Acartia* was scarce in 1952 and *Oithona nana* occurred poorly in 1953. It seems that autumnal community remained still in the bay in the winter of 1952. The diatoms appeared in the winter of 1952 were the neritic temperate water forms which are ordinarily found in this bay till April. Occurrence of these species in the coldest season of 1952 may be accepted as the result of the inflow of the open sea water of relatively high temperature. Contrarily, the occurrence of *Chaetoceros socialis*, a cold water form (KOKUBO, 1953) may be attributable to the weakness of the open sea water; in other word, this indicates a strong degree of stagnation of the bay water.

Taizi Bay is a small inlet showing a condensed state of the plankton distribution extending from the innermost part to the open sea; namely all plankton phases from *Oithona* or *Acartia* community to the open sea copepod community are represented in this bay. The bay water is always affected by the influx of the open sea water and consequently the distribution of plankton in this inlet may be considered as indicators of various water masses. The plankton in this bay comprises inlet or neritic and oceanic water forms, and at the same time tropical, temperate and boreal temperate forms. It seems, therefore, to be of great interest to know the degree of stability and the seasonal or regional changes of the plankton distribution in the bay.

The plankton in the bay may thus be divided roughly into the following groups: (1) Local stock occurring throughout the year. (2) Local plankton appearing only in a certain season. (3) The plankton in both neritic and oceanic waters brought into the bay by currents of various nature. In Taizi Bay the spring and early summer communities seem generally to be consisting chiefly of inlet-haunting forms indicated by (1) and (2).

The species of the group (1) are found abundantly in the inner part of the bay and generally euryhaline and eurythermal, such as *Oithona nana*, *Paracalanus parvus* and their nauplii in the inner part, and *Microsetella rosea*, *Oithona similis*, *Oncaea media*, *Corycaeus* sp. and *Oncaea venusta* in the outer part of the bay, of which the latter 5 species are also distributed widely in the open sea.

The species of the group (2) are extremely euryhaline, but fairly or extremely stenothermal. They occur abundantly in a favourable condition, but survive in the unfavourable season in a small number or in the resting state. Their advents seem to be limited by temperature more strongly than by salinity. The following forms are the representatives of this group in this bay.

(a) Winter form: *Chaetoceros socialis.*

(b) Spring-early summer forms:

Zooplankton—*Acartia clausi*, *Tintinnopsis radix*, *Poroecus apiculatus*, *Favella taraikaensis*, pelecypod and gastropod veligers and polychaete larvae.

Phytoplankton—*Thalassionema nitzschioides*, *Thalassiothrix Frauenfeldii*, *Nitzschia seriata*, *Chaetoceros Van Heurcki*, *Ch. decipiens* and *Rhizosolenia setigera.*

(c) Summer-autumn forms:

Zooplankton—*Acartia spinicauda*, *Oithona rigida*, *Penilia schmackeri*, *Evadne tergestina*, cirripedian nauplii, *Sagitta delicata*, *Oikopleura dioica* and *Favella campanulla.*

Phytoplankton—*Chaetoceros laciniosus*, *Ch. affinis*, *Ch. Lorenzianus*, *Ch. compressus*, *Ch. didymus* and *Bacteriastrum hyalinum.*

Acartia clausi disappeares when the temperature rises beyond 25°C or thereabout, while *Acartia spinicauda* begins to appear when the temperature is about 25°C, being maintained till the temperature falls to ca. 20°C. *Acartia spinicauda* and *Oithona rigida* seem to have the tolerable range of the temperature in the warm season narrower than that of *Acartia clausi* in the cold season.

As the plankton of the group (3), the following forms are known in this bay.

Zooplankton—*Calanus helgolandicus*, *Cal. darwinii*, *Cal. minor*, *Eucalanus attenuatus*, *Calocalanus pavo*, *Candacia* spp. *Oncaea* spp., *Sagitta enflata*, *Oikopleura longicauda*, *Fritillaria haplostoma*, *Doliolum tritonis*, *Salpa* sp., several species of tintinnids and radiolarians.

Phytoplankton—*Chaetoceros coarctatus*, *Ch. diversus*, *Ch. dadayi*, *Ch. messanensis*, *Ch. laevis*, *Ch. peruvianus*, *Ch. pseudocurvisetus*, *Bacteriastrum commosum*, *Rh. robusta*, *Rh. cylindrus*, *Rh. calcar avis*, *Rh. imbricata*, *Climacodium Frauenfeldianum* and *Hemidiscus Hardmanianus.*

Regional Distribution of Plankton

As mentioned above, the seasonal distribution of plankton in the years 1951–1953 may be summarized as follows, although it varies more or less according to the year and the places. *Oithona nana*, *Paracalanus parvus*, *Oithona similis*, *Microsetella*, *Oncaea media* and *Corycaeus* spp. occurred permanently throughout the year and *Acartia clausi*, *Acartia spinicauda* and *Oithona rigida* appeared each regularly in the favourable season; these species are very important members in the inlet waters. Their distributions in the bay were as follows:

(1) From February to May:

Acartia clausi-Oithona nana community in the inner part.

Oithona nana-Oithona similis community in the outer part in 1952–1953.

(2) From June to September:

Oithona nana-Paracalanus parvus community in the inner part and mixed community of *Oithona nana-Oithona similis-Microsetella-Oncaea-Corycaeus* in the outer part in 1952.

Oithona nana community in the inner part and *Oithona nana-Paracalanus parvus* community in the outer part in 1953.

(3) From October to January:

Oithona nana-Oithona rigida-Acartia spinicauda community in the inner part and *Oithona nana-A. spinicauda-O. rigida* or *Oithona nana-Paracalanus parvus* community in the outer part of 1952.

Oithona nana-Paracalanus parvus community in the inner part and *Oithona nana-Oithona similis-Paracalanus parvus* community in the outer part in 1951.

The community in the inner part (Sts. 13, 14 and 15) is relatively stable throughout the year as mentioned already for the bays of Kozima, Yosa-naikai, Kumihama, Nakanoumi and Miho (YAMAZI, 1953, 1954) and in the innermost part of Tanabe Bay (YAMAZI, 1955), while that in the outer part of the bay is relatively variable in the percentage composition, although the main constituents of these animal communities are nearly unchangeable all the year round excepting a few forms occurring seasonally.

Relations between the Distribution of Plankton and the Environment

The distribution of plankton community is affected much by the embaymental condition. Although the plankton community in the open sea keeps the uniformity of a certain degree in a wide area, that in the inlet waters shows a great deal of differences regularly occurring from place to place within a relatively small area. The main cause of such variations is the difference in the embayment degree in inlets or bays as already noticed previously (YAMAZI, 1951–1955). Various inlet-inhabiting organisms occurring in a great quantity and distributed regularly are applicable as good indicators of the environmental conditions, if the seasonal successions of these forms are strictly analysed.

The plankton distribution is also largely influenced by the one-side wind. The prevailing wind in the province including Taizi Bay blows from the north-west in winter and spring, from the north-east in early summer and autumn, and from the south-west in summer. The direct result of the one-side wind is the horizontal movement of some plankton components in the inlet as mentioned in the study of Tanabe Bay (YAMAZI, 1955). The summer and early autumn winds cause stowing of the surface water at the inner region of the bay during the long period from June to September, consequently the inlet plankton communities is restricted to the relatively small areas in the inner part and the open sea water is brought into the bay near the inner region. However, northerly winds during the period from late autumn to spring carry out the inner surface water, therefore the plankton of the inner region of the bay is now distributed in a larger area and found abundantly even in the outer part of the bay. In addition to the direct influence mentioned above, various currents, tidal or non-tidal, affected by the one-side wind may also give a serious indirect influence upon the composition of the inlet plankton communities (YAMAZI, 1955).

Biological Conditions of the "Buri" Fisheries

The fishing of yellowtail *Seriora quinqueradiata* TEMMINCK et SCHLEGEL (Japanese name "Buri") by the kiddle net begins to catch in the outer region of Taizi Bay in late December. The fishes are induced into the kiddle along the shore of the coastal line. UDA and HONDA (1934) reported the existence of a certain correlation between the catches and the water temperature of the fishing ground, namely the duration of the fishing period between the first and the last catches is longer than usual, when the average water temperature is lower in March than in January and when the rising of water temperature is slower than in average year. MIYAMOTO *et al.* (1954) reported on the fishing situations of the yellowtail on the Pacific coast during 1950–1953. The predominant catches were found in the fishing period of 1952, and during the next fishing season of 1953 the catches were smaller than during 1952. They found also that the abundant fishery of the yellowtail is in a close correlation with the development of the low atmospheric pressure. During our observations heavy catches were met with during the period from January to March in 1952, while in 1953 catches declined; moreover fair catches in this year were observed one month later than in 1952. As mentioned previously the composition and amount of plankton and the hydrological conditions of the bay differed distinctly between these two years. Thus, these planktological and hydrological differences are considered to be correlated directly or indirectly with the distribution of small-sized plankton predators and at the same time with the intrusion of yellowtail.

Summary

1. The seasonal quantitative and qualitative successions of plankton in Taizi Bay were studied during the period from July, 1951 to June, 1953.

2. There are two peaks in each of the total volume and number of plankton, one in winter and the other in summer; besides a small peak in autumn only in 1952. Seasonal successions of zoo- and phytoplankton communities are varied regionally.

3. Copepods and their nauplii are always predominant in the bay, while Copelata,

Chaetognatha, Cladocera, tintinnids, veligers, Cirripedian nauplii and other larval forms are significant only at the time when they occurred abundantly.

4. The plankton in the bay is divisible into three groups according to their origins and duration of their occurrence, because the plankton in this bay originates mostly from the local or neritic stocks and partly in the oceanic waters and the plankton composition in the bay differs seasonally and from year to year.

5. The regional distribution of the plankton is discussed. The plankton community in the inner region is more stable than in the outer region of the bay all the year round. Although the percentage composition of plankton is variable, the occurrence of main species is maintained throughout the year excepting a few forms.

6. Yellowtail *Seriola quinqueradiata* TEMMINCK et SCHLEGEL (Japanese name "Buri") fishing by kiddle net in the season from winter to spring is affected much by hydrological and biological conditions. The quantity of catches is correlated directly or indirectly with differences in the plankton communities, since the plankton is evidently applicable as a distinct indicator of the biological conditions of the fisheries.

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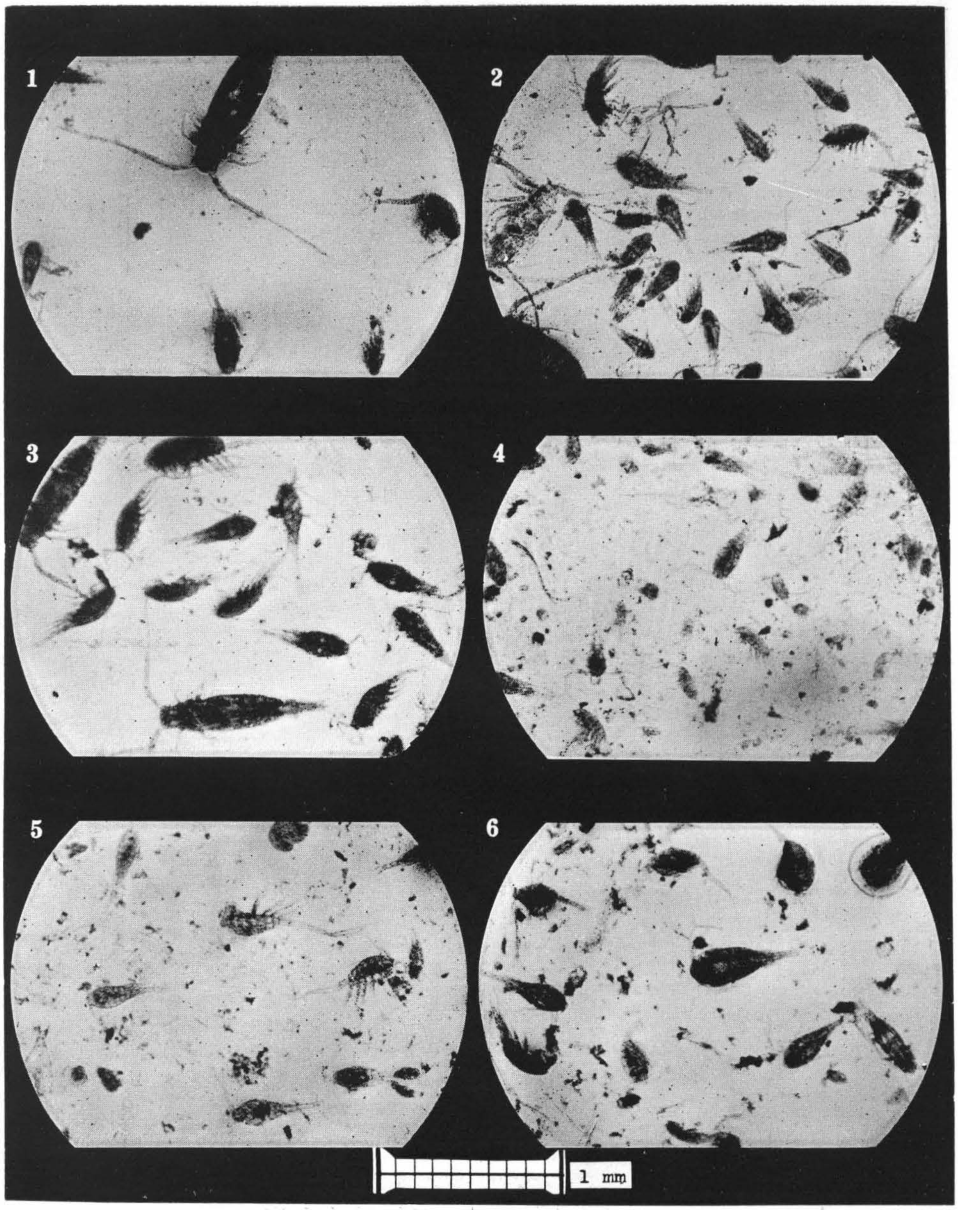
EXPLANATION OF PLATES XXI-XXII

PLATE XXI

Fig. 1. Example of plankton from catches at the innermost station 15 in Taizi Bay on April 6, 1952.
Fig. 2. The same on May 13, 1952.
Fig. 3. The same on June 15, 1952.
Fig. 4. The same on July 28, 1952.
Fig. 5. The same on August 26, 1952.
Fig. 6. The same on September 23. 1952.

PLATE XXII

Fig. 1. Example of plankton from catches at the innermost station 15 in Taizi Bay on October 10, 1952.
Fig. 2. The same on November 30, 1952.
Fig. 3. The same on January 17, 1953.
Fig. 4. The same on February 14, 1953.
Fig. 5. The same on April 1, 1953.
Fig. 6. The same on April 13, 1953.



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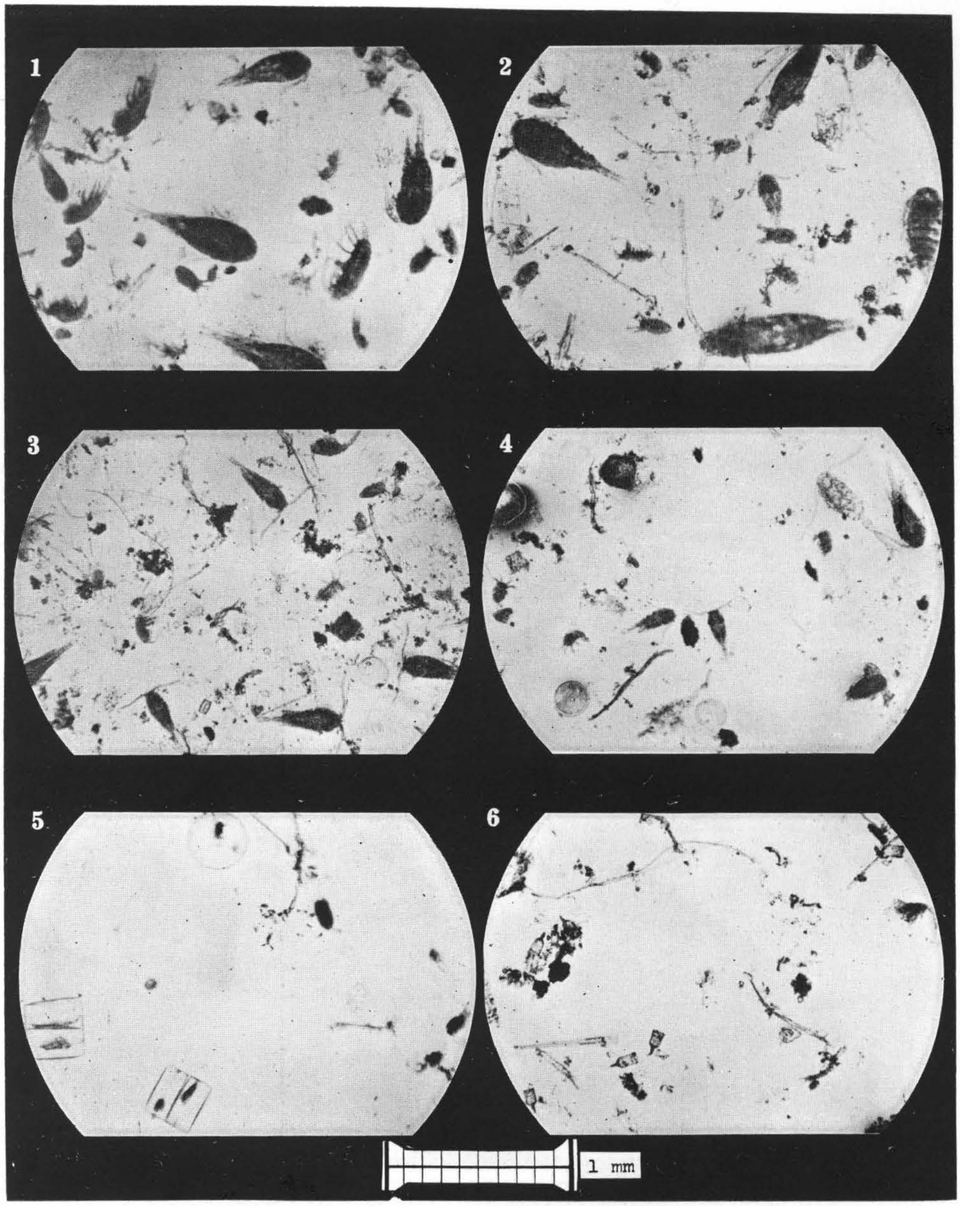

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