PLANKTON INVESTIGATION IN INLET WATERS ALONG THE COAST OF JAPAN

XIV. THE PLANKTON OF TURUGA BAY ON THE JAPAN SEA COAST[1)]

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With 11 Text-figures

The plankton survey was carried out on Oct. 19th, 1953, namely on the same day when another survey was made in Obama Bay. The samples were collected at the superficial and the 5 meter layers at each of 15 stations (Fig. 1). The methods of surveying and examining the material are similar to those described in previous papers. The writer is much indebted to the Director and staff members of Fukui Prefectural Fisheries Experimental Station for allowing me to use the research boat for the collection of samples, and here he wishes to express his hearty thanks for their kindness.

Hydrological Conditions

Turuga Bay is a small inlet, situated at the eastern corner of Wakasa Bay (Fig. 1). The bay is nearly wedge-shaped in outline, and has a wide mouth. The basin is very steep, thus the 20 m isobath line running near the shore. The water temperature of the 0 m and the 5 m layers is shown in Fig. 2, A and B. The salinity (Fig. 3, A) of the superficial layer varied from 30.5 to 32.6‰, and was lower in the inner part and the eastern area of the bay, because the low saline water was transported there from the inner part by current and wind. At the 5 m layer (Fig. 3, B) it was uniform and 32–32.7‰ were found at all stations.

The transparency of water was larger than in Obama Bay (Fig. 2, C). It was largest in the western area of the mouth (about 17.5 m) and decreased towards the inner part of the bay (from 14 m to 4 m). The water of the eastern part was less transparent than in the western part.

The highest concentration of silicates (SiO_2) (Fig. 3, C) occurred in the inner part, while the lowest was in the eastern area near the mouth. The contents of SiO_2 varied from 700 to 4,500 mg per m^3 at the superficial layer and from 1,500 to 2,500

1) Contributions from the Seto Marine Biological Laboratory, No. 244.

mg/m³ at the 5 m layer.

The catalytic activity of sea water at the surface showed higher values in the western area of the mouth and inner part of the bay. The minimum values were extending along the western part of the central region. At the 5 m layer it was higher than that at the surface. The maximum value was found in the area extending

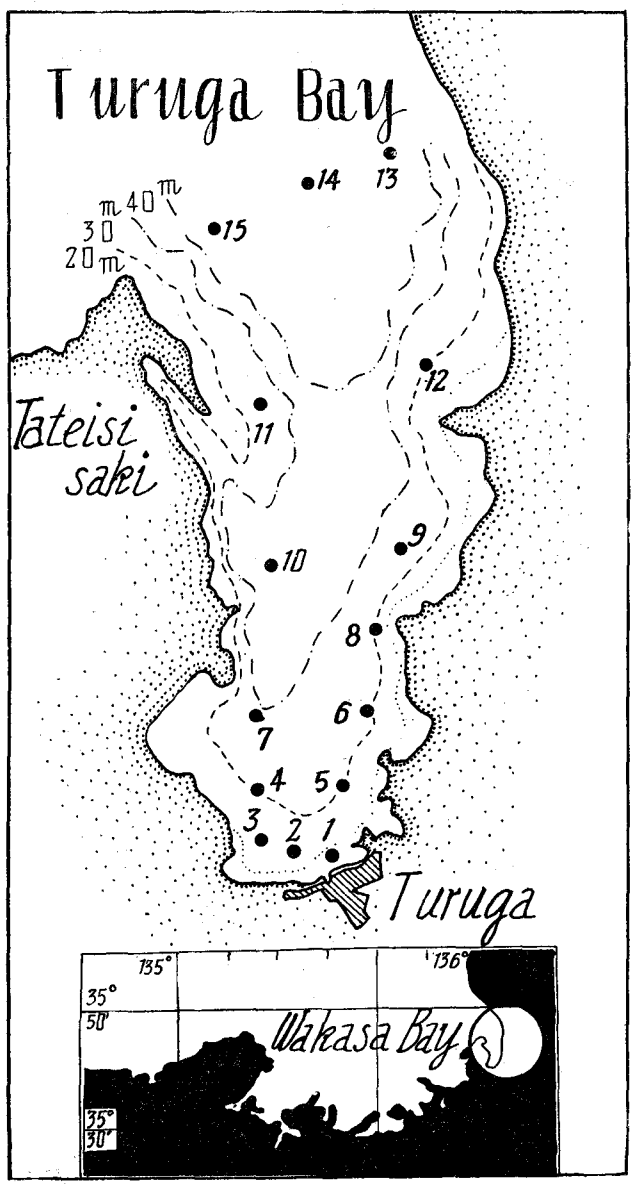

Fig. 1. Map of Turuga Bay showing stations and bathymetric contours.

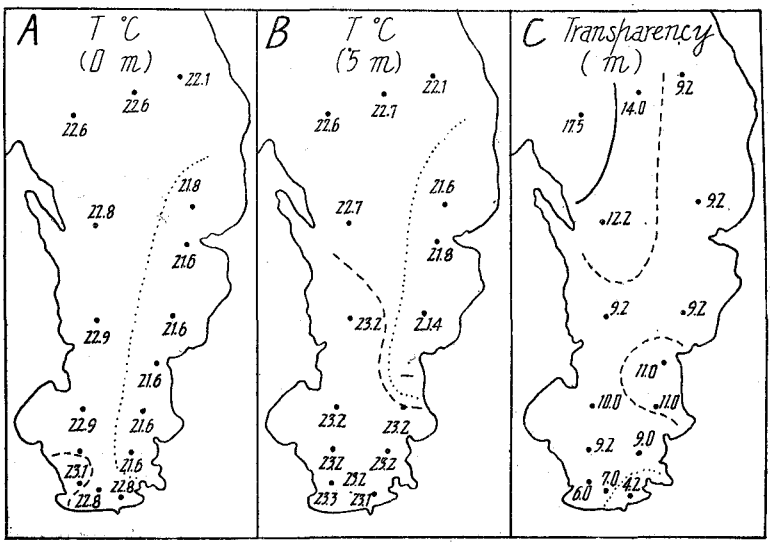

Fig. 2. Distribution of water temperature (A and B) and transparency (C).

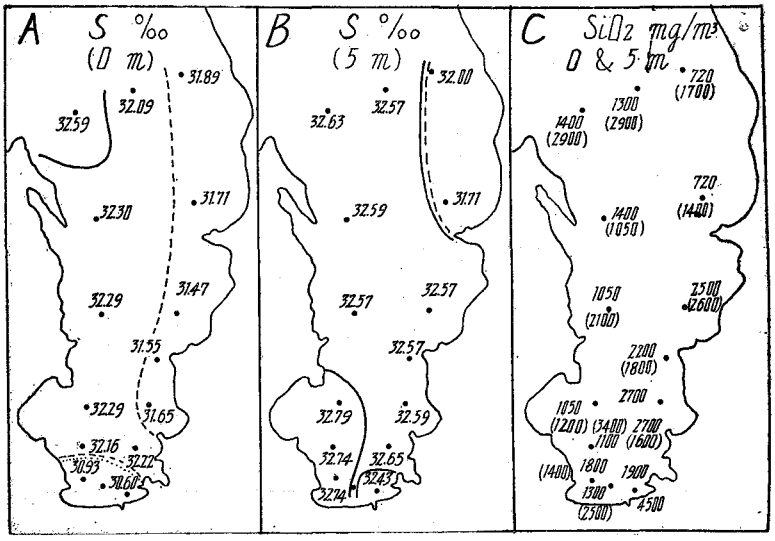

Fig. 3. Distribution of salinity at the surface (A) and 5 m layer (B) and silicates (SiO_2 mg/m^3) at the 0 m and 5 m layers(C).

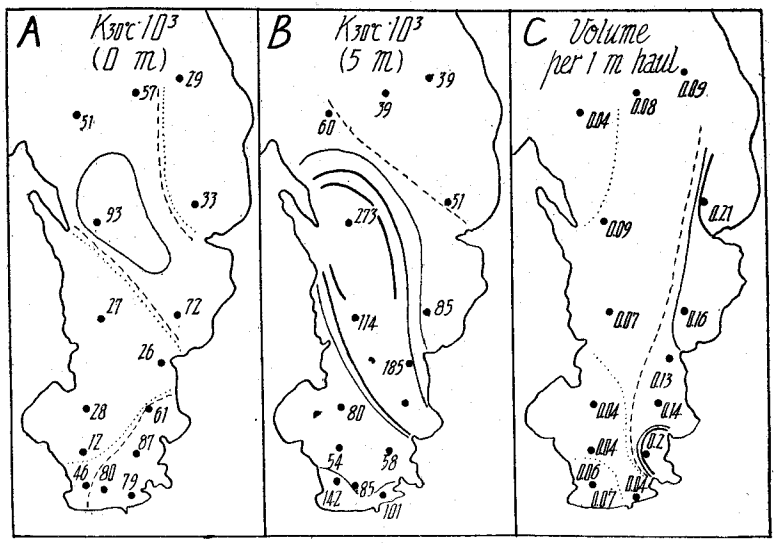

Fig. 4. Distribution of catalytic activity of sea water (A and B) and settling volume (cc) of plankton per one meter haul from 15 m layer or bottom to the surface (C).

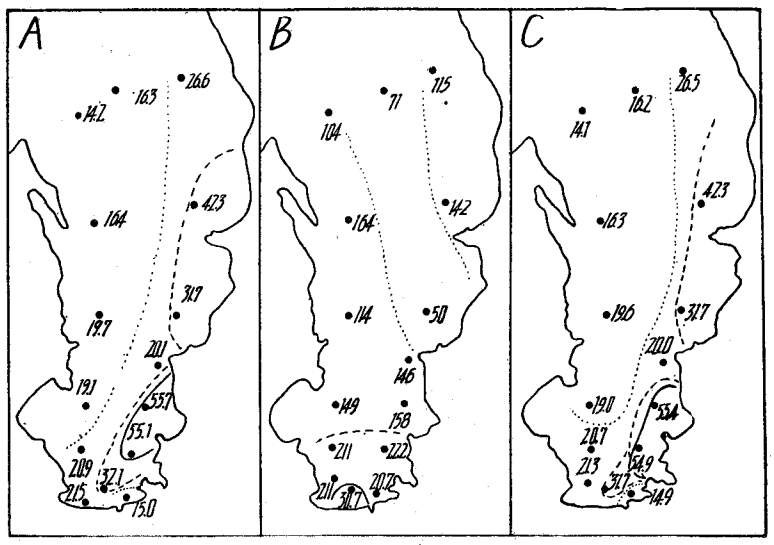

Fig. 5. A. Total number of plankton individuals, cells, or colonies per one meter haul (Unit of number is thousand).
B. Total number of zooplankton individuals per one meter haul.
C. Total number of phytoplankton per one meter haul (Unit of number is thousand).

from the western part of the mouth to the southeastern part of the bay and was about twice as high as observed in the same area at the 0 m layer (Fig. 4, A and B).

Plankton

A. Quantitative Analysis of Plankton

The plankton samples were hauled by the same method as used in Obama Bay (YAMAZI, 1954 b). The settling volume was larger than in Obama Bay. It varied between 0.04 and 0.21 cc per one meter haul, showing higher values in the eastern

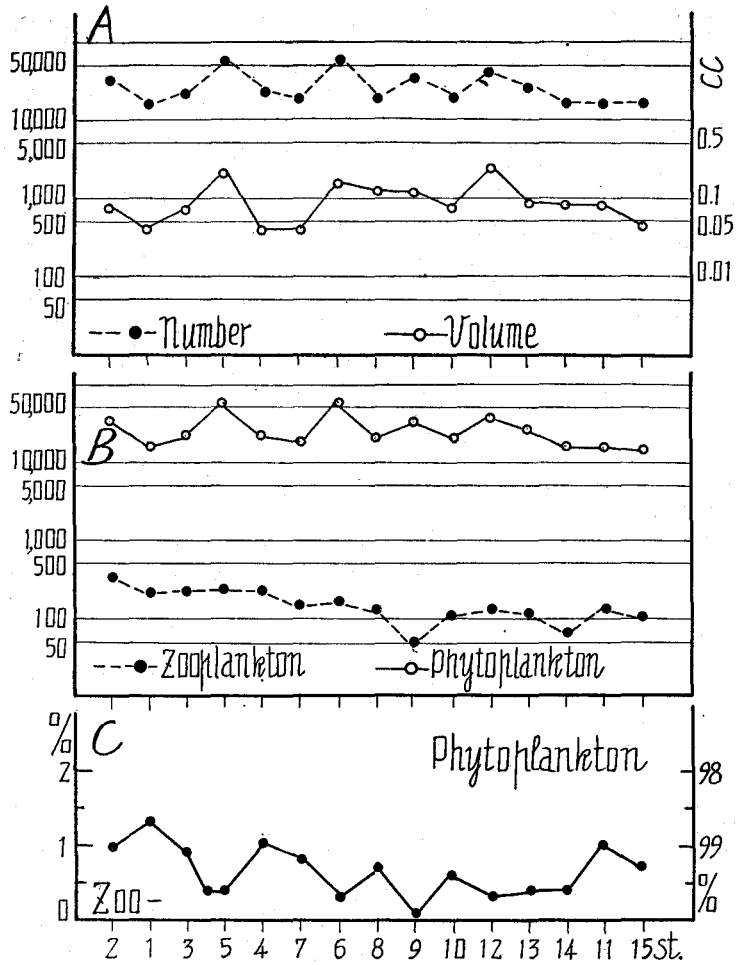

Fig. 6. A. Relation between settling volume and total number of plankton per one meter haul.
B. Distributional graph of total number of zoo- and phytoplankton.
C. Percentage composition of zoo- and phytoplankton.

area. The total number of plankton was also of the same case as the settling volume. The maximum occurred in the inner part of the eastern area (Fig. 5, A), where the number reached 55 thousands per one meter haul, while the minimum in the western area was 14 thousands.

The curves for volume and number distributions are given graphically in Fig. 6, A. There is a close parallelism between volume and total number at each station. This is clearly due to the similar components qualitatively. As shown in Fig. 6, B, the maximum number of zooplankton was found in the inner part and the minimum in the mouth; the maximum number of phytoplankton caused by dense diatoms was obtained from the eastern area of the inner part. The numerical percentage of zooplankton in total plankton was very small, less than 1%. It decreased towards the outer part and the eastern part of the bay. (Fig. 6, C).

B. Qualitative Analysis of Plankton

ZOOPLANKTON

The main components of zooplankton were copepods (40–80%), larvae (20–70%), protozoans (0–8%) and other animals (1–10%). The components of these groups varied at each station, but they were densest in the innermost region and decreased towards the outer region of the bay (Fig. 7, A and B). Of copepods, *Oithona nana* and *Paracalanus parvus* were by far the most dominant species even in the inner region, although less numerous in the several stations near the mouth. Other copepods comprising 1–40% of all copepods were: *Acartia clausi*, *A. spinicauda*, *Euterpe acutifrons*, *Oithona similis*, *Microsetella norvegica*, *Oncaea media*, *Oncaea venusta*, *Corycaeus* sp., *Calanus minor*, *Cal. tenuicornis*, *Calocalanus pavo*, *Eucal. attenuatus*, *Centropages bradyi*, *Oithona plumifera* and *Candacia* sp.

Oithona nana occupied 60–80% of copepods in the inner region, 50% in the eastern area and 15–20% in the mouth. *Paracalanus parvus* occupied 20–40% in the inner region and decreased towards the outer region of the bay (Fig. 8, B, C and Fig. 10). Other copepods showed higher percentages than in Obama Bay. Of these, *Acartia clausi* and *A. spinicauda* were restricted to the innermost region more clearly than *Oithona nana* and *Paracalanus*, although they occurred in very low percentages. Other species were found very sparsely, but they occurred richer in the outer part than in the inner part (Figs. 8, 9 and 10).

Penilia schmackeri was found widely, but never plentifully. *Podon* sp. was caught scarcely in the outer part of the bay. Neritic chaetognath *Sagitta delicata* and oceanic chaetognath *S. enflata* were also represented by only a few individuals at each station. Of the tunicates, *Oikopleura dioica*, *O. longicauda* and *Fritillaria* sp. were sparsely found. A siphonophora, *Muggiaea atlantica*, and some hydromedusae were found in small number near the mouth.

Larval forms were important components of the plankton in the bay, although only copepod nauplii were found abundantly throughout the stations (Fig. 7, A

and Fig. 9, C). Copepod nauplii were most numerous in the inner part of the bay and decreased towards the outer part. The larval forms of bottom animals were polychaete larvae, gastropod veligers, pelecypod veligers, cirripede nauplii, auricularia, ophiopluteus, actinotrocha and pilidium. The pelecypod veligers were found relatively richly from the inner to the eastern areas (10–50 individuals per one meter haul), while the gastropod veligers were never found in great abundance. The polychaete larvae were recorded at almost all stations and numbered from 2 to 8 individuals.

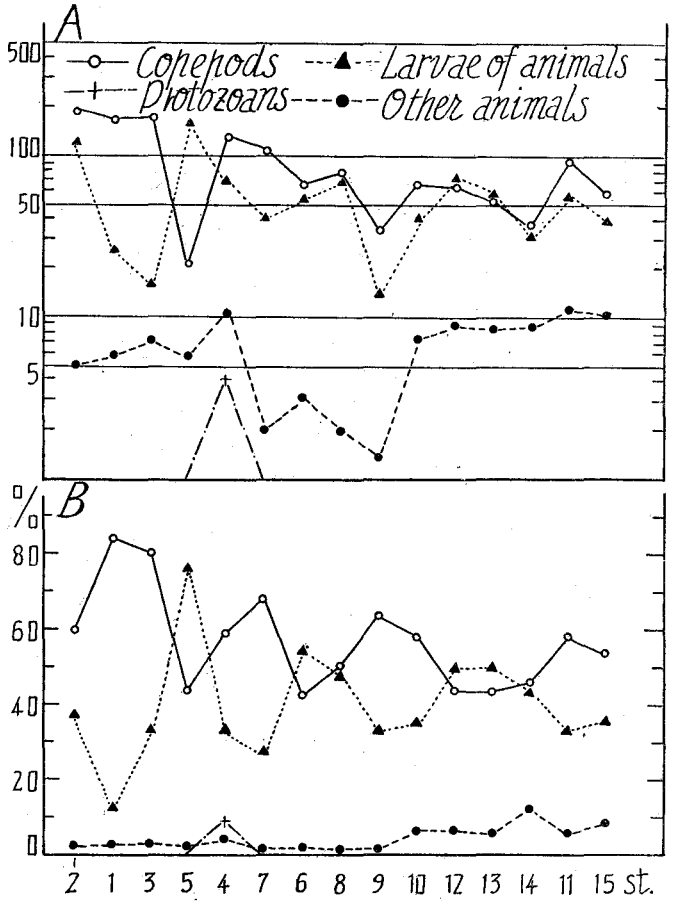

Fig. 7. Number of zooplankton groups per one meter haul (A) and their percentage composition.

PHYTOPLANKTON

Diatoms were richer than in Obama Bay. Their populations were larger in the inner and eastern areas of the bay than in the western area, although the components at each station were almost similar. The dominant diatoms were mostly neritic species, such as *Chaetoceros Lorenzianus* (4–13 thousands), *Ch. didymus* (1–7 thousands),

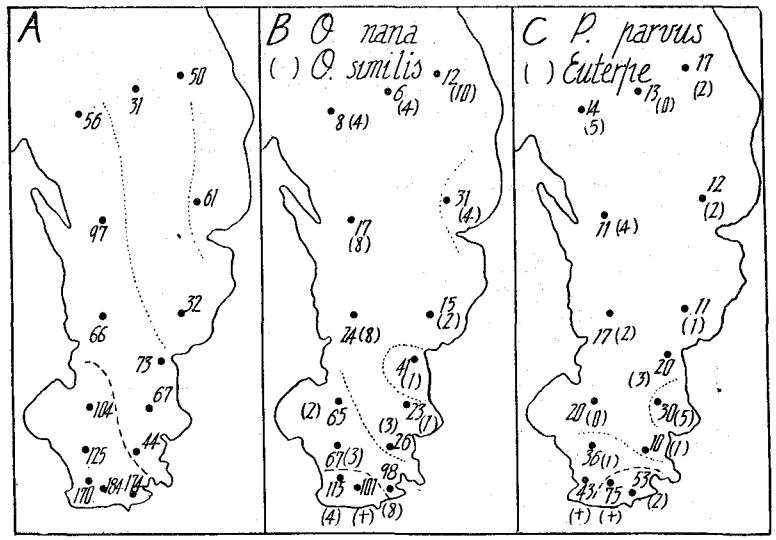

Fig. 8. Distribution of total number of copepods per one meter haul (A) and four important copepods in the bay (B, C).

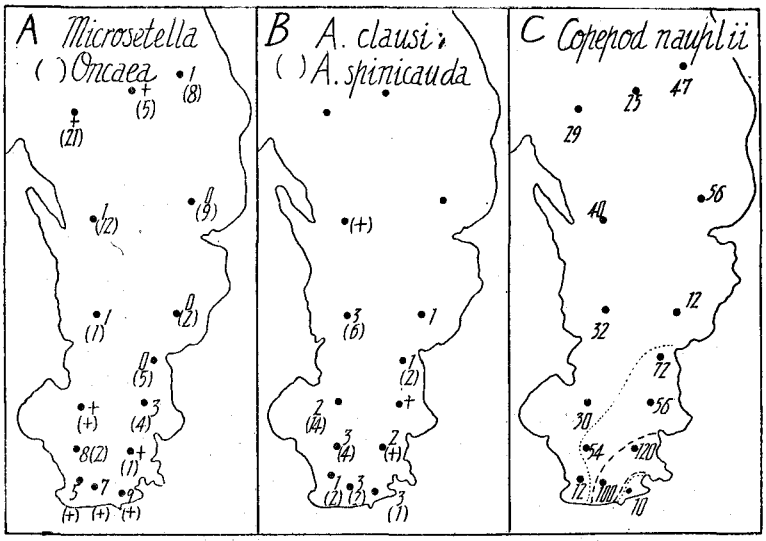

Fig. 9. Distribution of four important copepods (A, B) and copepod nauplii (C).

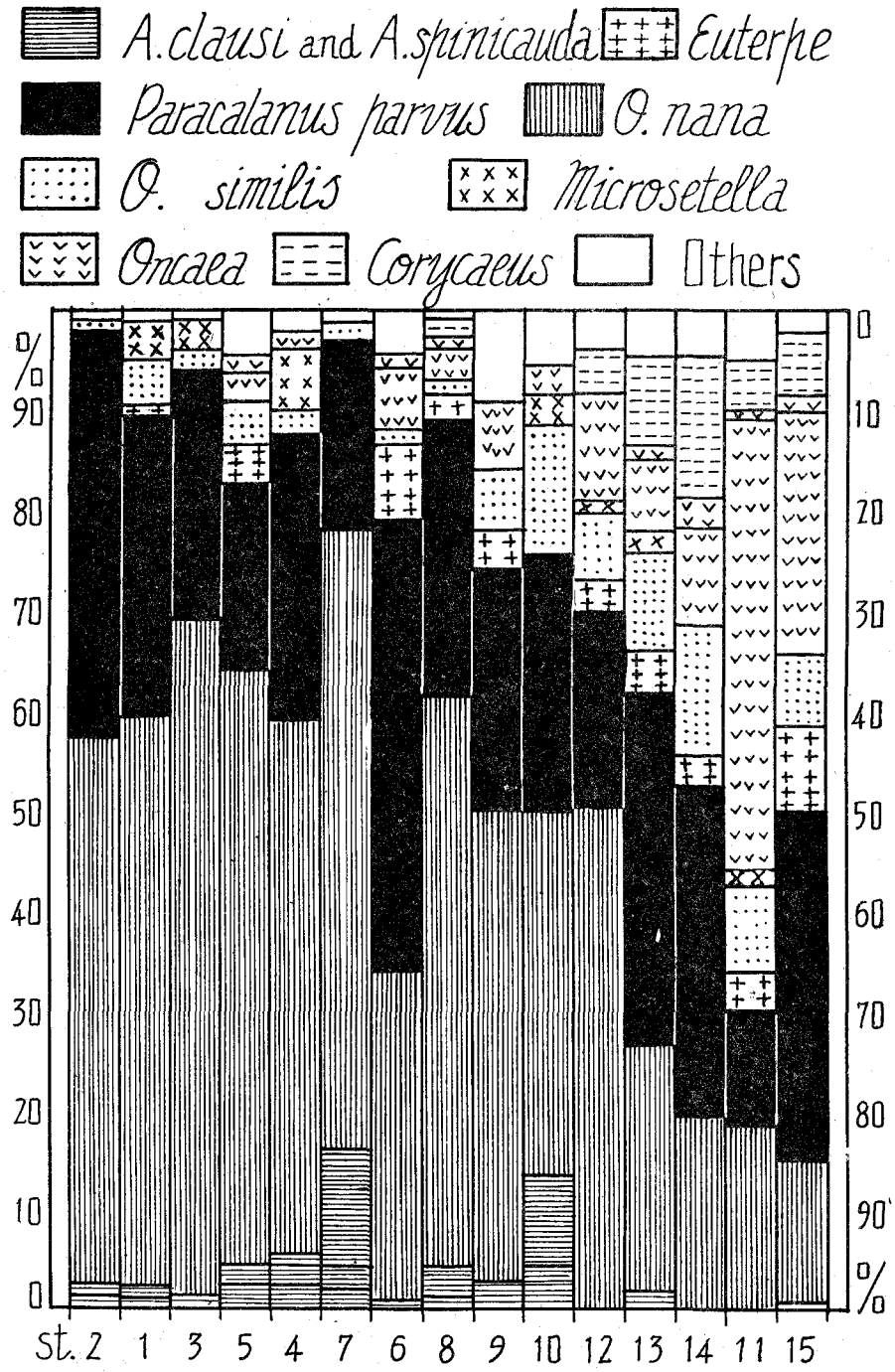

Fig. 10. Percentage composition of important copepods.

Ch. decipiens (less than 3 thousands), *Ch. affinis* (less than 10 thousands), *Ch. curvisetus* (less than 7 thousands), *Ch. laciniosus* (less than 8 thousands), *Rhizosolenia setigera* (less than 0.8 thousands), *Rh. alata* f. *gracillima* (less than 0.2 th.), *Bacteriastrum hyalinum* (0.1–13 th.), *Thalassiothrix Frauenfeldii* (1–4 th.), *Thalassionema nitzschioides* (1–5 th.), *Thalassiothrix longissima* (less than 0.4 th.), and *Nitzschia seriata* (less than 3 th.). A small number of oceanic forms, such as *Rh. calcar avis*, *Rh. Bergonii*, *Rh. hebetata*, *Rh. styliformis* var. *latissima*, *Ch. coarctatus*, *Ch. denticulatus*, *Ch. atlanticus* var. *neapolitana*, *Ch. peruvianus*, *Ch. messanensis*, *Climacodium biconcavum* and *Ditylum sol* were found widely. *Asterionella japonica*, *Nitzschia longissima*, *Nit. delicatissima*, *Hemiaulus Hauckii*, *Bidd. longicruris*, *Bidd. sinensis*, *Stephanopyxis Palmeriana*, *Dac. antarcticus*, *Bac. delicatulum*, *Leptocylindrus danicus*, *Ch. willii*, *Ch. laevis*, *Ch. Eibenii* etc. occurred, but very sparsely.

Dinoflagellates were quantitatively very scarce, although rich in number of species. They were *Ceratium trichoceros* (less than 300), *C. extensum* (less than 100), *C. deflexum* (less than 40) *C. fusus* (less than 50), *C. tripos* (less than 100), and a small number of *Pyrophacus horologicum*, *Oxytoxum* sp., *Pyrocystis noctiluca*, *Pyr. fusiformis*, *Peridinium grande*, *Per. depressum*, *Ceratocorys horrida*, *Ceratium furca*, *C. macroceros*, *C. masciliense*, *C. smatoranum* var. *angulatum*, *C. gibberum* f. *sinistrum*, *C. molle*, *C. candelabrum*, *C. carriense* f. *caylanicum*, *C. palmatum* var. *ranipes* etc. Thus the general features about diatoms and dinoflagellates were: 1) both neritic and oceanic forms were distributed in the whole area of the bay; 2) oceanic forms were relatively rich; and 3) diatoms were richer in the inner part along the eastern half in the bay than in the western half.

Consideration and Conclusion

The basin of Turuga Bay is largely deep and gradually shallower towards the inner part of the bay. This topographical feature closely resemble that of Miyako Bay on the Sanriku coast of Tôhoku district (YAMAZI, 1954 b). The salinity at the surface and the transparency of water are slightly lower in the inner and eastern area of the bay, though the salinity at the 5 m strata is uniform throughout the stations. The productivity of plankton is higher in the inner and eastern area of the bay. The bay is also characterized by the relatively richer oceanic forms entered from Wakasa Bay. These species distribute evenly at nearly all stations. The most important component of the zooplankton in this bay is copepods, and its distribution is summarized in Fig. 11.

The inner part and the eastern half of the bay are characterized by the dominance of *Oithona nana* and *Paracalanus parvus* in the percentage composition of copepods. A small number of *A. clausi*, *A. spinicauda*, *Euterpe acutifrons*, *Oithona similis*, *Oncaea venusta*, *Microsetella norvegica* and *M. rosea* and several oceanic copepods are found in the inner part.

The western half and the mouth part are characterized by the abundance of

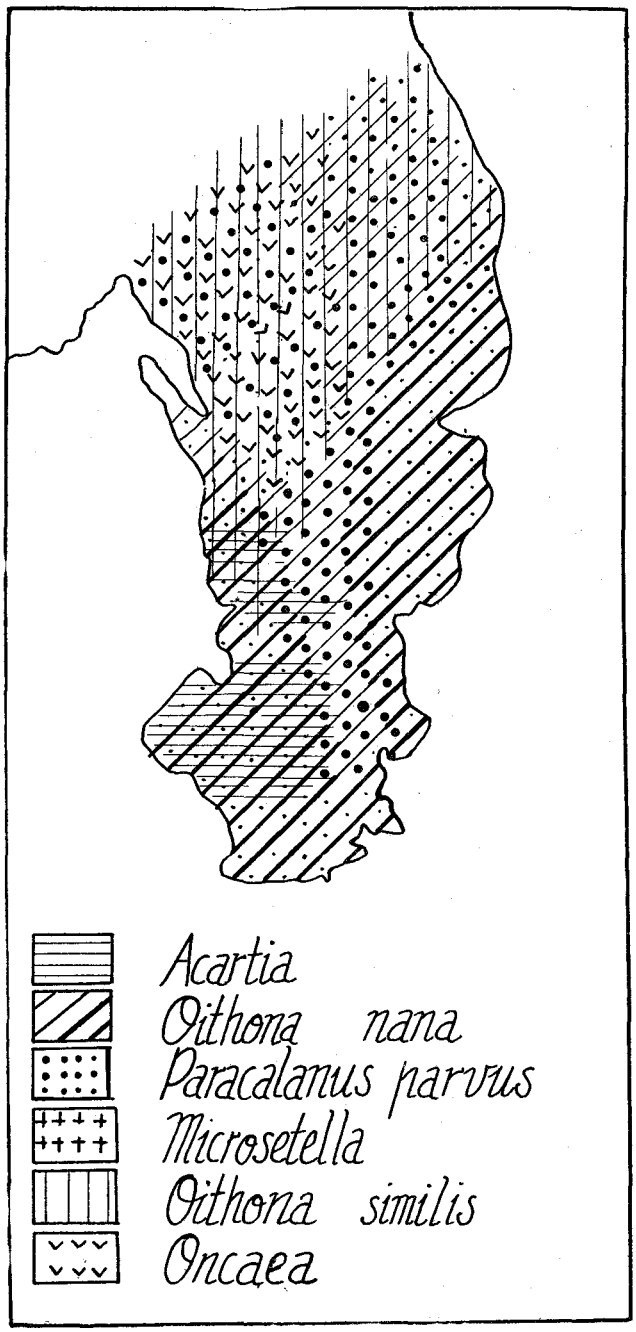

Fig. 11. Distribution of copepod communities in Turuga Bay.

Oncaea media, *Paracalanus*, *Oithona nana*, together with a small amount of *O. similis*, *Euterpe acutifrons*, *Microsetella*, *Oncaea venusta*, *Calocal. pavo*, *Eucal. attenuatus*, *Centropages*, *Oithona plumifera* and *Candacia* sp. et al, although these oceanic copepods distribute very sparsely in the eastern half. Oceanic tunicates, chaetognaths, diatoms and a large number of oceanic species of dinoflagellates occur widely. They are by far richer in number and penetrating inwards more deeply in this bay as compared with Obama Bay. This is due to the heavy influence of the open sea water. Thus, the regional arrangement of plankton communities cannot be so distinctly recognized as in bays which have each a narrow mouth and are affected only slightly by ocean water.

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