

## A DECADE OF MARINE ZOOPLANKTON RESEARCH IN CHINA

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### ABSTRACT

Marine plankton research, as well as other branches of science, has made great progress after the liberation which is rendered possible through the great attention and support given by the Communist Party of China and the Government to scientific research. A considerable amount of plankton samples and data have been accumulated during the past ten years by surveys of fishing grounds, bays and coastal waters, the results of which have been partly published in a number of papers and reports. Since autumn of last year, a very extensive oceanographic survey is being carried out along the entire coast of China. The outcome of this large-scale survey will, without doubt, make a notable contribution to the planktology of China.

The following is a brief account of taxonomic and ecological studies made for the last ten years:

### 1. Taxonomic research

During the past 10 years, taxonomic studies have been made of the following groups of zooplankton: Tintinnoinae<sup>[2,3]</sup>, Hydromedusae<sup>[10,11]</sup>, Ctenophora<sup>[5,6]</sup>, pelagic Crustacea (including Copepoda<sup>[8,9]</sup>, Euphausiacea<sup>[16]</sup>, and Sergestidae<sup>[14,15]</sup>, Chaetognatha<sup>[7]</sup>. The following is a list of new species found in the above groups:

Tintinnoinae: *Tintinnopsis kiaochoowensis* Yin

*T. tsingtaoensis* Yin

*T. hemispivalis* Yin

Hydromedusae: *Hybocodon ectopleurus* Gai

Copepoda: *Paracalanus intermedius* Shen & Bai

*Tortanus spinicaudatus* Shen & Bai

*Cyclopina heterospina* Shen & Bai

*Hemicyclops dilatatus* Shen & Bai

*Parameira pendula* Shen & Bai

*Parameira brevifurca* Shen & Bai

*Schmackeria poplesia* Shen

*Tortanus vermiculus* Shen

### 2. Ecological research

The ecological study of zooplankton is carried out mainly through the survey of fishing grounds, survey of the bays and oceanological survey of the seas. Of the fishing grounds surveyed the following surveys are relatively of greater importance: the fishing ground of the mackerel, *Pneumatophorus japonicus* (Houttuyn) off Chefoo and Wei-Hai; the fishing ground of *Acces chinensis* Hansen in the Liaotung Bay, the fishing ground of the small croaker, *Pseudosciaena polyactis* Bleeker off the mouth of the Yellow River, and the over-wintering ground in the Yellow Sea and the East China Sea carried out in co-operation with the U.S.S.R.

1. The survey of the mackerel fishing ground off Chefoo and Wei-Hai deserves special notice, because of its study of zooplankton in greater detail. The results of this survey may be summarized as follows:

1. The zooplankton off Chefoo and Wei-Hai is composed chiefly of temperate neritic species with the addition of a small number of off-shore species such as *Calanus pacificus*, *Themisto gracilipes*, *Euphausia pacifica*, etc. In view of its composition, the zooplankton of the northern part of the Yellow Sea appears to be less varied than that of the East China Sea and the South China Sea.

2. From the data of seasonal distribution of zooplankton in 1957, it will be seen that the total biomass ( $\text{mg./m}^3$ ) increases with the advance of the fishing season from April onwards, attaining its great maximum in July and a smaller maximum in October. These two maxima represent the breeding periods of the important species of pelagic Crustacea. The maximum of *Calanus pacificus*, *Paracalanus parvus*, *Centropages abdominalis* and *Themisto gracilipes* occurs in July. It is noteworthy that *Calanus* possesses three breeding periods within a year, namely March—April, June—July, October—November; whilst *Themisto* appears to reproduce throughout the year.

3. According to the pattern of vertical distribution in daytime, the zooplankton of the fishing ground may be divided into two groups:

a. Those that inhabit mainly the upper layer (0—10 m) such as *Paracalanus parvus*, *Sagitta crassa* (1st stage), *Noctiluca scintillans*, etc., and

b. Those that inhabit mainly the lower layer (below 10—15 m) such as *Calanus pacificus*, *Centropages abdominalis*, *Acartia clausi*, *Themisto gracilipes*, *Euphausia pacifica*, *Sagitta crassa* (2nd and 3rd stage).

The above pattern will be altered at night as a result of diurnal vertical migration.

4. In accordance with the pattern of diurnal vertical migration, the zooplankton of the fishing ground may be separated into the following types:

a. Those with marked diurnal vertical migration, i.e., stay in the deeper layer in daytime and ascend to the surface layer at night, but show midnight sinking and twilight ascending—such as *Calanus*, *Themisto*, *Euphausia*, *Sagitta* (2nd and 3rd stage).

b. Those without marked diurnal vertical migration: It may further be divided into the following types in accordance with the extent of the migration:

(1) Those that stay in the surface layer throughout the day and night, such as *Paracalanus*;

(2) Those that stay in the deeper layer in daytime and ascend a little at night, such as *Acartia*, *Centropages*; and

(3) Those that stay in both surface and deeper layers in daytime and do not show any distinct sign of migration even at night, such as *Oithona similis*, *Corycaeus japonicus*.

It should be pointed out, however, that the pattern of migration of each species may change with different places, seasons or ages.

5. The zooplankton of the fishing ground may be separated into two different communities, one belonging to the offshore community of relatively high-salinity water (greater than 30‰) with the dominance of offshore species such as *Calanus*, *Themisto*, *Euphausia*, etc., and another belonging to the inshore community of relatively low-salinity water (less than 30‰) with the dominance of neritic species such as *Noctiluca*, *Labidocera cucheta*, *Pseudodiaptomus marinus*, etc. In general, the former is mainly distributed in the eastern and northern sides of the fishing ground with water of high salinity; whilst the latter in the center of the fishing ground (south of 38°N) and also close to the shore with water of low salinity. The expansion and contraction of the area of distribution of these two different communities reflect the movement of the two different water masses (high salinity and low salinity) in the fishing ground and

its vicinity.

II. A general survey was made of the fishing ground of *Acetes chinensis*, a pelagic neritic species of Sergestidae, inside the Liaotung Bay, together with a study of its reproduction, development, habitats and resources, showing that this species commences to breed at optimum temperature of 18°C and reaches its maximum breeding period at 20°C. Abundant rainfall and low salinity during its breeding period tend to enhance the rate of reproduction. It is now possible to make forecast of its yield based upon the knowledge of its fluctuation in population<sup>[17]</sup>.

III. In the fishing ground of *Acetes chinensis* inside the Liaotung Bay and in the fishing ground of *Pseudosciaena polyactis* off the mouth of the Yellow River often occurs red tide caused by the overproduction of *Noctiluca scintillans*. An experimental study of *Noctiluca* in its living condition shows that this large naked dinoflagellate causes the death of fish by adhering to the gills in great masses and leading to its suffocation. The experiment confirmed the lethal property of  $Cu^{++}$  ion towards *Noctiluca*<sup>[18]</sup>.

IV. In September, 1958, a large-scale oceanographic survey was carried out along the entire coast of China from the Pei-Hai in the north to the South China Sea in the south. As a result of recent 10 months' survey of the Pei-Hai, the Yellow Sea and the East China Sea, the following results were obtained:

1. The total biomass of zooplankton is, on the whole, highest in the East China Sea and lowest in the Yellow Sea. In general, it reaches a maximum in late spring, i.e. in June, and reduces to a minimum in winter. Its seasonal variation appears to be most marked in the East China Sea and least in the Yellow Sea where the biomass remains quite stable throughout the year.

2. In the Pei-Hai with its relatively less saline water, the zooplankton is dominated by such neritic species as *Labidocera euchaeta*, *Acartia bifilosa*, *Noctiluca scintillans*, etc. During the time of outflow of the Yellow River, these species spread further away from the coast and are carried into the center of the bay, whilst in winter when the outflow from this river greatly diminishes, the offshore species from the northern part of the Yellow Sea are brought into the bay.

3. The zooplankton of the central water mass of the Yellow Sea is composed mainly of temperate species such as *Calanus pacificus*, *Themisto gracilipes*, *Euphausia pacifica*, etc., inhabiting offshore water of relatively high salinity. In the less saline coastal waters, these offshore species markedly reduce in number, being replaced by neritic species such as *Noctiluca scintillans*, *Labidocera euchaeta*, *Pseudodiaptomus marinus*, etc. Noteworthy is the appearance of warm-water species such as *Sagitta inflata*, *Euchaeta concinna*, *Undinula darwinii*, etc., in the southeast corner of the South Yellow Sea, being brought there by the warm current.

4. In the East China Sea there occur three different communities inhabiting three different water masses. Firstly, there is a tropical community in the warm current with high temperature and high salinity entering the East China Sea from the South. This community consists entirely of subtropical and tropical species such as *Pterosagitta draco*, *Sagitta regularis*, *Porpita pacifica*, *Euchaeta concinna*, *E. plana*, *Rhincalanus cornutus*, *Globorotulia menardii*, etc. As a rule, their distribution off the Chekiang Coast does not extend beyond 31°N. Secondly, there is a temperate community in the central water mass of the Yellow Sea with relatively low temperature and high salinity coming down from the north with *Sagitta crassa*, *Themisto gracilipes*, *Euphausia pacifica* and *Calanus pacificus* in dominance. Thirdly, there is a neritic community in the coastal water of low salinity, being dominated by *Labidocera euchaeta*, *Acartia bifilosa*, *Schmuckeria poplesia*, etc. From the change in the spatial distribution of these three different

communities, it is possible to follow the movement of the three different water masses in the East China Sea.

5. Very little is known of the zooplankton of the South China Sea. Judging from the data so far obtained in the national oceanological survey, its composition is essentially of tropical character, being composed mainly of tropical species such as *Porpita pacifica*, *Sagitta robusta*, *Phronimella* sp., *Pyrosoma* sp., etc., but the temperate species from the other seas such as *Calanus pacificus*, *Sagitta bedoii*, etc., may also appear in the plankton.

V. A more detailed study of zooplankton has been made in Amoy harbor than made in other bays. As a result of continuous survey of several years (1953—1957), it is evident that the Amoy zooplankton belongs to the subtropical community, being dominated by warm-water species, such as *Paracalanus aculeatus*, *Undinula vulgaris*, *Euchaeta concinna*, *Sagitta enflata*, etc. The majority are, however, neritic species, and, owing to the outflow of the Chiu-Lung River a few estuarine species such as *Pseudodiaptomus marinus* are often present in the samples. In general, the zooplankton occurs in greatest abundance in summer (July—August), but owing to the prevalence of relatively high temperature (often above 10°C), the winter plankton is not so poor as in northern waters<sup>[13]</sup>.