A DECADE OF MARINE PHYTOPLANKTON RESEARCH IN CHINA

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(Abstract)

A brief account is given of the progress of marine phyto-plankton research in the People's Republic of China for the last ten years. Most of these studies have been carried out, particularly before 1957, in close connection with investigations on fishing grounds and sea-farming inshore waters. During the last two years the progress of marine phyto-plankton research has been especially rapid and the area investigated has been greatly enlarged in pace with the comprehensive oceanographic investigation of the four seas, Peihai, Yellow Sea, East China Sea and South China Sea.

1. Taxonomic research

The importance of taxonomic studies is emphasized and special reference is given to two published works, "Studies on the Genus *Chaetoceros* Ehrenberg from the fishing ground of the mackerel, *Pneumatophorus japonicus* (*Houttuyn*), off the Shantung coast from Chefoo to Weihai. Part 1. A systematic study[1]," and "Studies on marine planktonic diatoms of Amoy[3]." In the former paper the universally accepted system of the classification of the Genus *Chaetoceros* was revised because of its drawbacks leading to confusion and difficulties in the identification of the species of the genus. Instead of two subgenera and eighteen sections of the old system, the revised system consists of three subgenera: (1) Subgenus *Monochromatophorus,* including all the species with one large plate-like chromatophore in each cell, each chromatophore containing a pyrenoid; (2) Subgenus *Dichromatophorus,* including all the species with two large plate-like chromatophores in each cell, each chromatophore containing a pyrenoid; and (3) Subgenus *Polychromatophorus,* including all the species with more than two chromatophores in each cell, the chromatophores mostly without pyrenoid. The Subgenus *Polychromatophorus* is again subdivided into two sections: (1) Section Achromatocerae, including all the species without chromatophores in the setae; and (2) Section Chromatocerae, including all the species with chromatophores in the setae. Chromatophores of a few species of the Section Achromatocerae are comparatively large in size, but less in number, and may each contain a small pyrenoid; but

chromatophores of the rest of the species of this section and of all the species of the Section Chromatocerae are small and numerous, without pyrenoid.

The revision of the system of classification of the Genus *Chaetoceros* is based on the view that species with a single large plate-like chromatophore in each cell are more primitive than those with two large plate-like chromatophores in each cell, and those with numerous small chromatophores in each cell are higher on the evolutionary scale. Chromatophores of *Chaetoceros* without pyrenoid are also considered as more evolved than those with pyrenoids. Such characteristics of chromatophores are, furthermore, considered as less variable and, hence, more important than the morphological features of the cell wall and setae in systematic studies of the Genus *Chaetoceros*.

Among the species studied from the mackerel fishing ground and adjacent regions, twelve species and a variety are grouped under Subgenus *Monochromatophorus*, eight species under Subgenus *Dichromatophorus*, five under Section Achromatocerae of Subgenus *Polychromatophorus* and six under Section Chromatocerae.

As the result of studies on the weekly collections (once or twice a week) for more than six years (1932, 1935—'36, 1947—'50), 127 species of diatoms were identified from the Amoy region. Altogether, 181 species are described in this paper[3], including species from other places along the coast of China, among which 140 species were obtained from various places along the coast of Fukien Province. Besides working out the seasonal distribution of many species, this work has made a valuable contribution to the taxonomic study of marine diatoms along the coast of China, and has been helpful to those working on diatoms.

Many of the Fukien marine diatoms here described have also been found in South China Sea, East China Sea as well as Yellow Sea. Thus, of the 181 species described, 48 have been observed from East China Sea, 52 from the Tsingtao region and 12 species of *Chaetoceros* from the mackerel fishing ground and adjacent regions north of the Shantung Peninsula[1].

Marine diatoms from the inshore waters of Kwangtung Province, including Hainan Island, have also been investigated and 116 species identified, of which 22 species are most abundant and frequently observed, and 17 species are new records from China[4].

Large amount of taxonomic work has been carried out since last year and is being carried on actively in connection with the comprehensive oceanographic investigation of the China seas. So far, 81 species have been identified from the Peihai, 127 species from the East China Sea and 91 species from the South China Sea, of which no less than 10 species need further studies in order to arrive at an accurate identification.

2. Ecological research

Ecological studies of the phytoplankton in the fishing grounds of *Acetes chinensis* in the Liaotung Bay of Peihai[6] and of the mackerel in the North Yellow Sea are worthy of notice. *Coscinodiscus asteromphalus* and *C. Jonesianus*, both being the main food of *Acetes chinensis*, make their first appearance in the northern part and near the eastern and western shores of the Liaotung Bay. They increase greatly in number in June, and as a result of their being heavily fed upon by these small shrimps, zooplankton, and fish fry in July, become impoverished in August[6]. Their number increases again in September, becoming abundant all over the bay in October, and decreases again in December to a scanty amount in April of the next year, when a noticeable number is observed only in the northern part of the bay near estuaries. It is evident that intensive feeding by *Acetes* and other predators is one of the main causes for the decrease in number of these two species of *Coscinodiscus*.

Melosira sulcata, another plankton diatom eaten by *Acetes,* appears in March, becoming abundant in May, and almost disappears in summer after being heavily fed upon by *Acetes.* The number of three other plankton diatoms, *Biddulphia sinensis, Thalassionema nitzschioides* and *Th. frauenfeldii,* is also observed to be affected by the feeding of *Acetes* and other animals.

Pleurosigma affine, P. angulatum, Nitzschia seriata and *Navicula cancellata,* though also eaten by *Acetes* to a small extent, are, on the other hand, not noticeably affected in number by its feeding.

In the mackerel fishing ground north of the Shantung Peninsula, a correlation exists between the distribution of the species of *Chaetoceros* and that of the hydrographical conditions. The variation of the total number of cells of *Chaetoceros* in various regions of the fishing ground is found to be connected with distribution of inshore and offshore waters. The largest number of *Chaetoceros* occurs ordinarily near the shore and consists mainly of species of the two subgenera *Monochromatophorus* and *Dichromatophorus* as well as the following species of the subgenus *Polychromatophorus*: *Chaetoceros lorenzianus, Ch. compressus, Ch. castracanei, Ch. peruvianus* and *Ch. densus. Ch. densus* is sometimes more abundant than that of any other species of the Genus *Chaetoceros*[2].

Dense concentration of these species near the shore is sometimes greatly dispersed by the influx of offshore water bringing *Ch. convolutus* into the fishing ground.

The distribution of the following three species of Subgenus *Polychromatophorus* is rather interesting. *Chaetoceros convolutus,* as just mentioned, may possibly be used as an indicator of more saline offshore water, especially in the early part of the mackerel fishing season; while *Ch. castracanei* and *Ch. densus* both occur abundantly almost all over the fishing ground and last throughout the main period of the fishing season, their distribution correlating well with hydrographical conditions.

The results of the ecological studies in connection with the comprehensive oceanographic investigation show that the main constituents of phytoplankton in our seas are diatoms. The abundance of diatoms are greater in North Yellow Sea and Peihai than in South Yellow Sea and East China Sea. The seasonal variation in number of phytoplankton cells is larger in Peihai and East China Sea than in Yellow Sea where the hydrographical conditions remain fairly stable. The location of dense phytoplankton populations is rather more constant in Peihai and Yellow Sea than in East China Sea. Dense concentrations often occur near the shore and in regions where inshore and offshore waters mix with each other, as mentioned above in the mackerel fishing ground.

In Peihai dense concentrations often occur near the estuarine regions with higher contents of dissolved nutrient salts carried into the sea by rivers. Here neritic and temperate species form the main constituents, such as *Skeletonema costatum* and species of the two subgenera *Monochromatophorus* and *Dichromatophorus* in spring and *Thalassionema nitzschioides* and species of *Coscinodiscus* in autumn. In April and May small number of an oceanic species, *Rhizosolenia styliformis,* may also be observed.

Areas of dense concentration occur in the region of Haiyang Islands in North Yellow Sea, and also near the northern shore of the Shantung Peninsula where inshore and offshore waters intermix, phytoplankton cells being more abundant in the former region as a result of the continuous supply of nutrients from the Yalu River.

Rhizosolenia styliformis and *Hemiaulus membranacus,* preferring water of higher salinity, occur more often and in rather noticeable number in the central part of the North Yellow Sea.

Rh. styliformis may also be observed in the region of the Haiyang region.

The densest phytoplankton concentrations in South Yellow Sea persist for most of the time near the southern coast of the Shantung Peninsula, while *Rhizosolenia styliformis* and *Hemiaulus membranacus* are mainly distributed in the eastern part of the sea. During winter *Planktoniella sol*, a tropical and oceanic species, can be collected in the area south of 35°N and east of 123°E.

Biddulphia mobiliensis, B. regia, Ditylum brightwellii and species of Coscinodiscus often accumulate in the shallow water near the coast of the northern region of Kiangsu Province. *Rhizosolenia alata* forma *gracillima* is often collected as almost pure culture from the Tasha fishing ground in autumn.

Thalassionema nitzschioides, Chaetoceros debilis and some other neritic temperate species are the main components of phytoplankton in the East China Sea. *Skeletonema costatum* and such estuarine species as *Melosira islandica* and *Bellerochea malleus* are often found in the vicinity of the Yangtze estuary, while *Thalassiosira subtilis* and *Planktoniella sol* are present in regions near the warm current southeast of the Yangtze estuary.

In the South China Sea, *Rhizosolenia bergonii, Rh. imbricata, Rh. robusta* and *Rh. cylindurus* are the main constituents of phytoplankton, while the bluegreen algae, *Trichodesmus,* dominants in the area south of Hainan Island where diatoms are less in number.

Of studies on the seasonal distribution of plankton diatoms in inshore waters and sea-farming regions, those carried out in Amoy are worthy of special notice. Here the material of the monthly variation in number for 63 species of diatoms has been worked out, together with diagrams of monthly variation of 40 species common in Amoy.

Suggestions are made for further marine phytoplankton studies in China in the fields of ecology, physiology and taxonomy in accordance with the urgent needs in the rapid development of various marine fisheries and sea-farming.