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MARINE BIOLOGY IN CHINA DURING THE PAST DECADE

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Inasmuch as marine biology is a science that deals with the development of animal and plant life in the ocean, its scope is not confined to biology alone. It is, for all practical purposes, an integral part of oceanic study. This science has been well developed by advanced countries bordering seacoasts. Like other branches of science, it was neglected by the reactionary rule before the liberation.

In the short space of a decade after the liberation, marine biology witnessed enormous development, as did other branches of science, under the party's correct leadership and endorsement; the scope of research expanded from a study of classification to a close understanding of practical embryology and the resource situation. For the past few years, the main work of marine biology has been the classification and area examination of animal and plant life along and near the seacoast, together with the study of their biological peculiarities, in order to accumulate basic material for the utilization and further development of marine biological resources. At the same time, practical biological methods have been applied to the study of important animal and plant life not only to meet the popular demand for marine products but also to guard against the growth of Corbicula leana Prime (hsien), which handicapped navigation and harbor construction.

Research on marine animal and plant life by classification and area -- This study lays the foundation for the procurement of basic data for the development and utilization of marine resources. During the past few years, the scope of area investigation work has been

extended to the coastal regions of China and classification by important species and publication of a local directory of fauna and flora by area and locality has been completed. In this connection, special articles has been published, contributing to a basic understanding of the characteristics of Chinese marine animal and plant life.

Investigations on marine production in the Huang Hai [Yellow Sea], Pai Hai [Gulf of Pohai] and Nan Hai [South China Sea] regions in China were completed resulting in the publication of "Report on Fish Species in the Huang Hai and Pai Hai Regions" and "Preliminary Directory of Fish Production in the Nan Hai Area." About 250 temperate-belt types were observed in the Huang Hai and Pai Hai areas. Types of economic fish that were seen in quantity and distributed over a broad area consisted principally of Carvula schlegeli (shih-shou-yu) and Paralichthys alivacens (pi-mo-yu), while Huang Hai, Pai Hai and Tung Hai [East China Sea] abounded in the production of a local variety known as "hsiao-huang-yu." According to investigation data compiled during the past five years, 854 varieties of fish of tropical and subtropical types were observed in the Nan Hai area. They were of the lower and middle strata, mostly found in the Indian and Malayan regions, although some species such as "ta-huang-yu," being local in type, were found only in the Nan Hai and Tung Hai regions. Over 400 kinds of fish, according to available data, were seen in the Tung Hai area. Among them were many types of economic fish identical with those seen in the Nan Hai region, while some species were fauna as far away as part of Huang Hai.

As to the invertebrates, stress was placed on Mallusea, Crustacea and Echinodermata because of their economic value. Upon completion of investigations in the Huang Hai and Pai Hai regions special treatises dealing with Mallusea and shrimps were published. Regarding the general distribution of Mallusea, the composition of the Chinese system was dominated principally by the Indian and West Pacific varieties. Malluses found in the Huang Hai and Pai Hai region were basically of the temperate zone while those seen in the Tung Hai area were somewhat marked by subtropical features. The variety observed in Nan Hai fell within the province of the varieties found in subtropical India and the West Pacific.

Concerning the shrimp observed in China seas, a

common element noted among these marine districts was that the chief economic species consisted of shrimp of all kinds and a representative type of "long-armed" shrimp (ch'ang-pi-hsia). Types frequently observed in the warm current of subtropical and tropical belts almost dominated the scene. Few varieties were seen in the Huang Hai area: apart from some local species such as prawns and "mao-hsia" seen in China seas, they were essentially similar to those found in the shallow coastal areas of Japan. The volume of marine production was apparently limited. Warm current varieties were, however, observed in greater number in the Tung Hai area. "Tung-hsia" alone accounted for more than 20 kinds. There were many types of Palinurus japonicus (lung-hsia) and cicada-shaped shrimp (ch'an-hsia) seen especially in the Taiwan Strait, and they were predominantly of the tropical Indian-West Pacific type. Many of these varieties were found frequently in Southeast Asian countries bordering on the Pacific and Indian Ocean, but the cold-current variety that penetrated into Huang Hai by way of the Korean Strait from Japan did not, as a rule, spread to the Tung Hai area.

Research on Foraminifera (yu-kung-ch'ung) established that more than 350 kinds of Foraminifera were to be found at the bottom of Pai Hai, Huang Hai and Tung Hai. Of these some 20 types which floated on the surface were mostly of the warm-current variety. They were carried northward by the warm current into the Tung Hai region. Representatives of some varieties entered into the northeastern part of Nan Huang Hai. Foraminifera that inhabited the bottoms of Pai Hai and Huang Hai were found to be mainly of the type identified with the northern part of the north temperate zone, interspersed with some varieties that were of the cold-current type from the subfrigid belt. The Tung Hai region was frequented by tropical and subtropical kinds.

In addition, Ostrea talienwahnensis Cross (mu-li) and Ligia (chu) from the littorals of China, Echinoidea (hai-t'an) and bivalves (shuang-k'o) from Nan Hai and Hydromedusae (hsieh-shui-mu), Pagurus (chi-sheng-hsien-mao-ch'ung), sand-shell Pagurus (sha-k'o-hsien-mao-ch'ung), "limping-leg" type, "hairy" shrimp (mao-hsia), "snake-tail" type (she-we) and Stichopus japonicus Selenka (hai-shen) from Huang Hai were classified.

Research on Algae (hai-tsao) in the Huang Hai and Pai Hai regions was consummated with the publication of a book entitled "Algae Production in the Huang Hai and

Pai Hai Regions," which lists 204 kinds of seaweed found on the sea bottoms of the area under review. As evidenced by their distribution in the Huang Hai, Pai Hai and Tung Hai areas, most of these varieties, with the exception of a few subtropical kinds, were temperate-belt types; there was no spontaneous generation of true tropical and frigid-zone types. Available data seemed to indicate that Algae found in the Huang Hai, Pai Hai and Tung Hai regions was in type and composition close to that seen in Korea and Tsushima, where warm currents and their tributaries play an important role. Some varieties, such as Anemone flaccida, Fr. Schm. (o-chang-ts'ai) and Ulopteryx pinnatifida, Kjellm. (ch'un-tai-ts'ai), local marine products common to the three regions were conspicuous by their absence in other areas.

As to the reasons for the interrupted distribution of Sargassum Horneri (t'ung-tsao) and Phaeophyceae (ho-tsao) along the Chinese coast, it was pointed out that the movement of these varieties in Tung Hai toward a point north of Shantung Peninsula was restricted by physical factors and that the species found in Liaotung Peninsula were brought down from the west coast of the Korean Peninsula.

Furthermore, in the case of Porphyra laciniata (tzu-ts'ai) proposals for three newly distinguished units were incorporated in the subheadings for true Porphyra laciniata. In line with evolutionary practice, a new system of classification was evolved for Diatomaceae (kuei-tsao), a pelagic fauna.

In short, incomplete data available to date indicated that marine animal and plant life along the Chinese coast had characteristics identified with the temperate, subtropical and tropical belts, assuming in increasing proportion subtropical and tropical features in the gradual movement from north to south. Types seen in the Huang Hai and Pai Hai regions, whose marine production was associated with the temperate zone appeared to be pure. Some subtropical varieties were nevertheless noted. The Tung Hai area was very complicated. While it was strong in subtropical varieties, its northern sector was greatly influenced by the temperate belt, especially in the area where algae was observed. Subtropical varieties figures rather prominently in its southern portion. In the Nan Hai region, principally along the mainland coast, the varieties were subtropical in character, while those found off the southern tip of

Taiwan, the southern part of Hainan Island and the Paracel Islands were decidedly tropical and became an integral part of the Indian-Malayan system.

Investigation on Marine Embryology

The care of marine biological work is marine embryology, which supplies data for the development and utilization of biological resources. Comprehensive marine research including a study of fishing fields in the past few years has contributed to a general understanding of fluctuations in the production volume of plankton and sub-surface marine life and of the distribution and seasonal changes of major species.

In average value of gross production of plankton, the Tung Hai area ranked first; Pai Hai next; and Huang Hai, last. Excepting the Huang Hai area, marine production volume would begin to rise in April. The increase could be noted in all other regions. It accelerated in May and June. The peak was usually reached during the month of June.

The results thus attained demonstrated that a close relationship existed between the classification, composition and distribution of plankton and the water circulatory system of various marine areas. For example, the low-salinity shore area of Pai Hai was the scene of most activity; while plankton societies in the Huang Hai region varied significantly with the differences in its water circulatory system. The central water circulatory system of Pai Huang Hai and Nan Huang Hai was mainly confined to the pelagic high-salinity area. The volume of production dropped noticeably as the low-salinity coastal area of Huang Hai was approached; there, low-salinity shore species thrived in great number. Generally speaking, three different communities were observed in the complicated classification and composition of the varieties in the Tung Hai area: those from the Huang Hai region, tropical species from northern warm current areas, and species identified with low-salinity shore regions.

The passively floating plant life is divided into high-salinity pelagic and low-salinity shoreline varieties. In the Pei Huang Hai region, Diatomaceae (kuei-tsao) species appear primarily in high-salinity pelagic areas, while other varieties thrive in low-salinity shore water circulatory system. Therefore, by

observing fluctuations in the production volume of Daitomaceae, definite knowledge of water circulatory systems may be obtained.

Investigations on the gross volume of production of sub-surface marine life (computed by weight per square meter) were conducted in various marine regions in winter (January, 1959, cited as representative) and in spring (April, 1959, cited as representative). In addition, research on total marine production volume was undertaken in the Huang Hai and Pai Hai areas in autumn, 1958 (October cited as representative). The rank order of production was as follows: Huang Hai, Tung Hai, Pai Hai, Nan Hai. The results apparently differed from those mentioned above, i.e., Tung Hai, Pai Hai, Huang Hai.

Research on tidal embryology in China began in 1957 in collaboration of Soviet scientists. An analysis of available data indicated that the vertical distribution limits of animal life corresponded basically with findings on stratum limits in tidal belts. By far the largest number of varieties did not possess the capacity to rise to the surface stratum. Beginning with the second stratum of the second area, the distribution zone of most species to the base level on reaching the lower limits. These characteristics were clearly discernible in the tidal belt of Huang Hai, whose marine production volume was estimated at 150-200 grams per square meter.

Investigation on Marine Biological Resources

Realizing that such investigation work would contribute to the development and utilization of resources, research was systematically conducted during the past few years on marine resources of harbor, bay and beach areas and along the shoreline.

Varieties of economic fish and some types of self-swimming and passively floating invertebrates are important marine biological resources. During the past decade, these resources were investigated. Over 50 species were listed as of considerable economic value. Those with an annual volume of production exceeding 100,000 tons were "ta-huang-yu," "hsiao-huang-yu," Trichinrus japonicus T. & S. (Tai-yu), etc.; those with an annual volume of production in excess of 10,000 tons consisted of "t'ai-yu," Congrellus anagosche (hai-man), "she-liu," etc. Among the invertebrates, "mao-hsia" ranked highest in production, with an annual volume placed at more than 50,000 tons. Next in importance were

cuddlefish (mo-yu), "tui-hsia" and Hirudo nipponia (hai-che).

Regular long-term research on the biological features of marine life and the environmental factors of fishing fields should be undertaken to determine the laws governing changes in marine resources. Since 1952, research programs for "t'ai-yu," "hsiao-huang-yu," "ta-huang-yu" and Trichinrus japonicus T. & S. were planned and initiated. The results thus obtained have been applied to production increase.

Data on "t'ai-yu" communities obtained in the pelagic area of Chefoo indicated that they should be placed in the second category according to "Mon-na-ssuti-erh-ssu-chi's" law. These resources fluctuated and recovered easily, and their recuperative power was apparently strong. Water temperature and salinity were, comparatively speaking, related to the fishing season. On the strength of related data, concrete measures for increasing production and for protecting "t'ai-yu" are under consideration.

To ascertain the biological peculiarities of "hsiao-huang-yu", research work was conducted in great detail on breeding fields in the estuary of Huang Ho and on environmental factors in the fishing fields in the west portion of Pei Huang Hai, especially the base-level temperature, salinity and other oceanographic features. On the basis of these data, the location of fishing fields and the timing of fishing seasons at Chefoo and Wei-hai-wei were spot-forecast with a high degree of accuracy. The promotional effect on production was definite.

These data demonstrated that at least two different local "ta-huang-yu" types existed along the Chinese coast and that their embryonic models differed even within the same marine area. The influence of "ta-huang-yu" types on production volume was complex. To establish a correct relationship between water temperature and fishing seasons, an analysis was made of the relationship existing between the environmental factors of breeding grounds and the fishing season.

Concerning data on Trichinrus japonicus T. & S., a preliminary forecast of the winter catch at Ch'eng-shan, Chekiang Province, was first made in 1958. An analysis of data on "six-gill" Konosirus punctatus, J. & S. (Ch'i) and "six-thread" Konosirus punctatus, J. & S. (ch'i) and on the distribution and behavior of "hung-yu" was undertaken.

Recent studies of "mao-hsia" in Liaotung Wan, one of the principal breeding grounds, pointed out the influence of seawater temperature on its reproductive capacity and showed that it multiplied favorably under low-salinity conditions. Surrounded by plankton, "mao-hsia" had for its basic feed a weed known as sieve-plate Diatomaceae (yuan-shai-kuei-tsao), but the weeds' existence was threatened by Noctiluea (yeh-kuang-ch'ung), so that any change in the volume of Noctiluea would have an immediate effect on this variety of shrimp.

Sub-surface marine resources of Chinese harbors, bays and beaches are exceptionally rich in variety, volume of production and application. Ostrea talienwahnensis Cross (mu-li), Solecurtus constrictus Lemark (ch'eng-tzu), Mytilus carsitesta Lisehk (i-pei), Corbicula leana Prime (han), Macra veneriformis (ha), Stichopus japonicus (tz'u-shen), Laminaria (hai-tai), Porphyra laciniata (tzu-ts'ai), moss, etc. were considered as delicacies; Gelidium catilagineum, Grev. (shih-hua-ts'ai) and Gracilaria confervoides, Grev. (kiang-li) were regarded as gelatinous raw materials; and Halochloa macrantha, Kg. (ma-wei-tsao) and "hai-kao-tzu" (a sea plant) served as raw materials for Phaeophyceae glue. In addition, from Gloiopeltis furcata (hai-lo) was extracted a substance for the preparation of adhesives; and "ch'i-ling-ts'ai" was employed for the manufacture of Digenea simplex. Wulf (che-ku-ts'ai), a popular medicine in China. Shells and seaweed were extensively used as animal feed and farm fertilizers.

For the extension of culture grounds for marine animal and plant life, investigation groups were organized by various provincial marine products departments along the coast in conjunction with various colleges. These units, stationed in Shantung, Fukien and other coastal provinces, conducted joint surveys on marine biological and environmental factors, on the basis of which many proposals for development of and increase in biological resources were formulated.

Practical Embryologic Studies on Major Economic Marine Animal and Plant Life

From an economic standpoint, some organisms are beneficial while others are harmful. It is the task of marine scientists to step up the production of beneficial species and to inhibit the development of harmful varieties. The researchers are mainly concerned with the

application of practical biological methods to the complex problems of biological and environmental factors. In other words, the studies are calculated to increase or decrease production in line with embryologic experiments.

During the past few years some achievements have been made in the study of beneficial species through practical embryologic research and in greatly promoting their culture in China. The culture of valuable animal and marine life in accordance with the mass line received an added impetus when the party announced its correct policy of "breeding principally" for the development of the marine products industry in 1958. In a brief period some preliminary results were obtained and many cultured species were found to be increasing.

The culture of Laminaria in recent years accounted for a rapid growth of the marine products culture industry. Its volume of production rose from a high of 370 tons per annum before the liberation to more than 37,000 tons in 1958. Production figures for 1959 will be even greater.

In recent years, adoption of scientific methods for the culture of Laminaria, using a set of "raft-style" artificial cultivation devices was responsible for the increasing share of artificial control in its production. By rational close cultivation its volume of production per unit area was greatly increased, accompanied by reduced production costs. A "nursery" method of artificially creating low temperatures removed the threat to its growth by miscellaneous seagrass under natural conditions and raised the rate of seedling culture. By creating a "ceramic can fertilization" method, the problem of utilizing unproductive marine areas for the cultivation of commercial Laminaria was resolved and the basic problem of the extension of production areas was also solved. Through further research a method for intermittent fertilization and for suspension of fertilization after the growth period was formulated to economize on the application of chemical fertilizer and to increase its effectiveness. By transplanting Laminaria to Chekiang, Fukien, Kiangsu and Kwangtung provinces in the south, a broad avenue was opened for the culture of Laminaria in the naturally rich area of Tung Hai.

Research on the embryonic aspect of Porphyra laciniata (tzu-ts'ai) was undertaken, with special emphasis on its protonemal stage. In growth behavior, the protonema differed in many aspects from the thallus

(the customary variety), sometimes almost to the point of contradiction. The most outstanding feature was that the protonema developed in a shell. In China, it grew not only in the empty shells of Ostrea talienwahnensis Cross and Mactra veneriformis but also in the calcareous tubes of Siphonophora (kuan-ch'ung) and sometimes even among lime seaweed. It was learned that in its protonemal stage, direct exposure to sunshine and dryness should be avoided, since it thrives best in an environment where feeble light and higher water temperatures prevail. On the contrary, during the thalloid stage it adapts to strong sunlight and is exposed to light on submerged rocks for a few hours during the tidal period. Its growing season occurred between late autumn and early spring when the temperature was at its lowest. The research made it possible to determine the relationship existing between the temperature required for acervulus to mature to protonemal formation and the diffusion of acervulus on the one hand and light and external motive power on the other.

Through research, prawns (tui-hsia) were enabled to survive under simulated conditions of wintry weather and eggs were laid and hatched about a month ahead of time compared with growth in a natural environment. Stichopus japonicus Selenka was cultured by artificial means and, with this advance in research, a new era for its development dawned.

During recent years, experiences in the culture of Ostrea talienwahnensis Cross as obtained from the masses has been systematically and scientifically summarized and a basic understanding of its reproduction, growth and environmental factors has been reached. With the solution of the feed problem, Mytilus carstitesta larvae could be successfully developed indoors under controlled conditions. Research on such environmental factors as were required for their growth -- temperature, light, salinity and calcium content -- was systematized. To develop embryologic data for the culture of Solecurtus constrictus Lamark and Pecten yessoensis Jay, their reproduction and development in relation to environment was investigated.

"Chin-yu" is an important species found in the harbors of Huang Hai and Pai Hai. In the past its growth was retarded and its production volume per unit area was low because of crude methods of cultivation. With the use of inorganic fertilizer, the young of the species were observed to have increased their weight 2.4 times

equally during the first and the second year, and their vitality was doubled during the first year. A preliminary understanding of the environmental requirements for their growth on coral islands, such as the specific gravity of seawater, light, temperature, oxygen content, reproductive behavior, feeding habits, etc., was reached. By examining the embryonic aspects of *Ligia* growth, it was possible to ascertain the seasonality of reproduction, its stratified growth and its growth period as influenced by the environment. Low-priced, effective agents were discovered for the extermination of *Ligia*, and the results were considered satisfactory by the parties concerned. *Mytilus carsitesta* presented a serious problem in the operation of factories using vast quantities of seawater, when pipes were blocked its growth. By systematic experiments, the problem was effectively resolved. The growth of this parasite keels tended to obstruct navigation and to increase fuel consumption considerably. The problem was, therefore, an important one.

Principal parasites found in the vicinity of Ch'ing-tao appeared subject to seasonal variations in quantity. For their prevention and elimination, necessary data were accumulated concerning their rate of growth in relation to oceanic factors.

Other Factors

The culture of beneficial animal and plant life and the prevention and destruction of harmful species constitute one of the basic reasons for research on the biological activities of these forms of marine life. By examining the growth history of a sweet variety of *Porphyra laciniata*, new methods were provided to approach thereto unsolved major problems such as the process by which acervulus develop into algae and the origin of the compact cluster known as acervulus, with reference to its inter-stage growth history and environment. By studying the developmental history of *Ligia*, it was possible to understand how larvae changed on penetrating into timber and what kinds of food were needed for their subsistence. These data gave important clues for conducting tests on the prevention and destruction of *Ligia*. Not only did the growth history of living organisms found on ships, such as *Balanus amphitrite* ("t'eng-hu" or acorn shell), a species of *Cynthia* (hai-ch'iao), *Mytilus carsitesta*, etc., come to be understood, but also the culture of larvae in the lab-

oratory was accomplished, enabling these organisms to reproduce, develop and undergo metamorphosis under controlled conditions. Thus, the necessary conditions were created for the promotion of indoor laboratory tests on prevention without any restraint from seasonal reproduction, and the time required for such research was also shortened.

Research on the law of individual development constitutes a basic problem in the theory of biology, since it pinpoints the conflict between materialism and various concepts of spiritualism. In studying the development of "wen-ch'ang-yu" eggs, the ovum was found to undergo segregation definite in its early stage with the components reacting strongly on one another. This distribution of matter and its mutual reaction are important factors influencing embryology.

Research on fertilization evidence is a principal method for understanding the origin of animal and plant species. Among marine life, the genital glands of such species as "ling" and Mugil cephalus ("tzu") are capable of delivering fertilized eggs and sperms without any difficulty on reaching their fourth stage. The development of eggs and their hatching appear to be quite normal. Fishes such as Pleuronectes (tieh), etc. also lay eggs in a normal manner after fertilization. Some results were accomplished in respect to fecundation indications in Ostrea talienwahnensis Cross, Corbicula leana Prime, prawns, Stichopus japonicus, Paralichthys alivacens, etc., including studies on their artificial fertilization. Effective ways and means were taken to examine the origin of such economic animal species.

Upon an ample supply of marine animal feed hinges the culture of marine animal life. Since the great leap forward, the cultivation of vast quantities of green seaweed such as Gymnogongrus pinnulatus Harv. (pien-tsao), Halophytenvereine (yen-tsao), Chlorophyceae (lu-chih-tsao), Scirpus fuirenoides Maxim (hsiao-chiu-tsao), Diatomaceae (kuei-tsao), etc. has been signally successful, thus solving the feed problem for invertebrates and the young of species. Young salt-water larvae that breed in winter serve well as feed for marine animal life. This breeding has been extensively practiced abroad. With its development in China the age-old feed problem for the young of marine species has been solved.

In the field of embryology, research was conducted on a sweet variety of Porphyra laciniata while it was still at its protonemal stage, testifying to the presence of a tubular relationship among the cells and pointing out the signs of ecological and positional changes of chromatophores among cells of the same species. The existence of antherozoids during primary fecondation was also verified. The seeding of Laminaria was divided into three embryonic stages, with a view to examining the cell structure of the parasitic worms in the light of a new classification.

The biological aspect of Laminaria was examined in the light of algae growth. It was observed that the photosynthetic capacity of Laminaria was weakest at its base, increasing to several times that capacity in the middle. Cutting its upper-middle leaves clearly affected its growth at the base and the accumulation of organic matter. Evidently there exists a definite system for the delivery of organic matter from the upper-middle portion of the plant to the growing region at its base. By studying the absorption of nitrogenous fertilizer by Laminaria, an understanding of this function in relation to the density of nitrogenous solution, timing and nutritional requirements was reached. At the same time, it was established that carbohydrates accumulated normally in the late growth period of Laminaria even if there has been a shortage of nitrogenous fertilizer. The seeding development of Laminaria indicated that the plant was a negative heliotropic type.

During the past few years, many accomplishments were made in the field of marine biology under the correct leadership of the Chinese Communist Party. The capacity for research has expanded greatly. It is our belief that the development of marine biology in China will be accelerated to contribute adequately to the construction of socialist enterprises and to satisfy the people's needs under the party's correct leadership.

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