

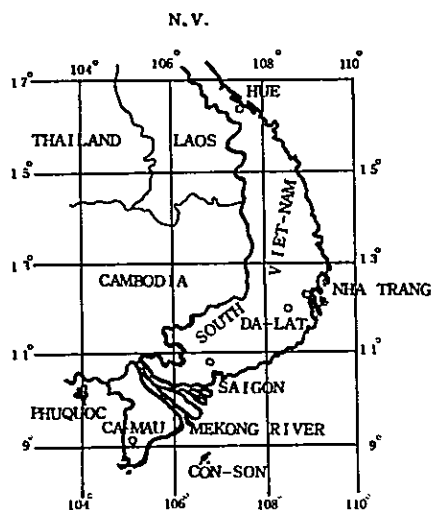
THE PLANKTON OF SOUTH VIET-NAM

—Fresh Water and Marine Plankton—

by

Dr. AKIHIKO SHIROTA

Colombo Plan Expert on Planktology :
Faculty of Science, Saigon University and
the Oceanographic Institute of Nhatrang
Viet-Nam
1966



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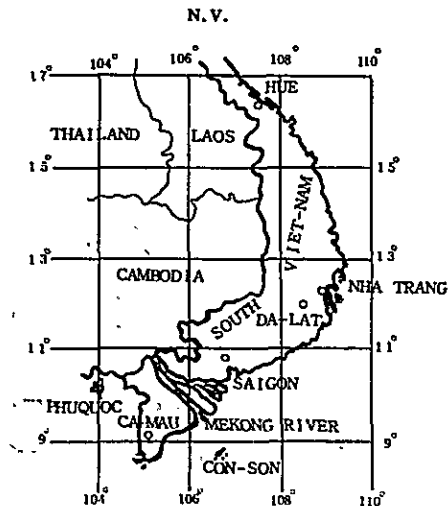
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PREFACE

At present when the world situation is making rapid progress and development, there is no good reason why the study of the oceans and lakes accounting for approximate 2/3 of the earth may be left behind the times. It should be said to be quite significant that the event of International Geophysical Year has recently been inaugurated and the unknown regions as well as the areas not fully surveyed heretofore are being exploited and revealed one by one.

The study of number of floating animals and floating plants living in water, that is, zoo-plankton and phyto-plankton has been prosecuted by many investigators, as a result of which it turned out that they also affect the human life directly or indirectly, and their importance is now being recognized increasingly.

At the request of Viet-Nameese Government, the author proceeded to lead the planktology for the Viet-Nameese students as the Expert of Japan under the Colombo Plan in Saigon University in 1963. The researches in plankton had just been instituted in this country and therefore the author was obliged to start with the most fundamental subject of what kinds of plankton are living there in what distribution pattern. A large number of literatures pertaining to plankton in the world are published, but those dealing with planktons in Southeast-Asia are not many in number. Further, the author keenly felt inconvenience in that no well-compiled reference materials concerning plankton were available in Viet-Nam.

The motive which actuated the author as a young and immature scholar to dare the survey of one country and undertake the publication of this book can be attributed, on one hand, to the author's great affection for Viet-Nameese students and research workers silently continuing their studies under the present tragic situation in Viet-Nam as well as the author's great joy of co-operation in the same science. In the meantime, while working for Saigon University (1963-1965) and Nhatrang Oceanographic Institute (1965-1967), the author received a visit from a number of experts of UNESCO, FAO, USOM and COLOMBO including the research workers from abroad specializing in the same subject as well as the prominent persons of various universities. They gave the author many helpful advices as well as encouragement and desired the immediate publication and introduction of Viet-Nameese plankton, which greatly moved the author.

Though this book is mostly based on the unaided surveys by the author himself and may not entirely be satisfactory, it would be

the greatest pleasure for him if it should serve as a guide for the young Viet-Nameese students and be utilized also by the research workers in the Southern Asian countries, by making up its deficiency, and contribute towards the basic studies as well as the oceanic and lacustrine development and researches including those related to fisheries.

The author hereby expresses his heartiest thanks to the Director of Viet-Nam Fisheries Bureau, Dr. Ngo-Ba-Tham; the directors of the respective local fisheries bureaus; Dr. Le-Van-Thoi, the former Dean of Faculty of Science, Saigon University; Dr. Hoang-Quoc-Truong, Professor of Zoological Laboratory, Science Department of Saigon University; the Professor of Botanical Laboratory, Dr. Pham-Hoang-Ho; the ex-Director of Nha Trang Oceanographic Institute Dr. Nguyen-Chung-Tu, the former Director Dr. Hoang-Ngoc-Can, the present Director Dr. Nguyen-Hai, the Assistant Director Mr. Tran-Ngoc-Loi, the Chemical Laboratory assistant Mr. Nguyen-Thuong-Dao for their kind assistance, as well as to all the staff of the University and Research Institute for their co-operation.

The author also extends his thanks to Dr. Chikayoshi Matsu-daira, Professor of oceanography at Tohoku University Agricultural Department, for his kind offer of electron microscopic photographs and Dr. Teiji Kariya, Professor of fisheries and biology at Tohoku University Agricultural Department, for his encouragement. Finally, the author expresses his deepest thanks to Director General Mr. Shinichi Shibusawa, the former Chief of External Operation Division, Mr. Kohei Yoshida, the former Chief of Experts Assignment Section, Mr. Yasuichi Uehara, and also Mr. Michio Takeda, and present Chief of Experts Assignment Section, Mr. Moriya Miyamoto, respectively of Overseas Technical Co-operation Agency taking charge of the furnishing of experimental equipments as well as technical aid to Asia, Africa, Middle and Near East, Central and South America, etc. and at the same time interested in the publication of this book, and to the staff of O.T.C.A. for their kind offices.

At Nha Trang Oceanographic Institute,
March 6, 1966

Akihiko Shirota

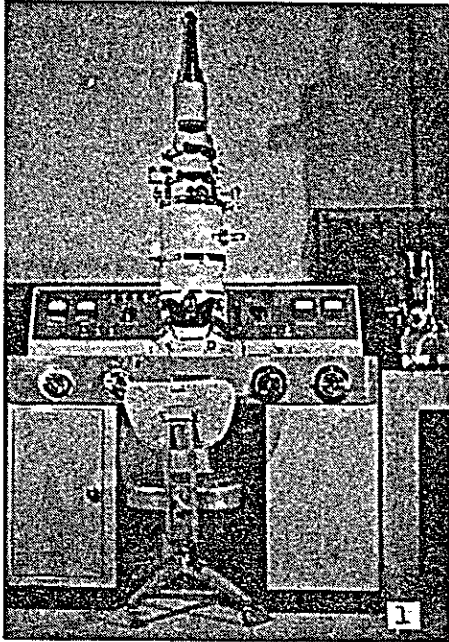
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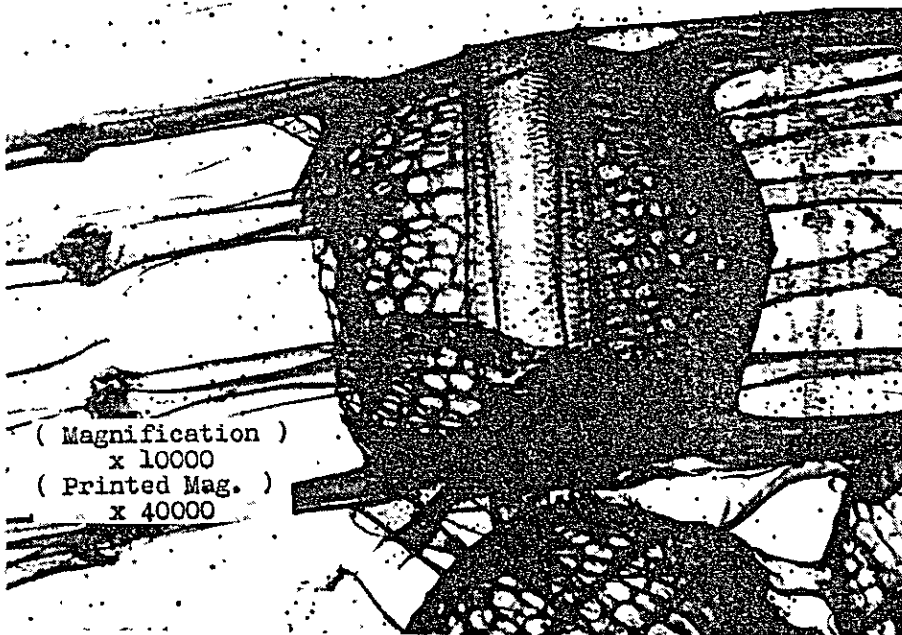
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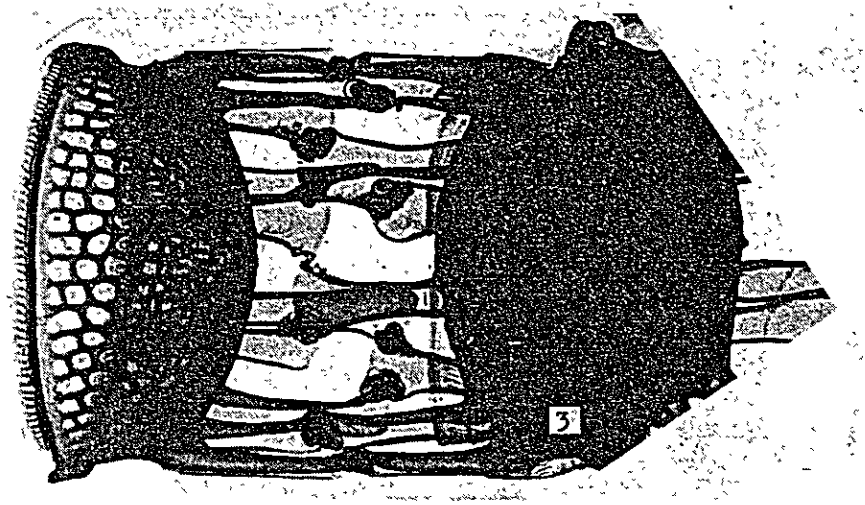
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FRONTISPIECE

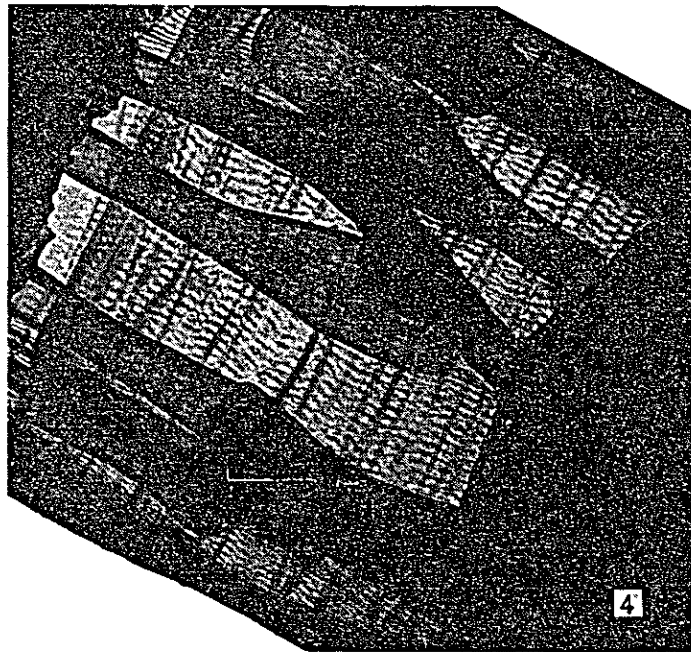


These pictures (2, 3, 4) show Skeletonema costatum (marine Diatom), they are taken by the Electron-microscope (made by Hitachi Co. in Japan ... 1) at the Laboratory of Oceanography, Department of Fisheries, Faculty of Agriculture, Tohoku University in Japan on June 2, 1960.

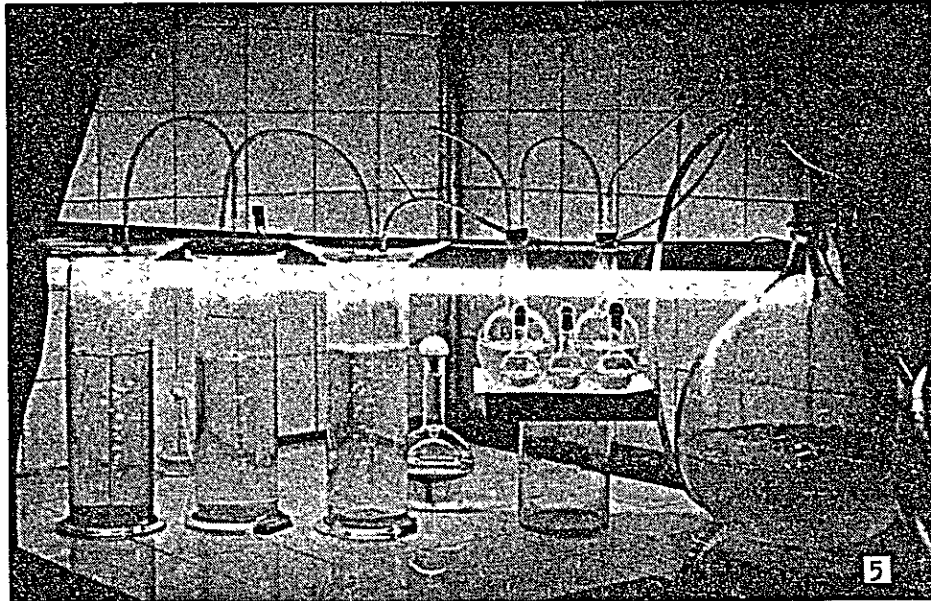




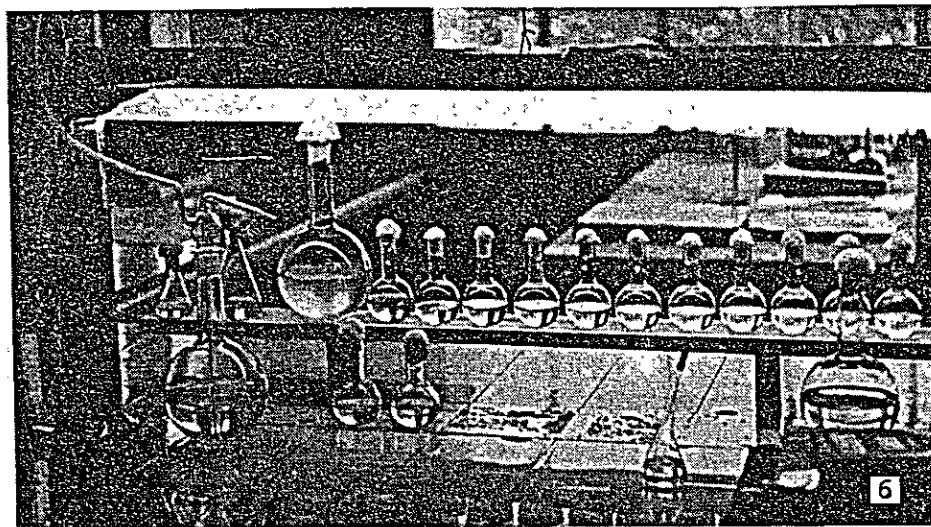
Picture 3. and 4. *Skeletonema costatum* (x 40000)



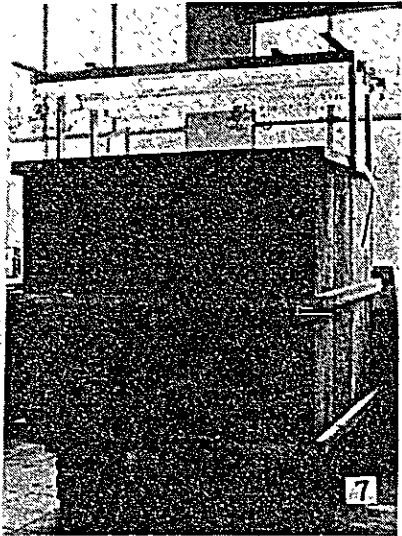
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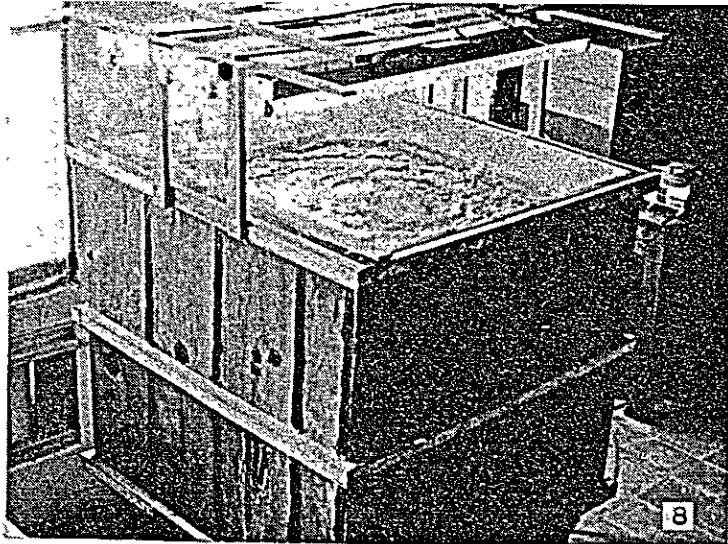
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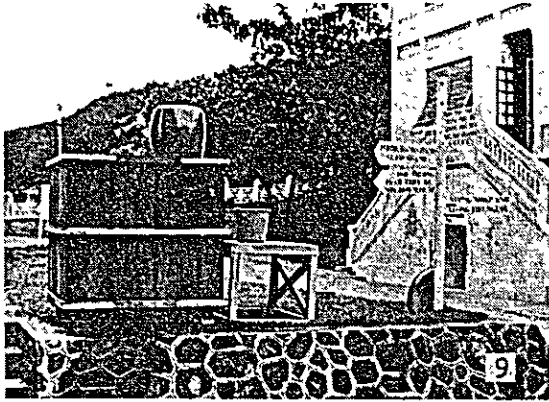


Mass culture (1 ton) of
Plankton at the Oceanographic
Institute of Nhatrang,
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Picture 7. Outward appearance
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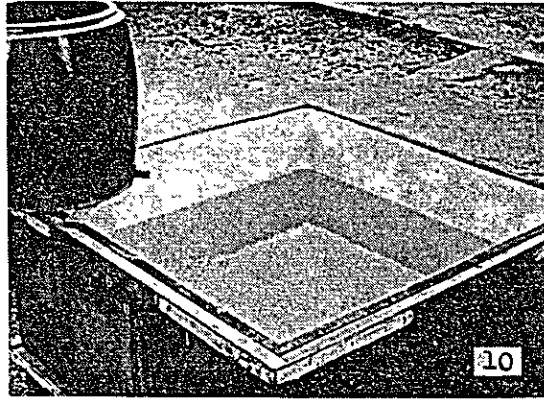
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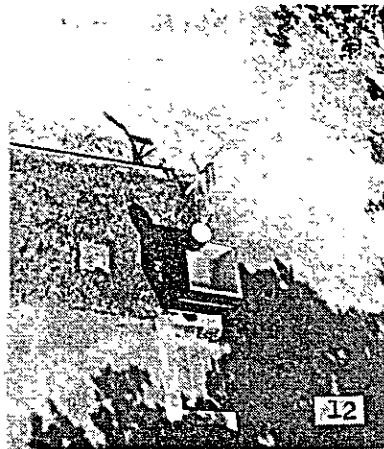
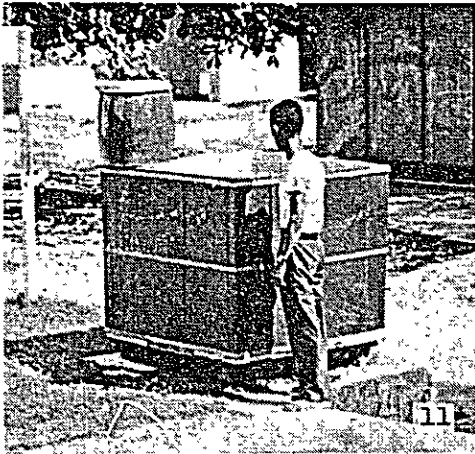


Out-of-door
mass culture;
1965.

Pictures 9. 11. 12.
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Mass culture's
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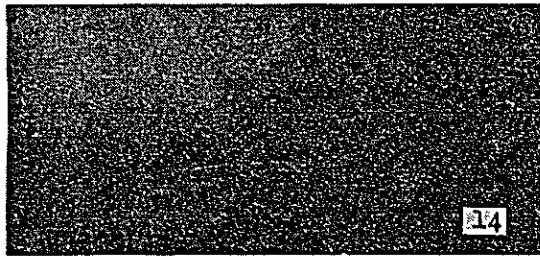
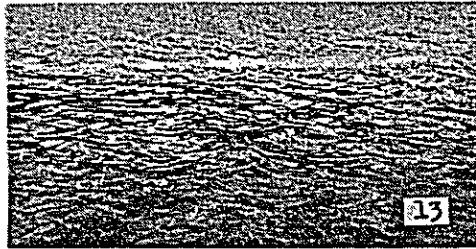


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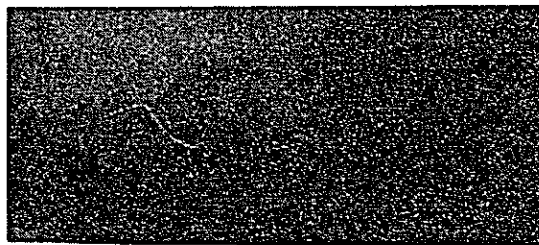


Current-rip occurs at the open sea of Nha-Trang (Pictures 13. 14. 15.).

The place is very important for fishery, because it is rich in plankton, as well as in small and younger fish as food for the big fish which have the economic value.



Pictures 14. 15. Current-rip. (Air view)



INTRODUCTION

South Viet-Nam is located on the east side of Indo-China Peninsula, adjoins North Viet-Nam in the north at N.L. 17° , borders on Cambodia as well as Laos in the west, facing South China Sea in the east, and has long shorelines in the south extending down to N.L. $8^{\circ}30'$. The year's temperature ranges from 26 to 30°C and under the influences of tropical monsoon, a year can be divided into dry and wet seasons subject to certain deviations according to the areas.

Though the major reports so far published on plankton in South Viet-Nam are enumerated in Chapter I, no reports are available on fresh water plankton except only a nominal part of Protozoa while in respect of marine plankton, the existing reports deal chiefly with the classification of plankton in specific areas and it may be said that up to the present no reports have been published pertaining to plankton over the entire area (coastal region) of Viet-Nam. As for the culture of plankton, no reports have been made before 1963.

The author has had opportunities to conduct the survey of plankton in principal inland water and coastal regions of Viet-Nam in and after 1963. However, in the case of inland survey, it was possible to visit only the limited areas and a thorough survey of seasonal variations of plankton in various areas could not be made. In the meantime, however, the author classified Viet-Namese fresh water and marine plankton according to the samples related to these regions and indexed approx. 1,700 kinds of plankton.

This book is chiefly based on the results of above-mentioned researches, but it also incorporates the following items. The contents of this book are as follows:

1. The principal studies made so far of plankton in Viet-Nam as well as the trends of planktology being currently pushed forward are introduced in Chapter I, to which some of the author's personal comments are added. By knowing the particulars of reports made by these pioneers, it would be possible to determine a policy concerning the types and methods of research and study to be made in future in that country.
2. About 1,700 types of fresh water plankton in lakes, marshes, ponds, culture ponds and streams in various areas of Viet-Nam as well as marine plankton in the coastal regions as indexed out by the author are described in Chapter III, while their distribution is shown in Chapter IV. The Chapter IV also

provides a paragraph related specifically to the plankton in hatcheries, in which plankton obtained from various fish ponds are compared and evaluated.

3. The itinerary of above survey and the brief memoranda pertaining to the survey sites are compiled in the form of tables in Chapter II.
4. As the study of plankton in Viet-Nam has so far been directed chiefly towards their classification, no reports were available concerning the relationship between plankton and their habitats. For the purpose of grasping the causes of increase or decrease of plankton depending on the environmental conditions, the author took an example of Nhatrang in Central Viet-Nam and made comparative analysis of the relations between plankton biomass and the environments in Nhatrang Bay and its open sea in dry and wet seasons. The result thereof is described in Chapter V.
5. For the purpose of information, part of the Report on Naga Expedition carried out in 1959-1961 to determine the characteristics of the current along Viet-Nameese coasts and in the ocean, especially the South China Sea, and monsoon winds is extracted and described in Chapter VI.
6. In Chapter VII, the conclusion is drawn pertaining to South Viet-Nameese fresh water and marine plankton on the basis of the results of above-mentioned survey conducted by the author and at the same time, the author's opinion is given as to the course to be taken in future application and development related to plankton in consideration of the geographical conditions in South Viet-Nam.
7. In Chapter VIII, the plankton in the southern region (low latitude zone) is observed from various angles and compared with the plankton in the northern region (high latitude zone) and their environments. The utilization of plankton is also briefly described and further, as to the culture of plankton, the world's major culture methods are outlined for both fresh water and marine plankton. I hope that these data will contribute to the future development of plankton physiology and culture.
8. The sketches of South Viet-Nameese fresh water and marine plankton are shown in Chapter IX. These sketches were made by the author with an intention to make the beginners familiar with various types of plankton.

9. The pictures contained in Chapter X are those of stations and places taken by the author in course of survey of various areas. From what places had these plankton been collected can be clearly seen from the pictures, which indicate that in the case of survey of fresh water lakes, marshes and rivers, the characteristic color of water comes to the fore. Aerial photos are attached to the pictures related to the survey along the rivers in cities, etc., for better understanding of the conditions in the vicinity. These pictures are included in the hope that they may be of some benefit to those who are interested in the place of collection.

CHAPTER I. THE HISTORY OF PLANKTOLOGY IN VIET-NAM

The principal researches and studies of plankton which have been and are being conducted in Viet-Nam are introduced together with the author's comments as follows:

A. Fresh Water Plankton

The first study of fresh water plankton in Viet-Nam was initiated by M. Lefevre (1933). His report is concerned with phytoplankton collected from the pond in Saigon Botanical Garden. Hoang-Q-Truong (1960) examined the free living Protozoa in Saigon-Cholon area and classified them into 110 kinds. Though his report deals with a biological classification, the survey seems to have been made bearing in mind the study conducted in Viet-Nam by C. Boisson (1957a, 1957b) as to Protozoa parasitic on man and animal. A. Shirota (1963a) investigated into fresh water plankton at the fish culture stations in Cholon, Saigon, Thu-Duc, Dalat, Nha Trang and Hue as well as in the lakes, marshes and streams, and classified them into 175 types of phyto-plankton and 55 types of zoo-plankton. This report may be the first one on the fresh water plankton in Viet-Nam in that it 1) deals with both phyto-plankton and zoo-plankton, 2) employs quantitative representation (gram or number per 1 m³) and 3) takes into account the relation between plankton and fish culture. Subsequently, A. Shirota and Hoang-Q-Truong (1965a in press) made a survey of fresh water plankton in the principal areas of Viet-Nam and obtained many new informations. Tran-thi-Hanh has been studying the seasonal variations of plankton at Thu-Duc fish culture station in and after 1964 while Nhuyen-Thoung-Dao also started in 1966 the survey of the distribution and seasonal variations of Rotifera in the lakes and marshes in Dalat.

B. Marine Plankton

In respect of marine plankton, M. Rose (1926) made the first survey of plankton in Nha Trang Bay of Central Viet-Nam. Thereafter, C. Dawydoff (1936) examined quite in detail the plankton in Nha Trang Bay. This report furnishes the most valuable data in the past. The said report was prepared during the five years from 1929 to 1935 while he stayed at Nha Trang Oceanographic Institute, and describes 500 odd types including the classification of samples and benthos in the Gulf of Thailand. In addition, salinity and water temperature, though not complete, are also contained therein. R. Serène (1937) published a list of marine invertebrata living along the coast of Viet-Nam.

Serène (1948) investigated during the period of 1938 to 1942

into plankton (except Diatoms and Protozoa) in Nhatrang Bay. His report indicates the plankton appearing throughout a year in Nhatrang Bay in the number of individual per group and month, recording both day and night data. Specially interesting is that by providing the upper part of plankton net with electric lamps, plankton was collected 3 times, 30 minutes each, from 7 p.m. to 4:30 a.m. from the surface layer of 25 to 30 cm. As a result, Crustacea (Ostracoda, Copepoda, Cumacae, Schizopoda, Isopoda, Amphipoda, Zoea, Megalopa, Decapoda, Stomatopoda), Chaetognatha, Polychaeta, Nematoda and pisces larva were caught scores of times or depending upon the species, several thousand times as many as a daytime 30 minute catch. For instance, in the case of Copepoda, the data of 1938-1939 set forth a daytime catch of approx. 1,400-10,000 (3,000 individuals on an average) from morning (6:30 a.m.) till evening (5:30 p.m.) as against 3,000-80,000 (53,000 individuals on an average) from evening (7 p.m.) till early morning (4:30 a.m.). Such tendency of markedly increased catch of plankton at night as compared with daytime could be observed similarly each year. On the contrary, Coelenterata including Medusa and Siphonophora as well as Tunicata (Salpa, Appendiculata) rather showed a decreasing tendency.

Needless to say, the fact (that the greater number of individuals are found at night) may be interpreted in terms of the influence due to phototaxis of organism to a certain degree, but clarifying it with regard to such environmental aspects as the distribution in the respective layers of dissolved oxygen, water temperature, salinity or chlorinity, difference between the cases of employment and non-employment of the lamp, relations with fishery, and to other aspects not taken up by him, will be a significant problem to be solved in future. Also, the question of the use of the lamp is quite interesting in connection with the fishery of pisces strong in phototaxis, such as squid, and is considered to be applicable quite extensively. In Japan, T. Suzuki (1963) published a detailed report on his studies made of the relations between squid migration and plankton, etc. by means of the meteorological radar and fish finder during daytime and at night.

M. Hamon (1956) made a survey of Chaetognatha in Nhatrang Bay while M. Yamashita (1958) investigated during the period of 1957 to 1958 into plankton in Nhatrang Bay and reported that the monthly maximum was 36.6 cc/m^3 in May, 1958 with the minimum of average 0.28 cc/m^3 in February, 1958, and that the increase at the time when the maximum of plankton was reached was due to phyto-plankton (chiefly Diatoms and green-algae) instead of zoo-plankton. The "green-algae" as termed by Yamashita is considered to be Trichodesmium Thiebautie and T. erythracum falling under Cyanophyta according to the author's survey.

M. Rose (1955) classified plankton on the basis of data of Nhatrang Bay plankton collected by M.G.Ranson during the period December 1953 to January 1954. The region surveyed was the small water area in the western part of Nhatrang Bay encompassed by the Islands Hon Lon, Hon Mieu, Hon Tam, Hon Mot and the Oceanographic Research Institute. This report does not contain any novel information. In the meantime, the said survey region is a calm sea located behind the large island called "Hon Lon" and not affected by strong northeast wind even in the rainy season. (His report is related to rainy season).

Hoang-Q-Truong (1962) directed his attention to phyto-planktons, especially Diatoms, in Nhatrang Bay and classified them into 154 species. This report is the first one made in Viet-Nameese language by a Viet-Nameese in investigating into Viet-Nameese marine plankton (zoo-plankton not included).

A. Shirota (1963 b) conducted researches in the plankton biomass and environmental conditions in Nhatrang Bay and open sea (all the prior researches had dealt with the Bay only and no open sea survey had been made) and made clear the characteristics of Nhatrang plankton as follows; that is to say, plankton biomass in the dry season is 2.7 times higher in the Bay (0.88 g/m^3 on the average) than in the open sea (0.33 g/m^3 on the average, about 15 km from the beach) whereas in the rainy season, it is lower in the Bay (0.65 g/m^3 on the average) than in the open sea (1.49 g/m^3 on the average or 2.3 times that of Bay), a tendency entirely contrary to the case of dry season having been thus confirmed. He further drew the conclusion that the maximum plankton biomass in the open sea in the rainy season was higher than the maximum in Bay in the dry season and that the plankton fluctuations in dry and wet seasons were attributable to the influence of fresh water flowing from the two rivers into the Bay upon the sea water chlorinity.

He further points it out that discussing the Nhatrang plankton on the sole basis of the Bay data may lead to an erroneous conclusion and especially in case of taking into account fishery in Nhatrang (All the fishing boats are less than 1 ton and the area 10 to 20 km from the beach constitutes the principal fishing zone while the fishing operation is carried out quite seldom in the Bay in both dry and rainy seasons), the survey of open sea in comparison with the Bay data is indispensable.

In respect of an ocean survey and especially that of South China Sea, Naga reports (1961, 1963) incorporating the results of the recent Gulf of China and South China Sea Expedition (1959-1961) are available. This expedition was undertaken under the

auspices of the University of California and Scripps Institution of Oceanography of U.S.A., in which several Thai and Viet-Nameese staff also participated. This survey was made, as mentioned in the "INTRODUCTION", for the purpose of the development of unexploited or not fully surveyed areas from the viewpoint of the exploitation of protein resources with consideration for overpopulation in Southeast Asia as well as for the purpose of development of fishery. In point of plankton data, the survey was mainly directed towards zoo-plankton or the secondary producers living on phyto-plankton or the basic producers and therefore the said report does not deal with phyto-plankton. Among the zoo-plankton, Copepoda, Euphausia, Petropoda, Chretogratha and Siphonophora presenting useful water mass indices in many oceanic areas and being also important feed for commercial fish were taken up in the report.

According to the said report, the zoo-plankton biomass in the South Viet-Nam area is, if compared in terms of the standing crop, equivalent to 1/3-1/5 of plankton in the Gulf of Thailand coastal waters while the plankton biomass in the South China Sea is said to be corresponding to the plankton volume as measured in the open tropical Pacific by King and Demond (1953). The report says that the plankton in the Viet-Nam coastal region often accounted for more than 100 cc/1,000 m³, whereas the mean value in the Total South China Sea Area ranged from 36 cc/1,000 m³ in December 1959 to 68 cc/1,000 m³ in September-October 1960.

Dividing the South China Sea facing South Viet-Nam into 4 parts on the basis of the said report, it could be said as follows:

1. Zoo-plankton in the coastal waters from Hue (N. Lat. 16°30') up to E. Long. 110° including Nhatrang and Phan-Rang amounts to 0.1 cc/m³.
2. 0.15 cc/m³ in the waters within the range from Phan-Rang to the southern tip (east side) of Ca-Mau Peninsula and up to N. Lat. 5-6°.
3. Varying depending on the season in the coastal water from the southern tip (west side) of Ca-Mau Peninsula to Phu-Quoc, that is, 1.0-1.1 cc/m³ during the April-May period and 0.3-0.5 cc/m³ during the August-January period.
4. 0.05 cc/m³ or less in the external water farther to the east of 1. (East of E. Long. 110°).

According to the result of survey made by A. Shirota during the period of 1963 to 1965 in the Viet-Nam coastal waters (within

10-20 km from the beach), the plankton biomass including phyto- and zoo-plankton recorded less than 1.0 g/m^3 with the mean value of 0.3 g/m^3 , while the maximum reached 2.0 g/m^3 in Central Viet-Nam in the rainy season. In the meantime, Shirota examined the plankton in the coastal waters to the west (about 15 km from the beach) of Ca-Mau Peninsula at Phu-Quoc and Rach-Gia from the middle to the latter part of September, 1964 and obtained the values of $0.6-0.8 \text{ g/m}^3$, though one cannot discuss the plankton in the waters west of Ca-Mau Peninsula regarding these two places as representing the entire area. The said period falls on the closing period of rainy season, but the above values are two to three times higher than the mean plankton biomass in the Viet-Nam coastal waters facing South China Sea. Accordingly, this tendency of higher plankton biomass in the waters west of Ca-Mau Peninsula as observed by Shirota coincides with the conclusion of Naga expedition. The difference in mass is considered to have been caused in that the places more than about 100 km from the beach were surveyed in the case of Naga expedition whereas Shirota surveyed the places only about 15 km from the beach. In the meantime, in respect of the survey at the same place, the higher plankton biomass in the rainy season than in the dry season is demonstrated by the result of Naga expedition covering the Ca-Mau Peninsula waters (higher biomass in the March-September period which falls on the rainy season).

C. Environmental Survey

As for the oceanic environmental survey, the reports by C. Dawydoff (1931-1933) and R. Serène (1935, 1949) are available and they drew the following conclusions concerning surface salinity and temperature in Nhatrang Bay of Central Viet-Nam. That is, they observed that in the Nhatrang Bay, the mean water temperature ranged between 28°C and 29°C in the April-October period (dry season) with the maximum of $31-31.4^\circ\text{C}$, while it ranged between 23°C and 24°C in January and February (rainy season) with the maximum of $21-22^\circ\text{C}$ and salinity ranged between 33 and $35^\circ/\text{oo}$ (the maximum is $36.66^\circ/\text{oo}$ according to N. Hai), but it decreased down to $25-28^\circ/\text{oo}$ in the rainy season. Further, N. Hai, etc. (1960) and H. N. Can (Not yet published) made a survey of Nhatrang Bay as to the entirely same factors as above and deduced the entirely same conclusions.

Mentioned above are the survey results obtained in respect of Nhatrang Bay, but as to the survey of the open sea and the South China Sea, the reports by Shirota (1963 b and the one not yet published) and Naga expedition (1959-1961) are the only ones available. Table 1 shows the results of survey by A. Shirota

(1963) of Nhatrang Bay and its open sea, but no researches have so far been conducted into nitrate, phosphate and silicate, etc.

		Bay		Open sea (from beach 15-20 km)	
		Dry season	Rainy season	Dry season	Rainy season
Water Temperature (°C)	Surface	29.0	27.95	29.1	28.5
	15 m	26.4	28.45	28.35	28.5
Oxygen (cc/L)	Surface	4.33	4.35	4.38	4.33
	15 m	4.40	4.22	4.43	4.22
		13.2 m	5.6 m	13.15 m	13.13 m
Alkalinity CO ₂ (mg/L)	Surface	-	50.05	-	36.5
	15 m	-	34.0	-	36.5
Chlorinity (‰)	Surface	20.09	14.81	20.35	19.13
	15 m	20.0	19.87	20.0	19.96
Salinity (‰)	Surface	36.29	26.76	36.76	34.56
	15 m	36.13	35.89	36.13	36.06

Table 1: The environment in the Dry and Rainy season in Nhatrang Bay and the open sea, Central Viet-Nam (by A. Shirota, 1963 b)

The result of oceanographic survey of the South China Sea is described in the aforementioned "Naga Expedition" reports.

D. The Culture of Plankton

It will not be too much to say that a study of culture has not been made at all in Viet-Nam. Pham-H-Ho of the Saigon University previously tried the culture of marine algae and ulva (though not being plankton). Also, he and a few colleagues initiated the culture of Spirogyra, Zygneme and Mougetial, etc. falling under fresh water Zygnemataceae. In respect of animal, Hoang-Q-Truong is now undertaking the culture of Protozoa.

As the study of culture is also the study of physiology and ecology and possible artificially to create an optimum environment for that species, so the study can develop to an applied research.

In the Planktology Laboratory of Nha Trang Oceanographic Institute, the following cultures are in progress:

1. Fresh Water Plankton

The author et al. carried out a pure culture of Scenedesmus dimorphus of Chlorophyta by means of Matsudaira medium. Scenedesmus is one of the most popular species and has been studied by a number of specialists. In this country, however, it may be the first time that such systematic culture has been undertaken.

Scenedesmus dimorphus employed is the one purely separated by A. Shirota in the Saigon University. According to Le-thi-Ngoc-Anh and A. Shirota (unpublished), the number of individuals reached 2×10^6 /ml on an average and 4577760 individuals/ml as the maximum during the culture. (These values were obtained in an experiment to change the volume of nitrogen in Matsudaira medium). In the case of aeration, the mean value reached 5×10^6 individuals/ml which is 2.5 times as high as the value in the case of still water experiment.

As for zoo-plankton, the culture of Moina affinis of Cladocera was undertaken (by A. Shirota and Tran-D-An, 1966 a, in press). In this experiment, a satisfactory result was obtained employing Scenedesmus dimorphus as feed and therefore mass culture was tried. Using 1-ton box and four 40W fluorescent lamps and under continuous day-and night illumination, Moina affinis was placed in a 1 ton water tank in which Scenedesmus had been caused to multiply beforehand, and the multiplication process was observed. As a result, the number of Moina reached a maximum of 8560 individuals/L in about 10 days. This value (8.6 individuals/ml) is a high one as the experimental value in mass culture. In the case of experiments on the culture of Daphnia of Cladocera in a glass container of less than one litre, the value of 12 individuals/ml is the maximum obtained as far as the author knows.

The culture of Rotifera (Brachionus and a few other species) is being carried on by Nguyen-Thuong-Dao at Dalat under the guidance of the author.

In the meantime, no applied experiments have so far been conducted on pisces larva in Viet-Nam.

2. Marine Plankton

Similar to the case of fresh water plankton, the culture

of marine plankton is still in a rudimentary stage. The author et al. are carrying out pure culture of Chaetoceros Lorenzianus and several species of Diatoms utilizing Miquel-Allen-Nelson culture medium. The culture of Diatoms has recently made a remarkable progress and also in respect of its culture medium, new ones have been invented and are being employed, that is, successful results have been achieved using EDTA (Ethylene-Diamine-Tetra-Acetic-Acid), TRIS (Tris-Hydroxymethyl Aminomethane), Glycerophosphates, NTA (Nitro-Trioacetate) and Vitamin B₁₂, etc., but the culture by means of such media has not yet been conducted in Viet-Nam.

On the other hand, the culture of naturally caught zooplankton is not yet undertaken, but in respect of Artemia salina (A. Shirota introduced dry eggs first in Viet-Nam in 1963), eggs could be obtained in about 5 to 6 days by feeding Artemia with cultured Chaetoceros and Coscinodiscus and through an aeration for about 10 days in still water (water temperature: 28°C), and could be bred repeatedly through ten-odd generations. At the same time, many permanent eggs could be recovered successfully. (A. Shirota and Nguyen-T.-Dao; Not published yet). Further, the author and others are studying the life history and breeding of Mysis (Mesopodopsis slabberi) by means of such cultured Artemia.

E. The Relation Between Plankton & Fishing-Ground

It is often observed that when supersonic waves are emitted into the water, reflections from the positions other than the sea bottom or the school of fish are recorded and appear as if they represent the sea bottom or the school of fish. With the progress of study in various countries on the cause of such phenomenon, it has been found that such layer can be observed at every place in any sea of the world and inasmuch as it is the layer which scatters sound waves in the deep sea, it has been designated as "Deep sea Scattering Layer" or in short "DSL".

The cause of formation of DSL is being studied by many research workers and so far it has been confirmed that it consists of planktons and especially 1) it comprises zoo-plankton serving as feed for principal pisces and Mollusca (especially Decapoda = squid), 2) they can be observed abundantly in current rip and 3) the school of fish moves in accordance with the daily cycle of zoo-plankton movement (to rise at about sunset and fall at about sunrise), and so the move of fish school can be detected on the basis of such changes in DSL. Accordingly, it is confirmed that a place where DSL exists constitutes comparatively good fishing-ground in many

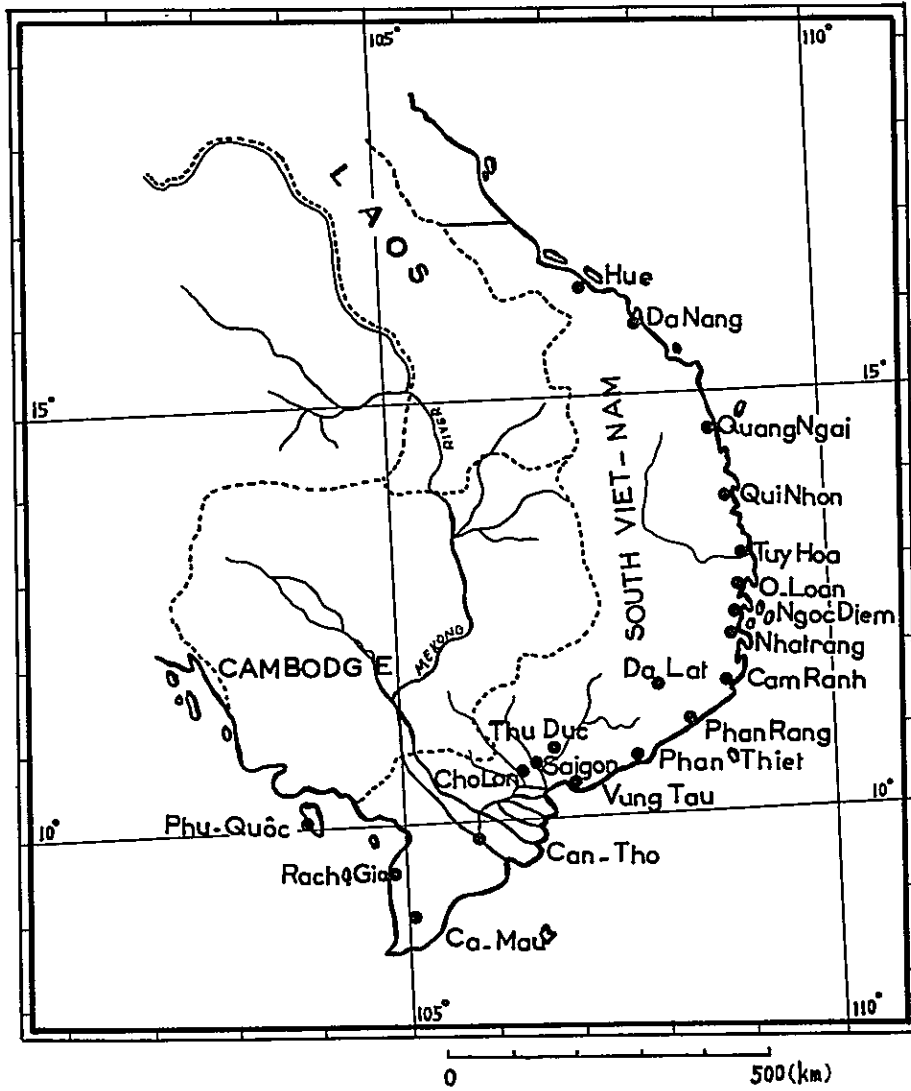
cases.

Such studies by means of fish finders are carried out mostly in the high latitude zones (due also to an abundant existence of planktons) and this kind of study seems to be conducted quite seldom in the southern areas. Such researches have already been carried out exhaustively in the East China Sea, but the survey of the South China Sea seems to have not yet been undertaken.

At the advice of Dr. Kinosuke Kimura, Professor of TOHOKU University, and with the cooperation and support of Dr. Hai, Director of Nhatrang Oceanographic Research Institute in Viet-Nam, the author started to tackle with this problem and is now continuing the researches.

CHAPTER II. RESEARCHING PLACES AND DATES

SITUATION OF SOUTH VIET-NAM AND THE AREA OF RESEARCH



THE PLANKTON RESEARCH ON FRESH WATERS
OF SOUTH VIET-NAM

Place	Sampling Station	Date	Note
Hue	Fish culture station	July 23, 1963	28 ^o C pH= 5,8
	Perfumes river	Mar. 10, 1964	24,7 ^o C pH= 5,2
Da-Nang	Buong river	Mar. 11, 1964	25,9 ^o C Brackish
Quang-Ngai	Drir river	Mar. 13, 1964	24,1 ^o C Brackish
O-Loan Dam	Bay	Apr. 10, 1964	30,9 ^o C Brackish
Phu-Huu (Ngoc-Diem)	Pond	May 12, 1965	30 ^o C pH= 6,4
Nhatrang	Fish culture station	May 13, 1963	29,0 ^o C Brackish
	"	Jun. 18, 1964	29,5 ^o C pH= 8,0
	"	Dec. 5, 1964	29,1 ^o C pH= 8,0
	River (Cua Be Nhatrang)	Jun. 20, 1964	28,8 ^o C pH= 8,0
	Ponds	Nov. 6, 1964	26 - 30 ^o C
Da-Lat	Cam-Ly river	Apr. 16, 1963	24,0 ^o C pH= 5,5
	Fish culture ponds	(:-Apr. 16, 1963	26,0 ^o C pH= 6,0
		(:-Aug. 30, 1964	28,7 ^o C pH= 6,2
	Pond of Frenn	Apr. 18, 1963	23,0 ^o C pH= 5,5
	Than-Tho lake	Apr. 17, 1963	25,0 ^o C pH= 5,5
	Me-Linh lake	Apr. 17, 1963	24,0 ^o C pH= 5,5
	Van-Kiep lake	A 19, 1963	24,2 ^o C pH= 5,6
Xuan-Huong lake	Apr. 22, 1963	24,3 ^o C pH= 5,8	
Song-Pha	Dam of Da-Nhim	Apr. 20 - 21, 1963	25,6 ^o C pH= 5,8
		Aug. 31, 1964	28,2 ^o C pH= 6,7
Phan-Thiet	River	May 21, 1964	29,0 ^o C Brackish
		Jan. 28, 1965	26,0 ^o C Brackish
Bien-Hoa	Dong-Nai river	Feb. 21, 1964	26,0 ^o C pH= 5,0
		Sep. 27, 1964	28,4 ^o C pH= 5,2
Thu-Duc	Fish culture pond	Apr. 9, 1963	28,0 ^o C pH= 5,0
		Dec. 7, 1963	28,2 ^o C pH= 5,0
		Jan. 8, 1964	27,4 ^o C pH= 5,2
		Aug. 11, 1964	29,8 ^o C pH= 6,0
		Mar. 2, 1965	29,0 ^o C pH= 5,5
Saigon	Saigon river	Mar. 22, 1963	25,8 ^o C pH=5,8-6,2
		Aug. 3, 1963	28,0 ^o C pH= 6,2
Cholon	Fish culture pond	Mar. 26, 1963	31,0 ^o C pH= 7,6
	Kieu-Long Muoi	Mar. 26, 1963	29,5 ^o C pH= 7,4
	River, ponds	Feb. 7, 1964	28,6 ^o C pH= 5,8
			28,3 ^o C pH= 4,0
Can-Tho	Mekong river	Nov. 16, 1963	28,0 ^o C transparency 20cm
	Pond of Airport	Sep. 10, 1964	31,4 ^o C pH= 5,8
Ca-Mau	Fish culture pond 1	Sep. 12, 1964	27,9 ^o C pH= 6,8
	" 2	Sep. 12, 1964	27,8 ^o C pH= 7,2
	River	Sep. 12, 1964	28,4 ^o C pH= 4,5
	Lake	Sep. 13, 1964	27,7 ^o C pH= 6,4
Rach-Gia	Fish culture pond	Sep. 16, 1964	29,5 ^o C pH= 6,0
	River and pond of field	Sep. 16, 1964	River is brackish
	Lake WT. 29,5 ^o C		Pond 29,2 ^o C pH= 5,8
Phu-Quoc	River	Sep. 18, 1964	28,4 ^o C Brackish

THE PLANKTON RESEARCH ON SEA WATERS
OF SOUCH VIET-NAM

Place	Sampling Station	Date	Note
Thuan-An	15-20 Km from beach	Mar. 9, 1964	W.T. 22.5°C
Da-Nang	"	Mar. 11, 1964	25.2°C
Quang-Ngai	"	Mar. 13, 1964	24.4°C
Qui-Nhon	" (Bay)	Apr. 12, 1964	26.8°C 28.1°C
Tuy-Hoa	"	Apr. 9, 1964	28.1°C
O-Loan	Bay	Apr. 9, 1964	31.0°C
Phu-Huu	Brackish river	Apr. 17, 19, 27, 1965 May 20, 1965 Jun. 10, 1965 Aug. 18, 1965	29-32°C ; Cl(‰) 7.7-15.5
Ngoc-Diem	Bay	Apr. 17, 27, 1965 May 20, 1965	28.4°C ; Cl(‰) 19.8 28.5-30°C
Nha-Trang	Bay and Open Sea	Apr. 25, 1965 May 20, 21, 1965 Jun. 11, 1963 Oct. 1, 2, 1963 May 12, 1964 Jun. 17, 1964 Aug. 28, 1964 Dec. 16, 1963 Dec. 12, 1963 Apr. 15, 1965 Jun. 15, 1965 Sep. 6, 1965	
Cam-Ranh	Bay	Jun. 14, 1963 May 12, 1964	29.0°C 29.3°C
Phan-Ranh		May 20, 1964	29.2°C
Phan-Thiet	15-20 Km from beach	Mar. 30, 31, 1963 May 21, 1964	29.2°C
Vung-Tau		Sep. 12, 1963 Apr. 10, 1964	30.6°C 29.2°C
Rach-Gia	"	Sep. 16, 1964	30.4°C
Phu-Quoc	"	Sep. 18, 1964	28.2°C

CHAPTER III. CLASSIFICATION OF THE FRESH WATER AND
THE MARINE PLANKTON IN SOUTH VIET-NAM

1. Fresh water plankton
2. Marine plankton
3. Plankton of the coastal zone
4. Plankton of the estuarine zone
5. Plankton of the river zone
6. Plankton of the lake zone
7. Plankton of the reservoir zone
8. Plankton of the pond zone
9. Plankton of the ditch zone
10. Plankton of the canal zone
11. Plankton of the stream zone
12. Plankton of the brook zone
13. Plankton of the creek zone
14. Plankton of the rivulet zone
15. Plankton of the streamlet zone
16. Plankton of the rill zone
17. Plankton of the rilllet zone
18. Plankton of the rillulet zone
19. Plankton of the rilluletlet zone
20. Plankton of the rilluletletlet zone

A.

FRESH WATER PLANKTON

Note: D. ----- Diameter
Col. D. ----- Diameter of a Colony
F. ----- Female
M. ----- Male
♀ ----- Female
♂ ----- Male
H. ----- Height
L. ----- Length
W. ----- Width
Leg 5 ----- 5 th. Leg

PHYTO-PLANKTON

Phylum CYANOPHYTA

Order CHROOCOCCALES

Family CHROOCOCCACEAE

Chroococcus giganteus West	D.50 μ	1
" limneticus Lemmermann	D.8-10 μ	2
Coelosphaerium Kutzingianum Nageli	D.48-90 μ	3
Aphanocapsa pulchra (Kutz.) Rab.	Col.D.60 μ	4
Merismopedia elegans A.Braun	Col.D.50-60 μ	5
Polycystis incerta Lemm.	D.60-70 μ	6
Synechocystis aquatilis Sauvageau	D.4 μ	7

Order OSCILIATORIALES

Suborder OSCILLATORINEAE

Family OSCILLATORIACEAE

Arthrospira Jenneri (Kutz.) Stiz.	W.5-7 μ	8
Lyngbya contorta Lemm.	.....	9
" Birgei G.M.Smith	W.20-24 μ	10
Oscillatoria formosa Bory	W.7-8 μ	11
" limosa Ag.	W.14-17 μ	12
" princeps Vaucher	D.16-90 μ	13
Phormidium autumnale (Ag.) Gomont	W.7-10 μ	14
Phorphyrosiphon Notarisii (Menegh.) Kutz.	W.25-30 μ	15
Spirulina major Kutz.	W.3-4 μ	16
" princeps (W&G.S.West) G.S.West	D.10-14 μ	17
Symploca muscorum (Ag.) Gomont	D.5-8 μ	18
Trichodesmium lacustre Klebahn	W.7 μ	19

Suborder NOSTOCHINEAE

Family NOSTOCACEAE

Anabaena circinalis (Kutz.) Rab.	.....	20
" Levanderi Lemm.	W.5 μ	21
Anabaenopsis Elenkinii Miller	W.4-5 μ	22
Aulosira implexa Bornet & Flahault	W.8-10 μ	23
Aphanizomenon flos-aquae (L.) Ralfs	W.5 μ	24
Nostoc Linckia. (Roth.) Born.	W.3-4 μ	25
" Sphaericum Vaucher	.....	26
Nodularia spumigena Mert	W.16-18 μ	27
" " var. minor Fritsch	W.6-8 μ	28

Family SCYTONEMATACEAE

Plectonema Tomasiniana (Kutz.) Born	W.17-20 μ	29
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Phylum	CHRYSOPHYTA	
Class	BACILLARIACEAE (DIATOMS)	
Order I	CENTRALES	
Suborder I	DISCINEAE	
Family 1.	MELOCIRACEAE	
Melosira	Agussizii	30
"	distans Kutzing D.4-20 μ H.4-9 μ	31
"	granulata Ralfs D.5-21 μ H.5-18 μ	32
"	" var. angustissima Mull D.3-5 μ L.30-50 μ	33
"	" " fo. spiralis D.15-25 μ H.4-8 μ	34
"	" var. muzzanensis	35
"	" " valida	36
"	islandica O. Mull D.7-27 μ H.4-21 μ	37
"	italica Kutzing D.5-28 μ H.8-21 μ	38
"	malayensis	39
"	varians Agardh D.8-35 μ H.9-13 μ	40
Family 2.	COSCINODISCACEAE	
Cyclotella	comta Kutzing D.15-50 μ	41
"	Kutzingiana Thwaites D.10-45 μ	42
"	Meneghiniana Kutzing D.10-30 μ	43
Stephanodiscus	Hantzschii Grunow D.8-20 μ	44
Suborder II	SOLENTINEAE	
Family 3.	RHIZOLENIACEAE	
Rhizosolenia	eriensis H.L. Smith D.6-15 μ L.40-150 μ	45
"	longiseta Zacharias D.4-10 μ L.70-250 μ ..	46
Suborder III	BIDDULPHIINEAE	
Family 4.	CHAETOCERACEAE	
Chaetoceros	Muelleri Lemmermann W.5-30 μ	47
Family 5.	BIDDULPHIACEAE	
Attheya	Zacharias J. Brunow W.12-40 μ	48
Order II	PENNALES	
Suborder I	ARAPHIDINEAE	
Family 5.	FRAGILARIACEAE	
Asterionella	formosa Hassall L.40-130 μ W.1-2 μ	49
"	gracillima (Hant.) Heiberg L.40-130 μ	50
Fragilaria	capucina Desm L.25-100 μ	51
"	construens Grunow L.7-25 μ W.5-12 μ	52
"	crotonensis Kitton L.40-70 μ	53
Synedra	acus Kutzing L.100-300 μ W.5-6 μ	54
"	" var. angustissima L.500 μ W.1-2 μ	55
"	" " radians Hust W.2-4 μ L.40-200 μ ...	56

Synedra	affinis (Kutz)	L.60-15 μ W.2-5 μ	57
"	" var. fasciculata Grun.	L.20-100 μ W.3-7 μ .	58
"	cunningtoni		59
"	pulchella var. lanceolata O'Meara	L.33-150 μ	60
"	tabulata Kutzing	L.25-200 μ	61
"	" var. grandis Mereschkowsky	L.250 μ	62
"	ulna Ehrenberg	L.50-350 μ W.5-9 μ	63

Family 7. TABELLARIACEAE

Tabellaria	fenestrata Kutz.	L.30-140 μ W.3-9 μ	64
"	" var. asterionelloides		65
"	" " intermedia		66
"	frocculosa Kutz.	L.12-50 μ W.5-16 μ	67
Diatoma	elongatum Agardh	L.40-120 μ W.2-4 μ	68
"	linearis Grun.		69
"	valgare Bory	L.30-60 μ W.10-13 μ	70
"	" var. brevis Grun.	L.20-30 μ	71

Suborder II MONORAPHIDINEAE

Family 8. ACHNANTHACEAE

Achnanthes	coarctata (Breb) Grunow		72
"	lanceolata (Breb) Grun.		73
Cocconeis	pediculus Ehrenberg	L.15-56 μ W.10-37 μ	74
"	placentula Ehr.	L.11-70 μ W.10-40 μ	75
"	" var. klinoraphis Geitler		76

Suborder III BIRAPHIDINEAE

Family 9. NAVICULACEAE

Navicula	cuspidata Kutz.	L.80-150 μ	77
"	gracilis Ehr.	L.36-60 μ W.6-10 μ	78
"	gastrum Hustedt		79
"	placentula Grun.	L.30-70 μ W.14-28 μ	80
"	" form jennisseyensis Meister	L.80 μ .	81
"	" " lanceolata Grun.		82
"	" " latiuscula Meister		83
"	" " rostrata Meyer		84
"	radiosa Kutz.	L.40-120 μ W.10-19 μ	85
"	rhynchocephala Kutz.	L.35-60 μ W.10-13 μ ..	86
Amphipleura	pellucida Kutz.	L.80-140 μ W.7-9 μ	87
Amphora	hendeyi n. sp.	L.35-40 μ	88
"	ovalis		89
Cymbella	cistula Grun.	L.35-180 μ W.15-36 μ	90
"	lanceolata Van Heurck	L.70-210 μ W.24-34 μ ..	91
"	naviculiformis Auerswald	L.30-50 μ W.9-16 μ	92
"	obtusiuscula Grun.	L.25-35 μ W.11-12 μ	93

Cymbella	parva	Cleve	L.25-70 μ W.8-12 μ	94
"	turgida	Cleve	L.30-100 μ W.9-25 μ	95
"	ventricosa	Kutz.	L.10-40 μ W.5-12 μ	96
Frustulia	rhomboides	(Ehr.) Toni	L.70-140 μ	97
Gomphonema	acuminatum	Ehrenberg	L.30-70 μ	98
Gyrosigma	attenuatum	(Kutz.) Rabh.	L.150-240 μ W.23-26 μ ...	99
Mastogloia	danseii	(Thwaites) W. Smith	L.40-65 μ .	100
Neidium	affine	(Ehr.) Pfitzer	L. very variable	101
"	" var. amphirhynchus	(Ehr.) Cleve	...	102
Pinnularia	gibba	Ehr.	L.80-90 μ	103
"	splendida	Hust.	L.45 μ	104
"	nobilis	Ehr.	L.230-260 μ	105
Stauroneis	anceps	Ehr.	.....	106

Family 10. EPITHEMIACEAE

Epithemia	argus	Kutz.	L.30-130 μ W.6-15 μ	107
"	" var. alpestris	Grun.	.....	108
"	turgida	Kutz.	L.60-100 μ W.15-18 μ	109
"	zebra	Kutz.	L.30-150 μ W.7-14 μ	110
"	" var. porcellus	Grun.	.....	111
"	" " saxonica	Grun.	L. 15-70 μ W.8-10 μ	112
Rhopalodia	gibba	(Ehr.) O.Muller	L.150 μ	113
"	ventricosa	(Kutz.) O.Muller	L.80 μ ...	114

Family 11. NITZSCHIACEAE

Hantzschia	amphioxys	(Grun.)	L.35-60 μ	115
Nitzschia	acicularis	W.Smith	L.50-150 μ	116
"	actinastroides	.....	.....	117
"	filiformis	Hust	L.20-100 μ W.4-6 μ	118
"	fonticola	.....	.....	119
"	brebissonii	W.Smith	L.200-250 μ	120
"	nyassensis	.....	.....	121
"	philippinarum	.....	.....	122
"	ricta	Hantsch	.....	123
"	subrostrata	.....	.....	124
"	vermicularis	(Kutz.) Grun.	L.90-250 μ W.5-7 μ ...	125

Family 12. SURIRELLACEAE

Cymatopleura	solea	(Breb) W.Smith	L.30-300 μ W.10-40 μ	126
Campylodiscus	hibernicus	Ehr.	L.80-130 μ	127
Surirella	biseriata	Brebisson	L.80-350 μ W.30-80 μ	128
"	elegans	Ehr.	L.130 μ W.40-90 μ	129
"	ovalis	Breb.	L.40-80 μ	130

Surirella	robusta	Ehr.	L.150-400 μ	W.50-150 μ	.....	131
"	"	var. splendida	L.75-250 μ	W.40-60 μ	...	132
"	striatula	Turp.	L.110-140 μ	.....		133
"	tenera	Greg.	L.100-150 μ	.....		134

Class HETEROCONTAE (XANTHOPHYCEA)

Order HETEROCOCCALES

Family 13. PLEUROCHLORIDACEAE

Botrydiopsis	arhiza	Borzi	L.10-40 μ	.....		135
Leuvenia	natans	Gardner	L.30-50 μ	.....		136

Order HETEROTRICHALES

Family 14. TRIBONEMATACEAE

Tribonema	bonbycinum	(AG)	Derbes and Sol	D.15 μ	..	137
Bumilleria	sicula	Borzi	D.10-13 μ	.....		138

Phylum	CHLOROPHYTA	
Class	CHLOROPHYCEAE	
Order	TETRASPORALES	
Family	PALMELLACEAE	
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Family ZYGNEMATACEAE

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Suborder ULOTRICHINEAE

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Order CRYPTOPHYCEAE

Suborder MONOMASTIGACEAE

Family MONOMASTIGACEAE

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Suborder CRYPTOMONADALES

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ZOO-PLANKTON

Phylum PROTOZOA

Subphylum PLASMODROMA

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Subclass ZOOMASTIGOPHORA (ZOOFLAGELLATA)

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Class SARCODINA

Subclass RHIZOPODA

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Subclass ACTINOPODA

Order ACTINOPHRYDIA

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Subphylum CILIOPHORA

Class CILIATA

Subclass EUCILIATA

Order HOLOTRICHA

Suborder GYMNSTOMATA

Family HOLOPHRYIDAE

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Family ACTINOBOLINIDAE

Actinobolina radians (Stein)	L.125μ	448
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Family AMPHILEPTIDAE

Amphileptus claparedei Stein	L.250μ	449
Acineria incurvata Dujardin	L.120μ	450
Loxophyllum helus (Stokes)	L.220μ	.....	451

Family CHLAYDODONTIDAE		
<i>Chilodonella uncinata</i> (Ehr.)	L.42μ	452
Family COLEPIDAE		
<i>Coleps elongatus</i> Ehr.	L.50μ	453
" <i>hirtus</i> (O.F.Muller)	L.60μ	454
Family DIDINIIDAE		
<i>Didinium balbianii</i> (Fabre-Domergue)	L.80μ	455
Family DYSSTERIIDAE		
<i>Trochilioides recta</i> (Kahl)	L.40μ	456
Family LOXODIDAE		
<i>Loxodes magnus</i> Stokes	L.500μ	457
Family NASSULIDAE		
<i>Chilodontopsis depressa</i> (Perty)	L.74μ	458
<i>Cyclogramma trichocystis</i> (Stokes)	L.60μ	459
<i>Nassula ornata</i> Ehr.	L.125μ	460
<i>Orthodon hamatus</i> Gruber	L.180μ	461
Family SPATHIDIIDAE		
<i>Homalozoon vermiculare</i> (Stokes)	L.450μ	462
<i>Spathidium spathula</i> (O.F.Muller)	L.120μ	463
<i>Spathidioides sulcatum</i> Brodsky	L.75μ	464
Family TRACHELIIDAE		
<i>Branchioecetes gammari</i> (Penard)	L.125μ	465
<i>Dileptus anser</i> (O.F.Muller)	L.155μ	466
<i>Lionotus fasciola</i> (Ehr.)	L.140μ	467
<i>Paradileptus robustus</i> Wenrich	L.350μ	468
Suborder TRICHOSTOMINA		
Family COLPODIDAE		
<i>Colpoda cucullus</i> O.F.Muller	L.86μ	469
<i>Bresslaua vorax</i> Kahl	L.90μ	470
<i>Bryophrya bavariensis</i> Kahl	L.100μ	471
<i>Tillina magna</i> Gruber	L.135μ	472
Family CONCHOPHTHIRIDAE		
<i>Conchophthirus anodontae</i> (Ehr.)	L.135μ	473
Family PARAMECIDAE		
<i>Paramecium aurelia</i> Ehr.	L.165μ	474
" <i>caudatum</i> Ehr.	L.210μ	475
" <i>multilicronucleatum</i> Powers & Mitchell	L.275μ	476

Paramecium trichium Stokes L.90μ	477
Physalophrya spumosa (Penard) L.240μ	478
Family PLAGIOPYLIDAE	
Plagiopyla nasuta Stein L.125μ	479
Family TRICHOPELMIDAE	
Pseudomicrothorax agilis Mermod L.54μ	480
Suborder HYMENOSTOMINA	
Family FRONTONIIDAE	
Colpidium colpoda (Ehr.) L.100μ	481
Dichilum platessoides Faure-Fremiet L.135μ ...	482
Frontoniella complanata Wetzel L.110μ	483
Glaucoma scintillans Ehr. L.50μ	484
Leucophrys patula Ehr. L.180μ	485
Leucophrydium putrinum Roux L.130μ	486
Tetrahymena pyriformis (Ehr.) L.50μ	487
Uronemopsis kenti (Kahl) L.80μ	488
Family PLEURONEMATIDAE	
Ctedoctema acanthocrypta Stokes L.25μ	489
Cyclidium glaucoma O.F.Muller L.28μ	490
Histiobalantium natans (Claparede & Lachmann) ..	491
Pleuronema coronatum Kent. L.55μ	492
Order SPIROTRICHIDA	
Suborder HETEROTRICHINA	
Family BURSARIIDAE	
Bursaria truncatella O.F.Muller L.775μ	493
Bursaridium schewakoffi Lauterborn L.250μ	494
Thylacidium truncatum Schewiakoff L.80μ	495
Family METOPIDAE	
Bryometopus sphagni (Penard) L.80μ	496
Metopus es (O.F.Mull.) L.135μ	497
Family REICHENOWELLIDAE	
Balantidioides bivacuolata Kahl L.100μ	498
Family SPIROSTOMIDAE	
Blepharisma lateritum (Ehr.) L.180μ	499
Phacodinium metchnikoffi (Certes) L.100μ	500
Pseudoblepharisma crassum Kahl L.200μ	501
Spirostomum minus Roux L.900-2000μ	502
" teres Claparede & Lachmann L.500μ .	503

Family STENTORIDAE		
Climacostomum	virens (Ehr.)	L.280μ 504
Stentor	ignaeus Ehr.	L.500μ 505
"	roesali Ehr.	L.540μ 506
Family HALTERUDAE		
Halteria	grandinella (O.F.Muller)	L.27μ 507
Family TINTINNIDAE		
Tintinnidium	fluviatile Stein	L.180μ 508
Tintinnopsis	cylindrata Kofoid & Campbell	L.45μ 509
Suborder HYPOTRICHINA		
Family ASPIDISCIDAE		
Aspidisca	costata (Dujardin)	L.32μ 510
Family EUPLOTIDAE		
Euplotes	eurystomus Wreniowski	L.118-124μ 511
"	patella (O.F.Muller)	L.20μ 512
Family EPALCIDAE		
Discomorpha	pectinata Levander	L.75μ 513
Pelodinium	reniforme Lauterborn	L.45μ 514
Family OXYTRICHIDAE		
Amphisiella	oblonga Schewiakoff	L.160μ 515
Balladyna	elongata Roux	L.30-36μ 516
Histrio	histrio (O.F.Muller)	L.160μ 517
Holosticha	vernalis Stokes	L.180μ 518
Hypotrichidium	conicum Ilowaisky	L.120μ 519
Kahlia	acrobates Horvath	L.150μ 520
Kerona	polyporum Ehr.	L.165μ 521
Onychodromopsis	flexilis Stokes	L.100μ 522
Opisthotricha	procera Kahl	L.110μ 523
Oxytricha	fallax Stein	L.150μ 524
Paraholosticha	herbicola Kahl	L.170μ 525
Pleurotricha	grandis Stein	L.260μ 526
Steinia	candens Kahl	L.175μ 527
Strongylidium	crassum Sterki	L.145μ 528
Stylonvchia	mytilus Ehr.	L.150μ 529
Trichotaxis	fossicola Kahl	L.160μ 530
Tachysoma	pellionella (O.F.Muller)	L. 100μ 531
Uroleptus	piscis (O.F.Muller)	L.200μ 532
Urostyla	grandis Ehr.	L.350μ 533
"	trichogaster Stokes	L.200μ 534

Order	PERITRICHA	
Suborder	MOBILIA	
Family	URCEOLARIIDAE	
	<i>Cyclochaeta spongillae</i> Jackson	L.60μ 535
	<i>Opisthnecta henneguyi</i> Faure-Fremiet	L.160μ ... 536
	<i>Trichodina</i> sp.	..... 537
Suborder	SESSILIA	
Family	ASTYLOZOOONIDAE	
	<i>Astylozoon faurei</i> Kahl	L.40μ 538
Family	EPISTYLIDAE	
	<i>Campanella umbellaria</i> Linnaeus	L.18-μ 539
	<i>Rhabdostyla pyriformis</i> (Perty)	L.30μ 540
Family	OPHRYDIDAE	
	<i>Ophrydium eichhorni</i> Ehr.	L.260μ 541
Family	VAGINICOLIDAE	
	<i>Cothurnia imberbis</i> Ehr.	L.77μ 542
	<i>Vaginicola ingenita</i> (O.F.Muller)	L.55μ 543
Family	VORTICELLIDAE	
	<i>Vorticella campanula</i> Ehr.	L.100μ 544
Class	SUCTORIA	
Order	TENTACULIFERIDA	
Family	PODOPHRYIDAE	
	<i>Podophrya fixa</i> (O.F.Muller)	L.42μ 545
	<i>Sphaerophrya magna</i> Maupas	L.38μ 546

Phylum	ARTHROPODA		
Subphylum	MANDIBULATA		
Class	CRUSTACEA		
Subclass	ENTOMOSTRACA		
Order	PHYLLOPODA		
Suborder	CLADOCERA		
Tribe	CTENOPODA		
Family	SIDIDAE		
Sida	crystallina	(O.F.Muller)	F.3-4mm M.1.5-2.0mm 547
Latona	setifera	(O.F.Muller)	F.2-3mm M.1.5mm 548
Diaphanosoma	brachyurum	(Lieven)	F.0.8-0.9mm M.0.4mm 549
Pseudosida	bidentata	Herrick	F.1.8-2.0 mm M.0.9mm 550

Tribe	ANOMOPODA		
Family	BOSMINIDAE		
Bosminopsis	deitersi	Richard	F.0.35mm M.0.25mm 551
Bosmina	longirostris	(O.F.Mull.)	L.0.46-0.6mm. 552
"	"	var. cornuta	L.0.5-0.7mm 553
"	"	var. brevicornis	L.0.4-0.5mm 554
"	coregoni	Baird	L.0.45mm 555
Grimaldina	brazzai	Richard	F.0.9mm M.0.5mm ... 556
Ophryoxus	gracilis	Sars	F.2.0mm M.0.9-1.0mm.. 557

Family	CHYDORIDAE		
Alona	affinis	Leydig	F.1.0mm M.0.7mm 558
"	costata	Sars	F.0.5mm M.0.4mm 559
"	karau	King	F.0.45mm 560
"	monacantha	Sars	F.0.35-0.4mm 561
"	rectangula	Sars	F.0.35-0.43mm 562
Alonella	dadayi	Birge	F.0.25-0.3mm M.0.2mm .. 563
"	dentifera	Sars	F.0.4mm M.0.35mm 564
"	diaphana	(King)	F.0.5mm M.0.4mm 565
"	globulosa	Daday	F.0.3-0.4mm 566
Camptocercus	rectirostris	Schodler	F.1.0mm ... 567
Chydorus	barroisi	(Richard)	F.0.4mm 568
"	gibbus	Lilljeborg	F.0.5mm 569
"	sphaericus	(O.F.Mull.)	F.0.3-0.5mm M.0.2mm 570
Dadaya	macrops	(Daday)	F.0.3mm 571
Euryalona	occidentalis	Sars	F.1.0mm M.0.7mm .. 572
Kurzia	latissima	(Kurz)	F.0.6mm M.0.4mm ... 573
Leydigia	acanthocercoides	(Fischer)	F.1.0-1.5mm M.0.7mm 574

Oxyurella	longicaudis	(Birge)	F.0.5-0.6mm	.....	575
Pleuroxus	denticulatus	Birge	F.0.5-0.6mm		
			M.0.36mm	.....	576
"	hamulatus	Birge	F.0.6mm	.....	577
"	striatus	Schodler	F.0.8mm M.0.6mm	...	578

Family DAPHNIDAE

Daphnia	rosea	Richard	L.F.1.2-2.0mm	M.0.8mm	579
"	catawba	Coker	L.1.0-1.5mm	.....	580
"	longispina	O.F.Muller	F.0.8-1.2mm	..	581
"	pulex	Richard	F.3.0-4.0mm		
			M.1.0-1.5mm	.....	582
Ceriodaphnia	rigaudi	Richard	F.0.4-0.5mm	M.0.4mm	583
"	reticulata	(Jurine)	F.0.6-1.4mm		
			M.0.4-0.8mm	.....	584
"	megalops	Sars	F.1.0-1.5 mm		
			M.0.6-0.8mm	.....	585
"	lacustris	Birge	F.0.8-0.9mm	.....	586
"	quadrangula	(O.F.Muller)	F.1.0mm		
			M.0.6mm	.....	587
Moina	brachiata	(Jurine)	F.1.5mm	.....	588
"	macrocopa	Straus	F.1.8mm M.0.5-0.6mm	...	589
"	rectirostris	Leydig	F.1.0-1.6mm		
			M.0.8-1.0mm	.....	590
Moinodaphnia	macleayii	Herrick	F.1.0mm	.....	591
Scapholeberis	kingi	Sars	F.0.8-1.0mm		
			M.0.5mm	.....	592
Sinocephalus	vetulus	Schodler	F.2.0-3.0mm		
			M. 1.0mm	.....	593

Family MACROTHRICIDAE

Macrothrix	rosea	(Jurine)	F.0.66mm	M.0.4mm	... 594
"	laticornis	(Jurine)	F.0.5-0.7mm		
			M.0.3-0.4mm	.....	595

Tribe ONYCHOPODA

Family POLYPHEMIDAE

Polyphemus	pediculus	(Linne)	F.1.5mm	M.0.8mm	.. 596
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Order COPEPODA

Suborder CALANOIDA

Family CENTROPAGIDAE

Osphranticum	labronectum	S.A.Forbes			
			F.1.7-2.5mm	M.1.4-2.3mm	..... 597
Sinocalanus	sinensis	Popper var. tenellus			
		Kikuchi	L.1.6-1.7mm	.....	598

Family DIAPTOMIDAE

Acanthodiaptomus	pacificus (Burckhardt)	F.1.3-1.5mm M.1.1mm	599
Diaptomus	connexus Light	F.0.9-1.5mm M.0.9-1.5mm	600
"	kenai M.S.Wilson	F.2.0-3.0mm M.1.8-2.5mm	601
"	mississippiensis Marsh	F.1.2-1.3mm M.1.1mm	602
"	pygmaeus Pearse	F.1.0-1.1mm M.1.0mm	603
"	siciloides Lilljeborg	F.1.0-1.3mm M.1.0-1.1mm	604
"	reighardi Marsh	F.1.1-1.2mm M.1.0mm	605
Eodiaptomus	japonicus (Burckhardt)	L.1.0-1.4mm	606
Sinodiaptomus	chaffanjoni (Richard)	L.1.7-2.0mm	607
"	Sarsi (Rylov)	F.1.8-2.0mm M.1.7-1.8mm	608

Family TEMORIDAE

Eurytemora	affinis Poppe	F.1.45mm M.1.3mm	609
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Suborder PODOPLEA

Family CYCLOPIDAE

Cyclops	magnus Marsh	L.1.85-2.55mm	610
"	bicuspidatus-thomasi S.A.Forbes	F.0.9-1.2mm M.0.8mm	611
"	strnns Fischer	F.1.5-3.0mm M.1.6mm	612
"	varicans-rubellus Lilljeborg	F.0.5-1.0mm M.0.5mm	613
"	vernalis Fischer	F.1.0-1.8mm M.0.8-1.5mm	614
"	vicinus Uljanin	F.1.7-1.9mm M.1.9-2.0mm	615
Eucyclops	agilis (Koch.)	F.0.8-1.5mm M.0.7-0.8mm	616
"	macrurus (Sars)	F.1.1-1.4mm M.2.0-2.5mm	617
"	parasinus (Fish.)	F.0.8-0.9mm M.0.7mm	618
"	prionophorus Kiefer	F.0.7-0.95mm M.0.8mm	619
"	serrulatus (S.Fish.)	F.1.3mm M.0.9mm	620
Macrocylops	fuscus (Jur.)	F.3.0-4.0mm M.2.0-2.5mm	621
Mesocyclops	Leuckarti (Claus)	L.1.35mm	622

Mesocyclops oithonoides (G.O.Sars)	
F.O.8-0.9mm M.O.6-0.7mm	623
Tropocyclops prasinus (Fischer)	
F.O.5-0.9mm	
M.O.55-0.6mm	624
Family CANTHOCAMPTIDAE	
Canthocamptus staphylinus Jurine	
F.O.6-0.9mm	
M.O.6-0.8mm	625
Family ERGASILIDAE	
Limnoncaea genuina Kokubo	
F.O.8mm M.O.75mm ...	626

Phylum	TROCHEIMINTHES	
Class	ROTIFERA (ROTATORIA)	
Order	BDELLOIDEA	
Family	PHILODINIDAE	
	Rotaria citrinus Scopoll	L.1000-1500μ 627
	Embata commensalis Bryce	L.600μ 628
	Macrotrachela quadricornifera	L.600μ 629
	Philodina roseola Ehr.	L.500μ 630
Order	MONOGONONTA	
Suborder	PLOIMA	
Family	ASPLANCHNIDAE	
	Asplanchna priodonta Gosse	L.900-1500μ 631
	Asplanchnopus myrmeleo Guerne	L.700-1000μ 632
Family	BRACHIONIDAE	
	Brachionus bakeri (Laut;)	L.160-250μ 633
	" bidentata	L.250-45μ 634
	" calyciflorus	L.300μ 635
	" falcatus Zacharias	L.150-300μ 636
	" havanaensis	..... 637
	" plicatilis Pallas	L.350μ 638
	" pala Ehrenberg	L.250-400μ 639
	" quadridentatus Hermann	..... 640
	Colurella adriatica Bory	L.80-100μ 641
	Dipleuchlanis propatula	Beauchamp 642
	Diplois daviesiae Gosse	L.300-370μ 643
	Epiphanes brachionus Ehr.	L.350-500μ 644
	" clavulata Ehr.	L.5--μ 645
	" senta (Hydatina) Ehr.	L.500-420μ.. 646
	Euchlanis dilatata Ehr.	L.500μ 647
	Kellicottia bostoniensis	L.150-170μ 648
	" longispina Ahlstrom	L.150-200μ ... 649
	Keratella cochlearis Bory ;	Vincent L.100μ.. 650
	" hiemalis	..... 651
	" quadrata (O.F.Mull.)	L.135μ 652
	" stipitata	..... 653
	" valga	..... 654
	" serrulata Gillerd	..... 655
	Lepadella patella St.Vincent	L.100-200μ 656
	" ovalis	L.100-200μ 657
	Notholca acuminata Gosse	L.180μ 658
	Platyias polyacanthus	Harring L.250μ 659
	" patulus	L.200-220μ 660
	" quadricornis	L.180-200μ 661

Family LECANIDAE		
Lecane	elasma	L.90-120 μ 662
"	luna	Nitzsch. L.100-150 μ 663
Monostyla	bulla	Ehr. L.110-140 μ 664
"	lunaris	L.120-150 μ 665
"	quadridentata	L.120-160 μ 666
Family PROALIDAE		
Proales	decipiens	Gosse L.200-400 μ 667
Family DICRANOPHORIDAE		
Albertia	typhylina	Duj. L.150 μ 668
Dicranophorus	forcipatus	Nitzsch L.250-300 μ .. 669
Encentrum	felis	Ehr. L.110-130 μ 670
Family GASTROPIDAE		
Ascomorpha	ecaudis	Perty L.200 μ 671
Gastropus	stylifer	Inhof. L.150-170 μ 672
Family MICROCODONIDAE		
Microcodon	clavus	Ehr. L.180-240 μ 673
Family NOTOMMATIDAE		
Cephalodella	megaloccephala	St. Vincent L.250 μ . 674
"	auriculata	St. Vincent L.150 μ ... 675
Resticula	melandocus	Harring & Myers L.400 μ 676
Scaridium	longicaudum	Ehr. L.452 μ 677
Family SYNCHAETIDAE		
Ploesoma	triacanthum	Herrick L.130-160 μ 678
"	truncatum	Herr. L.220-250 μ 679
"	lenticulare	L.200 μ 680
Polyarthra	euryptera	L.200 μ 681
"	vulgaris	Ehr. L.110-130 μ 682
"	sp.	..... 683
Family TETRASIPHONIDAE		
Tetrasiphon	hydrocora	Ehr. L.850-1000 μ 684
Family TRICHOCERCIDAE		
Ascomorphella	volvocicola	Wiszniewski L.120 μ .. 685
Elosa	woralli	Lord L.90-100 μ 686
Trichocerca	cylindrica	Lamarck L.280-300 μ 687
"	longiseta	L.320-340 μ 688
"	similis	L.100 μ 689

Order	FLOSCULARIACEAE	
	Family CONOCHILIDAE	
	<i>Conochilus unicornis</i> Hlava	L.400-600μ 690
	Family HEXARTHRIIDAE	
	<i>Pedalia mira</i> Hudson	L.300-400μ 691
	Family TESTUDINELLIDAE	
	<i>Filinia brachiata</i>	L.100-125μ 692
	" <i>longiseta</i> St. Vincent	L.140-165μ 693
	" <i>opoliensis</i>	L.190-250μ 694
	" <i>terminalis</i> Plate	L.70μ 695
	<i>Pompholyx sulcata</i> Gosse	L.120μ 696
	<i>Voronkovia mirabilis</i> Fadeew	L.200μ 697
Order	COLLOTHECACEAE	
	Family COLLOTHECIDAE	
	<i>Collothea gracilipes</i> Haring	L.80-95μ 698

Phyto-Plankton (Fresh water)

Phylum	Class	Subclass	Order	Suborder	Family	Number of Species					
Cyanophyta			Chroococcales		Chroococcaceae	7					
			Oscillatoriales	Oscillatorineae	Oscillatoriaceae	12					
			Nostocales	Nostochineae	Nostocaceae	9					
					Scytonemataceae	1					
Chrysophyta	Bacillariaceae		Centrales	Diactinaceae	Meloidiaceae	11					
				Soleninaceae	Gomphonoliscaceae	4					
				Biddulphiaceae	Rhizosoleniaceae	2					
				Pennales	Biddulphiaceae	Chaetocernaceae	1				
					Araphidniaceae	Biddulphiaceae	1				
				Monoraphidniaceae	Tabellariaceae	Fraxillariaceae	15				
					Naviculaceae	Achnantheaceae	8				
				Biraphidniaceae	Naviculaceae	Naviculaceae	5				
					Nitzschaceae	Epithamniaceae	30				
						Nitzschaceae	8				
						Surirellaceae	11				
						Pleurochloridaceae	9				
							2				
				Heterocontae (Xanthophyceae)			Heterococcales	Pleurochloridaceae		2	
								Heterotrichales	Tribonemataceae		2
				Chlorophyta	Chlorophyceae				Tetrasporales	Palwelliaceae	3
									Chlorococcales	Chlorococcaceae	4
										Microactiniaceae	3
										Characiaceae	1
										Coelastraceae	1
										Dictyosphaeriaceae	1
										Hydrodictyaceae	3
	Oocystaceae	16									
	Scenedesmaaceae	12									
	Zygnematales	Zygnemataceae	9								
		Mesotaeniaceae	1								
		Desmidiaceae	61								
	Ulotrichales	Microsporaceae	1								
		Protococconeae	1								
		Trentepohliaceae	1								
		Ulotrichaceae	1								
		Sphaeroplexaceae	1								
		Schizomeridaceae	1								
		Cladophoraceae	2								
		Oedogoniaceae	3								
		Schizogoniaceae	1								
Total species of the fresh water phyto-plankton											

Zoo-Plankton (fresh water)

Phylum	Class	Subclass	Order	Suborder	Family	Number of Species											
Protozoa	Kastigophora	Phytomastigophora (Phytoflagellata)	Chrysoomonadales		Mallomonadaceae	2											
			Chrysocapsales		Ochromonadaceae	5											
	Chlorophyceae			Rhizochloridales		Sipitiococcaceae	1										
				Rhizochrysidales		Rhizochrysidaceae	1										
				Chlorochytridiales		Chlorochytridiaceae	1										
				Polyblepharidales		Polyblepharidaceae	4										
				Volvocales	Chlamydomonadaceae	9											
					Haematococcaceae	1											
					Phacocaceae	1											
					Spondylococcaceae	1											
					Volvocaceae	8											
				Dinophyceae				Gymnodiniales	Gymnodiniaceae	5							
								Dinococcales	Phytodiniaceae	1							
								Peridinales	Ceratocaceae	1							
									Clenodiniaceae	8							
									Gonyaulacaceae	2							
								Cryptophyceae				Peridiniaceae	7				
	Monomastigales	Monomastigaceae	1														
	Cryptosacnadales								Cryptochrysidaceae	1							
									Cryptomonadaceae	2							
	Euglenales								Astacaceae	1							
				Euglenaceae	50												
	Zooastigophora (Zooflagellata)					Parameciaceae	4										
						Protomonadina	7										
	Sarcodina					Amoebina	7										
						Testaceana	28										
	Ciliata					Actinopoda	4										
						Duciliata					Holotricha	16					
											Gymnostomata					Holophryidae	1
																Actinobolinidae	1
																Aphileptidae	3
																Chlamydomontidae	1
																Colepidae	2
																Didymidae	1
																Dysteriidae	1
Loxodidae																1	
Masculidae																4	
Spathidiidae																3	
Trachelidae	4																
Colpoidae	4																
Trichostomina					Conochophthiridae	1											
					Parameciidae	5											
					Flagellocyidae	1											
					Trichopeinidae	1											
					Hymanostomina	Frontonidae	8										
						Fluoromonadidae	4										
					Spirotrichida					Bursariidae	3						
										Metopidae	2						
										Reichenowellidae	1						
										Spirostomidae	5						
										Stentoridae	3						
										Aspidiidae	1						
Euplotidae	2																
Epelidae	2																
Oxytrichidae	20																
Peritricha	Urculariidae	3															
	Stylocomonidae	1															
Suctorina										Epistylidae	2						
					Ophryotrocha	1											
					Vaginicolidae	2											
					Vorticellidae	1											
					Podophryidae	2											
					Arthropoda	Crustacea	Entomostraca	Phyllozoa	Cladocera	Sididae	4						
										Bosminae	7						
										Cytheridae	21						
										Daphnidae	15						
										Macrothricidae	2						
										Polyphemidae	1						
										Copepoda					Centropagidae	2	
Diaptomidae	10																
Temoridae	1																
Cyclopidae	15																
Canthocamptidae	1																
Ergasilidae	1																
Turbellinthes: Rotifera					Philodinidae	4											
					Asplanchnidae	2											
					Brachionidae	29											
					Lecanidae	5											
					Proalidae	1											
					Dicranophoridae	3											
					Gastropidae	2											
					Microcodonidae	1											
					Notommatidae	4											
					Synchaetidae	6											
					Tetraesphonidae	1											
					Trichocercidae	5											
Flosculariaceae					Conochilidae	1											
					Hexarthridae	1											
					Testudinellidae	6											
Collothecaceae					Collothecidae	1											
Total species of the fresh water zoo-plankton						428											

B.

MARINE PLANKTON

Note: D. ----- Diameter
Col. D. ----- Diameter of a Colony
F. ----- Female
M. ----- Male
♀ ----- Female
♂ ----- Male
H. ----- Height
L. ----- Length
W. ----- Width

PHYTO-PLANKTON

Phylum CYANOPHYTA
 Class CYANOPHYCEAE
 Order HORMOGONEAE
 Family OSCILIATORIACEAE
 Trichodesmium erythraeum Ehr. L.-100μ 1
 " Thiebauti Gom. W.5-16 L.(Col.)-6000μ.. 2

Phylum CHRYSOPHYTA
 Class BACILIARIACEAE (DIATOMS)
 Order CENTRALES
 Suborder DISCINEAE
 Family MELOSIRACEAE
 Melosira Juergensii Agardh D.10-38μ 3
 " nummuloides Agar. D.10-40μ 4
 Hyalodiscus stelliger Bailey D.30-85μ 5

Family COSCINODISCACEAE
 Actinophychus undulatus Ralfs D.20-150μ 6
 Actinocyclus Ehrenbergi Ralfs D.50-300μ 7
 Asterolampra Grevillei Wallich D.70-125μ 8
 " marylandica Ehr. D.50-150μ 9
 Asteromphalus Cleveanus Grunow D.40-70μ 10
 " flabellatus Greville D.40-60μ ... 11
 " hepaticus Ralfs D.42-175μ 12
 Coscinodiscus asteromphalus Ehr. D.80-400μ 13
 " curvatulus Grunow D.40-100μ 14
 " excentricus Ehr. D.20-100μ 15
 " gigas Ehr. D.150-300μ 16
 " " var. praetexta Hustedt
 D.300-600μ 17
 " Janischii A.Schmidt D.115-250μ .. 18
 " lineatus Ehr. D.30-150μ 19
 " marginatus Ehr. D.200-375μ 20
 " nitidus Gregory D.25-100μ 21
 " nobilis Grunow D.325-490μ 22
 " nodulifer Schmidt D.20-100μ 23
 " oculus-iridis Ehr. D.100-300μ ... 24
 " perforatus Ehr. D.90-200μ 25
 " radiatus Ehr. D.30-180μ 26
 " Rothii Grunow D.40-175μ 27
 " stellaris Roper D.60-175μ 28
 " subtilis=fasciculata Ehr.
 D.48-90μ 29
 Cyclotella striata (Kutz.) Grunow D.10-50μ.. 30

Cyclotella	striata var. ambigua	Grunow	D.20-30μ	.....	31
Ethmodiscus	Gazellae	Janisch	D.2000μ		
			H.3000μ	.....	32
Gossleriella	tropica	Schutt	D.120-250μ	.....	33
Hemidiscus	cuneiformis	Wallich	D.40-110μ	...	34
Planktoniella	sol	Schutt	D.10-60μ	.....	35
Family CORETHRONACEAE					
Corethron	hystrix=(criophilum)	Castracane	D.20-33μ	L.30-50μ	..... 36
"	pelagicum	Brun	D.90-150μ	L.100μ	. 37
Family LEPTOCYLINDRACEAE					
Dactyliosolen	antarcticus	Castracane	D.15-75μ	..	38
"	mediterraneus	Peragallo	D.10-35μ	..	39
Leptocylindrus	danicus	Cleve	D.6-12μ		
			L.80-130μ	.....	40
Guinardia	Blavyana	Peragallo	D.40680	.....	41
"	flaccida	(Castr.) Perag.	D.25-90μ	L.80-150μ	42
Family SKELETONEMACEAE					
Skeletonema	costatum	(Grev.)	D.18-35μ		
			L.-10000μ	.....	43
Stephanopyxis	nipponica	Gran & Yendo	D.27-40μ	..	44
"	palmeriana	(Gran) Grunow	D.35-150μ	.....	45
"	turris	(Greville)	D.10-75μ	.....	46
Family THALASSIOSIRACEAE					
Coscinosira	Oestrupi	Ostenfeld	D.10-20μ	.....	47
Lauderia	borealis	Gran	D.30-50μ	.....	48
Schrodella	delicatula	Peragallo	D.18-30μ	...	49
"	schroderi	(Bergon)	D.13-40μ	.....	50
Thalassiosira	condensata	Cleve	D.17-30μ	.....	51
"	rotula	Meunier	.....	.....	52
Suborder SOLENIINEAE					
Family RHIZOLENIACEAE					
Rhizosolenia	acuminata	Gran.	D.35-225μ		
			L.1000μ	.....	53
"	alata	Brightwell	D.7-15μ	L.700μ	. 54
"	" fo. curvirostris	Gran	.....	.....	55
"	" " gracillima	Grunow	D.5-7μ		
			L.700μ	.....	56
"	" " indica	Ostenfeld	D.20-50μ	.....	57
"	" " inermis	(Castr.)	.....	.....	58

Rhizosolenia	arafurenris	Castracane	D.120 μ	59
"	Bergonii	H.Peragallo	D.100 μ L.500 μ	60
"	calcar-avis	M.Schultze	D.80-100 μ	61
"	castracanei	H.Perag.	D.150-200 μ L.600-1000 μ	62
"	clevei	Ostenfeld	D.36-85 μ L.275-405 μ	63
"	cylindrus	Cleve	D.12-50 μ L.300 μ .	64
"	delicatula	Cleve	D.10-20 μ L.30-100 μ	65
"	hebetata fo. semispina	Gran	D.5-15 μ L.300-750 μ	66
"	imbricata	Brightwell	D.100 μ L.500 μ	67
"	" var. Schrubsolei	Cleve	D.10-30 μ L.200-500 μ	68
"	robusta	Norman	D.50-400 μ L.500-1000 μ	69
"	setigera	Brightwell	D.6-25 μ	70
"	Stolterfothii	H.Perag.	D.15-45 μ L.250 μ	71
"	stvliformis	Brightwell	D.100 μ L.150 μ	72
"	" var. latissima	Bright.	D.60-150 μ	73

Suborder BIDDULPHIINEAE

Family BACTERIASTRACEAE

Bacteriastrum	comosum	Pavillard	D. 5-10 μ L.15-35 μ	74
"	delicatulum	Cleve	D.10 μ	75
"	elegans	Pavillard	D.15-28 μ	76
"	elongatum	Cleve	D.10-20 μ	77
"	hyalinum	Lauder	D.13-56 μ	78
"	" var. princeps (Castracane)	Ikari	D.15-60 μ	79
"	mediterraneanum	Pavillard	D.28-32 μ L.28-30 μ	80
"	varians	Lauder	D.10-30 μ L.15-35 μ .	81

Family CHAETOCERACEAE

Chaetoceros	affinis	Lauder	W.9-30 μ	82
"	brevis	Schutt	W.10-40 μ	83
"	coarctatus	Lauder	W.30-45 μ	84
"	compressus	Lauder	W.10-24 μ	85

Chaetoceros	costatus	Pavillard	W.23-27 μ	.....	86
"	curvisetus	Cleve	W.10-30 μ	.....	87
"	dadayi	Pavillard	W.10-28 μ	.....	88
"	denticulatum	Lauder	W.24-30 μ	....	89
"	decipiens	Cleve	W.10-80 μ	.....	90
"	didymus	Ehr.	W.12-34 μ	.....	91
"	" var. anglica		W.10-40 μ	.....	92
"	" var. protuberans	Gran & Yendo.			93
"	distans	Cleve	W.10-50 μ	.....	94
"	diversus	Cleve	W.8-12 μ	.....	95
"	hispidum	Brightwell	W.30-40 μ	.....	96
"	indicum	Karsten	W.20-30 μ	.....	97
"	laciniosus	Schutt	W.10-42 μ	.....	98
"	" var. peragicus	Cleve	W.5-8 μ	..	99
"	Lauderi	Ralfs	W.18-24 μ	.....	100
"	leavis	Leuduger-Fortmorel			
			W.5-12 μ	.....	101
"	Lorenzianus	Grunow	D.10-40 μ	.....	102
"	messanensis	Castracane	W.12-40 μ	..	103
"	paradoxum	Cleve	W.20-45 μ	.....	104
"	pendulus	Karsten	W.9-18 μ	.....	105
"	peruvianus	Bright.	W.10-30 μ	.....	106
"	" fo. gracilis	(Schurod) Hust.			
			W.10-15 μ	.....	107
"	pseudocurvisetus	Mangin	W.15-50 μ	..	108
"	seiracanthus	Gran	W.12-24 μ	.....	109
"	setoensis	Ikari	W.30 μ	.....	110
"	siamense	Ostenfeld	W.25-60 μ	.....	111
"	tetrastichon	Cleve	W.10 μ	.....	112
"	Van-Heurckii	Gran	W.12-36 μ	.....	113
"	Weissflogii	Schutt	W.36-70 μ	.....	114

Family BIDDULPHIACEAE

Bellerochea	malleus	Van Heurck	W.80-110 μ	.....	115
Biddulphia	aurita	var. obtusa	Hustedt		
			W.40-60 μ	.....	116
"	dubia	(Bright.) Cleve	L.42-65 μ		
			W30-45 μ	.....	117
"	longicruris	Greville	L.45-55 μ	...	118
"	mobilensis	Bailey	L.45-80 μ	.....	119
"	pulchella	Gray	L.20-150 μ		
			W30-45 μ	.....	120
"	reticulata	Roper	W.59 μ	.....	121
"	regia	Ostenfeld	W.90-310 μ	.....	122
"	sinensis	Greville	W.90-250 μ	.....	123
"	Thuomeyi	Bailey	L.40-70 μ	.....	124
Cerataulina	Bergonii	Peragallo	D.18-50 μ	.....	125

Cerataulina	compacta	Ostenfeld	.....	126
Dithyllum	Brightwellii	Grunow	D.25-100μ	
			L.80μ	127
"	sol	Grunow	D.40-225μ	128
Hemiaulus	Hauckii	Grunow	L.8-75μ	129
"	indicus	Karsten	.....	130
"	membranacus	Cleve	W.67-97μ	131
"	sinensis	Greville	L.12-90μ	132
Isthmia	nervosa	Kutz.	L.170-240μ W.240μ...	133
Lithodesmium	undulatum	Ehr.	L.40-90μ	134
Triceratium	arcticum	var.	D.80-150μ	135
"	favus	Ehr.	L.40-350μ	136
"	alternans	Van Heurck	L.27-34μ	
			W.32-39μ	137
"	reticulum	Ehr.	L.25-80μ	138
"	revale	A.Schmidt	L.140-180μ	139

Family EUCAMPIACEAE

Climacodium	biconcavum	Cleve	L.60μ	
			W.35-65μ	140
"	Frauenfeldianum	Grunow		
			L.10-30μ W.75-225μ	141
Eucampia	cornuta	Grunow	L.100-160μ	
			W.30-40μ	142
"	zodiacus	Ehr.	L.10-60μ	143
Streptotheca	indica	Karsten	W.200μ	144
"	thamesis	Shrubsole	L.60-120μ	145

Order PENNALES

Suborder ARAPHIDINEAE

Family FRAGILARIACEAE

Asterionella	japonica	Cleve	L.50-100μ	146
"	notata	Grunow	L.50-105μ	147
Fragilaria	intermedia	Grunow	L.15-60μ	
			W.2.5-5μ	148
"	oceanica	fo. typica	Cleve	
			L.8-60μ W.3-8μ	149
Pseudoeunotia	doliolus	Grun.	L.40-60μ	
			W.6-8μ	150
Synedra	fulgens	W.Smith	L.170-450μ	151
"	"	var. mediterranea	Grun. L.170-	
			440μ	152
"	Gaillonii	Ehr.	L.110-270μ	153
Thalassionema	nitzschioides	Gru.	L.10-110μ	
			W.2-3μ	154
Thalassiothrix	delicatula	Cupp.	L.1500-1700μ..	155
"	Frauenfeldii	Gru.	L.8-200μ	
			W.2-4μ	156

Thalassiothrix mediterranea var. *pacifica*
Cupp. L.580-750 μ 157

Family TABELLARIACEAE

Climacosphenia moniligera Ehr. L.300-600 μ
W.25-35 μ 158
Grammatophora angulosa Ehr. L.14-35 μ 159
" *marina* Kutzing L.18-100 μ
W.8-15 μ 160
" *serpentina* Ehr. L.25-150 μ
W.12-18 μ 161
Licmophora abbreviata Agardh L.20-110 μ
W.4-8 μ 162
" *flabellata* (Garm) Agardh
L.100 μ 163
Plagiogramma vanheurckii Grunow L.20-35 μ 164
Rhabdonema adriaticum Kutz. L.25-150 μ
W.7-10 μ 165
Striatella unipunctata Agar. L.35-1 μ
W.8-20 μ 166

Suborder MONORAPHIDINEAE

Family ACNANTHACEAE

Achnanthes brevipes Agar. L.50-70 μ
W.20-25 μ 167
" *longipes* Agar. L.70-120 μ 168
Campyloneis Grevillei Gru. L.44 μ W.13 μ 169
Cocconeis scutellum Ehr. L.20-60 μ
W.12-40 μ 170

Suborder BIRAPHIDINEAE

Family NAVICULACEAE

Amphiprora alata Kutz. L.60-160 μ
W.30-60 μ 171
" *gigantea* Grun. var. *sulcata* (OMe) 172
Amphora hyalina Kutz. L.90-130 μ
W.25-34 μ 173
" *lineata* Greg. L.57 μ W.13 μ 174
" *lineolata* Ehr. L.30-60 μ
W.13-28 μ 175
" *quadrata* Breb. var. L.67 μ W.42 μ .. 176
Diploneis crabro Ehr. L.60-100 μ 177
Gyrosigma acuminatum Rabh. L.100-200 μ
W.15-20 μ 178
" *balticum* Rabh. L.150 μ 179
" *spenceri* Cleve L.150 μ 180
" *strigile* (W.Smith) L.250-360 μ
W.27-35 μ 181

Mastogloia	minuta	Grev.	L.18-20 μ	
			W.8-10 μ	182
Navicula	cancellata	Donk	L.52 μ	183
"	elegans	W.Smith	L.60-115 μ	
			W.20-30 μ	184
"	lyra	Ehr.	L.60-150 μ	185
Pleurosigma	affine	Grun.	L.120-150 μ	
			W.17-33 μ	186
"	angulatum	W.Smith	L.150-360 μ	
			W.36-50 μ	187
"	compactum	Grev.	L.281 μ W.62 μ	188
"	elongatum	W.Smith	L.130-380 μ	
			W.20-30 μ	189
"	fasciola	W.Smith	L.90-107 μ	190
"	intermedium	W.Smith	L.230 μ W.12 μ .	191
"	naviculaceum	Breb.	L.79 μ W.16 μ ..	192
"	nicobaricum	Grun.	L.130 μ	193
"	Normanii	Ralfs	L.127 μ W.24 μ	194
"	pelagicum	Perag.	L.194 μ W.24 μ	195
"	rectum	Donkin	L.142 μ W.12 μ	196
"	rigidum var. incurvata	Brun.	L.200 μ W.30 μ	197
"	salinarum	Grun.	L.90-130 μ	
			W.13-17 μ	198
Trachyneis	aspera	(Ehr.) Cleve	L.100-200 μ ..	199
Tropidoneis	lepidoptera	Cleve	L.65-100 μ	200

Family NITZSCHLACEAE

Nitzschia	closterium	W.Smith	L.32-260 μ	
			W.2-6 μ	201
"	hungarica	Grun.	L.80-120 μ	202
"	lanceolata	W.Smith	L.100-200 μ	
			W.17 μ	203
"	longissima	Grun.	L.250-300 μ	204
"	" var. reversa	W.Smith	L.115-220 μ	205
"	paradoxa	Gmelin	L.60-150 μ	
			W.4-8 μ	206
"	pacifica	Cupp	L.80-140 μ	207
"	plana	W.Smith	L.70 μ	208
"	pungens var. atlantica	Cleve	L.137 μ	209
"	seriata	Cleve	L.90-100 μ W.6 μ ...	210
"	sigma	W.Smith	L.50-100 μ W.4-15 μ .	211
"	" var. intercedens	Grun.	L.300 μ .	212
"	spectabilis	Ralfs	L.150-450 μ	
			W.10-15 μ	213
"	vitrea	Norman	L.90-120 μ	214

Family SURIRELLACEAE

Campylodiscus	biangulatus	Hantsch	L.60-80 μ	...	215
"	daemelianus	Grun.	L.80-100 μ	...	216
"	echeneis	Ehr.	L.80-100 μ	.....	217
"	ornatus	Grev.	L.85 μ	.....	218
"	undulatus	Grev.	D.100-140 μ	....	219
Surirella	fatua	Kutzing	L.65 μ	.....	220
"	javanica	A.Schmidt	L.60-80 μ	...	221
"	norvegica	Elu.	L.267 μ W.55 μ	..	222

ZOO-PLANKTON

Phylum PROTOZOA

Class MASTIGOPHORA

Order CHRYSOMONADINA

Family DICTYOHACEAE

Dictyocha fibula Ehr.	L.10-45 μ	223
" " var. stapedia Heack.	L.15-45 μ ...	224
" " var. major Rampi	L.15-50 μ	225
Distephanus speculum var. pentagona Schulz	L.24-35 μ	226

Order DINOFLAGELLATA

Family PHYTODINIDAE

Pyrocystis elegans	227	
" fusiformis Murray	L.100-150 μ	228
" hamulus var. inaequalis Schroder	...	229
" noctiluca Murray	D.1.7 μ	230

Family PROROCENTRIDAE

Prorocentrum micans Ehrenberg	L.1.5-2.0 μ	231
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Family PERIDINIIDAE

Amphisolenia bidentata Schroder	L.70-80 μ	232
" thrinax Schutt	L.900-1000 μ	233
Amphidoma steini Schill.	.....	234
Ceratium axiale Kofoid	L.570-610 μ	235
" arietinum Cleve	.....	236
" breve Schroder	.....	237
" belone Cleve	L.58-70 μ	238
" candelabrum (Ehr.) Stein	.....	239
" " var. dilatatum (Gourr.)	Jorgensen L.190-200 μ	240
" " fo. commune Bohm	.....	241
" " fo. curvatulum Schiller	.....	242
" carriense Gourret	.....	243
" deflexum (Kofoid) Jorgensen	L.420-450 μ	244
" declinatum Karsten	.....	245
" extensum (Gourr.) Cleve	L.950-1200 μ	246
" falcatum (Kof.) Jorg.	.....	247
" furca (Ehr.) var. berghia Jorg.	L.170-200 μ	248
" " var. eugramma Jorg.	.....	249
" fusus (Ehr.) var. seta Tschirn	....	250
" gibberum Gourret	.....	251

Ceratium	gibberum fo. Sinistrum Gourret	
	L.150 μ	252
"	gravidum Gourret	253
"	inflexum (Gourret) Kofoid	
	L.800-1000 μ	254
"	intermedium (Jorg.) Jorg.	
	L.500-650 μ	255
"	karsteni Schiller	256
"	longirostrum (Gourret) Jorg.	257
"	longipes Gran. L.51-57 μ	258
"	macroceros (Ehr.) Cleve L.350-400 μ	259
"	massiliense (Gourret) Jorg.	
	L.600-650 μ	260
"	" var. protuberans L.370-500 μ	261
"	molle Kofoid L.360-385 μ	262
"	pentagonum (Gour.) var. robusta	
	Jorg.	263
"	pennatum Kofoid var. scapiforme	
	L.600-800 μ	264
"	pulchellum Schroder L.380-450 μ	265
"	setaceum Jorg.	266
"	strictum (Okamura & Nishikawa)	
	Kofoid L.900-950 μ	267
"	sumatranum (Kars.) Jorg.	
	W.500-550 μ	268
"	" var. recurvum L.2500 μ	269
"	tenue (Ostf.; Schm.) Jorg.	
	L.500-650 μ	270
"	" var. buceros (Zacharias) Jorg.	
	L.580-660 μ	271
"	teres Schiller	272
"	trichoceros (Ehr.) Kofoid	
	L.630-680 μ	273
"	tripos (O.F.Muller) Nitsch.	
	L.300-350 μ	274
"	vultur Cleve L.490-510 μ	275
Ceratocorys	horrida Stein D.85-92 μ	276
"	gourreti Paulsen L.85-95 μ	277
Cladopyxis	brachiolatum (Stein) Pavillard	
	L.43 μ	278
Dinophysis	homunculus Stein L.90-100 μ	279
"	hastata Stein L.43-90 μ	280
"	ovum Schutt L.44-62 μ	281
"	sphaerica Stein L.44-47 μ	282
"	tripos Gourret L.95-105 μ	283
Diplopsalis	lenticula Bergh D.95-100 μ	284
"	" fo. asymmetrica (Mangin)	
	L.29-75 μ	285

Goniaulax	polyedra	Stein	L.40-65 μ D.48 μ	286
"	polygramma	Stein	L.42-75 μ	287
Goniodoma	polyedricum	(Pouchet) Stein	L.48-60 μ	288
"	sphaericum	Murr.; Whitt	L.35-50 μ ...	289
Gymnodinium	maguelonnense	Biecheler	290
"	gracile	Berg.	L.90-130 μ	291
Gyrodinium	glaucum	labour	L.40-56 μ	292
Heterodinium	mediterraneum	Pav.	L.65 μ	293
Micracanthodinium	setiferum	Lohmann	L.40-45 μ	294
Orinthocercus	magnificus	Stein	L.120-160 μ ...	295
"	splendicus	Schutt	296
Oxytoxum	milneri	Murr. & Whitt	L.126-131 μ ...	297
"	scolopax	Stein	L.112	298
"	tesselatum	(Stein) Rampi	L.58-60 μ	299
Parahistioneis	sphaeroidea	Rampi	300
Pachydinium	mediterraneum	Rampi	301
Peridinium	Brochi	Kofoid; Sw.	302
"	breve	Paulsen	L.30-75 μ	303
"	conicum	(Gran) Ostenfeld & Schmidt.	304
"	depressum	Bailey	D.75-85 μ	305
"	diabolus	Cleve	L.85-180 μ	306
"	divergens	Ehr.	L.80-84 μ	307
"	Granii	Ostenf. fo. mite	Pavillard .	308
"	leonis	Pavillard	L.65-95 μ	309
"	lenticula	(Bergh.) f. asymmetrica	(Mangin) L.30-75 μ	310
"	oceanicum	Vanhoffen var. oblongum	Auriv.	311
"	paulseni	Pavillard	L.45-50 μ	312
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<i>Krohnitta</i>	<i>pacifica</i>	Aida	L.6-15mm	630

Phylum	MOLLUSCA		
Class	GASTROPODA		
Subclass	PROSOBRANCHIA		
Order	MESOGASTROPODA		
Tribe	HETEROPODA		
Family	ATLANTIDAE		
Atlanta	fusca	Souleyet L.3-10mm	631
"	gaudichaudi	Soul. L.5-10mm	632
"	helicinoides		633
"	inclinata	Soul.	634
"	lesueuri	Soul. L.3-8mm	635
"	peroni	Lesueur L.10-11mm across	636
"	Quoyana		637
Oxygyrus	rangi	Soul	638
Family	CARINARIA		
Cardiopoda	placenta		639
Carinaria	lamarcki		640
Family	PTEROTRACHEIDAE		
Firoloida	desmaresti	Lesueur	641
Pterotrachea	mutica		642
Tribe	PTENOGLOSSA		
Family	JANTHINIDAE		
Janthina	globosa	Swainson H.30mm W.10mm	643
"	janthina	Linne H.20mm W.25mm	644
Tribe	NUDIBRANCHIATA		
Family	AEOLIDIDAE		
Glaucus	lineatus	Reinholdt L.15-20mm	645
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Phyllirrhoe	bucephalum	Per. & Les. L.20-30mm	646
Subclass	OPISTHOBRANCHIA		
Order	PTEROPODA		
Suborder	THECOSOMATA		
Family	LIMACINIDAE		
Limacina	trochiformis	d'Orb. L.1.5mm	647
"	inflata	d'Orb.	648
Family	CAVOLINIDAE		
Cavolinia	gibbosa	gibbosa Rang	649
"	globulosa	Rang L.7mm	650
"	inflexa	(Lesueur) L.4.5-5mm	651
"	longirostris	(Lesueur) L.4-5mm	652

Cavolinia	tridentata (Forsk.)	L.8-9mm	.....	653
"	uncinata (Rang)		.....	654
Creseis	acicula Rang	L.33mm	.....	655
"	virgula conica	Eschscholtz		
		L.6.0-8.0mm	.....	656
"	"	virgula Rang		
		L.6.0-10.0mm	.....	657
Clio	pyramidata	Tesch	.....	658
Cuvierina	columnella	columnella (Rang)		
		L.7-8mm	.....	659
Diacria	quadridentata	(Lesueur)	L.2.5mm	....
"	trispinosa	trispinosa (Les.)	.....	661
Euclio	cuspidata	Bon.	L.16mm	.....
"	polita	(Pfeffer)	L.7-14mm	.....
"	pyramidata	Tesch.	L.21mm	.....
Hyalocyclus	striata	Rang	.....	665
Styliola	subula	Quoy. & Gaimard	L.5.7mm	....
Family PERACLIDAE				
Peraclis	bispinosa	Pelseneer	L.11mm	.....
"	moluccensis	Tesch	L.3mm	..
"	reticulata	(d'Orbigny)	L.5mm	.....
Family CYMBULIIDAE				
Cymbulia	peroni	Blainville	.....	670
Desmopterus	papilis	Chun.	L.0.9-1.0mm	.....
Suborder GYMNOSOMATA				
Family PNEUMODERMATIDAE				
Pneumoderma	mediterranea	.....		672
Family THLIPTODONTIDAE				
Thliptodon	Gegenbauri	.....		673
Larva of MOLLUSCA				
Oyster larva	(Veliger larva)	.....		674
Nodilittorina	granularis	(egg)	.....	675
Nerita	albicilla	(Veliger larva)	.....	676
Larva of LAMELLIBRANCHEA	(Veliger and Post			
	larva)	.....		677
Phylum MOLLUSCOIDEA				
Bugula	neritina	Linnaeus (Cyphonautes larva).		678
Lingula	lingula	(Lingula larva)	.....	679
Phoronis	australis	(Actinotrocha larva)	.....	680

Phylum	ECHINODERMATA		
	Asterias	glacialis (Bipinnaria larva)	..... 681
	Asterina	pectinifera (Bipinnaria larva)	..... 682
	"	" (Brachiolaris larva)	..... 683
	Ophioglypha	albida (Ophiopluteus larva)	..... 684
	Ophiothrix	fragilis (Ophiopluteus larva)	..... 685
	Ophiarachnella	gorgonia (Ophiopluteus larva)	.. 686
	Holothuria	leucospilota (Auricularia larva)	.. 687
	"	tubulosa (Auricularia larva) 688
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	Echinocardium	cordatum (Echinopluteus larva)	.. 690
	Spatangus	purpurens (Echinopluteus larva) 691
	Strongylocentrotus	lividus (Echinopluteus larva) 692
	Tripneustes	gratilla (Echinopluteus larva)	.. 693
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Phylum ARTHROPODA

Class CRUSTACEA

Order PHYLLOPODA

Suborder CLADOCERA

Family POLYHEMIDAE

Evadne	spinifera	P.E.Muller	L.O.4mm	
			H.O.8mm	..... 695
"	tergestina	Claus		..... 696
Penilia	schmackeri	Richard	L.O.8-1.3mm	.... 697
Podon	leuckarti	G.O.Sars	L.1.0mm	..... 698
"	polyphemoides	Leuckarti	L.O.6-0.8mm	699
"	schmackeri	Poppe	L.O.7-0.8mm	..... 700

Order OSTRACODA

Family HALOCYPRIDAE

Asterope	marine			
Conchoecia	daphnoides	(Claus)	F.5.9	
			M.3.2-3.3mm	..... 701
"	imbricata	(Brady)	F.2.8-4.8mm	
			M.2.6-3.0mm	..... 702
"	obtusata	Sars	F.2.0mm	Ml.4mm 703
Cypridina	noctiluca	Kajiyama		..... 704
"	mediterranea			..... 705
Halocypris	globosa	(Claus)	F.3.0mm	M.2.3mm.. 706

Order COPEPODA

Suborder CALANOIDA (GYMNOPLEA)

Family EUCALANIDAE

Eucalanus	attenuatus	(Dana)	F.4.2-5.0mm		
			M.3.0-3.3mm	.....	707
"	crassus	Giesbrecht	F.2.9-4.0mm		
			M.2.7-3.5mm	.....	708
"	elongatus	(Dana)	F.4.4-8.3mm		
			M.3.6-5.0mm	.....	709
Mecynocera	clausii	Thompson	F.0.8-1.2mm	.....	710
Rhincalanus	nasutus	Giesbrecht	F.3.8-5.4mm		
			M.3.5-5.0mm	.....	711
"	cornutus	Dana	F.3.6mm	M.2.7mm ..	712

Family CALANIDAE

Calanus	brevicornis	Lubbock	F.2.3-2.9mm		
			M.2.3-2.4mm	.....	713
"	darwinii	Lubbock	F.2.0mm	M.1.8mm .	714
"	helgolandicus	Claus	F.3.0mm		
			M.2.8mm	.....	715
"	minor	(Claus)	F.1.6-2.0mm		
			M.1.5-1.8mm	.....	716
"	tenuicornis	(Dana)	F.1.3-2.5mm		
			M.1.9-2.0	.....	717
"	vulgars	Dana	F.2.6mm	M.2.4mm	718
Neocalanus	gracilis	(Dana)	F.3.0-3.9mm		
			M.2.5-2.5mm	.....	719
"	robustior	Giesb.	F.3.2mm	M.2.8mm .	720

Family PARACALANIDAE

Calocalanus	pavo	(Dana)	F.0.9-1.2mm	M.1.1mm..	721
"	plumulosus	Claus	F.0.9-1.1mm	....	722
"	styliremis	Giesb.	F.0.6-0.9mm		
			M.0.6mm	.....	723
"	tenuis	Farran	F.1.2-1.3mm	.....	724
Paracalanus	aculeatus	Giesb.	F.0.8-1.2mm	...	725
"	nanus	G.O.Sars	F.0.6mm	.....	726
"	parvus	Claus	F.0.8-1.0mm	M.1.0mm.	727

Family PSFUDOCALANIDAE

Clausocalanus	arcuicornis	Dana	F.1.2-1.3mm		
			M.1.1-1.2mm	.....	728
"	pergens	Farran	F.0.9-1.1mm	....	729
Ctenocalanus	vanus	Giesb.	F.0.9-1.2mm		
			M.1.2-1.3mm	.....	730
Drepanopus	bunnei	G.O.Sars	F.1.3mm	.....	731

Family AETIDEIDAE

Aetieus	armatus	Boeck	F.1.8-2.0mm	
			M.1.4-1.5mm	732
Aetideopsis	multiserrata	(Wolfenden)	F.2.7-2.8mm	733
Chiridiella	macrodactyla	G.O.Sars	F.2.7mm	734
Chirundina	streetsii	Giesb.	F.4.1-5.3mm	
			M.3.8-4.4mm	735
Chiridius	gracilis	Farran	F.2.4-2.8mm	736
Euaetideus	giesbrecht	(Cleve)	F.1.5-2.2mm	737
Euchirella	rostrata	(Claus)	F.3.0-3.1mm	
			M.2.5-3.0mm	738
"	brevis	(- amoena)	G.O.Sars	
			F.3.5-4.0mm	739
"	curticauda	Giesb.	F.3.5-4.4mm	
			M.4.3mm	740
"	maxima	Wolfenden	F.6.8-7.4mm	
			M.5.6-7.0mm	741
"	messinensis	Claus	F.4.7-6.2mm	
			M.4.0-5.5mm	742
"	pulchra	(Lubbock)	F.3.0-4.4mm	
			M.3.7mm	743
Gaetanus	kruppil	Giesb.	F.3.6-5.7mm	
			M.3.7-5.6mm	744
"	miles	Giesb.	F.3.5-3.9mm	745
"	minor	Farran	F.1.8-2.4mm	746
"	pileatus	Farran	F.5.6-6.2mm	747
Pseudochirella	cryptospina	(G.O.Sars)	F.4.7-4.9mm	
			M.5.3mm	748
"	notacantha	(G.O.Sars)	F.4.7-4.9mm	
			M.5.3mm	749
"	obtusa	(G.O.Sars)	F.5.3-5.8mm	
			M.4.8mm	750
"	pustulifera	(G.O.Sars)	F.7.3-7.4mm	751
"	scopularis	G.O.Sars	F.3.0-4.0	
			mm	752
Undeuchaeta	major	Giesb.	F.4.5-5.5mm	
			M.6.0-6.6mm	753
"	plumosa	(Lubbock)	F.3.0-4.2mm	
			M.3.2mm	754

Family SPINOCALANIDAE

Monacilla	tenera	G.O.Sars	F.1.8-2.3mm	755
"	typica	G.O.Sars	F.2.0-2.4mm	
			M.1.6-2.3mm	756
Spinocalanus	caudatus	G.O.Sars	F.1.5mm	757

Spinocalanus	spinosus	Farran	F.1.8-2.4mm	....	758
Family MEGACALANIDAE					
Bathycalanus	princeps	(Brady)	F.10.0-12.0mm		
			M.11.0mm	.....	759
"	richardi	G.O.Sars	F.9.0-11.2mm		
			M.7.8-8.2mm	.....	760
Megacalanus	princeps	Wolfenden	F.8.8-11.5mm		
			M.7.9-10.5mm	.....	761
Family HETERORHABDIDAE					
Heterorhabdus	Clausi	Giesb.	F.2.4mm		
			M.2.2-2.4mm	.....	762
"	papilliger	(Claus)	F.1.9-2.4mm		
			M.1.8-2.3mm	.....	763
"	vipera	(Giesbr.)	F.2.6-2.8mm		
			M.2.6-2.7mm	.....	764
Family ACARTIIDAE					
Acartia	clausi	Giesbr.	F.0.9-1.2mm		
			M.1.0-1.2mm	.....	765
"	danae	Giesbr.	F.1.1-1.2mm		
			M.0.7-0.8mm	.....	766
"	discaudata	Giesbr.	F.1.0-1.2mm		
			M.1.0-1.1mm	.....	767
"	negligens	Dana	F.1.0-1.3mm		
			M.0.8-1.0mm	.....	768
"	tonsa	Dana	F.1.3-1.5mm		
			M.1.0-1.1mm	.....	769
Family METRIDIIDAE					
Pleuromamma	abdominalis	Lubbock	F.2.8-4.0mm		
			M.2.8-3.5mm	.....	770
"	gracilis	Claus	F.1.9-2.3mm		
			M.1.5-2.2mm	.....	771
"	robusta	Giesbr.	F.3.0-4.3mm		
			M.3.0-4.0mm	.....	772
"	xiphias	Giesbr.	F.4.1-5.4mm		
			M.4.0-4.7mm	.....	773
Family EUCHAETIDAE					
Euchaeta	marina	Prestandrea	F.2.3-3.9mm		
			M.3.0-3.2mm	.....	774
"	acuta	Giesbr.	F.4.16-4.3mm		
			M.3.5-4.8mm	.....	775
"	hebes	Giesbr.	F.2.9-3.0mm		
			M.2.8mm	.....	776

Euchaeta	spinosa	Giesbr.	F.6.4mm	
			M.6.3mm	777
"	pubera	G.O.Sars	F.4.0mm	778
Family PHAENNIDAE				
Cornucalanus	simplex	Wolfenden	F.6.3mm	779
Heteremalla	dubia	T.Scott	F.3.7mm M.3.5mm ..	780
Family SCOLECITHRICIIDAE				
Scaphocalanus	magnus	T.Scott	F.4.5-5.0mm	
			M.4.5mm	781
Scolecithrix	dane	(Lubbock)	F.2.2mm	
			M.2.0-2.2mm	782
Family CENTROPAGIDAE				
Centropages	aucklandicus	Kramer		
			F.1.5-1.7mm M.1.5mm	783
"	Kroyeri	Giesbr.	F.1.3-1.4mm	
			M.1.2mm	784
"	orsinii	Giesbr.	F.1.2-1.0mm	
			M.1.2-1.4mm	785
"	violaceus	(Claus)	F.1.8-1.9mm	
			M.1.5-1.8mm	786
Family TEMORIDAE				
Temora	discaudata	Giesbr.	F.1.9-2.0mm	787
"	stylifera	Dana	F.1.5-1.9mm	
			M.1.4-1.5mm	788
"	turbinata	Dana	F.1.4-1.7mm	789
"	longicornis	O.Fr. Miller		
			F.1.0-1.5mm M.1.0-1.4mm	790
Family CANDACIIDAE				
Candacia	armata	Boeck	F.2.0-2.7mm	
			M.1.7-2.7mm	791
"	aethiopica	(Dana)	F.2.1-2.8mm	
			M.2.0-2.3mm	792
"	bipinnata	Giesbr.	F.2.4-2.6mm	
			M.2.4mm	793
"	bispinosa	Claus	F.1.9-2.0mm	
			M.1.8-2.0mm	794
"	longimana	(Claus)	F.3.6-3.9mm	
			M3.1-3.5mm	795
"	pachydactyla	Dana	F.2.3-2.8mm	796
"	simplex	Giesbr.	F.1.9-2.1mm	
			M.1.8-2.0mm	797
"	varicans	Giesbr.	F.2.3mm M.2.1mm ..	798

Family LUCICUTIIDAE

Lucicutia	atlantica	Wolfenden	F.3.5mm	
			M.3.4mm	799
"	flavicornis	(Claus)	F.1.4-1.8mm	
			M.1.3-1.7mm	800
"	longiserrata	Giesbr.	F.2.3-2.2mm	801
"	ovalis	Giesbr.	F.1.3-1.4mm	
			M.1.2-1.3mm	802
"	tenuicauda	G.O.Sars	F.5.2mm	
			M.5.0mm	803

Family AUGAPTILIDAE

Augaptilus	anceps	Farran	F.3.6-3.8mm	804
Euaugaptilus	affinis	G.O.Sars	F.5.4mm	805
"	bullifer	Giesbr.	F.4.9mm	806
"	facilis	Farran	F.5.4-5.9mm	807
"	filiger	Claus	F.4.9-6.8mm	
			M.4.1-6.5mm	808
"	gibbus	Wolfenden	F.2.8-3.4mm	
			M.2.7-3.2mm	809
"	elongatus	G.O.Sars	F.6.7mm	
			M.6.5mm	810
"	nodifrons	G.O.Sars	F.5.4mm	
			M.5.2mm	811
"	oblongus	G.O.Sars	F.7.4mm M.7.2mm	812
"	palumboi	Giesbr.	F.2.3mm	813
"	squamatus	Giesbr.	F.6.3-6.8mm	814
"	truncatus	G.O.Sars	F.7.6mm	815
Haloptilus	acutifrons	Giesbr.	F.2.6-3.2mm	816
"	angusticeps	G.O.Sars	F.3.5mm	817
"	longicornis	(Claus)	F.2.1-2.5mm	
			M.2.0mm	818
"	mucronatus	(Claus)	F.3.6mm	
			M.2.1-2.3mm	819
"	tenuis	Farran	F.4.4mm M.4.2mm	820
Heteroptilus	acutilobus	G.O.Sars	F.4.1mm	
			M.4.0mm	821
"	attenuatus	G.O.Sars	F.5.7mm	822

Family PONTELLIDAE

Anomalocera	patersoni	Templeton	F.3.2-4.1mm	
			M.3.0-4.0mm	823
Labidocera	acuta	Dana	F.3.0-3.4mm	
			M.2.8-3.4mm	824
"	acutifrons	Dana	F.3.7-3.9mm	
			M.3.8-3.9mm	825
"	detruncata	Dana	F.2.1-2.8mm	826

Labidocera	Kroyeri	Brady	F.2.4-2.5mm	
			M.2.0mm	827
"	pavo	Giesbr.	F.2.1mm	828
"	wollastoni	Lubbock	F.2.2-2.3mm	829
Pontellina	plumata	(Dana)	F.1.7-1.8mm	
			M.1.5-1.6mm	830
Pontella	chiercheae	Giesbr.	F.3.3mm	M.3.0mm 831
"	Lo Biancoi	Canu.	F.4.0-4.2mm	
			M.3.3-3.8mm	832
Pontellopsis	regalis	Dana	F.4.0-4.4mm	
			M.3.4-3.5mm	833

Suborder PODOPLEA (CYCLOPOIDA)

Family MORMONILLIDAE

Mormonilla	phasma	Giesbr.	F.1.6-1.7mm	834
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Family OITHONIDAE

Oithona	nana	Giesbr.	F.0.5-0.7mm	
			M.0.5-0.6mm	835
"	plumifera	Baird	F.1.0-1.5mm	
			M.0.8-1.0mm	836
"	robusta	Biesbr.	F.1.6-1.7mm	
			M.1.2mm	837
"	setigera	Dana	F.1.2-1.9mm	838

Family ECTINOSOMIDAE

Microsetella	norvegica	Boeck	F.0.4-0.5mm	
			M.0.3-0.4mm	839
"	rosea	Dana	F.0.6-0.9mm	840

Family MACROSETELLIDAE

Macrosetella	gracilis	(Dana)	F.1.4-1.5mm	
			M.1.1-1.3mm	841
Miracia	efferata	Dana	F.1.5-2.0mm	842

Family TACHYDIIDAE

Eyterpe	acutifrons	Dana	F.0.5-0.8mm	
			M.0.5-0.6mm	843

Family CLYTEMNESTRIDAE

Clytemnestra	scutellata	Dana	F.1.0-1.2mm	
			M.1.0-1.3mm	844
"	rostrata	Brady	F.0.6-1.0mm	
			M.0.8-0.9mm	845
Laophonte	brevirostris	Claus	F.0.7mm	846

Family ONCAEIDAE

Lubbockia	minuta	G.O.Sars	F.1.3mm	.....	847
"	squillimana	Claus	F.1.5-1.6mm		
			M.1.8-2.1mm	.....	848
Oncaea	media	Giesbr.	F.0.6-0.8mm		
			M.0.6-0.7mm	.....	849
"	mediterranea	Claus	F.1.0-1.3mm		
			M.0.7-1.1mm	.....	850
"	minuta	Giesbr.	F.0.5-0.6mm	.....	851
"	venusta	Philippi	F.1.1-1.3mm		
			M.0.7-1.0mm	.....	852

Family CORYCAEIDAE

Corycaeus	brehmi	Steuer	F.1.0-1.1mm	M.0.8mm..	853
"	Clausi	F.Dahl	F.1.6-1.7mm		
			M.1.3-1.5mm	.....	854
"	flaccus	Giesbr.	F.1.7-1.9mm		
			M.1.4-1.7mm	.....	855
"	giesbrechti	F.Dahl	F.0.5-1.0mm		
			M.0.7-0.9mm	.....	856
"	lautus	Dana	F.2.8-3.0mm		
			M.2.1-2.5mm	.....	857
"	latus	Dana	F.0.8-1.2mm		
			M.0.7-0.9mm	.....	858
"	limbatus	Brady	F.1.4-1.5mm	M.1.2mm.	859
"	ovalis	Claus	F.0.8-1.0mm		
			M.0.7-0.9mm	.....	860
"	speciosus	Dana	F.1.9-2.2		
			M.1.7-1.9mm	.....	861
"	typicus	Kroyer	F.1.6-1.7mm		
			M.1.2-1.6mm	.....	862
Corycella	carinata	Giesbr.	F.0.8-0.9mm		
			M.0.8-0.9mm	.....	863

Family SAPHIRINIDAE

Sapphirina	angusta	Dana	F.2.5-5.5mm		
			M.4.0-7.0mm	.....	864
"	bicuspidata	Giesbr.	F.2.3-3.0mm		
			M.2.6-3.4mm	.....	865
"	gastrica	Giesbr.	F.2.3-2.7mm		
			M.2.2-2.7mm	.....	866
"	gemma	Dana	F.2.1-3.7mm	M.2.3-4.5mm	867
"	intestinata	Giesbr.	F.1.6-2.8mm		
			M.1.6-2.9mm	.....	868
"	iris	Dana	F.5.2-7.4mm	M.5.9-7.5mm..	869
"	lactens	Giesbr.	F.1.4-1.6mm		
			M.1.5-1.7mm	.....	870

Sapphirina	metallina	Dana	F.1.7-2.5mm	
			M.1.6-2.6mm	871
"	maculosa	Giesbr.	F.1.8-2.2mm	
			M.2.7mm	872
"	nigromaculata	Claus	F.1.5-2.8mm	
			M.1.7-3.0mm	873
"	opalina	Dana	F.2.1-4.2mm	
			M.2.4-4.4mm	874
"	sali	Farran	F.2.3-3.1mm	M.2.0-2.8mm 875
"	scarlata	Giesbr.	F.3.3-4.7mm	
			M.3.4-4.9mm	876
"	opalina var.	Darwini	Haeckel	877
Copilia	mediterranea	Claus	F.3.2-4.4mm	
			M.4.5-6.1mm	878
"	mirabilis	Dana	F.2.2-4.1mm	
			M.3.2-6.1mm	879
"	quadrata	Dana	F.2.2-4.4mm	
			M.3.5-5.7mm	880
"	vitrea	Haeckel	F.3.2-5.4mm	
			M.5.5-9.0mm	881

Parasitic COPEPODA

Ascomyzon	parvum	882
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Order CIRRIPIEDIA

Balanus	amphitrite	(Nauplius larva)	883
"	balanoides	(Nauplius larva)	884
"	sp.	(Cypris larva)	885
"	sp.	(Metanauplius larva)	886
"	tintinnabulum	(Nauplius larva)	887
Lepas	anatifera	(Nauplius larva)	888
Lepadidae's	larva	(Nauplius larva)	889
Sacculina	sp.	(Nauplius larva)	890

Subclass MALACOSTRACA

Order AMPHIPODA

Family ANCHYLOMERIDAE (PHROSINIDAE)

Anchylomera	Blossevillei	Milne Edwards	891
Euprimno	macropus		892
Phrosina	semilunata		893

Family HYPERIIDAE

Hyperia	latissima	Bovallius	894
"	sibaginis	Stebbing	L.3.0-4.0mm 895
"	schizogeneios	Stebbing	896
Hyperioides	longipes	Chevreur	897
Hyperoche	kroyeri		898

Euthemisto	bispinosa	.....	899
Parathemisto	oblivia	.....	900
Phronimopsis	spinifera	Claus	901
Family LYCAEIDAE			
Brachyscelus	crusculum	.....	902
Lycaea	pulex	.....	903
Pseudolycaea	pachypoda	.....	904
Family OXYCEPHALIDAE			
Glossocephalus	Milne-Edwardsi	.....	905
Oxycephalus	porcellus	Claus	906
Phtisica	marina	.....	907
Pseudolirius	Kroyeri	.....	908
Rhabdosoma	sp.	.....	909
Streetsia	Challengeri	.....	910
Family PHRONIMIDAE			
Phronima	sedentaria	.....	911
"	pacifica	Streets L.10.Omm	912
Phronimella	elongata	Claus	913
Family PLATYSCELIDAE			
Lycaeopsis	themistoides	.....	914
Platyscelus	ovoides	.....	915
"	serratulus	.....	916
Family SCELIDAE			
Parascelus	typhoides	.....	917
Family VIBILIIDAE			
Vibilia	viatrix	Stebbing L.8.0-9.Omm.....	918
Order EUPHAUSIACEA			
Family EUPHAUSIDAE			
Euphausia	gracilis	Dana L.9.0-10.Omm	919
"	pellucida	Dana L.10.0-11.Omm	920
Stylocheiron	carinatum	G.O.Sars L.10.0-11.Omm.	921
Meganyctiphanes	norvegica	(Furcilia larva) ...	922
Meganyctiphanes	norvegica	(Metanauplius larva)	923
"		(Calyptopis larva)	924
Order MYSIDACEA			
Mysidae's larva			
Mesopodopsis	slabberi	P.J.Bened L.8.0-9.Omm ..	925
Neomysis	longicornis	.....	926
Siriella	clausi	G.O.Sars	927

Order	DECAPODA		
Suborder	MACRURA (REPTANTIA)		
Lucifer	acestra	.....	928
"	raynaudii	Bate L.7.0-12.0mm	929
"	sp.	(Zoea larva)	930
"	"	(Mysis larva)	931
Palinurus's	larva	(Pyllosoma larva)	932
Shrimps	larva	(Zoea larva)	933
"	"	(Mysis larva)	934

Suborder	ANOMURA		
Paguridea's	larva	(Glaucothoe larva)	935

Suborder	BRACHYURA		
Eriphia	spinifrons	(Zoea larva)	936
Inachus	sp.	(Zoea larva)	937
Maia	sp.	(Zoea larva)	938
Macropodia	sp.	(Zoea larva)	939
Porcellana	longicornis	(Metazoea larva)	940
Portunus	sp.	(Zoea larva)	941

Order	STOMATOPODA		
Squilla's	larva	L.10.0mm (Alima larva)	942
"	"	L.9.0-10.0mm (Alima larva)	943
Stomatopoda's	larva	(Erichthus larva)	944

Phylum PROCHORDATA

Subphylum UROCHORDA (TUNICATA)

Class APPENDICULARIA (COPELATA)

Family KOWALEVSKIDAE

Kowalevskia	tenuis	Fol. Trunk	L.0.5-1.0mm.	945
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Family APPENDICULARIDAE

Appendicularia	sicula	Fol. T.L.0.5mm	946
Fritillaria	pellucida	Busch. T.L.1.0-2.0mm.		947
"	borealis	acuta Lohm. T.L.1.3mm.		948
"	"	truncata Lohm.		
		T.L.0.9mm	.....	949
"	formica	Fol. T.L.1.5mm	.....	950
"	fraudax	Lohm.	.....	951
"	haplostoma	Fol. T.L.1.0mm	.....	952
"	megachile	Fol. T.L.0.9-1.0mm	...	953
"	tenella	Lohmann T.L.1.2mm	.....	954
"	venusta	Lohm. T.L.1.1mm	.....	955
Oikopleura	albicans	Leuck. T.L.5.0mm	.....	956

Oikopleura	cophocerca	Gegenbaur	T.L.1.4mm	....	957
"	dioica	Fol.	T.L.1.3mm	.....	958
"	fusiformis	Fol.	T.L.1.5mm	.....	959
"	labradoriensis	Lohm.	T.L.2.4mm	....	960
"	longicauda	Vogt.	T.L.1.2mm	.....	961
"	parva	Lohmann	T.L.0.8mm	.....	962
"	rufescens	Fol.	T.L. 1.5mm	.....	963
Stegosoma	magnum	Lohmann	T.L.1.5-3.5mm	.....	964
Ciona	intestinalis	(Appendicularia larva)			965

Class THALIACEA

Subclass MYOSOMATA

Order SALPIDA

Family SALPIDAE

Cyclosalpa	affinis	Chamisso	.....		966
"	bakeri	Ritter	L.3.0-5.0	.....	967
"	pinnata	Forsk.	.....		968
"	virgula	Vogt.	.....		969
Iasis	zonaria	Pallas	Pallas	L.3.0-6.0mm	970
Ihlea	punctata	Forsk.	.....		971
Pegea	confoederata	(Forsk.)	.....		972
"	" var.	bicaudata	Quoy & Gaimard	..	973
Salpa	fusiformis	Cuvier	L.3.0-6.5mm	.....	974
"	maxima	Forsk.	L.5.0-15.0mm	.....	975
Thalia	democratica	(Forsk.)	L.15-25.0mm	..	976
Thetys	vagina	(Tilesius)	L.19.0	.....	977

Order DOLIOLARIA

Family DOLIOLIDAE

Doliolum	denticulatum	Q. & G.	L.9.0mm	.....	978
"	gegenbauri	Uljanin	L.9.0mm	.....	979
"	" var.	tritoni	Herdman	L.17.0mm	980
"	mulleri	var. krohni	Borgert	L.7.0mm	981
"	nationalis	Borgert	L.3.0mm	.....	982

Subclass PYROSOMATA

Order PYROSOMATIDA

Family PYROSOMATIDAE

Pyrosoma	atlanticum	Peron		983
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Larva of PROCHORDATA

Balanoglossus	misakiensis	(Tornaria larva)		984
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Phyto-plankton (Marine)

Phylum	Class	Subclass	Order	Suborder	Family	Number of Species
Cyanophyta	Bacillariaceae (Diatoms)	Disciniae			Oscillatoriaceae	2
			Homogonae			
					Melosiraceae	3
					Coccolithaceae	30
					Cocconeaceae	2
					Leptocyclindraceae	5
					Sketeonemaceae	4
					Thalassiosiraceae	6
					Rhizosoleniaceae	21
					Bacteriastriaceae	8
					Chaetocercaceae	33
					Biddulphiaceae	25
					Eucampiaceae	6
		Pennales			Fragilariaceae	12
					Tabellariaceae	9
					Acanthaceae	4
					Naviculaceae	30
					Nitzschaceae	14
					Surirellaceae	8
Total species of the marine phyto-plankton						222

1.1. INTRODUCTION

The present study is a part of a larger project on the ecology of the coastal waters of South Vietnam.

The main objectives of this study are to determine the seasonal and spatial distribution of plankton in the coastal waters of South Vietnam.

CHAPTER IV. DISTRIBUTION OF PLANKTON IN SOUTH VIET-NAM

The distribution of plankton in the coastal waters of South Vietnam is characterized by a high degree of seasonal and spatial variability.

During the summer months, the plankton community is dominated by diatoms and dinoflagellates.

In the winter months, the plankton community is dominated by copepods and cladocerans.

The spatial distribution of plankton is also highly variable.

In the coastal waters, the plankton community is dominated by diatoms and dinoflagellates.

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A. FRESH WATER PLANKTON

The fresh water plankton in Viet-Nam can be divided into the following four kinds according to the places they live in.

1. Eulimno-plankton this kind lives in the lakes, which is also used for the fresh water fish culture, at Da-Lat, Rach-Gia, and Ca-Mau.
2. Potamo-plankton this lives in such large rivers as the Saigon and the Mekong, and be used for fish and fishery indirectly.
3. Helo-plankton this lives in small ponds and pools.
4. The plankton which grows in a cultivating farm artificially controlled at Thu-Duc, Da-Lat, Cholon, and Hue.

Even when the same kind of plankton lives in several places, its use differs according to the place where it lives. Except the kind of 3. these plankton have the value as plankton.

Fresh water plankton differs from marine plankton. In the case of fresh water plankton, quite different types of plankton are sometimes found even in places which are very near to each other. This is apparent from the distribution of plankton in each lake at Da-Lat. This is characteristic of fresh water plankton, which are largely influenced by the circumstances of the place they live in, especially by the quality of the water.

Here are some important fresh water plankton from the ones we have recognized in South Viet-Nam.

1. PHYTO-PLANKTON

The important types which are found in South Viet-Nam are the following three phylums: (1) Chrysophyta (2) Chlorophyta (3) Cyanophyta.

(1) Chrysophyta

The diatoms such as Fragilariaceae, Coscinodiascaceae, Melosiraceae, Rhizosoleniaceae, Tabelariaceae, Achnanthaceae, Surirellaceae, Naviculaceae, and Nitzschiaceae are found quite commonly in all areas. Among them, Fragilaria, Melosira glanulata, Navicula lanceolata, Nitzshia paradoxa (Bacillaria paradoxa),

N.nyassensis were sometimes found in great quantity.

(2) Chlorophyta

Selenastrum gracile, S.Bibraianum, Staurastrum tohopekali-gense, S.woltereckii, Crucigenia fenestrata, Franceia tuberculata, Arthrodesmus apiculatus, A.cuvatus are the sorts which are commonly found.

Ankistrodesmus falcatus, Staurastrum smithii, Spirogyra prolifica, Pandorina minodi, Mougestia, Dictosphaerium pulchellum, Scenedesmus armatus, and S.dimorphus, S.Bijiga, are found in great quantity at certain places in a certain season.

(3) Cyanophyta

Spirulina princeps is found everywhere, and Anabaena circinalis, Anabaenopsis Elenkinii and Oscillatoria limosa are the kinds which are found so abundantly at every fish farm as to make the water look dark green.

2. ZOO-PLANKTON

Among the zoo-plankton which are important are (1) Protozoa, especially Euglenoidea, Dinoflagellata (2) Rotifera (3) Crustacea etc.

(1) Protozoa

Protozoa as fresh water plankton is not so abundant, but some kinds, such as Euglenoidea, Dinoflagellata, Infusoria etc. are important from the quantitative point of view.

Euglena deses, Cryptoglena pigra, Peridinium striolatum etc. which belong to Phyto-mastigophora are found in huge quantity at places. Besides, of the 161 kinds which were found in Viet-Nam, at least one kind is always to be found. Dinobryon, Glenodinium, Chlamydomonas, Peridinium, Euglena, Phacus etc. are scarce in quantity but rich in variety.

Trichodina pediculus, Holophrya simplex, Spasmostoma viride, Pleuronema coronatum etc. which belong to Zoo-mastigophora are sometimes found in large quantity.

(2) Rotifera

Rotifera (Rotatoria) is widely distributed everywhere in

Viet-Nam, and is important as natural living food for small fresh water fish. Rotifera usually grows in small ponds and is sometimes found growing in large mass. For instance, Brachionus bakeri and B. urceolaris were discovered in the pond in the Airport of Can-Tho, and they proved to be excellent.

Rotifera multiplies rapidly in its season. It appears in abundance at a time, and vanishes suddenly. It changes its form according to the environments. Brachionus urceolaris (Can-Tho), Keratella aculeata (Ca-Mau) etc. are found in large quantity. Keratella valga, Filinia longiseta, Monostyla quadridentata, Lepadella patella etc. are also found very commonly.

(3) Crustacea

Most of the fresh water crustacea is Phyllopoda, especially Cladocera. Copepoda is comparatively scarce. This is quite the opposite to the case of marine crustacea, where Copepoda is by far the greater in quantity.

(a) Copepoda

In Viet-Nam, Cyclopidae and Diaptomidae make the most part of Copepoda, and are found commonly everywhere.

Cyclops strenuus, C. bicolor, Pseudodiaptomus marinus etc. are widely distributed. Cyclops vicinus (Da-Nhim), C. vernalis (Da-Nhim), Mesocyclops lenkarti (Xuan-Huong lake, Dalat), Diaptomus reighardi (Da-Nhim), Eodiaptomus japonicus (Da-Nhim), Sinodiaptomus Sarsi (Xuan-Huong lake, Da-Lat) etc. are the sorts which are found abundantly. Osphranticum labronectum, Diaptomus kenai are found in various places, though not in large quantity.

The identification of Copepoda is determined by the forms of the first antenna and the fifth legs, but even within the same kind some differences are seen in its forms according to the environments.

(b) Cladocera

The importance of Cladocera in fresh water is greater than that of Copepoda. In ordinary circumstances, most of its kinds increase by parthenogenesis among females. Because of its ovoviviparity it multiplies rapidly, which makes it important in point of productivity. What is more, its ability to swim is inferior to that of Copepoda, which makes it easier for Pisces at level stage to feed on it.

In South Viet-Nam also, as many as 50 kinds were found of Cladocera, while of Copepoda only 30 were recognized. It is found in large quantity in such alpine lakes as those at Dalat (1300 m above sea level), but more varieties and larger quantity of it can be found in lakes and ponds on lowlands.

Also commonly found are: Daphnia rosea, Moina macrocopa, Pseudosida bidentata, Oxyurella longicauda, Alona, Bosmina etc. Chydorus sphaericus, Moina brachiata, M. macrocopa, Sida crystallina etc. are sometimes found in great mass.

The classification of Cladocera is difficult like that of Copepoda and as even the same kind differs in its form according to the living environments, much care must be taken not to make mistakes (which is especially conspicuous with Daphnia and Bosmina).

B. MARINE PLANKTON

The marine plankton is more complicated than the fresh water plankton from the taxonomical and morphological points of view. For in the sea, there are numerous kinds of creatures, which are not to be found in fresh water, at their different stages: larval stage, metamorphosical stage, heterogenesical stage. These live in the sea in large quantity together with their adults.

Of the marine plankton, 1. Diatoms and 2. Copepoda are the important kinds and are found in plenty. Along the coasts of Viet-Nam, the following kinds are also easily found and are considered valuable as food for pisces and crustaceans:

- | | | |
|-------------------|-----------------|---------------------|
| 3. Dinoflagellata | 4. Chaetognatha | 5. Appendicularidae |
| 6. Siphonophora | 7. Radiolaria | 8. Cilliophora |

These will be explained in the following.

1. PHYTO-PLANKTON

(1) Cyanophyta

Of this type, Trichodesmium Thiebautie and T. erytheraeum are found in abundance along the coasts of Central Viet-Nam, including Nhatrang, regardless of the seasons. In Nhatrang there are times when these two kinds alone amount to as much as 0.5 g/m³ to 0.7 g/m³.

(2) Diatoms

This is considered to be the most important of the whole marine phytoplankton. About 200 kinds of this were discovered along the coasts of Viet-Nam.

Chaetoceraceae and Bacteriastreae are the most usual kinds. The following are found quite commonly at any time along all the coasts of Viet-Nam:

Rhizosoleniaceae, Coscinodiscaceae, Thalassiothrix,
Thalassionema, Eucampia, Asterionella, Nitzshiaceae,
Biddulphiaceae.

2. ZOO-PLANKTON

(1) Dinoflagellata

This includes the most important kinds of Protozoa. Especially Ceratium can be seen most plentifully along the area from Phan-Thiet to Nhatrang. 41 kinds of it was found in the whole area. Also to be found all over the area are: Peridinium, Gymnodinium, Glenodinium, Gonyaulax, Dinophysis (abundant in Nhatrang and Cam-Ranh), and Ornithocercus.

(2) Radiolaria

Though not abundant, this plankton has a large variety. 41 species of it have already been discovered, and its distribution covers the whole area. Of these species the most commonly found are: Amphibelone hydrotomica, Acanthocolla cruciata, Amphiacon denticulatus, Amphilonche elongata and Cyrtoidae (Theoconus zancleus, Dictyophimus tripus, Acanthocorys umbellifera).

(3) Ciliophora

Of this class, too, numerous species (72) have been found. Its distribution covers the whole area, but its quantity is small. The most commonly seen are: Tintinnopsis butschlii, Codonellopsis morchella, C.mortensenii, C.ostenfeldi, Stenosemella nivalis, Favella markuzowskii, Epiplocylis blanda, Xystonellidae, Eutintinnus fraknoi, E.latus, E.lusus-undae, E.elegans etc.

(4) Coelenterata

Among the already discovered species, Hydromedusae, Trachylina, Siphonophora, Scyphomedusae etc. are the important ones. Of these, Siphonophora is most abundantly found, and is distributed almost all over the area. Leptomedusae (Octorchis gegenbauri, Eirene viridula etc.) and Liriope tetraphylla etc. sometimes choke the cock of a plankton-net.

(5) Chaetognatha

This phylum is the largest of net-plankton that can be seen with naked eyes, sometimes reaching 50 mm. It is found over the whole area, though its quantity is more or less different at each place. The greater part of it is Sagitta, and 31 species of it have been identified along the coasts of Viet-Nam.

Chaetognatha is valuable not only as the food for fish, but also as an index to the study of the sea currents, being related to the sea temperature and the salt.

(6) Prochordata

This phylum is also distributed all over Viet-Nam and is especially abundant in the middle and the south of South Viet-Nam. It includes Oikopleura, Fritillaria, Doliolidae, Salpidae, and is important as the food for fish.

(7) Copepoda

This is the most important animal plankton of all the marine plankton. 176 species of this have been found along the coasts of Viet-Nam.

(a) Calanidae

This includes 9 species, among which are Calanus, Canthocalanus, Neocalanus etc. All of these are commonly to be found.

(b) Eucalanidae

This is a somewhat large kind. It includes Rhincalanus and Eucalanus, and can be seen very commonly everywhere.

(c) Paracalanidae

This includes Calocalanus and Paracalanus. It is

small and can be found in all areas, though not in large quantity.

(d) Pseudocalanidae

This has a characteristic that its female lacks the fifth legs, which makes it easy to distinguish it from another family by looking at its side. It is found throughout the country not in large quantity.

(e) Aetideidae

This is rather a large species. Though small in quantity, it is rich in kinds, and commonly to be seen.

(f) Acartiidae

A small coastal zoo-plankton to be found quite commonly.

(g) Metridae

Though originally a deep-sea plankton, this is commonly found along the coastal areas as well.

(h) Euchaetidae

Large size and a pointed head are the characteristics of this kind. Rarely to be found.

(i) Phaemnididae

Of its species, Cornucalanus is commonly found.

(j) Centropagidae

Though not found in large quantity this can be commonly found throughout the country.

(k) Temoridae

Also commonly seen throughout the country.

(l) Candaciidae

The characteristic of this is that the front part of its head is more or less square-shaped. To be found very

commonly along the coasts.

(m) Lucicutiidae

Of this family, Lucicutia longiserrata, L.lucida, L.atlantica are commonly found.

(n) Augaptilidae

19 species of this have been discovered. They can commonly be seen along the coastal areas.

(o) Pontellidae

11 species of this have been discovered so far, among which is Pontella Lo Biancoi, a beautiful, blue-colored one. They are commonly found along the coasts of Viet-Nam, though not in quantities.

(p) Oithonidae

An important species of a small size commonly found in the coastal areas and in the open sea.

(q) Ectinosomidae

A species of a small size, of which Microsetella norvegica and M.rosea can be most commonly found, sometimes in quantities, along the coasts of Viet-Nam.

(r) Macrosetellidae

Like Ectinosomidae this can be found very commonly, though not in abundance.

(s) Oncaeidae

Oncaea and Lubbockia of this family are commonly found in the open sea and along the coasts as well.

(t) Corycaeidae

This can be seen most commonly along all the coasts of Viet-Nam. 11 species have been found so far.

(u) Sapphirinidae

The body of this plankton is flat. With the male it

is flat and in the shape of a leaf, and it emits fluorescence. It is quite common along the coasts of South Viet-Nam. 18 species including Sapphirina and Copilia have already been discovered.

(8) Decapoda

Lucifer raynaudii and L.acestra of this group can be always found in abundance, especially in Nhatrang and in the Central Viet-Nam.

(9) Mollusca

Of this phylum, the most often found are those which belong to Cavolinidae, such as Creseis aciculata, C.virgula conica, C.virgula virgula, Styliola subula, Euclis etc. Atlantidae and Limacinidae are also found throughout the whole area.

Table 2

Distribution of Fresh Water Plankton
in South Viet-Nam

Note: (Regions) (Researching Places)

A region Rach-Gia, Phu-Quoc, Ca-Mau, Can-Tho.

B region Cholon, Saigon, Thu-Duc, Bien-Hoa,
Phan-Thiet.

C region Da-Lat, Da-Nhim (Song-Pha).

D region Nha-Trang, Phu-Huu.

E region Hue, Da-Nang, Quang-Ngai.

CCC	Abundant	(45%)
CC	Frequent	(30%)
C	Common	(15%)
R	Rare	(8%)
RR	Very rare	(2%)

Family or Genus	A	B	C	D	E
CYANOPHYTA					
Chroococcaceae	C	C	C	C	
Oscillatoriaceae	C C C	C C C	C	C	C
Nostocaceae	C C C	C C C	C C	C	C
Plectonema	C	C C	R	C C	
CHRYSOPHYTA					
Melosiraceae	R	R	C C	C C	C C
Coscinodiscaceae	C	R	R		
Rhizosoleniaceae		R R			
Chaetoceros		R R	R R		
Attheya	R R		R R		R
Fragilariaceae	C	R	C	R	R
Tabellariaceae	C	C	C	C	R
Achnantheaceae		R	C	C C C	R
Naviculaceae	C	C	C	C	C
Epithemiaceae				R R	
Nitzschiaceae	C	C	C	C	C
Surirellaceae	R	R	R	R	C
Pleurochloridaceae			R	R	
Tribonemataceae					
CHLOROPHYTA					
Palmellaceae	C	C	R	C	C
Chlorococcaceae		C	R	R	
Micractiniaceae	C	C	C	C	C
Schroederia			C		
Coelastrum			R		
Dictyosphaerium	R	R	R		
Hydrodictyaceae	C	C	C	C	C
Oocystaceae			C C	R	
Scenedesmaceae	C	C	C	R	R
Zygnemataceae	C	R	C C	C	C
Gonatozygon	C				
Desmidiaceae	C C	C	C C C	C	C
Microspora			R		
Protococcus		C	C	C	
Trentepohlia			R		
Ulothrix		R R			
Sphaeroplea			R R		
Schizomeris		R			
Cladophoraceae		C	C	C	
Oedogoniaceae	C	R	R R		
Schizogonium	C	C	C	R	

Family or Genus	A	B	C	D	E
PROTOZOA					
(Phyto-Mastigophora)					
Mallomonadaceae		C	R		C
Ochromonadaceae			C C		
Chrysocapsa		R	R R	R R	
Chrysamoeba		C	R	C	
Stipitococcus		C	C		
Polyblepharidaceae	C	C	C	C	
Chlamydomonadaceae	C	C C	C C	C	C
Haematococcus			R		
Pedinopera		C			
Pascheriella	C	C	C	C	C
Volvocaceae	C	C	C	C	C
Gymnodiniaceae			C		
Hypnodinium		C	R	R	
Ceratium			R R		
Prorocentraceae	C	C	C	C	C
Gonyaulacaceae			C	C	
Peridiniaceae		C	C	C	
Monomastix	C	C		C	
Cryptochrysis		C			
Cryptomonadaceae		C		C	
Astasia	C	C	C	C	
Euglenaceae	C C	C	C C	C	C C
Peranemaceae	R				
(Zoo-Mastigophora)					
Zooflagellata	C	C	C	C	C
Rhizopoda	C	C C	R	C	C
Actinopoda	C	C	C	C	C
Ciliophora	C C	C C	C	C	C
TROCHELMINTHES					
Rotifera	C C C	C C	C	C	C
ARTHROPODA					
Cyclopidae	C	C	C	C	C
Calanoida	C	C	C C	C	R
Diaptomidae	C	C	C	R	R
Daphnidae	C	C	C C	C	C
Sididae	C	C	C	C	C
Bosminidae	C	C	C	C	C
Chydoridae	C C	C	C C	C	C
Macrothricidae	C	C	C	C	C

Table 3

Distribution of Marine Plankton
in South Viet-Nam

Note: (Regions)

- A region Rach-Gia, Phu-Quoc, Westcoast of Ca-Mau
- B region East coast of Ca-Mau, Vung-Tau,
Phan-Thiet.
- C region Cam-Ranh, Nha-Trang, Phu-Huu, Tuy-Hoa,
Qui-Nhon.
- D region Thuan-An (Hue), Da-Nang, Quang-Ngai.

CCC	Abundant	(45%)
CC	Frequent	(30%)
C	Common	(15%)
R	Rare	(8%)
RR	Very rare	(2%)

Family	A	B	C	D
CYANOPHYTA				
Oscillatoriaceae	R	C C	C C C	C
CHRYSOPHYTA				
Melosiraceae	C	R	R	R
Coscinodiscaceae	C	C	C	C
Corethronaceae	R	R	R	R
Leptocylindraceae	R	R	C	R
Skeletonemaceae	C	C	C	C
Thalassiosiraceae	C	C	C	C
Rhizosoleniaceae	C	C	C C	C
Bacteriastraceae	C	C C	C C	C
Chaetoceraceae	C	C	C C	C
Biddulphiaceae	C	C C	C C	C
Eucampiaceae	C C	C	C C	C
Fragilariaceae	C C	C	C C	C
Tabellariaceae	C	C	C	C
Acanthaceae	R	C	C	
Naviculaceae	C	C	C	C
Nitzschiaceae	C	C	C	C
Surirellaceae	C	C	C	C
PROTOZOA				
Dictyochaceae	R R	R R	R	R R
Peridiniidae	C C	C	C C	C
Globigerinidae	C	C	C C	C
Cymbaloporidae			R	
Acanthochiasmidae	C	C	C	C
Acanthoplegmidae	R	R	R	R
Acanthometridae	R	C	C	R
Amphilitidae	R R	R R	C	R R
Aulacanthidae			R R	
Aulosphaeridae	R R		R R	
Cyrtoidae	C	C	C	C
Coelodendridae	R R		R R	
Discoidae		R R	R R	
Gigartaconidae	R	R	C	R
Medusettidae	R R	R R	R R	R R
Phyllostauridae			R	
Plectoidae			R R	
Spyroidae	R	R R	R	
Sphaeroidae			R R	
Sphaerozoidae		R R	R R	
Stauraconidae	R	R R	R	R

Family	A	B	C	D
Astrolithidae	R R	R R	R R	
Vorticellidae	C	C	C	C
Codonellidae	C	C	C	C
Codonelliopsidae	C	C	C	C
Coxliellidae	R	R	R	R
Cyttarocyclidae	R	R	C	
Dictyocystidae		R	R	
Epilocyclidae	C	C	C	C
Petalotrichidae	R	R	R	R
Ptychocyclidae	C	C	C	C
Tintinnididae	R	C	R	R
Rhabdonellidae	R	R	C	R
Tintinnidae	C	C	C	C
Undellidae	R		R	
xystonellidae	C	C	C	C
PORIFERA				
Clionadae			R R	
Leucosolenidae	R	R	C	R
COELENTERATA				
Hydromedusae	C	C	C	C
Trachylina	C	C	C	C
Siphonophora	C C	C C	C C	C C
Scyphomedusae	C	R	C	R
Ctenophora	C	C	C	C
PLATHELMINTHES				
Planocera (Larvae)		R	R	
NEMERTINI				
Cerebratulus (Larvae)			R R	
TROCHELMINTHES				
Synchaetidae	R R	R R	R R	R R
Dicranophoridae	R	C	C	
Sinantherinidae	R R		R R	
ANNELIDA				
Phyllodocidae			R R	
Typhloscolecidae		R R	R R	
Alciopidae	R R		R R	
Tomopteridae	R	R	R	R

Family	A	B	C	D
Polychaeta Larvae	C	C	C	C
CHAETOGNATHA				
Sagittidae	C	C	C	C
MOLLUSCA				
Heteropoda	C	C	C	C
Ptenoglossa	R R	R R	R R	R R
Nudibranchiata	R R	R R	R R	R R
Limacinidae	C	C	C	C
Cavolinidae	C	C	C	C
Peraclidae	R	R	R	R
Cymbuliidae	R	R	R	R
Pneumodermatidae			R R	
Thliptodontidae			R R	
Mollusca Larvae	R	R R	R R	R
MOLLUSCOIDEA				
Larvae	R R	R R	R R	R R
ECHINODERMATA				
Bipinnaria Larvae	R	R	R	R
Ophiopluteus Larvae	R	C	C	R R
Auricularia Larvae	R R	R R	R R	R R
Echinopluteus Larvae	R	C	C	R
ARTHROPODA				
Polyhemidae	C	C	C	C
Halocypridae	R	R	R	R
Eucalanidae	C	C	C	C
Calanidae	C	C	C	C
Paracalanidae	C	C	C	C
Pseudocalanidae	C	C	C	C
Aetideidae	C	C	C	C
Spinocalanidae	C	C	C	C
Megacalanidae	R	R	R	R
Heterorhabdidae	R R	R R	R	R
Acartiidae	C	C	C	C
Metridiidae		R R	R R	
Euchaetidae	C	C	C	R
Phaemidae	C	C	C	C
Scolecithriciidae	C C	C	C C	C
Centropagidae	R	R	R	R

Family	A	B	C	D
Temoridae	R	R	R	R
Candaciidae	R	R	R	R
Lucicutiidae	C	C	C	C
Augaptilidae	C	C	C	C
Pontellidae	R	R	C	R
Mormonillidae	C	R	C	C
Oithonidae	C	C	C	C
Ectinosomidae	C	C	C	C
Macrosetellidae	R	R	C	R
Tachydiidae	R R		R R	
Clytemnestridae			R R	
Oncaeidae	C	R	C	R
Corycaeidae	C	C	C	C
Sapphirinidae	C	C	C	C
Cirripedia (Larvae)	R R	R R	R R	
Amphipoda	R	R	R	R
Euphausiacea	R	R R	R R	R
Mysidacea	C	R	R	R
Decapoda (Larvae)	C	C	C	C
Stomatopoda (Larvae)			R R	
PROCHORDATA				
Kowalevskidae	R	R	R	R
Appendicularidae	C	C	C	C
Salpidae	C	C	C	C
Doliolidae	C	C	C	R
Pyrosomatidae	R	R	R	R
Prochordata Larvae			R R	

	CAN-LY	POND OF PRENN	THAM-TRO Lake	KE-LINH Lake	VAM-KIEP Lake	XUAN-HUONG Lake	DA-HEM Dua
DIATOMS							
<i>Oscillatoria princeps</i>	205				50		
<i>Spirulina princeps</i>							
CHRYSOPHYTA (Diatoms)							
<i>Achnanthes curvata</i>		548		164			
<i>Achnanthes ovalis</i>		167					
<i>Nitzschia paradoxa</i>		4759					
var. <i>humidula</i>		63					
<i>Cymbella naviculiformis</i>			520				
parva			1536				
<i>Diatoma vulgare</i>		204					
<i>Fragilaria capucina</i>			741	25			
constricta		83					
pinnata		33		11			
subaialina			468		75		
utermohlii		1000					
virescens		177					
sp.			271				
<i>Melosira Agassizii</i>	75			109			
glauclata							
<i>Navicula placentula</i>			334				
var. <i>lanceolata</i>			72				
radiosa		432	207				
rhyndrocephala		334					
rostrata			718				
<i>Nitzschia fonticola</i>			346				
rasnensis		67	1002				
seriata			540				
<i>Rhizosolenia longiseta</i>			65				
<i>Rhopalodia gibba</i>		84					
<i>Surirella splendida</i>		84					
<i>Synedra fasciculata</i>			50				
Utermohlii			48				
<i>Tribonana angustissimum</i>				9			
CHLOROPHYTA							
<i>Acanthosphaera Zecharisii</i>			486		35		
<i>Ankistrodesmus falcatulus</i>				8			
<i>Chodatella subulna</i>							
<i>Cosmarium indentatum</i>			33				
rymannianum			73				
phaeoculus			122				
<i>Echinoisphaerella limnetica</i>			16				
<i>Kougeotia viridis</i>				28	177		
<i>Kougeotopsis calospora</i>	474		1102				
<i>Gedogonium crispum</i>			5				
<i>Pachycladon rubrinus</i>			1394				
<i>Pandorina tinodi</i>							26887
<i>Pediastrum biradiatum</i>				13			
<i>Pleurodiscus purpureus</i>	327						
<i>Rhizoclonium hieroglyphicum</i>				103			
<i>Schizogonium murale</i>			802				
<i>Sphaerocystis schroeteri</i>					317		
<i>Sphaeropsis annulina</i>							272
<i>Spirogyra asyrgospora</i>	613						
iceni		4215					
prolifera			7515		115		
pseudocylindrica		1358					
<i>Staurastrum indentatum</i>			2680				
smithii			9352				
<i>Treuberia crassispina</i>					13		
<i>Zygnema insignis</i>					307		
PROTOZOA (Phyto-Mastigophora)							
<i>Chlamydomonas chrysoanada</i>			802				
compta			534				
<i>Dinobryon divergens</i>							324
<i>Euglena acus</i>				17			
<i>Hemidinium nasutum</i>					154		
<i>Peridinium striolatum</i>					192		
(Zoo-Mastigophora)							
<i>Bryosetopus sphagni</i>			130				
<i>Physomonas vestita</i>			47				
<i>Vorticella campanula</i>				4	7		
TROCHILMNETES							
<i>Filinia longiseta</i>				12			
<i>Notholca acuminata</i>				8			
<i>Platyla quadricornis</i>							1418
<i>Polyarthra vulgaris</i>				10			
ARTHEROPODA (Copepoda)							
<i>Cyclops strenuus</i>	33						
vernalis							12308
victimus							9369
<i>Diaptomus kanaï</i>			2512				
reigbardi	17						45558
<i>Eodiaptomus japonicus</i>							26687
<i>Megacalanus princeps</i>					13		
<i>Mesocyclops leuckarti</i>				1015	5	3206	
<i>Sinodiaptomus Sarsi</i>					8	4168	
(Cladocera)							
<i>Alona monocantha</i>	885						
<i>Cartodaphnia negoye</i>							1470
rigaudi	15						
<i>Cyprorus sphaericus</i>							3858
<i>Daphnia rosea</i>						1122	
<i>Moira brachiata</i>						7485	
macrocopa				20		8608	
<i>Cyprallea longicauda</i>						60	
<i>Sida crystallina</i>			312				29392
<i>Simocephalus vetulus</i>	18						

Table 4 The plankton in each lake of Dalat

(C) THE PLANKTON OF FISH CULTURE STATIONS

The Table 6 shows the result of my survey of the plankton in several fish culture stations in Viet-Nam. This is a mere survey of plankton and does not deal with its relationship with the productivity of fish, but in comparison with the ponds and lakes in general in Viet-Nam may at least be able to draw from this the following conclusions.

1. The rate of production of plankton (numbers/m³) is 5 to 15 times higher than that of the lakes and ponds in general. The author thinks this is because of the fact that the remnants of the food for fish (rice or rice bran) and the excrements of fish are decomposed into such catabolic matters as ammonia and nitrate, which in turn are fed by the plankton.
2. The PH is as low as 5.5 except at Cholon (PH 7.6) and Nhatrang (Brackish). This is the average PH of the lakes and ponds in general.
3. The following table (Table 5) shows the representative plankton groups developing in each of the fish culture stations.

Fish Culture Stations	Cyanophyta	Chrysoophyta	Chlorophyta	Protozoa (phyto-mastigophora)	Copepoda	Notes		
						Culture fish	PH	W.T. (°C)
Cholon (Kieu Cong Nuoi)				○		Cambodian Carp.	7.6	31.0
Thu-Duc	○					Carp. Tilapia	5.0	28.0
Dalat (larval stage)			○		○	Carp.	6.0	26.0
Dalat (younger stage)			○	○		Carp.	5.5	25.8
Hue		○				Carp.	-	-
Nhatrang (Breckish)		○				Tilapia Chanos chams	8.0	28.0

Table 5. The representative plankton groups which have developed in ponds of each fish culture station.

It is clear from Table 5 and 6 that the formation of the plankton in one culture station is different from that in another. Generally speaking, each kind of the marine animals lives on its own food suitable for itself. The natural living food varies in its kind according to the species of the animals and the places they live in, and the quantity of the food has influence on the production of the marine creatures. It is natural, therefore, that where there is much food there is a rapid growth and a great production of useful animals.

On the other hand, fish culture stations should be put under a good management, that is, we must try to provide the fish with such food and environments as are necessary and proper for their growth.

For example, in the case of Tilapia mossambica and Chanos chanos (generally called "milk fish") which are commonly cultivated in Viet-Nam, the phyto-plankton is given for food at their larval and younger stages.

(According to W.H. Schwester, 1952, 50% to 70% of the contents of Tilapia intestine is phyto-plankton, and 11% to 17% is zoo-plankton.) It is, therefore, necessary to take positive measures to increase phyto-plankton for these herbivorous fish.

In multiplying ordinary fish such as carp, it is necessary not only to provide them with suitable living environments (that is, to make dissolved oxygen, PH, and water conditions suitable for them) but also to pay full attention to such matters as the manufacturing and compounding of food based upon nutritive chemistry, the making of a food which is quick of digestion and absorption, the frequency of feeding in one day, growth rate, and an economical quantity of food to be given to fish.

	CHOLON (n/m ³)	THU-DUC (n/m ³)	DALAT (Hatched stage) (n/m ³)	DALAT (Younger stage) (n/m ³)	HUE (n/m ³)	NHATRANG (Brackish) (n/m ³)
ALGAE						
<i>Anabaena</i> sp.						
<i>Anabaena circinalis</i>			6827			
<i>Chroococcus giganteus</i>	29734					2472
<i>Coelosphaerium Kuetsingianum</i>						359
<i>Oscillatoria linearis</i>	11393					
<i>Spirulina princeps</i>	13604					
<i>Synploca muscorum</i>	807					
DIATOMS						10528
<i>Achnanthes</i> sp.						792
<i>Asphora ovalis</i>			1870			
<i>Botrydiopsis arrhisa</i>						457
<i>Chaetoceros muelleri</i>			200			
<i>Cyclotella kuetzing</i>						810
<i>Diatoma linearis</i>						259
<i>Diatoma balfouriana</i>						382
<i>Epithemia</i> sp.						1074
<i>Fragilaria capitata</i>		89		367		
<i>construens</i>						237
<i>lancoolata</i>						3560
<i>subaalina</i>						698
<i>Frustulia rhomboides</i>						
<i>Gyrosigma kuetzingii</i>						
<i>Hantzschia amphioxys</i>		187		662850		
<i>Melosira granulata</i>						
<i>var. valida</i>		2899			22752	
<i>islandica</i>		97			678	
<i>malayensis</i>					78	
<i>varians</i>		13				
<i>Meridion circulare</i>						
<i>Navicula lanceolata</i>					24	
<i>placentula</i>				334		6122
<i>Nitzschia acicularis</i>						2538
<i>actinastroides</i>						5078
<i>closterium</i>		123			108	
<i>kuetzingiana</i>						481
<i>nyassensis</i>			748			
<i>philippinarum</i>			94			
<i>subrotundata</i>			73			
<i>Phaeoglossa mucosa</i>				36		
<i>Pinnularia</i> sp.						
<i>Rhodonema adriaticum</i>						4696
<i>Rhopiledia gibba</i>				58		
<i>Sarirella robusta</i>						15137
<i>Synedra affinis</i>						2589
<i>acus</i>				528		
<i>cunningtoni</i>				238		
<i>fasciculata</i>				364		
<i>lancoolata</i>		284		351		
DIATOMS						
<i>Ankistrodesmus falcatulus</i>			8143	51300		
<i>Arthrodesmus apiculatus</i>				35800		
<i>arcuatus</i>				6276		
<i>curvatus</i>				29530		
<i>Closterium moniliforme</i>				2214		
<i>setosum</i>						3068
<i>Closteriopsis longissima</i>			434			
<i>Coelastrum cambricum</i>				367		
<i>Cosmarium exasperatum</i>			531			
<i>phaeolum</i>			334			
<i>praemorsum</i>				501		
<i>Crucigenia fenestrata</i>			6359	11072		
<i>quadrata</i>			374			
<i>Desmidium bengalicum</i>					18	
<i>Dietyosphaerium pulchellum</i>						
<i>Echinopsphaerall lametlica</i>				95958		
<i>Franseria tuberculata</i>			11414			
<i>Geminella interrupta</i>		13				
<i>Hyalotheca</i> sp.			18			
<i>Microasterias nahabulshwarensis</i>					12	
<i>Microspora amoena</i>						776
<i>Mougeotia</i> sp.				122531		
<i>Pachycladon umbrinum</i>			67			
<i>Palmella minima</i>				7381		
<i>Podoceros bidulatus</i>			237	351	120	
<i>Pleurodictus purpureus</i>					438	
<i>Protococcus viridis</i>						172
<i>Scenedesmus armatus</i>			468	19192		
<i>dimorphus</i>			3367	17715		
<i>Schroederia setigera</i>				3322		117
<i>Selenastrum Bitraianum</i>				11810		
<i>gracile</i>			9352			
<i>Spirogyra Ahmedabadensis</i>			654			
<i>prolifera</i>			296			
<i>Protocella</i>				110		
<i>Staurastrum scanthastrum</i>				175		
<i>anatinoides</i>			2993		120	
<i>corniculatum</i>			50	2214		
<i>kalimantanum</i>				2214		
<i>tohopekalingense</i>				8858		
<i>variabile</i>				2952		
<i>woltereckii</i>				12179		

	<i>negocantium</i>			281		
	<i>gracile</i>			629		
	<i>orbiculare</i>			85		
	<i>pseudopachyrhynchum</i>			94		
	<i>punctulatum</i>			140		
	<i>Tetraedron lobatum</i>			208		
	<i>Volvox aureus</i>	250				2707
	<i>Vestella botryoidea</i>					2580
	<i>Xanthidium burkillii</i>				1476	
	<i>sexmanillatum</i>					180
PROTOZOA (Phyto-Mastigophora)	<i>Ceratium hirundinella</i>				5	481
	<i>var. silasicum</i>					3039
	<i>Chlamydomonas inhaibilis</i>					247
	<i>krillensis</i>			2405		
	<i>praecox</i>					3840
	<i>Rodhei</i>			680		
	<i>Chrysocapsa planotonica</i>					
	<i>Cryptoglena pigra</i>	9690		247		
	<i>Dinobryon divergens</i>			1964		132
	<i>sertularia</i>					
	<i>Euglena clara</i>		84			
	<i>detes</i>	2170				
	<i>geniculata</i>					369
	<i>halina</i>			80		
	<i>pseudoviridis</i>			227		
	<i>velata</i>			82		
	<i>Glanodinium steinii</i>					2670
	<i>uliginosum</i>					596
	<i>Hypodinium sphaerium</i>			500		20
	<i>Peridinium aciculiferum</i>					651
	<i>africanum</i>					
	<i>spiniferum</i>					19561
	<i>striolatum</i>			184		300
	<i>Phacus longicauda</i>					
	<i>Protochrysis phaeophycearum</i>	17700				
(Zoo-Mastigophora)					334	
	<i>Acanthocystis chaetophora</i>					
	<i>Actinophrys sol</i>	72				
	<i>Ctedoctema acanthocrypta</i>			583		
	<i>Cyclidium glaucum</i>	651		100		
	<i>Didinium</i> sp.	585				
	<i>Euplates patella</i>	150				
	<i>Gaстромита membranacea</i>	250				169
	<i>Glaucocystis scintillans</i>					
	<i>Holophrys simplex</i>					
	<i>Pleurocystis coronatum</i>			838		11184
	<i>Spasmostoma viride</i>					
	<i>Steinia candeus</i>			189846		491
	<i>Trichodina</i> sp.					
TROCHELMINTHES	<i>Brachionus urceolaris</i>					96
	<i>Colurella obtusa</i>					30
	<i>Dipleuchlanis propatula</i>					60
	<i>Keratella cochlearis</i>			84		304
	<i>valga</i>			78		
	<i>Lepadella patella</i>	52				24
	<i>Monostyla quadridentata</i>					
CRUSTACEA	<i>Acartia Clausi</i>					157
	<i>Calanus</i> sp.					130
	<i>Cyclops bicolor</i>					164
	<i>stramuss</i>	84				
	<i>vernalis</i>			111		
	<i>Diaptomus reighardi</i>					174
	<i>Ediaptomus japonicus</i>					65
	<i>Mesocyclops leuckartii</i>			65		
	<i>Osphradiopsis leuckartii</i>					
	<i>Pseudodiaptomus marinus</i>					
	<i>Sida crystallina</i>					
				149		387

Table 6 The plankton species was taken from the ponds of each Fish culture station in Viet-Nam.
(unit the number of individuals per cubic meter (n/m³))

THE VIETNAM SEA

VIETNAM SEA

VIETNAM SEA

CHAPTER V ENVIRONMENT AND PLANKTON BIOMASS IN THE
DRY AND THE RAINY SEASON IN NHATRANG BAY
AND THE OPEN SEA, CENTRAL VIET-NAM



VIETNAM SEA

VIETNAM SEA

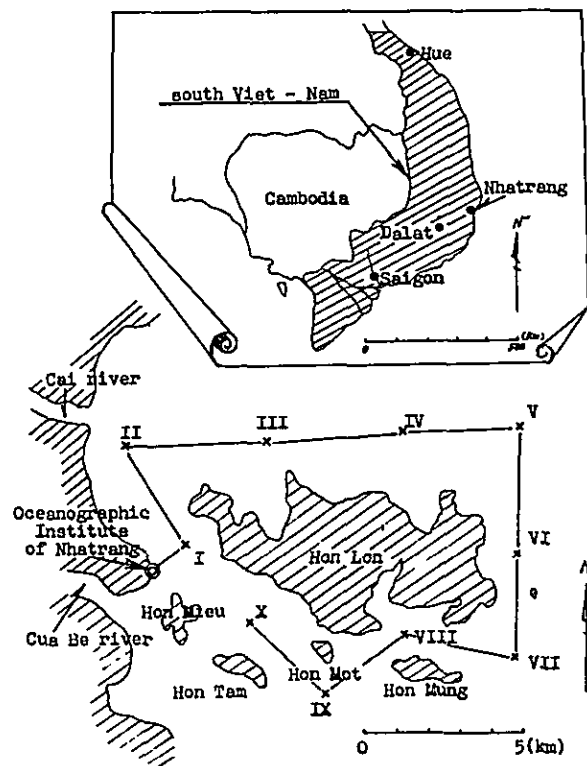
VIETNAM SEA

VIETNAM SEA

A. RESEARCHING STATIONS AND RESEARCHING METHODS

1. RESEARCHING STATIONS

Ten researching stations were established (Fig. 1) in Nhatrang Bay and the open sea (about 14 km. from the beach) around Hon Lon (Lon Island).



2. RESEARCHING INSTRUMENTS

- (1) Mercury thermometer (35°C)
- (2) Kitahara water collecting equipment.
- (3) Hydrometer.

- (4) Medicines are used to the fixation of dissolved oxygen.
($MnCl_2$ and KI + KOH solutions)
- (5) Oxygen bottles (about 100 cc Volume).
- (6) Secchi plate for the measurement of transparency.
- (7) Plankton nets.
 - (a) Phyto-plankton net (Mullergaze No. 5)
 - for the horizontal ---- Diameter 30 cm.
 - for the vertical ----- " 25 cm.
 - (b) Zoo-plankton net (Mullergaze No. 25)
 - for the horizontal ---- Diameter 30 cm.
- (8) Solution for the fixation of plankton
 - Formarin ----- 4 - 6 % neutral
- (9) Ropes. 100 m., 20 m., 10 m., ---- Diameter 6 mm.
- (10) Pouches and bottles for the collected samples.
 - (a) Pouch: Nylon or Vinyl ---- Size 20 x 30 cm
(mainly, it was used to the water samples)
 - (b) Bottles: Plastic bottle; D. (5.5; 3.5; 2.7 cm)
H. (11, 8, 7 cm)

3. ITEMS OF THE RESEARCH

- (1) Observation at the same station on one day.
 - (a) Station ---- St. I
 - (b) Date and Time

Dry season ---- May 20 - 21, 1963
 Rainy season --- Oct. 1 - 2, 1963

from sunrise to after sunset --- 5:30 a.m. to
 8:30 p.m.

- (c) Measurement: Temperature, Dissolved oxygen, Density, Alkalinity, Chlorinity and Salinity, Transparency, and Horizontal and Vertical distribution of plankton to each depths.
- (2) Observations in Nhatrang Bay and in the open sea.
- (a) Station ----- Sts. I - X
- (b) Date ----- Dry season May 21, 1963
 Rainy season Oct. 2, 1963
- (c) Measurement: Temperature, Dissolved oxygen, Density, Alkalinity, Chlorinity and Salinity, Transparency, Quantity of plankton (phyto- and zoo-plankton) at each station.

4. PREPARATION OF CHEMICALS AND THE METHOD OF ANALYSIS OF THE SAMPLES

(1) Determination of specific gravity -- the water was taken to the laboratory, as it is difficult to get a correct determination of the ship because of the rolling and pitching. Density of the sea water is determined by the Akanuma's specific gravity meter. As it varies with the temperature, the density determined in any temperature is converted into that of 15°C (σ_{15}) and is compared. This conversion is made according to Makalof's list (Appendix Table I).

Here is the formula used in the conversion of the gravity by the Table .

$$\sigma_{15} = (g - g') m + 1.0260$$

g is the standing density; g' is the density of the standard sea water at t °C obtained from this Table; m is a multiplier obtained from the Table; and 1.0260 is constant.

- (2) Determination of dissolved oxygen -- Winker's method.
- (3) Method of getting Cl (‰), S (‰) from the Density -- the relations among the Density, Cl and S can be known from Knudsen's table (Appendix, Table II). The values of Chlorinity and Salinity in this report are obtained from

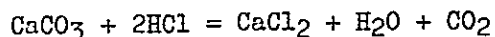
this Table. Although the determination of Chlorine by means of the AgNO_3 solution is no doubt accurate, it is not used here. The relation between Chlorinity and Salinity is given by Knudsen in the following formula.

$$S = 0.030 + 1.8050 \text{ Cl}$$

S is Salinity; Cl is Chlorinity.

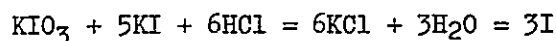
(4) Determination of Alkalinity -- The fixed quantity of carbonic acid and carbonate in the sea water, called "the determination of Alkalinity" was formerly indicated with the milligram of CO_2 or CC but is now indicated with the mg/atom/L or milli-equiv/L of HCL which is necessary for the neutralization of carbonate. The following is the method of determination. The carbonate of Ca is determined by the following method, as it does not show the color reaction.

Add HCl to the water containing CaCO_3 , and HCl neutralized by CaCO_3 diminishes in quantity.



Measure this decrease of HCl by means of Iodine method. This is called the determination of E. Ruppin, and is chiefly used for the determination of the sea water.

First, add a certain amount of HCl to a certain amount of the water, and after removing CO_2 by boiling it, potassium iodide and potassium acid iodide are to be added. Then I, equivalent to the amount of HCl remaining in the water, will be separated through the following reaction, and it is to be titrated.



(a) Reagent

- (i) N/20 HCl
- (ii) N/20 KIO_3 Dissolve 1.784 g. of KIO_3 into distilled water, making it 1 liter.
- (iii) Dissolve 10 gr. of pure KI into distilled water, making it 100 CC, and store it in the dark.

(iv) N/10 $\text{Na}_2\text{S}_2\text{O}_3$

(v) 1 % starch solution

(b) Operation

Take 100 CC of the sea water into a hard flask, and 1.5 CC of N/20 HCl to this, and after removing CO_2 with a few minutes boiling, cool it until it becomes of the same temperature as that in the room. Then, add 7.5 CC of N/20 KIO_3 and 5 CC of 10% KI, sealing it up and keeping it in the dark place for more than ten minutes, and I will be separated. Use starch solution for the indicator, and titrate it with N/10 $\text{Na}_2\text{S}_2\text{O}_3$.

(c) Calculation

If X CC of N/10 $\text{Na}_2\text{S}_2\text{O}_3$ was necessary,

$$\text{CO}_2 \text{ par 1 L.} = X \times 2.2 \text{ mg} \times 10$$

(5) Determination of plankton

(a) Balance of plankton

Samples fixed by formalin (about 4 - 5% neutral formalin) are collected and balanced through the following process (Fig. 2).

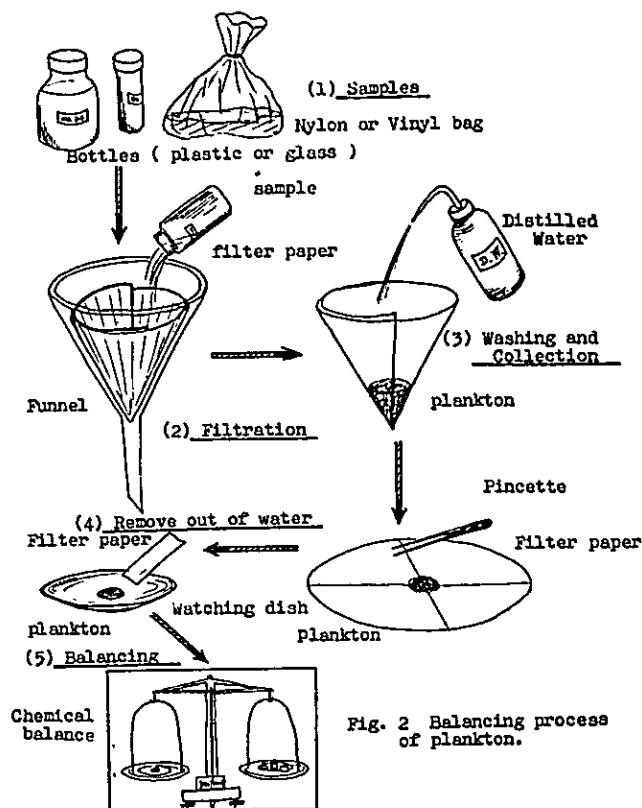


Fig. 2 Balancing process of plankton.

In filtering the samples fixed by formalin, the plankton left on filter paper should be from time to time washed down with distilled water so as to make it gathered at the bottom. It must be done immediately after filtering the water, for after it gets dry, plankton will be stuck to filter paper and won't come off. Twenty or thirty minutes later, open filter paper and, picking up the gathered plankton very carefully and quietly, remove it onto the watch dish. Then by press a piece of filter paper to the gathered plankton, remove water out of it, and weigh it with the micro-balance. (Weigh it together with the plate, and later deduct the weight of the plate.)

- (b) The method of determination of the individual number.

As for plankton, even among the same species, the size varies with the growth and the degree of reproduction, (sometimes it is influenced by the environment of water), so it is almost impossible to convert its number into quantity. It must be remembered that, if it done, there will be an error to a great extent,

(c) Measurement of the volume of plankton

Put the collected plankton into the mes-cylinder, and the amount of plankton precipitated after certain hours will be the whole volume. What we have to have in mind this method is that the error in the volume will be produced by the specific gravity of the sea water, by the difference in sedimentation verocity among the different species of zoo- and phyto-plankton, and also by the varieties of aperture during the precipitation caused by the different sizes of the species. Measurement must be done, therefore, taking these things into consideration.

Another method is to precipitate plankton by centrifugal separation and measure its volume. It is convenient, in this method, to convert the centrifugal, the volume, and the wet-weight beforehand.

(d) Determination of organic nitrogen in plankton.

This is the most accurate method to measure the quantity of plankton, and is generally used in Japan.

- (i) Filter the samples fixed by formalin, and then remove formalin.
- (ii) Wash plankton several times with distilled water.
- (iii) Reverse the filter paper, and pour plankton gently into the Kjeldahl's decomposition bottle with distilled water.
- (iv) Add concentrated sulfuric acid three to ten times as much as the amount of the sample (sometimes use catalyser) and boil it from ten to twenty hours.
- (v) Taking a certain amount of this liquid,

make it gasified ammonia by Kjeldahl's distilling method, and put it into the precise normal solution of HCl. Titrate it with N/100 Na₂S₂O₃, using starch solution as the indicator. The above is a rough summary of the operation, and the details will be obtained in the chemical books.

The author himself has determined the quantity by the balancing method (a).

B. RESULTS

Comparison between the dry season (May 20, 21, 1963) and the rainy season (October 1, 2, 1963) was the chief object of this survey.

1. THE OBSERVATIONS AT THE STANDING POINT. (AT ST. I)

(1) Atmospheric temperature and water temperature.

The results are shown in the Table 7, Table 8, and Fig. 3. In the dry season atmospheric temperature in the daytime is usually over 30°C, which occurs less often in the rainy season.

Time		a.m.		p.m.			Mean Tem.		
		5:30	8:00	11:00	14:00	18:00		20:30	
Dry season May 21, 1963	A.T. (°C)	26.4	28.5	30.8	31.4	29.8	28.9	29.3	
	W.T. (°C)	Depth (m)							
		0	28.4	28.9	29.6	29.5	28.9	29.0	29.1
		5	28.6	28.9	29.0	29.0	29.1	29.1	29.0
		10	26.4	26.7	26.8	26.7	26.3	26.9	26.6
	15	24.9	25.0	24.8	25.1	24.9	25.3	25.0	

Time		5:30	a.m. 8:00	11:00	14:00	p.m. 18:00	20:30	Mean Tem.
A.T. (°C)		24.8	28.9	29.6	29.5	28.9	29.0	29.1
W.T. (°C)	Depth (m)							
	0	28.4	28.4	29.0	29.2	28.3	28.5	28.6
	5	29.0	29.1	29.1	29.2	29.1	29.1	29.1
	10	28.8	28.9	29.0	29.0	28.8	28.9	28.9
	15	28.8	28.4	28.0	28.0	28.1	28.6	28.3

Table 7. Atmospheric temperature (A.T.) and Water temperature (W.T.).

	A.T. (°C)	W.T. (°C)				Devia- tion (°C)
		0 m.	5 m.	10 m.	15 m.	
Dry season	29.3	29.1	29.0	26.6	25.0	± 4.1
Rainy season	27.4	28.6	29.1	28.9	28.3	± 0.8

Table 8. Average A.T and average W. T.

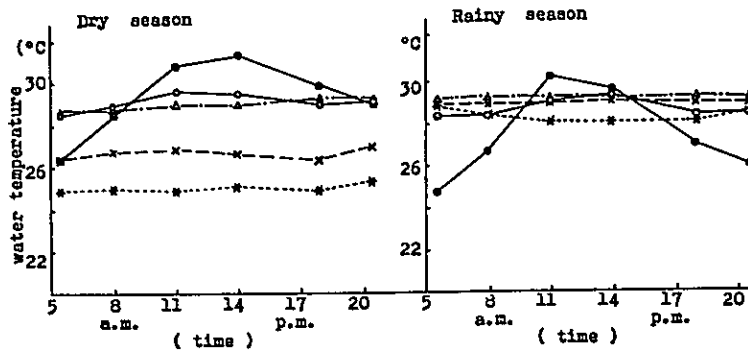


Fig.3 The relation between the depth and the water temperature at St. I.

The average temperature of the dry and the rainy seasons was respectively 29.3°C and 27.4°C , and the difference between them was about 2°C .

In both the dry and the rainy seasons, the water temperature is found to have a tendency of falling according as the water gets deeper. But, compared with the rainy season, this tendency is more remarkable in the dry season. The difference of temperature by about 4°C was recognized between the surface and the 15 m. layer. As the water mass between the surface and the 5 m. layer shows nearly the same degree with the average atmospheric temperatures, it is considered that the water temperatures suddenly falls under 5 meters. In the rainy season, however, the water temperature from the surface to the 15 m. layer was higher than the average atmospheric temperature, and the average difference of water temperature was very small -- 0.8°C .

The water temperature in the early morning is higher than the atmospheric temperature. This shows the keeping-warm quality of the sea water.

The fact that the difference in the water temperature between the surface and the 15 m. layer varies with the seasonal change, i.e. 4.1°C in the dry season, and 0.8°C in the rainy season, has a great influence upon the vertical distribution of plankton, which will be mentioned in the later chapter.

It means that the circulation between the surface and the underlying water is not easily done in the dry season, and that, accordingly, the distribution of plankton varies in quality and quantity with the different depths of the water. In the rainy season, on the contrary, the circulation is easily done, and so it is supposed that the plankton is almost equally distributed throughout. The temperature of the surface water was found to fall in some degree at sunrise and after sunset. This shows that the surface water is likely to be influenced by the atmospheric temperature.

As for the change from the dry to the rainy season in the average difference of water temperature, it will be explained that the temperature which has been falling during the rainy season of the preceding year, rises on and near the surface in summer (i.e. the dry season) because of the strong sunshine, while in the rainy season the sunshine is weak, and the surface water and the underlying water become easily mixed because of the wind and the rain.

(2) Dissolved oxygen.

The amount of dissolved oxygen obtained at the different hours at each depth at the same standing point, and also the average amount of oxygen at each depth, are shown in the Table 9.

Depth	0 m.		5 m.		10 m.		15 m.	
	D.S.	R.S.	D.S.	R.S.	D.S.	R.S.	D.S.	R.S.
5:30	4.39	4.49	4.37	4.34	4.53	4.28	-	-
8:00	-	4.42	-	4.28	-	4.35	-	4.28
11:00	4.49	4.35	4.60	4.49	4.72	4.21	4.69	4.28
14:00	4.37	-	4.23	4.42	4.57	4.35	4.48	4.21
18:00	4.47	4.35	-	4.40	4.70	4.35	4.57	4.42
20:30	4.36	4.56	4.61	4.28	4.61	-	4.61	4.35
Mean Oxygen (cc/L)	4.42	4.44	4.47	4.37	4.63	4.31	4.59	4.31

Table 9. Dissolved oxygen at each depth at the same station (St. I)

It was known from this Table that the amount of dissolved oxygen at the same depth on the same day changed in some degree as the time goes on.

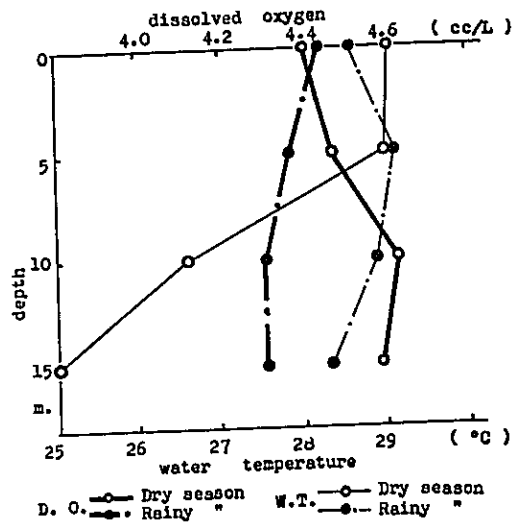


Fig. 4 The relation among the Dissolved Oxygen, Water Temperature and Water Depth at the same station (St. I).

In the Figure 4. are shown the average amount of dissolved oxygen at a certain depth on a certain day, and also its comparison with that of different depths and with the average water temperature.

This figure shows that the average amount of dissolved oxygen at each depth is greater in the dry season than in the rainy season. That is, in the rainy season, the amount of oxygen decreases as the water becomes deeper, and reaches the constant value (4.3 cc/L) at the depth of 10 - 15 meters, while, in the dry season, it conversly shows the tendency of increasing, and gets the constant value 4.5 cc/L also at the depth of 10 - 15 meters.

In both season, however, the amount of oxygen of the surface water is about the same, and the fact is common to both that at the 10 - 15 m. layer, there is not a sudden change in the amount but the value is almost constant.

In order to explain the difference of the two seasons, water temperature may be considered as one of the factors. In the dry season a sudden fall of water temperature under 5 meters was observed. This may mean that at the lower depth than 5 meters, the amount of dissolved oxygen increases, for it is known that the lower is the temperature, the greater is the amount of the oxygen in the water. This was proved by observation.

In the rainy season, having no sudden changes of water temperature and the water being mixed, not much difference was observed between each layer, but the amount of dissolved oxygen was seen to decrease gradually, from the surface to the 10 m. layer. This may be because the water of this season is muddy (whose transparency is small, probably owing to the influence of the rivers), and may have some relation to the consumption of oxygen by microbes and organisms, which are the cause of the mudiness of the water.

(3) Transparency

The transparency at the Station I. inside Nhatrang Bay was 13.5 - 14.0 Meter in the dry season, while in the rainy season it was 5.5 - 8.0 m., which was much lower than the other. The particles of mud carried by the rivers are considered to be the cause of this phenomenon. In Nhatrang Bay, the influence of mud carried by the rivers was observed one or two days after the rainfall, and the gradual change of the sea water from deep blue to muddy yellow was seen with the naked eye. Recovery of transparency generally takes 5 - 7 days, but in the rainy season, owing to the constant rain at the upper streams, recovery is either very slow or does not take place at all.

(4) Alkalinity

The average alkalinity in the dry and the rainy seasons at the Station I. was 35 and 50 mg/L respectively (as to the surface water). The values of alkalinity of the surface and of the 15 m. layer water are almost the same in the dry season, but in the rainy season, alkalinity of the surface water and that under the 5 m. layer differ in value. This is because on the surface is the sea water with the lighter (specific gravity) density (influenced by the rivers), and these two masses can be distinguished. The Table 10. shows alkalinity of the surface and at the 15 m. layer, and the Figure 5, the change of alkalinity within a day during the

rainy season.

(unit mg/L)

	Surface Water	15 m. layer Water
Dry season	35	35
Rainy season	45.8 - 55	35

Table 10. Alkalinity of the surface and at the 15 m. layer

From this Figure may be known the difference in the quality between the water mass of the surface and that under the 5 m. layer.

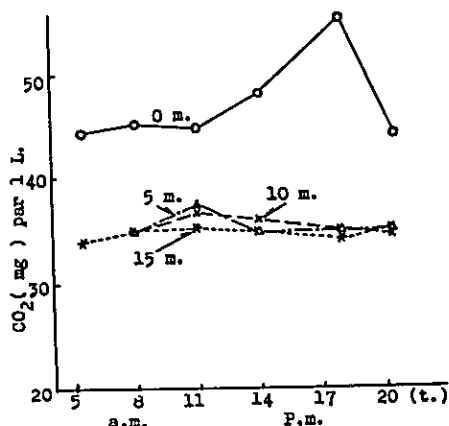


Fig. 5 The change of alkalinity within a day during the rainy season.

(5) Density

The Table 11. shows the density of the surface water and the 15 m. layer water, in both the dry and the rainy seasons. The density of the sea water (15) usually lies between 1.0000 and 1.0310. It is known from this Table that the densities of the surface and of the 15 m. layer are nearly

the same in the dry season, but that in the other season the difference is very great.

	Surface Water (σ_{15})	15m. layer Water (σ_{15})
Dry season	1.0250 - 1.0274	1.0265 - 1.0275
Rainy season	1.0180 - 1.0190	1.0265 - 1.0270

Table 11. Density at the same station.

As in the case of alkalinity, this is undoubtedly by the influence of the rivers in the rainy season - i.e., inflow of the fresh water, and it is proved that in the rainy season there lie two water masses of the different qualities, on and under the surface.

(6) The yield of plankton

When an investigation was made as to the amount of plankton living in Nhatrang Bay, in the water with the above qualities, the results obtained were as shown in the Figure 6. It shows the vertical and the horizontal plankton biomass at each hour in both seasons by g/m^3 , which was obtained through the night and day observations at a standing point (St. I).

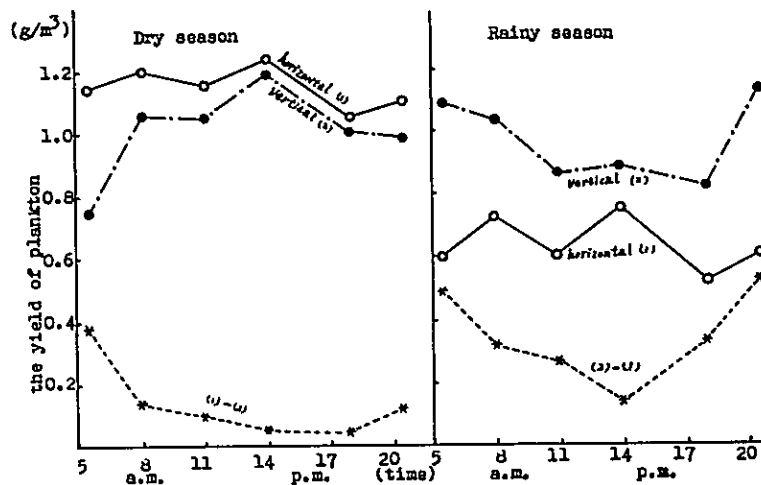


Fig. 6 The plankton biomass at the same station (St. I) on one day.

Comparing these two seasons, it is seen that the vertical and the horizontal plankton biomass is greater in the dry season, and that the difference between the two (i.e. the vertical biomass and the horizontal biomass) is also smaller then. For in the dry season the average horizontal plankton biomass was 1.15 g/m^3 and the vertical biomass 1.01 g/m^3 , the difference being only 0.14 g/m^3 , while in the rainy season the average horizontal biomass, 0.97 g/m^3 , the vertical biomass 0.63 g/m^3 , and so the difference was 0.34 g/m^3 . In this case, contrary to the dry season, the vertical biomass was greater than the horizontal one. Thinking about this difference, it is considered that in the rainy season the fresh water of the small (light) density covers the surface, (because there alkalinity is found to be greater and the density, smaller), which makes the water unsuitable for the existence of plankton, and consequently brings about the poor yield.

Through the observation of the change in the plankton biomass collected at certain time, a big difference was recognized in both seasons between the vertical and the horizontal yield before sunrise and after sunset (Fig. 6). The vertical distribution rate of plankton in the surface water and the under layer water is designated in the Table 12. in percentage.

	layer (m)	(Time)						mean %
		5:30	8:00	11:00	14:00	18:00	20:30	
D.S.	0 - 1	60	53	52	51	51	53	55
R.S.	0 - 1	35	41	41	46	38	35	39
D.S.	1 - 10	40	47	48	49	49	47	45
R.S.	1 - 10	65	59	59	54	62	65	61

Table 12. The vertical distribution rate of plankton at the same station on one day. (D.S.--Dry season; R.S.--Rainy season)

The average rate of the horizontal distribution in the surface water (0 - 1 m.) was 55 % in the dry season, and 39 % in the rainy season. The reason why it is lower in the latter is that the environment is not fit for plankton because of the inflow of the fresh water. In both seasons, however, the amount of plankton inhabiting the surface water between 0 - 1 m. was found through this table to be much greater than that inhabiting the lower part.

2. THE OBSERVATIONS IN NHATRANG BAY AND IN THE OPEN SEA

Here is the results of the survey in the dry season (May 20) and in the rainy season (Oct. 1), at the ten stations. Hon Lon (Lon Island) is the principal one, in Nhatrang Bay and the open sea.

(1) Wind verocity

Dry season ----- south or south-west wind.
 Rainy season ----- north or north-east wind.

(2) Atmospheric temperature and water temperature. The results are shown in the Fig. 7.

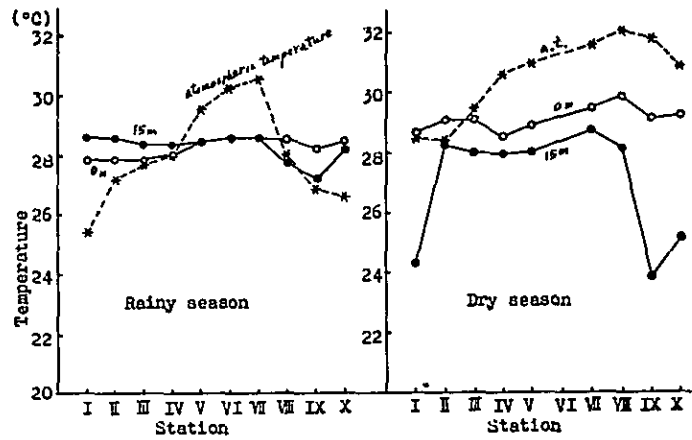


Fig.7 Atmospheric temperature and Water temperature at each Station.

The average atmospheric temperature was 30.4°C in the dry season, and 27.9°C in the rainy season, the difference being 2°C which is nearly the same with the difference of temperature observed at the standing point, mentioned earlier.

The average water temperature of the surface was 29.1°C in the dry season, and 28.2°C in the rainy season. At the 15 m. layer it was 27.0°C , and 28.25°C respectively.

The temperature of the surface water is higher in the dry season than that in the rainy season, while with the 15 m. layer it is conversly higher in the rainy season. This may be explained that, in the rainy season as the comparative temperature of the water is high, the temperature of the surface water gradually falls under the influence of the atmospheric temperature, while that of the under layer rises, influenced by the high temperature of the surface water.

(3) Dissolved oxygen

The amount of dissolved oxygen obtained through the survey at each station is shown in the Figure 8.

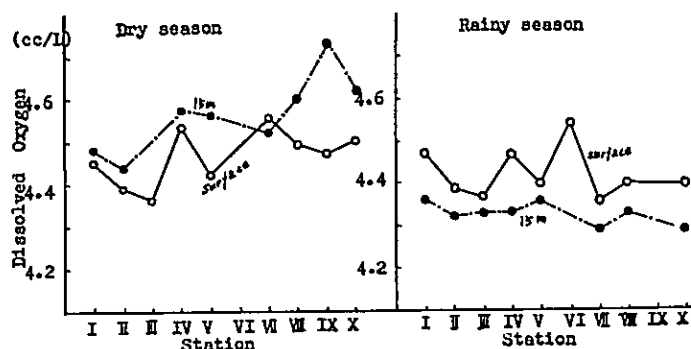


Fig.8 Dissolved oxygen at each station.

In the dry season, the average amount of oxygen was 4.46 cc/L with the surface water, and 4.56 cc/L with the 15 m. layer. In the rainy season, it was respectively 4.42 cc/L and 4.33 cc/L.

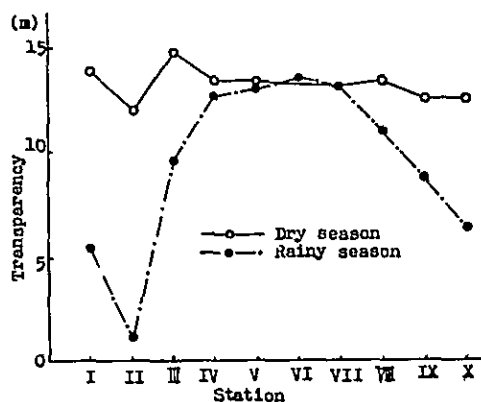
There is a great variety in the amount of dissolved oxygen with the surface water, the cause of which seems to be the waves on the surface. (The sample was taken with Kitahara's apparatus at 0.3 m. level from the surface.)

From this may be concluded that there is little difference in the amount of dissolved oxygen in the surface water, between the dry and the rainy seasons, though, with the 15 m. layer, the difference does exist, its amount of oxygen surpassing that of the surface water in the dry season and vice versa in the rainy season. This is an interesting fact in the light of the above-mentioned water temperatures. (As stated before, it is a general rule

that the lower is the water temperature, the greater is the amount of dissolved oxygen.)

(4) Transparency

The Figure 9. shows the transparency in Nhatrang Bay and in the open sea both in the dry and the rainy seasons. It was known from this Figure that the transparency of both seasons greatly differs one another.



Transparency in the dry season was from 12 m. to 14.7 m. The station II showed the lowest value of all in this season, probably because it was near the estuary and so had the influence of the turbidity of the river. Meanwhile, in the rainy season, transparency differed at each station, and here again the St. II showed 1.2 m., which was the lowest throughout both seasons, probably influenced by the rivers again. St. I, II, III and VIII, IX, X had the lower transparency than that in the dry season, but St. IV, V, VI, VII showed 13 m., which is nearly the same with the dry season.

It is concluded from this that at the St. IV, V, VI, VII in the open sea transparency is almost constant throughout the two seasons. But at every station inside the Bay is found the strong influence of the rivers, and this influence is seen to decrease as we get nearer to the open sea, accompanying the growth in transparency.

(5) Alkalinity

Through the measurement of alkalinity can be obtained the amount of carbonic acid in the sea water, which of course

has much relation to photo-synthesis, i.e. the growth of phytoplankton.

Alkalinity of the surface water and of the 15 meter layer in the dry season was from 30 to 37 mg/L, the under layer having the tendency of being greater. In the rainy season, as shown in the Figure 10, the difference in the value of alkalinity between the surface and the 15 m. layer is apparent. Alkalinity of the 15 m. layer water had nearly the constant value of average 35 mg/L, while with the surface water, excluding the St. VI, VII, VIII in the open sea where the value is comparatively stable (about 35 mg/L), high alkalinity was found at every station. Especially at the St. II near the estuary, the highest value of 53 mg/L was obtained. This is reverse to the case of transparency, but the cause may be the same -- the influence of the turbidity of the rivers.

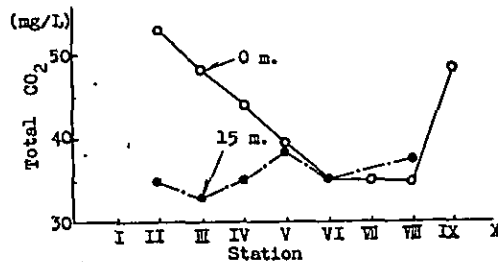


Fig.10 Alkalinity at each station in the rainy season.

(6) Density and Chlorinity

The difference between the surface water and the under layer water, which was mentioned before in relation to the influence of the rivers, was also confirmed through the measurement of the density of the sea water. As is shown in the Figure II, there exists between then an apparent difference in quality. Besides, different water masses were found in the dry and the rainy seasons.

In the dry season, Density (σ_{15}) of the surface water was 1.0267 - 1.0274, while in the rainy season the nearer to the estuary was the station in the Bay, the lower was the value of density, and at the St. II which was the nearest to the river; it was 1.0183. The value grows higher as the

station gets nearer to the open sea where (Sts. VI, VII, VIII, IX) it had a constant value of about 1.0265. As to the 15 m. layer water, ρ_{15} was 1.026 - 1.0269 throughout all researching areas, so the water mass was found to have nearly a constant value, without any influence, it seems, from the rivers or the fresh water.

The values of Chlorinity and Salinity calculated from ρ_{15} shown in the Table 13. and the Figure 12, are as in the case of density, high in the open sea, and in the Bay was found a strong influence of the rivers. It has been proved from these results that there exist apparently different water masses in the dry season and in the rainy season, and that in the rainy season the surface water and the underlying water (15 m. layer) differ in quality.

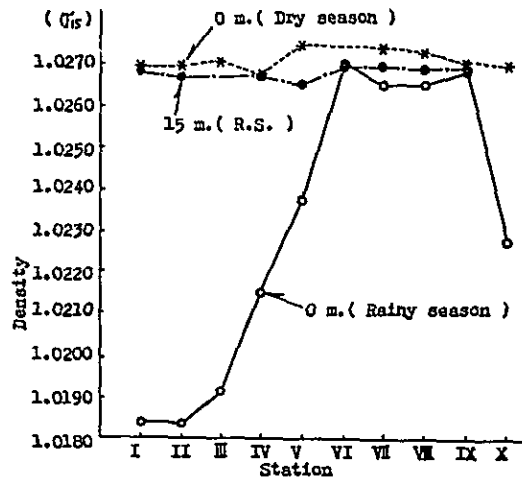
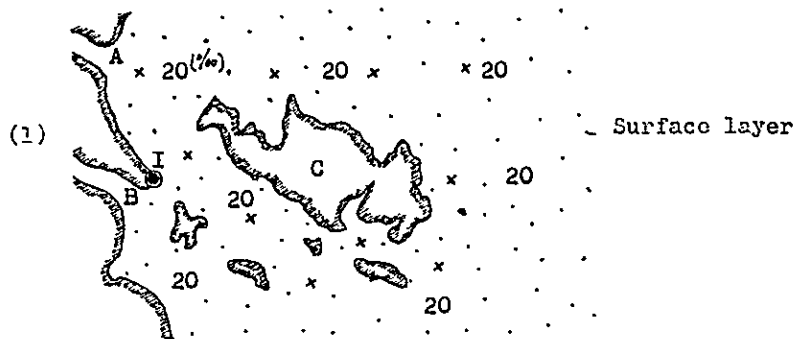


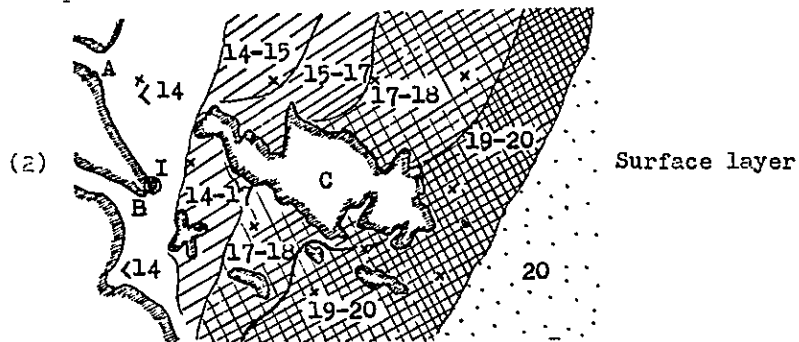
Fig.11 Density at each station.

Station	Season	Depth (m)	Density (15)	Chlorinity (‰)	Salinity (‰)
I	D.S.	0	1.0270	20.08	36.27
	"	15	1.0275	20.08	36.27
	R.S.	0	1.0185	14.00	25.30
	"	15	-	19.90	35.95
II	D.S.	0	1.0269	20.08	36.27
	R.S.	0	1.01835	13.86	25.04
	"	15	1.0267	19.86	35.88
	D.S.	0	1.0270	20.11	36.33
III	R.S.	0	1.0191	14.40	26.02
	"	15	-	-	-
IV	D.S.	0	1.0267	19.86	35.88
	R.S.	0	1.0215	16.13	29.14
	"	15	1.0267	19.86	35.88
V	D.S.	0	1.0274	20.39	36.83
	R.S.	0	1.0237	17.73	32.03
	"	15	1.0265	19.74	35.66
VI	D.S.	0	-	-	-
	R.S.	0	1.0268	19.96	36.06
	"	15	1.02695	20.07	36.26
	D.S.	0	1.0273	20.32	36.71
VII	R.S.	0	1.02645	19.70	35.59
	"	15	1.0269	20.08	36.27
VIII	D.S.	0	1.0272	20.25	36.58
	R.S.	0	1.02645	19.70	35.59
	"	15	1.0268	19.96	36.06
	D.S.	0	1.0269	20.08	36.27
IX	R.S.	0	1.0267	19.86	35.88
	"	15	1.0268	19.96	36.06
X	D.S.	0	1.0269	20.08	36.27
	R.S.	0	1.0227	17.00	30.72
	"	15	-	-	-

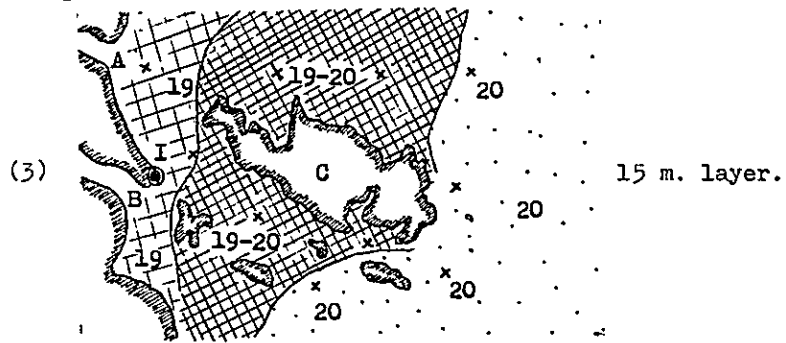
Table 13. Density, Chlorinity and Salinity at each station



Chlorinity (‰) in the dry season, in Nhatrang Bay and the open sea.



Chlorinity (‰) in the rainy season, in Nhatrang Bay and the open sea.



Chlorinity (‰) in the rainy season, in Nhatrang Bay and the open sea.

Fig 12. The variation of chlorinity in the dry season and the rainy season, in Nhatrang Bay and the open sea,
 (A -- Cai River; B -- Cua Be River; I C -- Lon Island
 I -- Oceanographic Institute of Nhatrang
 x -- Researching Station)

(7) Plankton biomass

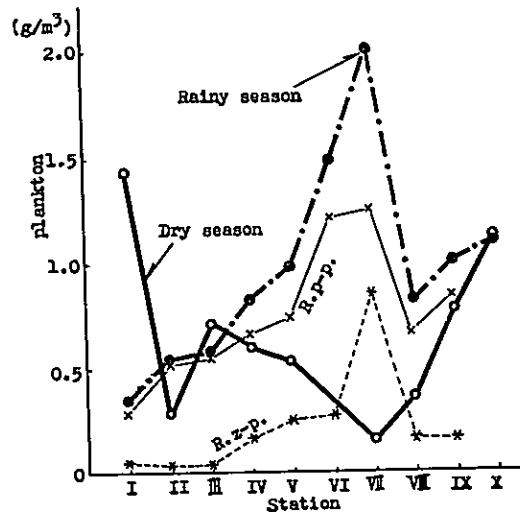


Fig. 13 The quantity of plankton in the dry and rainy season at each station.

R.p-p. shows Phyto-plankton of the rainy season.
 R.z-p. shows Zoo-plankton of the rainy season.

Station	I	II	III	IV	V	VI	VII	VIII	IX	X
Dry season	1.42	0.28	0.7	0.59	0.52	0.32	0.15	0.37	0.77	1.12
Rainy season	0.35	0.55	0.59	0.82	0.98	1.48	2.01	0.82	1.0	1.10

Table 14. Total plankton biomass in the dry and rainy season at each station in the Nhatrang (Bay and the open sea). (Unit shows g/m^3)

Figure 13 and Table 14 shows plankton biomass in the dry and rainy season at each station by the wet weight (g/m^3)

The plankton biomass in the dry season ranged between 0.15 and 1.42 g/m³, higher in the Bay (St. I, II, III, X) and decreasing towards the open sea (St. V, VI, VII). The maximum in the dry season was 1.42 g/m³ at St. I and the minimum, 0.15 g/m³ at St. VII. On the other hand, in the rainy season, the plankton biomass was within a range of 0.35 to 2.01 g/m³, higher in the open sea (St. V, VI, VII) and decreasing towards the Bay. The maximum in that season amounted to 2.01 g/m³ at St. VII as against the minimum of 0.35 g/m³ at St. I.

Further, it turned out that the mean plankton biomass total mean plankton biomass up to 15 km from the beach) in the dry and rainy seasons was 0.56 g/m³ in the case of dry season as against 0.97 g/m³ in the rainy season or 1.8 times as high as the value in the dry season.

As above, it became apparent that plankton biomass in Nhatrang Bay and open sea presented the relations completely reversed in the dry and rainy seasons. To bring to light the cause of such relations, the environmental factors at the respective survey stations as mentioned above were taken up and the data averaged per Bay (St. I, II, III, X) and open sea (St. V, VI, VII) were compared with plankton biomass, the result of which is shown in the Table 15.

Season		Bay I, II, III, X		Open sea V, VI, VII	
		Dry	Rainy	Dry	Rainy
Plankton biomass		0.88g/m ³	0.65g/m ³	0.33g/m ³	1.49g/m ³
Water Temperature (°C)	Surface	29.0	27.95	29.1	28.5
	15 m	26.4	28.45	28.35	28.5
Oxygen (cc/L)	Surface	4.33	4.35	4.38	4.33
	15 m	4.40	4.22	4.43	4.22
Transparency		13.2 m	5.6 m	13.15 m	13.13 m
Alkalinity CO ₂ (mg/L)	Surface	-	50.05	-	36.5
	15 m	-	34.0	-	36.5
Chlorinity (‰)	Surface	20.09	14.81	20.35	19.13
	15 m	20.0	19.87	20.0	19.96
Salinity (‰)	Surface	36.29	26.76	36.76	34.56
	15 m	36.13	35.89	36.13	36.06

Table 15. Average plankton biomass and the environmental conditions in the dry and the rainy seasons in Nhatrang Bay and the open sea.

In the above Table, the mean measured values in the 15 cm layer were added for information only and the mean values for the surface layer only come into question in this case.

In the dry season, the mean plankton biomass in the Bay is 0.88 g/m^3 or about 2.7 times as high as the case of open sea (0.33 g/m^3). If the environmental conditions are examined to account for the cause of the above mentioned water temperature, dissolved oxygen and transparency represent similar values for both Bay and open sea while chlorinity (as well as salinity) is higher in the open sea, but these cannot be considered as the major factors affecting plankton biomass and it is assumed that the increase of Bay plankton in the dry season may be due to the quantity of organic matter which was not measured in that case, but might be increasing towards the beach.

On the other hand, the mean plankton biomass in the rainy season is 0.65 g/m^3 in the Bay as against 1.49 g/m^3 in the open sea, that is, the biomass is about 2.3 times higher in the open sea as compared with the case of Bay. The environmental conditions in that case were as follows:

(a) The water temperature in the Bay is 0.5°C lower on an average as compared with that of open sea. (b) In respect of oxygen, it may be said that little difference exists between the Bay and the open sea in the surface layer. (c) Transparency in the Bay is 5.6 m or more than 1/2 lower than in normal cases. (d) Alkalinity in the Bay is 50.05 which is pretty high as compared with the open sea (36.5) and indicative of the existence of large volume of organic matter in course of decomposition. (e) Chlorinity is ordinarily about 20 ‰ (Salinity: 35 - 36 ‰), but the mean value in the Bay is 14.81 ‰ (Salinity: 26.76 ‰) which represents a considerable decrease. It became apparent from the above that in the rainy seasons, the environmental conditions in the surface layer of the Bay are different from those of the sea water at normal times. This is definitely due to the influences by the two rivers (Cai and Cua-Be Rivers) flowing into Nhatrang Bay. On the other hand, chlorinity in the open sea is about 0.9 ‰ lower as compared with ordinary times, which, however, may be considered to be approximately equivalent to the environmental condition in the dry season.

Such being the case, in the rainy season, plankton decreased in the Bay whose environmental conditions were inappropriate for plankton to live in, but multiplied in the open sea whose environmental conditions were similar to those of the Bay in the dry season. That is to say, it can be considered that the plankton production in the Bay moved towards the open sea.

As to why the mean plankton biomass in the open sea in the rainy season surpasses that of the Bay in the dry season, a conclusion may be drawn that the influences of the river are controlling also in that case.

Total average plankton biomass (from beach to 15 km)		Ratio of plankton biomass
<u>Dry season</u> 0.56 g/m ³	<u>Rainy season</u> 0.97 g/m ³	<u>Rainy season/Dry season</u> 1.8
Maximum of the average plankton biomass in Nhatrang		Ratio of plankton biomass
Bay (Dry season) 0.88 g/m ³	Open sea (Rainy season) 1.49 g/m ³	Rainy season/Dry season 1.7

Table 16 Ratio of plankton biomass between the dry and the rainy seasons in Nhatrang bay and the open sea.

As indicated in Table 16, the ratio of mean plankton biomass between the dry and the rainy seasons in Nhatrang is 1.8 with the rainy season representing a higher value. As described above, the ratio between the maximum plankton biomass observed in the Bay and that in the open sea is higher in the rainy season or 1.7, which is near the former ratio of 1.8. From this, it is assumed that dissolved organic matter transported by the river water in the rainy season brought about a result in favor of the multiplication of plankton.

Finally, the distribution of plankton biomass in Nhatrang (including the Bay and the open sea) is summarized in Fig. 14.

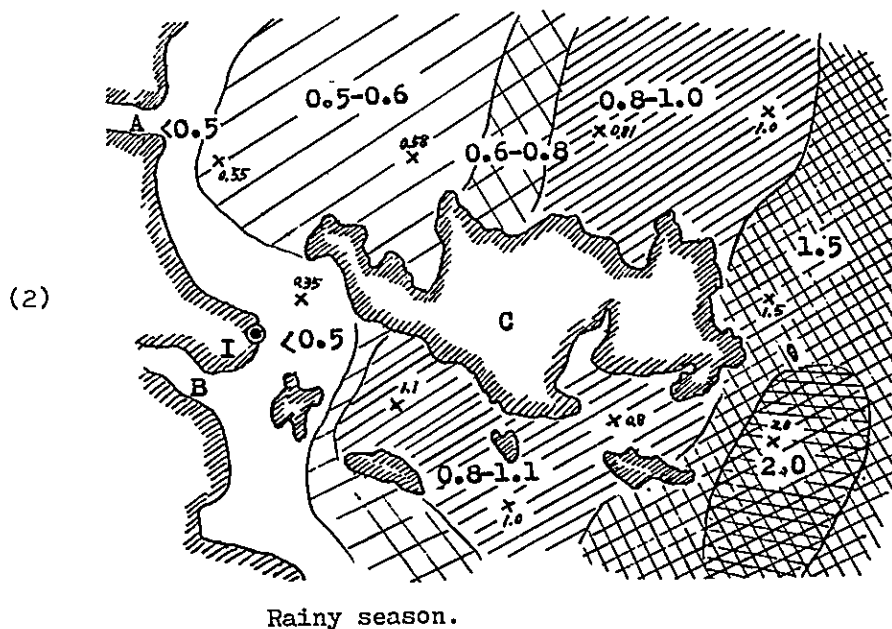
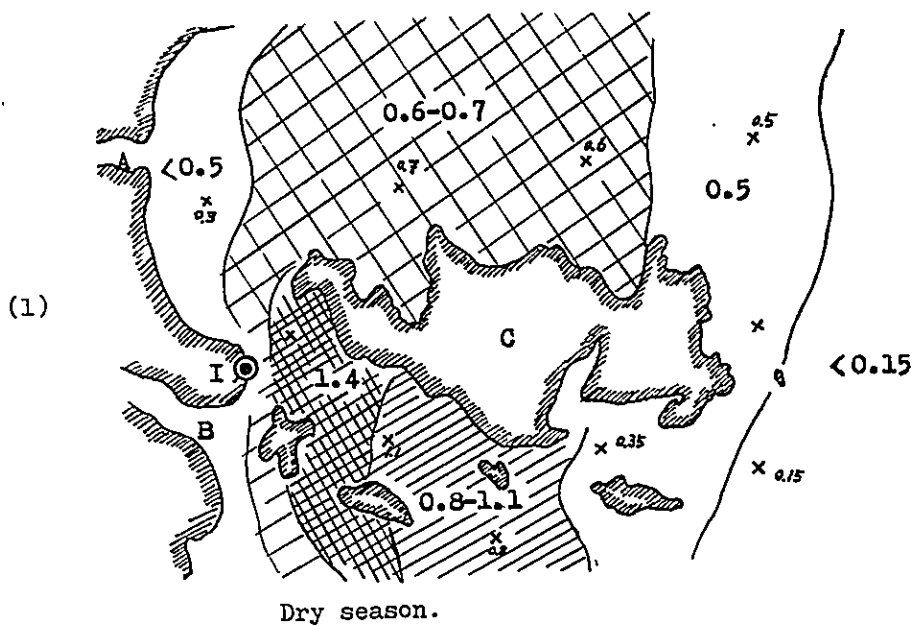


Fig. 14 The distribution of plankton in Nhatrang Bay and the open sea, in the dry and the rainy season. A-- Cai River; B -- Cua Be River; C-- Hon Lon; Number shows the quantity of plankton (g/m^3).

In the meantime, the result of measurement of plankton biomass per zoo-plankton and phyto-plankton is as indicated in dotted lines in Fig. 13, which is listed in terms of percentage in the following Table 17 which indicates that phyto-plankton is larger in quantity than zoo-plankton in both the Bay and the open sea, with zoo-plankton showing a tendency of slight increase in the open sea than in the Bay.

	Station	I	II	III	IV	V	VI
Phyto-plankton	g/m ³	0.29	0.52	0.55	0.66	0.74	1.21
	%	85	94.5	95	80	76	82
Zoo-plankton	g/m ³	0.05	0.03	0.03	0.16	0.24	0.27
	%	15	5.5	5	20	24	18

	Station	VII	VIII	IX	X
Phyto-plankton	g/m ³	1.25	0.66	0.84	-
	%	59	80	84	-
Zoo-plankton	g/m ³	0.85	0.16	0.16	-
	%	41	20	16	-

Table 17 Ratio between zoo- and phyto-plankton at the respective survey stations (Rainy season)

C. SUMMARY AND CONCLUSION

As a result of survey made in the dry season (May) and the rainy season (October) of 1963 in Nha Trang (Central Viet-Nam) Bay and the open sea as well as the environmental conditions at the standing points, the author obtained the following conclusions:

1. The observations at the standing point in the Nha Trang Bay

The following conclusion could be drawn from the fixed-point/ fixed-time observation from 5:30 a.m. to 8:30 p.m. of the same day:

As a result of survey made by taking an example of St. I in the Nhatrang Bay, it was found that both water quality and plankton biomass were changing constantly.

As for the quantity of plankton, the horizontal biomass, in the dry season, was 1.15 g/m^3 and the vertical biomass 10 g/m^3 , the difference being very small, while in the rainy season, the horizontal biomass being 0.97 g/m^3 and the vertical biomass 0.63 g/m^3 , the difference was great compared with that of the dry season. Investigations into the cause were made through the analysis of the water, and the difference was found in the rainy season between the density of the surface water and that of the underlayer water. (In the dry season the density of both was nearly the same, and the density of the 15 m. layer water in the rainy season was about the same with that in the dry season.) The density of the surface water in the dry season was 1.0260-1.0274, while in the rainy season it showed very low values, 1.0180-1.0190. This means that there exists over the surface the fresh water flowing in from the rivers, and the difference of the quality of the surface water and the 15 m. layer water is considered to have influenced the growth of plankton, bringing about the difference in the yield.

2. The observations in Nhatrang Bay and in the open sea

(1) The mean surface water temperature in the Bay reached 29.0°C in the dry season and 27.95°C in the rainy season as against 26.4°C in the dry season and 28.45°C in the rainy season in the case of 15 cm layer. On the other hand, the mean surface water temperature in the open sea was 29.1°C in the dry season and 28.5°C in the rainy season as against 28.35°C in the dry season and 28.5°C in the rainy season in the 15 m layer.

Thus, it was found that the difference in water temperature between the surface and the 15 m layer was larger in the dry season than in the rainy season.

(2) In respect of the mean dissolved oxygen in the surface layer, similar values were recorded for both the Bay and the open sea (4.33 and 4.35 cc/L respectively), except that in the open sea in the dry season (4.38 cc/L). The corresponding values in the 15 m layer were 4.40 and 4.43 cc/L for the Bay and the open sea respectively in the dry season as against 4.22 and 4.22 cc/L in the rainy season.

(3) Transparency measured in the dry season was some 13.2

m in both the Bay and the open sea whereas it varied remarkably in the rainy season, that is, 5.6 m on the average in the Bay.

In the rainy season, especially soon after rainfall, transparency decreased in certain cases down to 1 m or less at St. II located near the river mouth in the Bay while in the case of open sea, even the transparency of 8 m was recorded at St. VII (observed in December).

(4) Alkalinity showed a result completely contrary to the case of transparency. That is, the alkalinity in the surface water showed a tendency of decrease from the Bay (50.05 on the average) towards the open sea (36.5 on the average). However, in the 15 m layer, little differences were observed between the Bay and the open sea.

(5) The density in the Bay and open sea in the dry season was approximately constant in both the surface and 15 m layers, that is, $\rho_{15} = 1.0270$. The sea water density in the rainy season was same in both the Bay (mean chlorinity: 20.0 ‰) and the open sea (mean chlorinity: 20.0 ‰). However, in the rainy season, the density in the surface water presented prominent variances similar to the case of transparency, that is, the minimum value of $\rho_{15} = 1.0183$ (Cl: 13.86 ‰, S: 25.04 ‰) was recorded especially near the mouth of river, and the tendency of increase in density towards the open sea, gradually approaching the normal condition in the dry season or $\rho_{15} = 1.0270$, was observed. In the meantime, the mean chlorinity in the surface layer of the Bay in the rainy season was 14.81 ‰, being quite different from that in the 15 m layer (20.0 ‰)

(6) The mean plankton biomass in Nhatrang is as follows:

Bay: 0.88 g/m³ in the dry season and 0.65 g/m³ in the rainy season.

Open sea: 0.33 g/m³ in the dry season and 1.49 g/m³ in the rainy season.

The mean plankton biomass in the Bay decreased gradually towards the open sea in the dry season, showing a value about 2.7 times as high as that in the open sea. As for the cause, it is considered that small quantities of filth from river, fish market and houses, etc. constantly flew

into the part of the Bay near the beach and exercised influences upon plankton.

On the contrary, in the rainy season, the plankton biomass in the open sea was about 2.3 times higher than in the Bay. This is considered to have been caused by the environmental conditions, especially chlorinity and alkalinity in the Bay which varied remarkably as compared with the normal conditions and as a result, plankton multiplied in the open sea presenting the similar (ordinary) environmental conditions as in the Bay in the dry season. That is to say, the plankton production in the Bay decreased with the worsening of environment while it increased in the satisfactory ordinary environment in the off-shore open sea.

In the meantime, within the range from the beach to the open sea (15 m), the mean plankton biomass in the dry and the rainy seasons was 0.56 g/m^3 and 0.97 g/m^3 respectively, that is, 1.8 times higher in the rainy season, while the maximum plankton biomass observed in the Bay and open sea was 0.88 g/m^3 (dry season) and 1.49 g/m^3 (rainy season), that is, 1.7 times higher in the rainy season, from which it can be concluded that the total plankton biomass increases in the rainy season as against the dry season. The cause of such increase is considered to be the dissolved organic matter conveyed by the rivers.

Based on the above conclusions, it can be said that the measurement of organic matter (nitrate, nitrite and ammonia) and phosphate, etc. will have to be made in future for further detailed examination.

D. APPENDIX TABLES

	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	h
15°C	26.00	25.98	25.95	25.93	25.91	25.88	25.86	25.84	25.82	25.79	1,000
16	25.77	25.75	25.72	25.70	25.68	25.65	25.63	25.61	25.59	25.56	1,003
17	25.54	25.52	25.49	25.47	25.45	25.42	25.40	25.38	25.35	25.33	1,005
18	25.30	25.27	25.25	25.22	25.20	25.17	25.14	25.12	25.09	25.07	1,007
19	25.04	25.01	24.99	24.96	24.94	24.91	24.88	24.86	24.83	24.80	1,009
20	24.78	24.75	24.73	24.70	24.68	24.65	24.62	24.60	24.57	24.54	1,011
21	24.52	24.49	24.47	24.44	24.41	24.39	24.36	24.33	24.30	24.28	1,013
22	24.25	24.22	24.19	24.16	24.13	24.10	24.08	24.05	24.02	23.99	1,015
23	23.96	23.93	23.90	23.87	23.84	23.82	23.79	23.76	23.73	23.70	1,018
24	23.67	23.64	23.61	23.58	23.55	23.53	23.50	23.47	23.43	23.40	1,020
25	23.38	23.35	23.32	23.29	23.26	23.23	23.20	23.17	23.14	23.11	1,022
26	23.09	23.06	23.03	23.00	22.95	22.93	22.90	22.87	22.84	22.81	1,024
27	22.78	22.75	22.72	22.68	22.65	22.62	22.59	22.56	22.53	22.50	1,026
28	22.46	22.43	22.39	22.36	22.33	22.29	22.26	22.23	22.20	22.16	1,027
29	22.13	22.10	22.06	22.03	22.00	21.95	21.93	21.90	21.87	21.84	1,029
30	21.80	21.77	21.72	21.70	21.67	21.63	21.60	21.57	21.54	21.50	1,031

Appendix Table I. The conversion table of marine density. (by Makalof)

$Cl(^{\circ}/_{oo})$	$S(^{\circ}/_{oo})$	σ_{15}	$Cl(^{\circ}/_{oo})$	$S(^{\circ}/_{oo})$	σ_{15}	$Cl(^{\circ}/_{oo})$	$S(^{\circ}/_{oo})$	σ_{15}
14.0	25.30	18.55	17.0	30.72	22.70	20.0	36.13	26.86
14.1	25.48	18.69	17.1	30.90	22.84	20.1	36.31	26.99
14.2	25.66	18.82	17.2	31.08	22.98	20.2	36.49	27.14
14.3	25.84	18.96	17.3	31.26	23.11	20.3	36.67	27.27
14.4	26.02	19.10	17.4	31.44	23.25	20.4	36.85	27.42
14.5	26.20	19.24	17.5	31.62	23.39	20.5	37.03	27.56
14.6	26.38	19.37	17.6	31.80	23.53	20.6	37.21	27.69
14.7	26.56	19.52	17.7	31.98	23.66	20.7	37.39	27.83
14.8	26.74	19.65	17.8	32.16	23.81	20.8	37.57	27.97
14.9	26.92	19.80	17.9	32.34	23.94	20.9	37.75	28.11
15.0	27.11	19.93	18.0	32.52	24.09	21.0	37.94	28.25
15.1	27.29	20.07	18.1	32.70	24.22	21.1	38.12	28.39
15.2	27.47	20.21	18.2	32.88	24.36	21.2	38.30	28.53
15.3	27.65	20.35	18.3	33.06	24.40	21.3	38.48	28.67
15.4	27.83	20.48	18.4	33.24	24.64	21.4	38.66	28.81
15.5	28.01	20.62	18.5	33.42	24.78	21.5	38.84	28.94
15.6	28.19	20.76	18.6	33.60	24.92	21.6	39.02	29.09
15.7	28.37	20.90	18.7	33.78	25.06	21.7	39.20	29.22
15.8	28.55	21.03	18.8	33.96	25.19	21.8	39.38	29.36
15.9	28.73	21.18	18.9	34.14	25.34	21.9	39.56	29.51
16.0	28.91	21.31	19.0	34.32	25.47	22.0	39.74	29.64
16.1	29.09	21.45	19.1	34.51	25.61	22.1	39.92	29.79
16.2	29.27	21.60	19.2	34.69	25.74	22.2	40.10	29.92
16.3	29.45	21.73	19.3	34.87	25.89	22.3	40.28	30.06
16.4	29.63	21.87	19.4	35.05	26.03	22.4	40.46	30.21
16.5	29.81	22.01	19.5	35.23	26.17	22.5	40.64	30.34
16.6	29.99	22.15	19.6	35.41	26.31	22.6	40.82	30.48
16.7	30.17	22.28	19.7	35.59	26.45	22.7	41.00	30.62
16.8	30.35	22.42	19.8	35.77	26.58	22.8	41.14	30.77
16.9	30.53	22.56	19.9	35.95	26.72	22.9	41.36	30.91

Appendix Table II. Knudsen's Table

CHAPTER VI. VARIATION OF CURRENTS AND MONSOON WINDS
IN THE SOUTH CHINA SEA

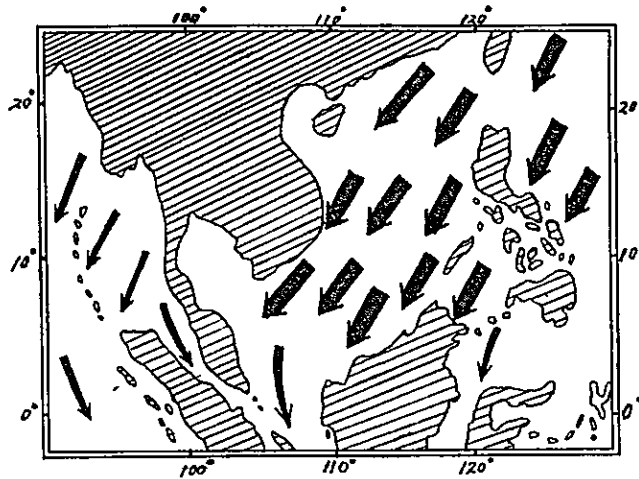


Figure 15 Northeast Monsoon Wind
 (October - March)
 (by the Naga report)

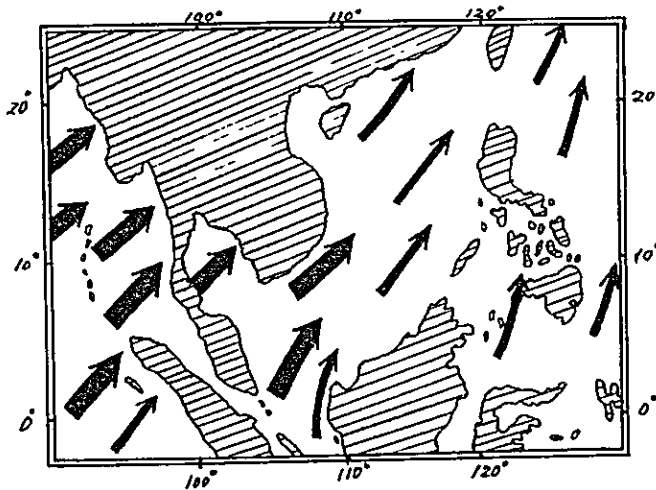


Figure 16 Southwest Monsoon Wind
 (May - September)
 (by the Naga report)

It seems to be very important to know the characters of the China Sea, which faces Viet-Nam; especially its currents, winds, salinity and the mutual relationships among them.

Therefore, in this chapter the results of Naga Expedition (1959 - 1961) is quoted as reference.

The character of the winds indirectly influences the life in the sea. Southeast Asia is dominated by two seasonal wind patterns; the northeast (Figure 15) and the southwest monsoon (Figure 16).

In summer the land mass, especially the area north of the Arabian Sea, is more heated than the sea and becomes a large, low-pressure area. This condition creates southwest monsoon winds, which generally blow from over the water toward the land or from the southwest. The stress of these monsoon winds on the water establishes the horizontal and vertical currents of the Southeast Asian marine environment.

In winter the land, especially the Plateau of Tibet in South China, becomes colder than the sea, and the wind direction is reversed as the air blows from the northeast toward the tropical seas. Since the winds are reversed, their effect on water circulation is nearly reversed. The west coasts of land masses then become upwelling centers and areas of nutrient enrichment.

The charts of the transports are constructed for every second month and are presented together with the charts of the surface currents, (Figures 17-22). The numerical values of the transports in the different current branches are given in the following Table 18 and Table 19.

Current	Feb.	Apr.	June	Aug.	Oct.	Dec.
South Asian Waters						
Luzon Strait, westwards positive	+2.5	0	-3.0	-2.5	+0.5	+3.0
Macassar Strait, southwards	1.5	1.0	1.0	1.5	1.0	0.5
China Sea, off Viet-Nam southwards positive	+5.0	+1.5	-3.5	-3.0	+2.0	+5.0

Current	Feb.	Apr.	June	Aug.	Oct.	Dec.
Java Sea, eastwards positive	+4.5	+0.5	-3.0	-3.0	+0.5	+4.0
Flores Sea, eastwards positive	+6.0	+2.0	-2.5	-2.0	+1.0	+4.5
Banda Sea, upwelling positive sinking negative	-2.0	-0.5	+2.0	+1.5	-0.5	-1.0
Timor Current, westwards	1.0	1.5	1.0	1.5	1.5	1.5
Halmahera Sea, southwards positive	-2.0	+1.0	+3.0	+3.5	+2.0	-1.5

Table 18 Transports (millions m^3/sec) of different currents in the Southeast Asian Waters. (by the report of Naga Expedition)

Current	Feb.	Apr.	June	Aug.	Oct.	Dec.
Pacific Ocean						
North Equatorial Current	41	32	41	39	37	37
Mindanao Current..	12	8	9	10	9	12
Formosa Current...	24.5	37.5	35	30.5	27	21.5
Indian Ocean						
Source of the South Equatorial Current.....	16	12	8	10	14	14
South Equatorial Current (southwest of the Sunda Strait resultant flow from the Indonesian....	20.5	19.5	16.0	16.5	16.0	17.0

Table 19. Transports (millions m^3/sec) of different currents in the Southeast Asian Waters. (by the Naga report)

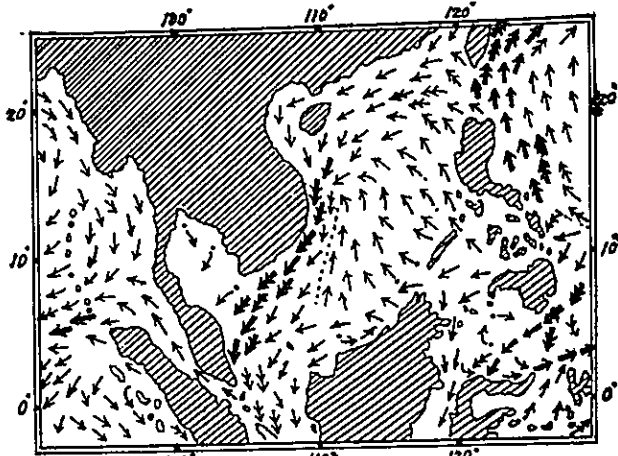


Fig. 17
Surface currents
in February.



Fig. 18
Surface currents
in April.



Fig. 19
Surface currents
in June.

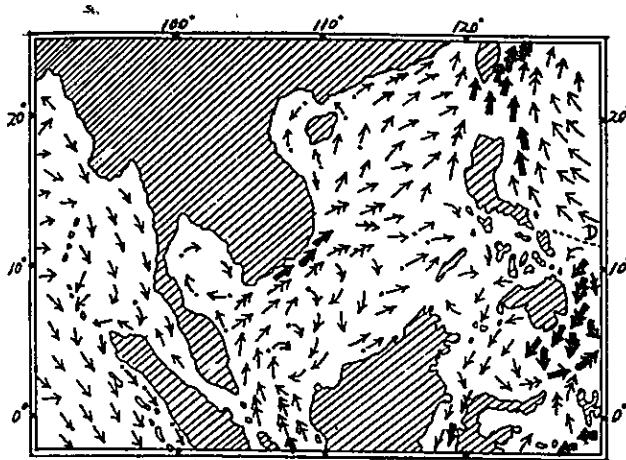


Fig. 20
Surface Currents
in August.

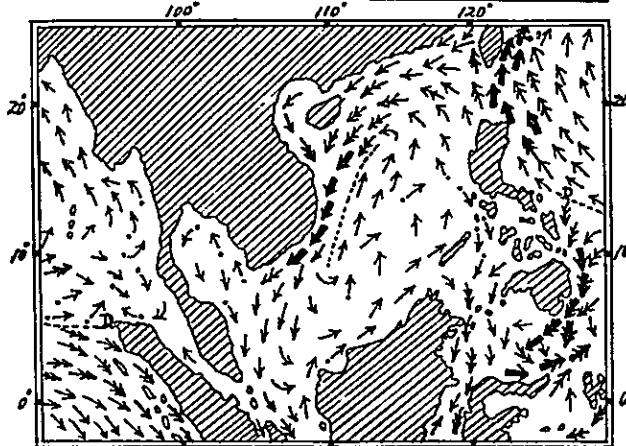


Fig. 21
Surface currents
in October.



Fig. 22
Surface currents
in December.

- ← . 12 cm/sec
- ←← 25 "
- ←←← 38 "
- ←←←← 50 "
- ←←←←← 75 "
- ←←←←←← 100 "
- - - current boundaries
- D Divergence
- C Convergence

Three almost separate circulations are distinguished. The first is the circulation in the Pacific Ocean, which affects the eastern parts of the region, but enters the Eastern Archipelago only in the range of the Celebes Sea. The second is the circulation of the Indian Ocean, where only the South Equatorial Current is included but which has no influence on the Southeast Asian Waters. The third is the circulation within the Southeast Asian Archipelago, which is determined by the monsoons. This monsoon circulation, as it might be called, is connected with the circulation in the Pacific Ocean to a small extent and linked with that of the Indian Ocean only by the Timor Current.

The monsoon circulation develops chiefly along the China Sea - Flores Sea - Banda Sea line, because these regions lie with their axis almost in the direction of the winds during both monsoons.

During the full development of the north monsoon the transport of the Monsoon Current through the Java Sea is about 4 million m^3/sec . In the China Sea the transport of the strong current branch off the coast of Viet-Nam is larger, because the transport of the eddy in the central parts of the China Sea has been added. The water masses of the Monsoon Current come during the north monsoon out of the North Equatorial Current and enter the China Sea chiefly through the Luzon Strait, smaller parts enter through the Philippines and the Sulu Sea. A relatively small transport of water occurs also through the Formosa Strait.

During the change from the north to the south monsoon in April, the whole circulation within the Southeast Asian Waters is only weakly developed, (Figure 18). In the China Sea two big eddies are found with a transport of 1 to 2 million m^3/sec each. The current still flowing eastwards in the Java Sea transports only 0.5 million m^3/sec , joins the water coming out of the Macassar Strait and forms along the north coast of the Lesser Sunda Islands a rather strong current of 2 million m^3/sec . From the Pacific Ocean a weak transport occurs through the Philippines and the Sulu Sea into the China Sea.

During the south monsoon the conditions are nearly inverse to those during the north monsoon, but the average transports of the Monsoon Current are smaller. In the southern China Sea a small eddy exists, but its transport is weak.

In October the change from the south to the north monsoon takes place over most of the region, and over the northern China Sea the north monsoon has already started with considerable strength. The Monsoon Current along the coast of Viet-Nam is

already developed and transport 2 million m³/sec southwards, but the larger part of this water turns northwards before entering the southern China Sea and is transported back along the coast of Borneo.

In December (Fig. 22) and February (Fig. 17) at the full development of the north monsoon a strong southward transport takes place in the whole China Sea, but not all its water can flow into the Java Sea. Consequently a piling up of water occurs in the South China Sea and causes the development of counter-currents in the central and eastern parts. The deflection of the current to the right and the piling up of water along the Asian coast with the highest sea level in the Gulf of Thailand are clearly seen. In the South China Sea at the equator where no slope exists, the currents are pure wind drifts.

Summarizing, the transport chart for October shows the formation of the Monsoon Current in the north monsoon season and the chart for April, the decay of this current. The Monsoon Current of the south monsoon season is formed in May and decays by the end of September. (Figure 15 -22).

The variation of Salinity in the China Sea.

The China Sea as the largest in these waters has a more oceanic character than the other seas. This is indicated by the relatively small annual variations of salinity in its northern and southern parts. The northern part receives water of high salinity from the Pacific Ocean during the northeast monsoon. These waters spread from the south of Formosa to the west and later along the coast of Viet-Nam to the south. The salinity gradually decrease in the direction of the flow, which gives the typical picture of a tongue-like spreading. The relatively dry air masses of the strong northeast monsoon also cause a considerable evaporation, which exceeds the rainfall from October to March, so this period has a surplus of evaporation of 620 mm. This would be sufficient to increase the salinity of a 70 m thick homogeneous layer by 0.3 ‰. But the observed increase during this season is 0.7 ‰, which shows that influx of water of high salinity also contributes to the increase of salinity. With the beginning of the southeast monsoon and the rainy season in May, the waters of high salinity are pressed back to the north, and their salinity is also decreased by the rain. The excess of the rainfall during this season is about 820 mm, which corresponds

to a decrease of almost 0.7 ‰ in salinity in a homogeneous layer of 40 m during this season. Off the south coast of China and along the coast of Viet-Nam the annual variation is larger, due to the river discharge and to the increase of rainfall towards the land.

In the central parts of the China Sea the annual variation of salinity is higher than in the regions north and south of it. Rainfall and evaporation can no longer be regarded as the dominant factors, especially as evaporation decreases rapidly towards the south while rainfall increases, so currents produce the variation of the salinity. The central parts of the China Sea are alternately filled with waters of higher and lower salinity. With the northeast monsoon, water of high salinity is transported along the coast of Viet-Nam to the south. In the central parts there is a counter-current flowing in the opposite direction and carrying less saline water to the northeast. This effect can clearly be seen in the chart of February (Figure 23). During the southwest monsoon the situation is reversed, that is water of about 32.5 ‰ is transported along the coast of Viet-Nam to the north, and in the central parts a counter-current carries water of above 33.2 ‰ to the southwest (Figure 24). Because on the average the rainfall exceeds the evaporation in this region, the salinity of the passing water is continuously decreased, though only by a small amount. The relatively big annual variation of about 1.1 ‰ is caused by currents carrying water of different salinities during the two monsoons.

Off the mouth of the Mekong the annual variation increases to more than 2 ‰ , whereas in the Gulf of Thailand it amounts to about 1.3 ‰ , although this value is still uncertain because of the small number of observations. The salinity in the Gulf of Thailand varies between 30.5 ‰ in January and 32.0 ‰ in September. This means that the maximum occurs at the end of the rainy season, after which a decrease of the salinity is observed. But the maximal discharge of the rivers normally occurs at the end of the rainy season, which may explain this variation. On the other hand the waters of low salinity, formed off the mouth of the Mekong, are pressed by the winds into the Gulf from October to January and cause a low salinity.

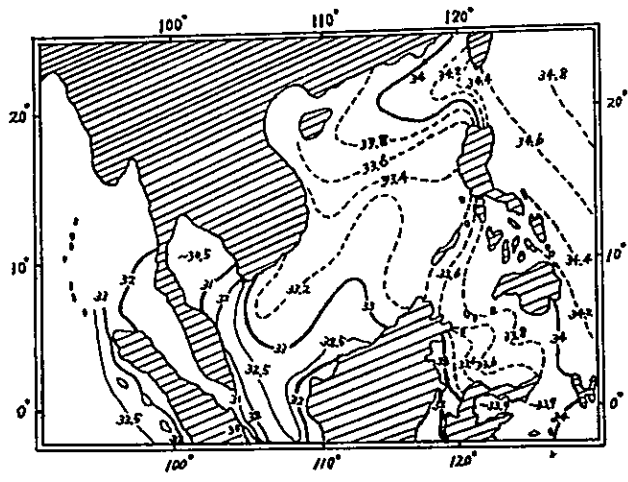


Figure 23. Average surface salinity (‰) in February, drawn from observations in the years 1950-1955.

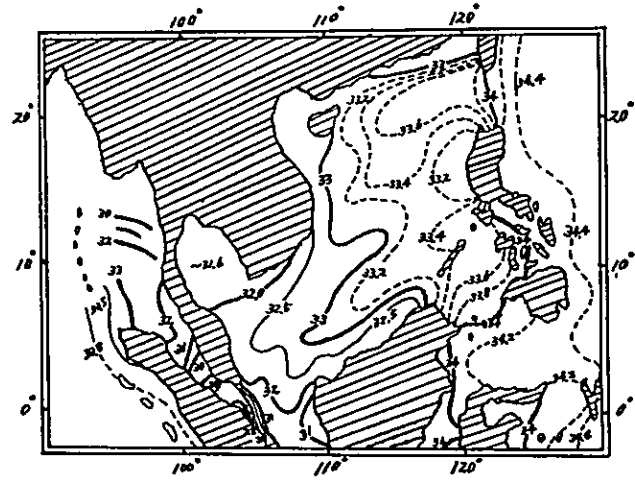


Figure 24. Average surface salinity (‰) in August, drawn from observations in the years 1950-1955.

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**CHAPTER VII: CONCLUSIONS AND PROSPECT FOR THE FUTURE
OF PLANKTOLOGY IN SOUTH VIET-NAM**

1968

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1968

It may be concluded that in South Viet-Nam, fresh water plankton and marine plankton are abundant in species, but not in quantity.

A. FRESH WATER PLANKTON

From the results of the survey made by the author in and after 1963, a conclusion can be drawn that the mean plankton biomass in general lakes and marshes in South Viet-Nam is below 1.0 g/m^3 with 0.3 g/m^3 as the average.

Recorded as the greater plankton biomass were 14.3 g/m^3 (mostly *Cladocera* and *Copepoda*) in the case of Da-Nhim Dam in Dalat, over 40 g/m^3 (mostly *Euglena*) in a small reservoir at Cholon and 28.5 g/m^3 (mostly *Cyanophyta*) at Ca-Mau, the average being 8.0 g/m^3 . The places at which such higher rates of biomass were observed are dams, small reservoirs containing accumulated dusts or artificial swamps made by damming up a stream and fall under the category of "special environment". In respect of PH, it was 6.5 (water temperature: 25.6°C) in the dam at Dalat, 7.9 (water temperature: 32.0°C) in the reservoir at Cholon and 7.2 (water temperature: 27.8°C) in the artificial marsh at Ca-Mau, all of which are pretty higher than the average PH of 5.8 for the entire Viet-Nam, and even by merely judging from the above mentioned PH values, it is apparent that phyto-plankton exists in great mass at these points (except the dam at Dalat) and photosynthesis is being carried on actively.

Though lakes and marshes having a low PH value of 4.0 can be found on rare occasions in South Viet-Nam, the mean PH 5.8 of lakes and marshes for the entire area is a lower value compared with the mean PH 6.8-9.0 in the case of other ordinary lakes and marshes. Generally, the range of PH suitable for plankton is 7.0 to 8.0. From such low PH, it can be judged that plankton biomass in Viet-Nam is smaller. It is therefore assumed that such low PH is adversely affecting the multiplication of plankton in the lakes and marshes, entailing the decrease of fresh water plankton biomass in Viet-Nam.

The cause of low PH in the fresh water lakes and marshes are not clear, but such acidic water is considered to be originating from organic corrosive acid or inorganic strong acid. However, even in the lakes and marshes having such low PH adversely affecting the multiplication of life, it is possible to promote normal multiplication of life by addition of lime, etc. to make neutral the water of such lakes and marshes.

Though the author did not apply neutralization test to all the waters having low PH, he tried the addition of lime, NaHCO_3 , $\text{Na}_2\text{S}_2\text{O}_3$, etc. to a few lakes and marshes and ascertained that the normal multiplication of phyto-planktons (Scenedesmus) and zoo-planktons (Euglena of phyto-mastigophora and Moina as well as Daphnia of Cladocera) could be achieved thereby. Needless to say, there may exist certain waters which do harm to life even after neutralization treatment, but in cases where it is desired to progressively multiply plankton as feed for larvae of fishes in a fish pond or to breed fish utilizing a lake or marsh, the PH of water will be one of the important problems to be considered.

B. MARINE PLANKTON

According to the survey (1963-1965) by A. Shirota, the plankton biomass in the South Viet-Nameese coastal water (15 to 20 km from beach) is 1.0 g/m^3 or below, with 2.0 g/m^3 as the maximum and 0.3 g/m^3 or less as the average. On the other hand, it was found that the plankton biomass (in September) on the west side of Ca-Mau Peninsula, that is, in the Gulf of Thailand including Rach-Gia and Phu-Quoc was $0.6-0.8 \text{ g/m}^3$, a value 2 to 3 times higher than that in the South China Sea coastal water.

In the meantime, according to Naga Expedition (1959-1961), the plankton biomass in the South China Sea more than 100 km off-shore from the beach is 0.1 cc/m^3 in the case of zoo-plankton in the coastal waters ranging from the Hue (N. Lat. $16^{\circ}30'$) to about E. Long. 110° including Nhatrang-Phan-Rang, 0.05 cc/m^3 in the further off-shore water and 0.15 cc/m^3 in the water within the range from Phan-Rang to the southern tip of Ca-Mau Peninsula which falls on N. Lat. $5-6^{\circ}$ whereas the plankton biomass in the coastal waters ranging from the southern tip of Ca-Mau Peninsula to Phu-Quoc varies with the seasons, that is, $1.0-1.1 \text{ cc/m}^3$ in the rainy season (April, May) and $0.3-0.5 \text{ cc/m}^3$ in the dry season (August to January).

Combining both results, it was found that the plankton biomass in the coastal water west of Ca-Mau Peninsula is 2 to 5 times higher as compared with that on the east side, that is, in the range from Hue facing South China Sea to the southern tip of Ca-Mau Peninsula, thus possessing a higher productivity.

The cause is considered to be lying in the topography of Ca-Mau Peninsula which is different from other areas. That is, as is clear from the picture included in Chapter X, it is considered that nutrient salts conveyed by numerous canals or rivers

running lengthwise and crosswise through the Peninsula exerted influences upon the multiplication of plankton in the coastal waters. The tendency was more conspicuous in the rainy seasons.

Though the climate in South Viet-Nam is characteristic in it that the dry and the rainy seasons are controlled by monsoon, the quantity of plankton is also influenced thereby. Taking Nhatrang Bay and its open sea as the examples A. Shirota (1963b) looked into the changes in plankton biomass as well as the environmental conditions at the standing points in the dry and the rainy seasons and confirmed that (1) the plankton biomass is larger in the Bay in the dry season than in the open sea, (2) in the case of the rainy season it is larger in the open sea than in the Bay and (3) the total plankton biomass including both the Bay and open sea is larger in a rainy season as compared with the case of a dry season.

Though the species of plankton are similar to those in the temperate zone, Trichodesmium of Cyanophyta are found in the entire area, which often accounts for more than 80% of the total sample and is considered to be one of the characteristics of the southern zone. Further, Salpa, Doliolum, Oikopleura and Sagitta are the species able to be found most commonly while luminescent Sapphirina and Corycaeus too are discovered commonly over the entire area.

C. PROSPECT FOR THE FUTURE

It is generally said that the plankton biomass in the southern zone, that is, low latitude zone is approx. 1/5-1/10 as compared with the high altitude zone. This also applies to South Viet-Nam. If the volume of resources of fresh water and marine pisces, crustacea, mollusca, etc. is estimated on the basis of the above-mentioned plankton biomass, it may be given as a conclusion that the volume is quite small.

At present, some 1 ton fishing boats account for the greater part of the total fishing boats in South Viet-Nam and the fish catch amounts to 500,000-600,000 tons a year. If, however, the fishing industry makes progress and a modern catching method comes to be adopted, inland water and marine resources will be exhausted quite quickly. And yet, the recovery capacity of fishery resources after haul is considered to be quite small judging from the small standing crop of plankton. Accordingly, the future of South Viet-Nameese inshore fishery is not very bright.

If, however, one reviews here again the following geographical

environments of South Viet-Nam, that is,

1. Climate and natural features are subject to monsoon and can be divided clearly into the dry and the rainy seasons;
2. The temperature difference as well as water temperature difference is small throughout the year and the temperature is high;
3. The water temperature of 25-28°C affords an environment suitable for the growth of many aquatic animals; and
4. No typhoon nor natural calamity and little gale, it may be said that the above conditions are quite favorable in connection with the utilization of ocean, lake and marsh and especially with the fishing industry in it that the temperature is not so low as in a high latitude zone and the possibility of calamities due to typhoon as in the case of Japan does not exist in South Viet-Nam.

In short, the question is how to utilize these favorable conditions and the author thinks that the key to the solution of this question is breeding under positive artificial management. Of course the organism coming into question in this case should be (1) the species suited to the taste of people, (2) costly and (3) well manageable and further, in the sense of acquisition of foreign currencies, (4) the ones exportable.

For instance, in South Viet-Nam, the crustacea can be said to be the most promising species meeting the above requirements. The crustacea is one of the species most difficult to be cultured in the world. The difficulty consists, needless to say, in the environmental conditions in course of growth and especially in the feed to be furnished at the larval stage, and the survival rate of larvae of crustacea is determined depending on the quantity of plankton serving as their feed. It is said that naturally more than 95% of hatched larvae die. In the area abundant in plankton in South Viet-Nam, that is, on the west coast of Ca-Mau Peninsula, not only pisces, but also considerable quantities of crustacea are caught and they were exported to the adjoining countries, U.S.A., etc. in former times while at present too, some crustacea are being exported. The fact that even a natural catch leaves a margin for export tells that if artificial culture were undertaken, the production scores of times higher could be expected.

Accordingly, the possibility of culture of plankton, especially Diatoms, Phyllopora and Copepoda to serve as feed for

the larvae can be said to be one of the keys to the success of crustacea culture. In this sense, the culture of plankton in large quantities has a great significance and in connection therewith, economical and low-priced feed will become the problem for future. For that purpose, the study of the physiology and primary production of plankton itself must be pushed forward actively.

If it were possible, in this way, to know the physiology of the organisms in question, utilize the favorable environmental conditions in Viet-Nam and progressively manage and breed such organisms, the future of the marine product industry of Viet-Nam would be quite bright and at the same time, the development of oceanographic and limnetic studies could be expected.