Allen, W. E. Marine phytoplankton of the San Diego region. (1921)

PRELIMINARY STATISTICAL STUDIES OF MARINE PHYTOPLANKTON OF THE SAN DIEGO REGION, CALIFORNIA

BY

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[Reprinted from SPECIAL PUBLICATIONS OF BERNICE P. BISHOP MUSEUM No. 7, pp. 537-554, also 3 insert tables, 1921.]

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INTRODUCTION

Recognizing the basic need of a better understanding of the occurrence and distribution of the synthetic organisms of the sea, the phytoplankton, the Scripps Institution for Biological Research has in the past four years devoted a considerable portion of its resources to increased investigation of these organisms. The methods of work have been somewhat modified in the last two years along lines of standardization and consistency, but no report on this period is yet available. This paper and the one by Ellis L. Michael which follows discuss the work on phytoplankton of the Southern California region in 1917 and 1918 and are intended to not only give some idea of the preliminary work already done in Pacific waters, but also to offer suggestions for guidance in future operations, either localized or general. These two papers although complete in themselves are based on the same records of numerical distribution and it is therefore desirable to publish them together. The more elementary paper which includes the records essential to both discussions is placed first because that seems to be the natural order.

Much of the work on phytoplankton done in Atlantic waters and in fresh water lakes and rivers shows two desiderata to be especially prominent. First, it is necessary to identify the species present; second, it is essential to maintain, as nearly as possible, continuous observation. It seems appropriate to discuss briefly these desiderata and certain other general features of marine work in phytoplankton before entering upon the explanation of the work done in 1917 and 1918.

DESIDERATA

The taxonomy of dinoflagellates of the San Diego region has been well covered by Professor C. A. Kofoid of the University of California. But this region is an infinitesimal portion of the area of the North Pacific and a great deal of strictly taxonomic work remains to be done. Not even an effective beginning has been made on the taxonomy of diatoms of the North Pacific. Fortunately for our work with both types of organisms, it appears that the more abundant, more prominent, and presumably more important forms are cosmopolitan and fairly easy to recognize. Preliminary statistical work gives little indication that *refined taxonomy* is of immediate importance, but it ought to be done in preparation for any future time when specific determinations of great accuracy may be needed for interpretation of some series of records.

One of the most, if not the most, urgent need in connection with statistical work with the microplankton is for the establishment of definite stations from which collections may be taken with great frequency and continuity, daily if possible. There ought to be at least one permanent station at which a permanent series may be run to serve as a standard for the work in any given area. With such a standard much effective work can be done by running daily or hourly catches through any one desired or immediately possible period of the year. Of course, it is highly desirable to have such series carried for various depths as well as for the surface but it is quite evident that the field of surface catches has scarcely been touched in most localities and that it still offers ample opportunities for work for many years to come. For practical purposes anything in the uppermost five meters of water may be regarded as belonging to the surface series. One distinct advantage of a standard series of surface catches is that it may serve as the basis of comparison not only of series from other surface areas but from various depths as well. A still greater advantage is in the greater simplicity of procedure and equipment required for surface work. This is of high importance because it vastly increases the probability that the series can be carried continuously. To those who realize the time, work, expense and risk in handling such series it is evident that a break in continuity after one is once established may be a very serious matter, hence anything that will tend to insure its satisfactory maintenance is extremely desirable.

If a good quantitative series is once opened it would be very desirable to have any particular phase of the work handled as nearly as possible by the same individual. Slight changes in individual methods sometimes produce great differences in the final quantitative results.

POSSIBLE COMMERCIAL APPLICATION

Aside from the academic interest it has in extending our knowledge of the laws of life and in broadening our conception of the phenomena of organic existence, I think the study of marine plankton may finally be made to have a decided practical value. The sections following illustrate possibilities.

Naturally, the food relation is the first to attract attention. If a series of records can be secured which will enable us to say that with a certain number of clear days in February and March the seasonal catch of marketable fish may be large because the photosynthetic organisms are able to build up enough food material to supply abundantly the next link in the chain which in turn may supply the next, and so on, up to the fish, it would be worth while even though the information is somewhat indefinite and faulty. Or, if we are able to say that a smaller number of clear days means a poor supply for the markets, or that existent pasturage can support only a limited population, or that certain fishes might be introduced to use it to better advantage, those concerned may be on their guard and not be taken entirely unawares. Some such predictions have been made in connection with fisheries in the North Sea. Judging from present knowledge it is reasonable to hope that if we do our work properly some succeeding generation may be able to make reports to fishermen quite comparable in value to those now made by the weather bureau to farmers. It may be found that some organisms which do not seem to have much value in the food chain, do have a direct value as indices to productivity.

There is another relation which may be as important as the food chain. That is the poison (or at least we may say the exclusion) chain. I mention this because of the considerable evidence to show that certain dinoflagellates may be fatally injurious to fishes and other organisms. If records were available to show the conditions under which such organisms become so numerous as to be of economic importance, advance report of the coming of such conditions might forewarn fishermen and so, to a considerable extent, forearm.

SOURCES OF ERROR IN STUDY

Sources of error have to be considered in connection with any piece of work which pretends to any degree of accuracy. I have taken a good deal of interest in these sources of error and since no considerable number of them is ever mentioned collectively, I have attempted to make a bare list of those most important in such plankton methods as are in general use. Some are important always; some are usually negligible; some counteract or cancel others at times. These conditions are themselves variable and so subject to error of usage and interpretation. For convenience we may call the conditions in which sources of error reside, variants. They may be enumerated as follows:

- Variants in sampling.
  - Selecting the station in the area.
  - Locating the station in the area.
  - Drift while hauling } Distance, Speed, Direction
  - Descending catch in net.
    - Pitching of boat (especially if vertical haul).
    - Cross currents.
  - Ascending catch in vertical hauls.
    - Pitching of boat.
    - Clogging of net.
    - Leakage of net.
      - Pressure.
      - Mesh.
    - Speed of haul.
    - Cross currents.
  - Taking from net.
    - Spillage.
  - Recording.
  - Preservation.
    - Distortion.
    - Fragmentation.
- Examination.
  - Dilution or concentration.
  - Transference, spillage and adhesion.
  - Measuring.
  - Mixing.
  - Sampling for count.
  - Counting.
    - Fractional sampling of the slide.
    - Miscounts { Small size. Distortion. Covered by debris, etc. Uneven distribution in counting cell. Personal error, fatigue, etc. Bad position for identification. Misnaming.

Recording.
Computing.
Recording.
Interpreting.
Differences in persons.

This looks like a formidable list, and it is. That is one reason why it seems necessary to simplify and to standardize all methods of collecting and handling as much as possible. One unfortunate effect of the contemplation of such a long list of variants is the feeling that any one error will be so much over shadowed by other errors as to be negligible, but it is evident that a minor variant may become very important if carelessly regarded, and that reasonable uniformity of degree of error is more important in a series than is extent of error. A large error clearly recognized may be less injurious than a small one left without consideration.

LENGTH OF PROGRAM

My experience with these preliminary studies leads me to believe that the most valuable plankton work will be that which is done laboriously over long periods of years. By such work errors or abnormalities of one year or season may be checked by many others so as to give a fair general view of conditions to be expected in a given area. It seems to me that the laws of distribution of life in the sea must be fundamentally the same as those governing life on land and in air. There are areas in the sea with little or no life, and all gradations between this condition and that of great abundance of life. Evidently, many organisms shift, voluntarily or involuntarily, from one area to another. Certainly there are vacillations in productivity corresponding with vacillations in the vast numbers of factors of environment.

These factors of the environment are so numerous that their possible permutations and combinations seem past finding out. The list of chemical factors alone, must be for the sea almost as large as the list of soluble chemical elements and compounds. The list of physical factors, while possibly shorter, is still very long and of primary importance, for example, temperature has a profound influence on the effect of many other factors. Furthermore, the number of biological factors is legion. Surely, with all this complexity, we cannot hope for clear insight until there are enough records to show certain combinations with sufficient frequency to fix our attention.

MATERIALS AND METHODS

I consider microplankton particularly useful for the study of these combinations because of the vast numbers of its organisms, their limited motility and their high adaptability through reproduction. Their short life cycles are also a point in favor since the effects of given conditions can be more quickly seen. Large numbers of individuals and large numbers of kinds in a given plankton population are both important in helping to reduce some of the errors in handling and study. Different species, for example, check each other to some extent and so aid in giving proof or in calling attention to error.

These studies were made in the summers of 1917 and 1918 on miscellaneous and somewhat heterogeneous groups of catches made from time to time and kept in storage. Most of the catches were made in the years 1917 and 1918 and some were studied within ten days after being taken.

As described in the detailed discussion the methods of making the catches varied. Methods of counting differed somewhat but most of the counts were made by the Sedgwick-Rafter method. The catch in its preservative formalin was brought to a standard quantity, one cubic centimeter of which was taken after thorough mixing and placed in a Sedgwick-Rafter slide. The count was then made under the low power of the compound microscope using a Whipple eyepiece micrometer with draw tube so adjusted as to cause the scale to cover one square millimeter in the field of the sixteen millimeter objective. If the catch was large a count was made of fifty fields (covering fifty cubic millimeters of fluid), distributed in groups of five about the margins and middle of the slide. Finally a half slide was examined for less abundant forms which were duly counted. If the catch was light half slide counts only were made. The counts were afterwards used to compute the total numbers in the catch and the results were tabulated according to taxonomic groups.

Diatoms and dinoflagellates only were counted as the other micro-organisms in the plankton were too few to be of much value for statistical studies. In fact it appears that diatoms are much superior to dinoflagellates for this purpose. Most of the numerically important forms in both groups are usually easy to identify. Some of the less abundant forms are easily confused under conditions of counting and others cannot be identified with certainty. In some cases it has been impossible, on account of small size, to distinguish some of those which have numerical importance. Some diatoms have not been specifically identified because too fragmentary or because spore stages were not found. There is no evidence that this deficiency has been sufficiently important to appreciably diminish the value of this statistical work.

MINOR STUDIES

STOMACH CONTENTS OF SARDINES AND ANCHOVIES

A very limited qualitative study was made of stomach contents of sardines (*Sardinella coeruleus* Starks and Morris) and anchovies (*Engraulis mordax* Girard) which serve as food for the albacore (*Thunnus alalunga* Gmelin). Five anchovies taken from the stomachs of three albacore were examined on August 13, 1917. The stomach contents of three of these were wholly unrecognizable. Of the other two, the little which was recognizable consisted of the shells of diatoms and dinoflagellates of various kinds, most of which could not be specifically identified. Three sardines taken at the Institution pier were examined. In two specimens remains of the dinoflagellates *Dinophysis homunculus* Stein and *Prorocentrum micans* Ehrbg. were found but about ninety-nine per cent of the stomach contents consisted of copepods. In the other sardine the following diatoms and dinoflagellates were found in quantity: *Coscinodiscus* sp., *Chaetoceras criophilum* Castr. and a number of smaller diatoms; *Peridinium divergens* Ehrbg., *P. grandii* Ostf., *P. oceanicum* Vauh., and many fragments of shells of Ceratium. This study was not carried further because it was only confirmatory of the well established idea of the important part which diatoms and dinoflagellates play in furnishing food for fishes or their prey.

SOME CASES OF "RED WATER"

Some isolated qualitative studies of "red water" and similar phenomena were made. These have value in a statistical series because they prove the occurrence of various species of microplankton in enormous swarms and consequently refute the old notion of uniform distribution of small organisms in sea water. Only two of these will be specifically mentioned here. On June 4, 1917, "red water" was encountered at a point about twelve miles west of San Pedro, where three hauls taken at depths of thirty meters, sub-surface and of surface "scum" showed the surface "scum" to be composed of *Prorocentrum micans* Ehrbg., the sub-surface haul to be composed mainly of this dinoflagellate, and the thirty meter haul to be composed mainly of diatoms and other dinoflagellates. This case of "red water" indicates the probability that plankton swarms are not only definitely limited in surface area occupied but also as to depth.

Another case of "red water" occurred on September 11, 1917, close inshore near Santa Barbara where it was causing a good deal of injury to fish and shore fauna and exciting much inquiry. Captain W. C. Crandall of the Scripps Institution made a special trip to get samples of this swarm. He made a total of twelve surface hauls nearly all of which consisted mainly of *Gonyaulax polyedra* Stein, some almost entirely so.

These two typical cases show not only that plankton swarms occur both inshore and off shore, but that they are to a very large extent exclusive against other organisms in their particular area many of which in fact, are killed.

SOME CASES OF LUMINESCENCE

In this connection mention may be made of some qualitative catches made by Mr. James Ross along the coast of Lower California in the Spring of 1919. Early in March a rather rich diatom plankton was found slightly to the north of Magdalena Bay. The Bay itself yielded little in the two catches made. Near Cape Magdalena there was an area of marked luminescence, but little microplankton. The presence of a few Ctenophores in the catch suggests their agency in this phenomenon. In Santa Maria Bay and at Santa Margarita Island catches showed large quantities of *Lauderia borealis* Gran. Brilliant luminescence was reported there which was also probably due to Ctenophores. In the Gulf of California near Espiritu Santo Island where remarkable luminescence was reported, it again seems probable that Ctenophores were responsible. Near San Martin Island an area of "brown water" was reported which was about fifty miles in extent. Catches from it consisted mainly of *Chaetoceras debile* Cl. and *Nitzschia seriata* Cl. Transtitions from luminescent to non-luminescent areas were very sharp. Transition from "brown water" to non-brown was more gradual.

SOME CLOSING NET CATCHES AT VARIOUS DEPTHS

On June 14, 1917, Mr. James Ross and Mr. P. S. Barnhart made a short series of closing net hauls at the kelp beds one and one-half miles west of La Jolla Point. These were taken from 5, 10, 15, 20, 25, and 30 meter depths and one was taken from the 44 meter level to the 30 meter level. They were taken successively as rapidly as possible beginning at 10 a. m. This single series showed quite clearly a scant microplankton population in the upper fifteen meters and heavy catches from the 20 meter level to the 44 meter level. Of course, no real conclusions can be reached from a single short series of this sort, but there are some interesting questions suggested by it. Perhaps the most important of these is as to whether large quantities of microplankton frequently occur near the 50 meter level or whether abundance below thirty meters may have been due in this case to mixing by currents induced by proximity to the shore line. There is also the important question as to what factors determine the level at which most microplankton may be found.

SEASONAL SERIES

We may now consider the "seasonal series" so called because it consists of a series of catches made at nearly weekly intervals at two certain stations, two and five miles off shore respectively from the Scripps Institution. This series ran from December 12, 1917, to July 11, 1918, covering approximately the most productive plankton season (judged from our other records). It was not possible to make many of these catches at Station 2 (five miles off shore) partly because of rough weather and partly because of lack of time necessary to do the work with the small boat available. For similar reasons some important breaks occurred in the series from Station 1 (two miles off shore). In spite of these deficiencies the series has a decided interest for comparison with other series and it also gives some valuable indications as to seasonal distribution and ecological successions. The most important points are the showing of a prominent diatom pulse in January characterized especially by *Chaetoceras curvisetum* Cl. and *Ch. convolutum* Castr., an enormous diatom maximum late in May characterized by *Chaetoceras criophilum* Castr. and *Ch. convolutum* Castr., a dinoflagellate pulse in December due to *Ceratium fusus* Ehr. and a dinoflagellate maximum in mid May due to *Peridinium crassipes* Kof., *P. divergens* Ehr. and *Ceratium furca* Ehr.

Next, we may consider the various series of catches made on special collecting cruises of several days duration at different periods in 1917 and 1918. These will be discussed in chronological order. Methods of making the catches differed somewhat with different cruises but all counts were made by the Sedgwick-Rafter method. Inasmuch as little comparison was made of catches of one series with those of another, the differences in collecting methods are not important for the purpose of the present paper.

PRINCIPAL STUDIES. LATERAL SERIES

FIRST SERIES. JULY A (1917)

The first series (July A) was made on a run from a point about fifty miles west of San Nicolas Island in to San Pedro on July 14 to 16 inclusive. In this series hauls were made with the fine meshed net (No. 25) from a depth of 200 meters to the surface at eighteen stations selected at more or less regular intervals on the run in. Of the eighteen stations hauled, only six showed large amounts of microplankton. Of the six two were farthest seaward, two near inshore and the other two at about equal distances between. At all of the other stations the catches were light or even scanty. Station 11 near San Nicolas Island gave a rather large amount and the catch near Point Fermin was especially large.

Five different diatoms were dominant numerically at one or more stations. *Chaetoceras affine* (?) Lauder was most abundant at the two stations farthest seaward and at Station 17 just north of Catalina Island. *Ch. criophilum* Castr. was dominant at all stations from 2 to 13 inclusive, except Station 11. It was much in excess of other diatoms at Stations 7 and 8. *Nitzschia seriata* Cl. was dominant at Station 14 and *N. longissima* Breb. at Stations 16 and 18, excessively so at the latter. It now becomes necessary to refer to a series of surface catches made from a similar run in June which was not studied in detail. The point of interest is that the June series showed a very marked dominance of Chaetoceras *criophilum* Castr. or of *Nitzschia seriata* Cl. at almost all stations in June, while in the present series they are barely able to keep a lead. Smaller Chaetoceras forms have replaced *Ch. criophilum* to a large extent in most cases. It is also true that *Nitzschia longissima* Breb. is smaller than *N. seriata* Cl.

The evidence from the July A series points superficially to the view that microplankton is more abundant inshore and near islands. Volumetric studies and statistical analysis of this material made by E. L. Michael show, however, that these differences were due to changes from old to new nets on account of loss or tearing. Since we have no accurate indication of the differences in nets no conclusion is possible from this evidence though there is some indication of maximum microplankton production seaward.

SECOND SERIES. JULY B (1917)

Another run was made in July which yielded the July B (Table II) series. This run (July 29 and 30) was from a point about fifteen miles west of Tanner's Bank to a point about five miles east of San Clemente Island. The twelve catches of this series were made by vertical hauls from a depth of 200 meters. This series consisted of light, or even scanty, catches throughout, and the diatoms were largely fragmented or otherwise in poor condition. They were mostly very small, many were atypical, and species distinction was much more difficult than formerly in the dominant forms.

Dinoflagellates in this series, as was also the case in the July A series, seemed in fair condition though few in numbers.

Since this series did not extend inshore on account of breaking of apparatus, there is no means of comparison of relative abundance inshore and offshore at the time it was taken. It may be noted, however, that this series agrees with July A in showing *Nitzschia longissima* to be distinctly characteristic of seaward plankton at this season.

The main points suggested by this series are that there is not uniformity of distribution of plankton forms over an area and that there is a still later stage of diatom decline than was shown by the July A series. It is notable also that *Dactyliosolen tenuis* Cl. was dominant at Station 9 in the midst of an area mainly characterized by *Chaetoceras contortum* Schütt, a fact which shows the possibility of a local break in a widespread dominance.

THIRD SERIES. AUGUST (1917)

One run was made in August and the twenty-eight catches then made constitute the August series. These catches were all made by vertical hauls from depths of 200 meters. This was a long run on zigzag lines from San Diego to Santa Cruz Island, and it extended from August 11 to August 20 inclusive. On account of its zigzag character, this series cannot well be considered as a whole, hence it may best be broken up into six subseries conveniently lettered A, B, C, D, E, and F. It may as well be stated here, however, that this series, as a whole, seems to show about 50% larger numbers of dinoflagellates than were shown in either July series. It appears that there were less than half as many diatoms as in the July B series and only about one-fifth as many as in the July A series. So far as the 1917 summer records are concerned, then, the general numerical increase of dinoflagellates in midsummer is not marked in this region as it is reported to be in others. The diatom decrease is thus prominent, however. Inasmuch as we know of vast localized increases of dinoflagellates at this time it may be thought that, on the one hand, dinoflagellates are less stable and more localized in distribution than the diatoms, or, on the other hand, that they have an apparent prominence due to the absence of large numbers of diatoms.

This latter view is somewhat supported by the fact that "red water" due to vast numbers of dinoflagellates was reported at various places at about this time. It is also true, however, that more dinoflagellates might escape through the meshes of the net when diatoms are few (because of less clogging) and thus the real increase in numbers would not be shown in the catches. In addition, it is necessary to remember that we do not know as yet the history of the cycles run by these organisms in this region.

Sub-series A, consisting of six catches, covers the line between Point Loma and San Clemente Island, which was omitted in the July B series. It gives some indication of an increase of plankton content inshore, but as the nearest station to the shore was fifteen miles out, the ground of inference is not very certain. The largest numbers of both diatoms and dinoflagellates were caught midway between San Clemente Island and the mainland.

As to the numbers in this sub-series, *Chaetoceras affine* Laud. was dominant at the two stations nearer San Clemente Island, while a small, unidentified species of *Navicula* was most numerous toward the mainland. Since this small *Navicula* seemed to be in fairly good condition it may have been a forerunner of the cycles leading to the autumnal increase in the diatom population.

About the only inference to be derived from this sub-series is that different stations present differences in kinds and relative numbers of organisms.

Sub-series B, consisting of four catches between San Clemente Island and Oceanside, shows nothing of very great prominence, except that the smallest numbers of both diatoms and dinoflagellates were found at Station 9 midway between San Clemente Island and Oceanside. Inasmuch as this is almost directly opposite to the condition in sub-series A, it might at first be thought that the showing was due to leakage of the net or some other accident in hauling of the net at Station 9. Station 8, however, is also low in numbers, and it may be that there actually was such remarkable scarcity of all diatoms and dinoflagellates at Station 9 as the records show.

Chaetoceras affine was dominant at all four of the stations in this sub-series, except in the small catch at Station 9, where *Peridinium crassipes* was most numerous.

Sub-series C includes five stations on the line from Oceanside to Santa Catalina Island. It, also, is mainly impressive through the fact that a very low minimum for both diatoms and dinoflagellates occurs at Station 14, midway between the island and the mainland. In this case, however, the maximum for diatoms occurs about six miles nearer Santa Catalina at Station 16, while the maximum for dinoflagellates occurs at Station 16, about eight miles from Catalina. The small *Navicula* sp. was dominant at three stations, *Chaetoceras affine* at one and *Peridinium cerasus* at one.

Sub-series D includes three stations between Santa Catalina and San Pedro. It agrees with the July series in showing a marked increase of diatoms nearer San Pedro. This is not yet accounted for in this series. *Chaetoceras affine* and a small *Navicula* sp. are the numerical dominants at stations 19, 17, and 18.

Sub-series E includes six stations from Pt. Fermin to the vicinity of Santa Barbara Island. As far as it goes this sub-series covers a good deal of the same ground covered by the July 1917 series. For this reason it has more interest than the other sub-series in this group.

Both diatoms and dinoflagellates appeared in largest numbers at Station 26 about six miles southeast of Santa Barbara Island. The numbers at Station 20 near Pt. Fermin were decidedly smaller. This distribution is markedly different from that in the July 1917 series when the station near Pt. Fermin showed largest numbers of all. As noted in discussing that series this showing of the July series was due to the net. Hence the showing of the August series is probably correct.

Nitzschia seriata was numerically dominant at the three stations farthest seaward, occurring in relatively enormous numbers at the two stations nearest Santa Barbara Island. This is approximately the general region in which it was especially prominent in the June series and the July 1917 series. The small Navicula was most numerous at Station 21, and *Chaetoceras affine* at Stations 22 and 20.

This sub-series shows plainly that there are marked differences in plankton content in different localities. While it does not support the questionable indication of the July 1917 series that heavier plankton occurs close inshore, it does show some resemblance to that condition by its heavier plankton being found near Santa Barbara Island. The dominance of *Nitzschia seriata* in the region near this island at three different times suggests the possibility of an organism being characteristic of a given area over a considerable period of time.

Sub-series F includes four stations not covered in such a way as to be directly comparable with the other sub-series. Station 40 was just north of Santa Cruz Island. *Nitzschia seriata* was distinctly dominant here, giving the impression that something in nearness to islands favors it. The catch as a whole closely resembled others in the main series except that dinoflagellates were made prominent by large numbers of *Gonyaulax polyedra*.

Stations 50, 51 and 52 were about fifteen or twenty miles from Oceanside. Nothing of prominence appears in their records to indicate much difference from conditions in that region a week before, except that Station 51 is almost identical with Station 10 and it shows a dominance of the small Navicula, instead of *Chaetoceras affine* as at the other time.

Considering this August series again as a whole, it is interesting to note that *Chaetoceras affine* is dominant at ten stations out of the twenty-eight, the small Navicula at twelve stations, *Nitzschia seriata* at four stations, *Chaetoceras decipiens* at one station and *Peridinium cerasus* at one station.

COLLECTIVE DISCUSSION OF 1918 SERIES IN COMPARISON WITH 1917 SERIES

The work in 1918 was along lines somewhat similar to those of 1917, hence it may be most conveniently discussed by making comparisons. Only two additional points seem to be clearly indicated. First, it seems almost certain that the production of diatoms reaches a maximum somewhere from April to early June, a conclusion which agrees with the results of various European observations. Second, owing partly to the use of the shorter, fifty meter vertical haul, a complete series of catches with the No. 25 net was made on the long August trip, even including catches in the Santa Barbara Channel and beyond Point Conception.

Monthly cruises (except April) were made from January to August in 1918. The January trip shows nothing of particular note unless it be that *Chaetoceras criophilum* Castr. is the most prominent microplankton in nearly the whole lot of rather light catches. February catches were slightly heavier with a predominance of *Chaetoceras curvisetum* Cl. In March *Chaetoceras curvisetum* retained its dominance in much heavier catches. *Nitzschia pungens* Grun. was most abundant at the two stations east of San Nicolas Island, however. In May *N. pungens* was much the most prominent microplankton at all stations beyond Santa Barbara Island. Considering the small size of this diatom and the probable heavy losses through the net, this is a remarkable showing in a group of rather heavy catches. *N. pungens* retained its prominence in June, *N. seriata* being next most abundant. Considering the opinion of some experts that *N. pungens* and *N. seriata* are merely different forms of the same species, this fact has considerable interest. Catches in June (Table III) were distinctly lighter.

Some details of the August records require more attention than those for other months. For one thing, there is the same relative scarcity of microplankton at the two stations (No. 6 and No. 7) midway between San Clemente and Oceanside, as has already been noted for the August trip of 1917. It is interesting to see that this 1918 cruise also shows a similar scarcity at Station 10 midway between San Juan and Santa Catalina Island. As yet there is no means of knowing whether this is the typical condition in those localities, but there is some probability that it is and the question of the possible explanation is interesting. The distance from land is not such as to make it probable that dearth of organic matter is the cause. Other factors must be responsible for the peculiar condition. The most likely explanation seems to be in some peculiarity of the currents.

Another interesting feature of this August trip is its greater extent beyond San Nicolas. As a matter of convenience in tabulating the records, the stations near and beyond San Nicolas have been arbitrarily grouped together into an "off shore group" by way of contrast to the "south inshore group" between San Diego and Santa Barabara Island and the "north inshore group" north of Santa Cruz Island. This "off shore group" showed large numbers of diatoms to quite a distance beyond San Nicolas, but there was a very marked reduction in numbers at the seven stations farthest out. This reduction was not so marked for the dinoflagellates which kept up their numbers fairly well at the outer stations. The larger number of both diatoms and dinoflagellates in the vicinity of Point Conception is quite noticeable and leads to the question as to whether this indicates a later maximum of microplankton production in that region than we have found farther south. Another feature of this August series is the prominence of *Rhizosolenia calcar avis* Schultze. At about the same time in 1917 *Nitzschia seriata* Cl. was much the most prominent in similar locations. This condition may be due to a difference in seasonal dominants.

From some extra hauls in the August series a comparative study was made of the results of vertical hauling at depths of 200 meters and at the surface in addition to the regular vertical hauls of fifty meters. Too few hauls were taken to be conclusive. In this case the catches were not greatly different except that the surface hauls appeared rather light, and this may have been due to difference in hauling. Vertical hauls of 200 meters and fifty meters were much alike, a fact which indicates that practically all of the microplankton is usually to be found at less depths than 50 meters.

SUMMARY OF RESULTS OF STUDIES OF LATERAL SERIES OF 1917 AND 1918

The summary of the results of these studies requires little space.

1. It is fairly evident that diatoms usually exceed dinoflagellates in numbers and also in bulk. August and September seems to be the only period of the year in which there is extensive exception to this rule. There is some evidence that maxima of dinoflagellates come with minima of diatoms and vice versa.

2. There is strong indication that annual maxima for both diatoms and dinoflagellates occur in the period from April to early June.

3. There is indication that the minimum of diatom production for the year comes in August or September.

4. There is some evidence that the annual minimum of dinoflagellate production comes sometimes in the winter. It would also appear that dinoflagellates are much more unstable in occurrence than diatoms. These differences may prove of distinct value in interpretation of relative distribution of microplankton in the sea.

5. It is very evident that plankton content differs markedly in different areas at a given time and in a given area at different times, even at short intervals.

6. It is very evident that plankton collections taken at long and irregular intervals of time are of little value for statistical study of the biology of the sea.

7. It is necessary to improve and to standardize the methods of collecting. Some way should be found to locate the organisms more accurately, to make the records more nearly continuous, and to place all phases of the work in the hands of skilled, interested and persevering workers. Otherwise the work will remain at the dead level of repeated preliminary activities for which no advance is provided.

8. The problem of marine plankton distribution is almost identical with the problem of marine life, one of the most difficult problems which the human mind can set for itself. It cannot be completely solved in a day, or a year, or a century. It requires a long series of observations at many definite stations in definite areas, made through frequent collections during decades or centuries of time. Continuity of effort both in time and space is essential to real progress toward solution of plankton problems.

9. The marine plankton problem is, for practical purposes, a problem of ecological cycles, associations and successions. It is distinctly general rather than specific in nature.

10. There is little hope of commercial utilization of studies of marine microplankton until methods have been made more exact and more nearly standardized, and until trustworthy records have accumulated to such an extent as to compare favorably with the records which are used for tidal and meteorological predictions. Instead of being content with distinguishing biological sciences from "exact sciences", it would be worth while to see how exact they can be made.

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NOTE ON THE TABLES

On account of the preliminary character of these studies it has not been considered necessary to print the complete records, hence the tables for July 1917 and June 1918 are the only ones included with this paper.

All catches were made by vertical hauls with the number 25 tow net. Hauls for 1917 were from depths of 200 meters to the surface. Those for 1918 were from depths of fifty meters to the surface. Numbers given in tables are estimated totals in each catch of any species or designated group. Where two numbers are given the smaller gives the number of colonies.

The map accompanying the paper by E. L. Michael published in the proceedings of this Conference covers most of the territory referred to in this paper.

TABLE I. PHYTOPLANKTON—FISHERIES SERIES. HAUL NUMBERS F.12—F.93. JULY 14-16, 1917

Haul Numbers	F.23	F.21	F.14	F.12	F.32	F.34	F.42	F.43	F.52	F.54	F.61	F.64	F.72	F.73	F.81	F.84	F.92	F.93
Stations	4	3	2	1	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Ceratium—Total	2,800	500	600	1,600	2,200	2,100	1,700	2,200	2,000	3,750	2,700	500	4,400	2,800	2,000	4,400	4,800	
		(16,000)?																
Peridinium—Total	8,600	19,400	3,100	2,200	7,500	5,800	10,100	5,300	1,850	4,800	7,400	4,500	6,200	5,300	7,400	29,600	18,100	
Dinoflagellates—Number of species	22	9	9	14	23	24	23	20	20	27	24	14	23	19	25	28	17	
Asteromphalus heptactis (Breb.)	2,000	2,000	0	200	2,000	600	2,000	4,000	350	650	4,000	2,000	4,000	10,000	5,000	2,000	4,000	0
Bacteriastrum varians, Lauder	8,000	44,000	4,000	16,000	8,000	4,000	20,000				28,000				8,000	30,000	14,000	920,000
	34,000	178,000	38,000	106,000	30,000	22,000	70,000	6,000	0	0	108,000	0	0	0	25,000	128,000	60,000	5,520,000
Ceratium arietinum Cl.	400	0	200	200	0	0	100	100	250	200	100	0	0	0	100	100	0	0
breve (O. & F.) Sch.	300	0	0	200	300	200	100	100	450	900	500	200	900	500	200	500	400	1,000
candelabrum (Ehr.) Stein	100	0	0	200	100	100	100	500	0	150	0	0	100	0	50	0	0	200
carriense Gour.	0	0	0	0	0	0	0	200	0	0	0	100	0	0	0	0	0	0
contortum (Gour.) Cl.	0	0	0	0	0	0	0	0	50	50	0	0	0	0	0	0	0	0
deflexum (Kof.)	100	0	0	0	100	0	0	0	0	0	0	0	0	0	50	0	100	0
divaricatum Bergh.	100	0	0	0	200	200	400	200	0	150	600	100	700	1,300	200	400	500	200
furca (Ehr.) Clap. Lachm.	0	0	0	0	0	100	100	0	0	100	100	0	300	0	400	500	0	6,400
fusus (Ehr.) Clap. Lachm.	0	0	0	0	100	100	0	0	50	50	100	0	100	200	50	200	300	300
inflexum Schroder	0	0	0	0	0	0	100	0	100	50	100	0	300	100	300	100	100	800
intermedium Jörg.	200	0	200	100	400	400	400	200	400	900	600	100	400	100	0	400	300	0
kofoidii Jörg.	0	0	0	0	100	100	0	100	0	50	100	0	300	200	50	200	0	0
lamillicorne Kof.	100	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
lineatum (Ehr.) Cl.	0	0	0	0	100	100	0	0	250	500	200	0	500	0	200	200	0	0
? longipes (Bail.) Gran	200	0	0	100	0	300	200	0	0	50	0	0	0	0	0	0	0	0
macroceros (Ehr.) Cl.	100	0	0	0	0	100	100	100	150	200	100	0	100	0	0	300	200	0
pnetagonum Gour.	200	0	200	0	0	0	0	500	0	0	0	0	0	0	200	1,100	2,200	400
sp.	0	0	0	0	0	200	0	300	0	0	0	0	. 0	0	200	300	700	200
tripos (O. F. M.) Nitzsch.	900	500	0	800	700	200	100	0	300	400	200	0	700	400	0	100	0	0
Dinophysis acuta Ehr.	0	0	0	0	100	200	500	800	100	400	100	200	300	100	300	200	600	1,200
homunculus Stein	400	200	0	200	0	300	200	0	150	300	100	0	100	0	0	200	1,400	200
rotundata Cl. Lachm.	600	200	0	500	100	0	100	0	0	200	0	0	600	200	0	200	0	1,000
Gonyaulax spinifera Cl. Lachm.	100	0	200	200	100	0	0	200	0	100	100	0	500	200	100	400	1,900	400
Oxytoxum sp.	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peridinium cerasus Pauls.	200	0	0	0	700	1,000	1,200	900	300	1,200	700	1,400	900	700	900	4,400	4,300	10,600
conicum Gran	0	0	0	0	0	200	0	0	0	0	100	100	0	100	100	400	0	
crassipes Kof.	3,000	800	500	0	1,700	1,800	2,400	1,400	500	1,500	300	800	1,900	1,400	1,000	5,600	2,500	13,600
divergens Ehr.	2,000	?10,000	600	500	1,700	500	2,100	1,200	300	600	1,800	600	900	800	800	5,400	2,400	7,600
granii Ostf.	0	0	0	200	0	0	0	600	0	50	200	400	0	300	100	800	100	0
oceanicum Vanh.	700	500	0	500	600	500	1.700	300	50	50	2,500	300	100	300	800	6,400	4,200	4,400
ovatum (Pouch.) Schütt	0	0	0	0	100	0	100	0	0	100	300	300	400	200	100	1,200	700	800
pallidum ? Ostf.	0	0	0	0	500	500	100	0	0	0	0	0	0	0	0	0	0	0
pellucidum (Bergh.) Schütt	900	400	800	0	1,500	700	1,300	100	500	900	900	400	1,100	900	1,100	2,200	1,000	1,800
sp.	600	0	1,200	1,000	400	300	500	500	100	0	0	0	0	0	1,500	2,000	500	0
steinii Jörg.	1,200	500	0	0	300	300	700	300	100	400	600	200	900	600	1,000	1,200	2,400	800
Phalacroma rudgei Murr. Whitt	0	0	0	0	0	0	0	100	50	0	0	0	0	0	0	0	500	0
Prorocentrum micans Ehr.	33,000	500	16,000	8,000	300	700	200	0	300	200	300	0	200	0	100	600	200	200
Biddulphia aurita (Lyngb.)	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0
Chaetoceros affine Lauder	50,000	198,000		8,000	18,000		72,000				272,000	6,000				8,000	580,000	
	1,016,000	1,830,000	0	36,000	92,000	10,000	242,000	0	250	0	1,192,000	16,000	0	0	0	38,000	3,870,000	3,660,000
boreale Btw.	2,000	4,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
breve Schütt	4,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120,000
constrictum Gran					4,000		56,000	14,000			124,000				2,000	33,000	4,000	120,000
	0	0	0	0	16,000	0	222,000	54,000	0	0	696,000	6,000	6,000	0	9,000	124,000	20,000	440,000
contortum Schütt	68,000	62,000			30,000		22,000				116,000				6,000	350,000	460,000	
	482,000	530,000	36,000	14,000	254,000	6,000	92,000	0	0	0	696,000	0	0	0	34,000	2,480,000	3,350,000	13,000,000
criophilum Castr.	162,000	74,000	52,000	120,000	190,000	142,000	512,000	408,000	60,000	52,000	120,000	256,000	156,000	54,000	55,000	42,000	46,000	440,000
	446,000	216,000	160,000	322,000	596,000	382,000	1,468,000	1,166,000	179,000	131,000	388,000	652,000	422,000	132,000	135,000	126,000	134,000	1,440,000
debile Cl.	22,000			4,000			36,000				96,000				4,000	18,000	16,000	600,000
	162,000	?	0	28,000	0	800	162,000	0	0	0	660,000	0	0	0	29,000	136,000	100,000	4,640,000
decipiens Cl.	20,000	30,000	10,000	54,000	30,000	4,000	40,000	10,000		500	68,000				2,000	26,000	16,000	240,000
	82,000	106,000	38,000	172,000	90,000	8,000	146,000	80,000	0	1,000	276,000	500	2,000	0	3,000	82,000	44,000	680,000
didymun Ehr											16,000					4,000		400,000
	0	0	0	0	0	0	6,000	0	0	0	56,000	0	0	0	0	14,000	0	1,600,000
laciniosum Schütt	4,000						16,000				8,000				3,000	270,000	10,000	200.000
	34.000	1,200	0	4,000	0	0	72,000	0	0	0	32,000	800	0	0	14,000	1,690,000	84,000	1,280.000
pelagicum Cl.											24,000						12,000	
	0	0	0	0	0	0	0	0	0	0	72,000	0	0	0	0	0	48,000	200,000
sp.	20,000	40,000	8,000	32,000	12,000			18,000			24,000				2,000	210,000		
	32,000	148,000	32,000	70,000	34,000	1,000	8,000	76,000	0	200	116,000	0	0	0	16,000	920,000	0	5,960,000
volans	4,000	12,000	4,000	6,000	4,000	2,000	10,000	2,000	2,000	0	20,000	0	2,000	6,000	3,000	22,000	12,000	0
Coscinodiscus radiatus Ehr.	18,000	6,000	0	2,000	4,000	4,000	2,000	0	0	100	4,000	2,000	6,000	2,000	2,000	400	6,000	0
subbulliens Jörg.	0	0	2,000	2,000	0	2,000	200	0	2,000	2,000	0	2,000	0	0	150	6,000	2,000	0
sp.	0	2,000	26,000	4,000	4,000	4,000	2,000	8,000	2,000	200	4,000	6,000	0	6,000	0	0	100	40,000
Diatoma sp.	6,000	0	0	0	2,000	10,000	8,000	0	0	1,000	0	0	0	0	2,000	2,000	200	80,000
Eucampia groenlandica Cl.	0	0	0	0	0	0	0	0	0	0	12,000	0	0	0	0	0	0	0
Fragilaria sp.	600	0	0	0	0	0	0	0	0	0	0	0	0	0	14,000	0	0	0
Lauderia borealis Gran	0	0	0	1,800	0	0	2,000	0	0	0	0	0	0	0	0	400.	1,500	120.000
Navicula sp.	0	4,000	0	8,000	14,000	0	0	0	0	0	0	2,000	0	0	0	0		80,000
Nitzschia longissima (Breb.)	536,000	270,000	18,000	64,000	144,000	58,000	80,000	58.000	0	1,000	2,304,000	56,000	34,000	92,000	165,000	130,000	164,000	960,000
seriata Cl.	12,000	42,000	6,000	20,000		18,000	56,000	24,000			616,000	12,000	32,000	58,000	58,000	42,000	86,000	2,800,000
	36,000	110,000	16,000	58,000	4,000	44,000	122,000	44,000	0	3,000	1,752,000	96,000	114,000	156,000	146,000	84,000	254,000	8,200,000
Planktoniella sol (Wallich)	2,000	200	0	2,000	300	600	700	100	1,000	1,000	0	100	400	100	1,000	200	300	400
Rhizosolenia alata Btw.	0	0	0	0	0	0	0	0	0	'0	0	0	0	0	5,000	0	6,000	80.000
hebetata (Bail.)			4,000											4,000				
	4,000	2,000	6,000	6,000	10,000	14,000	8,000	16,000	3,000	7,000	16,000	56,000	6,000	6.000	13,000	2,000	8,000	800
obtusa Hensen	4,000	2,000	2,000	8,000	8,000	6,000	200	0	1,000	3,000	20,000	76,000	46,000	76,000	7,000	16,000	14,000	0
robusta Norm.																		
	300	200	200	200	200	300	0	0	1,000	1,000	0	0	200	100	0	400	0	160,000
styliformis Btw.					8,000									8,000				280,000
	100	0	0	0	10,000	0	0	0	350	1,000	0	2,000	14,000	16,000	10,000	8,000	4,000	
Thalassiosira subtilis (Ostenf.)																4,000		2,400
	48,000	0	0	0	0	0	0	0	0	0	0	20,000	0	1,200	2,000	136,000	3,500	340,000
																colonial?		
Thalassiothrix longissima Cl. & Grun.	2,000	0	4,000	200	4,000	100	100	6,000	3,000	3,000	36,000	14,000	8,000	10.000	22,000	60,000	32,000	80,000
nitzschioides Grun.	6,000			400	6,000	6,000										4,000	400	1,200
	44,000	16,000	6,000	2,000	62,000	48,000	8,000	800	0	400	20,000	16,000	4,000	2.000	8,000	12,000	3,300	9,600
Chaetoceros—Total	446,000	404,000	70,000	218,000	284,000	146,000	754,000	450,000	60,000	52,150	868,000	262,000	156,000	54,000	74,000	960,000	1,144,000	6,800,000
	2,264,000	2,847,000	270,000	652,000	1,086,000	409,000	2,428,000	1,378,000	181,250	132,200	4,186,000	675,300	432,000	138,000	243,000	5,632,000		33,020,000
Diatoms—Total	3,001,000	3,439,400	388,200	916,400	1,384,400	623,500	2,733,200	1,520,900	194,950	156,550	8,466,000	1,025,400	668,600	515,400	670,150	6,219,400		48,504,800
Number of Species	25	20	15	23	21	22	24	14	12	17	22	19	14	14	24	26	26	25

(Divaricatum; combine with tripos?)

TABLE II. PHYTOPLANKTON—FISHERIES SERIES. HAUL NUMBERS F.136—F.187. JULY 29-31, 1917

Haul Numbers	F.148	F.146	F.141	F.136	F.185	F.180	F.178	F.169	F.167	F.159	F.156	F.187
Stations	4	3	2	1	11	10	9	8	7	6	5	12
Ceratium arcuatum Vanh. Jörg.	0	0	0	0	0	200	0	0	50	0	0	0
arietinum Cl.	100	200	50	50	200	100	100	400	100	50	100	0
breve (O&F) Sch.	200	900	100	100	400	0	200	0	300	0	50	200
candelabrum (Ehr.) Stein	0	100	0	0	300	0	0	100	50	50	0	0
carriense Gour.	0	0	0	0	0	0	300	200	0	0	0	0
contortum (Gour) Cl.	0	0	0	100	200	0	0	0	100	0	0	0
deflexum (Kof.)	0	0	0	50	300	0	0	100	50	0	0	0
divaricatum Bergh.	200	1,000	200	0	0	0	0	0	0	0	0	0
extensum Gour.	0	0	0	0	100	0	0	100	0	0	0	0
furca (Ehr.) Clap. Lachm.	100	100	0	300	900	300	400	100	300	150	100	200
fusus (Ehr.) Clap. Lachm.	0	200	0	150	800	600	1,100	700	350	250	350	300
gallicum Kof.	200	0	50	0	0	200	0	100	150	0	50	0
gracile (Gour.)	0	0	0	0	0	0	0	0	50	0	0	0
inflexum Schr.	100	0	50	100	100	300	500	100	250	150	50	0
intermedium Jörg.	200	300	0	0	100	0	0	100	0	50	0	0
karstenii Pavill.	0	0	0	0	100	0	0	0	0	0	0	0
kofoidii Jörg.	0	100	50	0	0	0	0	300	600	0	50	100
lineatum (Ehr.) Cl.	100	200	0	0	0	0	0	0	0	50	250	0
macroceros (Ehr.) Cl.	100	300	0	0	0	0	0	0	50	0	0	0
massilense (Gour.)	100	700	0	50	0	0	0	0	0	0	0	0
pentagonum Gour.	200	700	150	300	2,900	1,000	1,100	800	200	200	0	500
setaceum Jörg.	0	0	0	0	100	0	0	0	0	0	0	0
reticulatum (Pouch.) Cl.	0	0	0	50	0	0	0	0	0	0	0	0
sp.	100	100	0	300	900	300	200	500	150	50	250	100
tenuissimum Kof.	0	0	0	0	0	0	0	0	50	0	0	0
tripos (OFM) Nitzsch.	0	0	0	50	0	100	0	0	0	50	50	0
Dinophysis ellipsoides Kof.	400	500	0	0	0	0	0	0	0	0	0	100
hastata Stein	0	0	0	0	100	100	0	0	200	0	50	100
homunculus Clap. Lachm.	0	0	350	300	100	0	0	0	0	0	150	200
norvegica Clap. Lachm.	0	0	0	0	0	200	0	0	0	50	0	100
rotundata Clap. Lachm.	100	400	300	50	0	0	100	100	0	50	0	100
schuettii Murr Whitt	0	0	0	0	0	0	0	300	50	50	0	0
sp.	0	0	0	0	0	0	0	0	50	0	0	0
Gonyaulax sp.	0	0	50	0	1,300	800	800	900	700	200	500	700
spinifera Clap. Lachm. Dies.	100	300	50	0	0	0	0	0	0	0	0	0
Oxytoxum diploconus Stein	0	0	0	0	0	100	300	200	150	100	0	0
reticulatum (Stein) Buts.	0	0	0	50	0	0	0	0	0	0	0	0
Peridinium cerasus Pauls	1,700	2,400	750	350	900	1,600	300	1,600	550	150	300	1,800
crassipes Kof.	1,000	5,800	1,100	950	600	200	500	600	100	250	800	1,500
divergens Ehr.	1,100	600	300	100	700	200	200	500	300	250	150	400
granii Ostf.	0	100	50	50	0	0	0	0	0	50	100	0
oceanicum Vanh.	400	300	50	50	100	100	100	200	150	50	0	100
ovatum (Pouch) Sch.	0	600	50	0	0	200	100	0	200	150	100	200
pellucidum (Bergh) Sch.	400	1,100	500	500	200	200	500	800	250	150	500	900
sp.	100	200	0	100	100	0	0	300	150	50	150	500
steinii Jörg.	300	700	150	100	300	200	400	100	50	50	200	400
tenuissimum Kof.	0	0	0	0	300	200	100	400	300	150	0	500
Phalacroma rudgei Murr. Whitt	0	0	50	0	200	0	0	200	200	0	0	100
Prorocentrum micans Ehr.	10,000	31,500	400	0	200	100	100	0	100	50	100	300
Pyrocystis lunula Schütt	0	0	50	0	0	0	100	0	200	0	0	0
Totals—Ceratium	1,800	5,200	700	1,250	5,100	3,300	3,900	3,600	2,800	1,050	1,300	1,400
Totals—Peredinium	5,000	11,800	2,950	2,200	3,200	2,900	2,200	4,500	2,050	1,300	2,300	6,300
Number of Species	23	26	23	22	27	22	21	26	33	26	22	23
Actinoptychus splendens (Ehr.)	0	0	0	0	0	.0	100	100	50	50	0	0
Asteromphalus heptactis (Breb.)	200	2,000	1,000	500	400	2,000	200	400	500	500	0	400
Bacteriastrum elongatum Cl.							4,000	5,000	1,000	500	500	
	0	0	0	0	2,000	0	18,000	18,000	3,500	1,500	1,000	0
varians Lauder		3,000	3,500	2,000	3,000		3,000	4,000	1,000	1,500		
	2,000	4,000	13,500	8,000	20,000	0	8,000	11,000	4,000	4,000	500	1,000
Biddulphia biddulphiana (Smith)	0	0	0	0	200	0	0	0	0		0	0
Chaetoceros affine Lauder	0	3,000	4,500	9,000	15,000	4,000	6,000	5,000	5,000	2,000	3,000	22,000
	0	11,000	18,500	44,500	56,000	10,000	21,000	28,000	22,000	10,000	14,000	95,000
atlanticum Cl.	0	0	0	1,500	0	0	0	0	0	0	0	0
constrictum Gran				1,500					1,000	500	1,500	
	0	0	0	9,500	0	800	0	0	4,000	2,000	4,000	0
contortum Schütt			3,000	1,500	16,000	17,000	6,000	25,000	13,000		6,000	11,000
	500	12,000	14,500	9,500	87,000	96,000	31,000	195,000	85,000	19,500	36,500	54,000
criophilum Castr.	54,000	34,000	14,500	14,000	2,000		2,000	2,000				9,000
	133,000	95,000	38,000	32,000	6,000	6,000	3,000	7,000	0	500	3,500	25,000
criophilum f. volans (Sch.)	8,000	8,000	8,500	2,500	2,000	4,000	0	7,000	8,000	4,500	5,500	1,000
debile Cl.	2,000	3,000	1,000	2,000			5,000	3,000	3,500		1,000	2,000
	6,000	27,000	12,000	14,500	10,000	6,000	28,000	17,000	16,500	0	6,500	10,000
decipiens Cl.				2,000	4,000		3,000		2,000		1,500	
	2,000	0	1,500	5,000	15,000	3,000	8,000	2,000	5,500	5,000	4,000	6,000
dichaeta Ehr.	0	0	0	0	4,000	0	0	0	3,000	0	0	0
didymum Ehr.												2,000
	0	2,000	1,000	1,000	0	0	1,000	0	0	0	2,000	4,000
furca Cl.	0	0	0	0	1,000	0	0	0	1,500	0	0	0
gracile Sch.	0	0	0	0	1,000	0	3,000	4,000	5,500	1,500	0	1,000
neapolitanum Schr.							6,000	4,000	8,500	1,500		
	0	0	0	0	3,000	3,000	13,000	13,000	21,000	2,500	0	6,000
pelagicum Cl.	0	0	0	0	0	2,000	1,000	0	3,000	0	0	0
pendulum Btw.	0	0	0	0	3,000	0	0	0	0	0	0	0
peruvianum Btw.	0	0	0	0	3,000	1,000	5,000	7,000	0	0	0	9,000
ralfsii Cl.					12,000	5,000	5,000	13,000	8,500	2,000		4,000
	0	0	0	0	26,000	12,000	13,000	34,000	22,000	7,000	0	8,000
sp.		5,000	5,500	3,500	21,000	16,000	15,000	25,000	12,500	4,500	4,000	35,000
	0	12,000	17,000	11,000	66,000	34,000	38,000	102,000	30,500	14,000	9,000	86,000
teres Cl.	0	0	0	1,000	0	0	4,000	0	0	0	0	0
Corethron criophilum Castr.											1,000	
	0	0	0	1,500	3,000	4,000	2,000	2,000	3,000	2,000	1,000	4,000
Coscinodiscus radiatus Ehr.	600	1,000	500	550	0	100	200	100	50	0	100	1,000
sp.	4,000	4,000	600	350	1,000	700	300	5,000	2,000	100	250	4,000
Dactyliosolen tenuis Cl.						4,000	10,000	8,000	7,000			10,000
	0	0	50	50	2,000	15,000	49,000	34,000	10,000	2,000	0	46,000
Diatoma sp.		3,000						4,000	1,000			
	0	9,000	1,000	0	1,000	0	0	10,000	2,000	0	50	0
Eucampia groenlandica Cl.	0	0	0	0	0	0	0	0	1,500	0	0	0
Fragilaria sp.												200
	0	0	0	50	0	0	0	0	0	0	0	800
Hemiaulus hauckii Grun.					5,000	2,000	3,000	1,000				
	0	0	0	0	13,000	5,000	5,000	5,000	0	0	0	0
Navicula sp.	0	0	0	1,000	4,000	6,000	11,000	5,000	5,500	1,500	0	0
Nitzschia longissima (Breb.)	636,000	159,000	22,500	4,000	6,000	6,000	21,000	11,000	3,500	1,000	500	4,000
seriata Cl.	15,000	21,000	24,000	9,500	5,000	3,000	13,000	20,000	9,000	5,000		17,000
	40,000	41,000	64,500	23,500	9,000	6,000	36,000	68,000	31,000	13,000	0	51,000
Planktoniella sol (Wallich)	0	300	0	500	1,000	800	1,000	600	7,500	500	200	0
Rhizosolenia alata Btw.	0	14,000	7,000	500	2,000	0	100	2,000	4,500	3,000	1,000	5,000
faroeensis Otsenf.	0	0	0	0	0	0	0	0	0	0	50	0
fragillima Bergon.	0	0	0	0	0	0	300	0	0	0	0	0
hebetata (Bail).	4,000	10,000	1,000	3,500	5,000	3,000	2,000	7,000	5,500	1,500	2,500	2,000
obtusa Hensen	12,000	34,000	4,500	0	4,000	1,000	2,000	2,000	3,500	0	1,000	4,000
robusta Norm.	100	1,000	200	0	0	0	0	0	0	0	0	0
sp.	0	0	0	0	1,000	100	2,000	100	1,000	0	0	1,000
styliformis Btw.									1,000			
	3,000	1,000	3,000	2,000	2,000	5,000	1,000	3,000	1,500	100	500	4,000
Thalassiosira subtilis (Ostenf.)		1,000										
	200	10,000	0	0	0	0	0	0	0	0	0	4,000
Thalassiothrix acuta Karsten	0	0	0	0	5,000	2,000	11,000	0	0	0	0	10,000
longissima Cl. & Grun.	4,000	15,000	6,500	500	2,000	2,000	3,000	12,000	4,500	3,500	1,500	4,000
nitzschoides Grun.	200						5,000	7,000	1,000			
	1,100	3,000	0	250	0	0	9,000	22,000	2,500	0	0	200
Totals—Chaetoceros	56,000	45,000	28,500	34,500	70,000	42,000	48,000	77,000	54,000	15,650	17,000	85,000
	149,500	167,000	111,000	132,000	283,000	177,800	169,000	416,000	222,000	66,500	85,000	304,000
Totals—Diatoms	856,700	471,000	248,350	178,750	365,600	236,500	351,200	633,300	319,100	100,750	93,650	450,000
Number of Species	18	23	22	27	34	28	35	32	34	25	23	30

TABLE III. PHYTOPLANKTON—FISHERIES SERIES. HAUL NUMBERS F.553—F.606. JUNE 27–29, 1918

Haul Numbers	F.553	F.555	F.558	F.561	F.564	F.567	F.570	F.573	F.576	F.579	F.582	F.585	F.588	F.591	F.594	F.597	F.600	F.603	F.606
Stations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Actinoptychus undulatus (Bail.)	0	0	0	0	0	0	0	0	400	0	0	0	0	0	4,000	0	0	0	0
Asteromphalus heptactis (Breb.)	0	2,000	0	0	4,000	8,000	16,000	16,000	8,000	400	8,000	24,000	8,000	8,000	2,400	8,000	4,000	800	0
Bacteriastrum elongatum Cl.	2,000		12,000		8,000	8,000 ,	16,000				4,000			8,000			12,000	16,000	4,000
	8,000	2,000	28,000	0	20,000	20,000	368,000	0	4,000	0	8,000	0	0	24,000	0	0	48,000	36,000	16,000
varians Lauder	2,000	2,000	400		4,000	4,000		16,000	8,000	8,000	4,000	800	16,000		4,000			12,000	
	4,000	4,000	2,800	0	16,000	28,000	0	64,000	24,000	20,000	8,000	8,000	32,000	0	28,000	0	0	24,000	0
Biddulphia aurita (Lyngh.)	200	200											800						
	200	200	0	0	0	0	0	0	0	0	0	0	1,600	0	0	0	0	0	0
punctata (Grev.)	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mobiliensis (Bail.)	400	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaetoceros A	0		4,000		4,000	4,000	96,000	112,000	8,000	12,000	32,000	48,000	24,000			4,000	20,000	8,000	8,000
	0	0	16,000	0	36,000	36,000	528,000	480,000	40,000	68,000	184,000	272,000	96,000	0	0	16,000	104,000	24,000	28,000
breve Schütt		200				8,000	32,000	1,600	8,000	20,000	12,000		8,000				4,000		
	0	600	0	0	0	28,000	144,000	11,200	16,000	60,000	36,000	0	24,000	0	0	0	20,000	0	0
constrictum Gran.						800	1,600			4,000	4,000		8,000						
	0	0	0	0	0	9,200	17,600	0	0	52,000	28,000	0	40,000	0	0	0	0	0	0
contortum Schütt		2,000	4,000						8,000		4,000	16,000			400	4,000	4,000	4,000	4,000
	0	14,000	44,000	0	0	0	0	0	84,000	0	20,000	96,000	0	0	1,600	28,000	12,000	12,000	24,000
convolutum Castr.	4,000	4,000	4,000		8,000	20,000	176,000	96,000	12,000	20,000	24,000	8,000	8,000	8,000	8,000	12,000		16,000	4,000
	22,000	10,000	8,000	0	28,000	52,000	384,000	320,000	28,000	60,000	64,000	24,000	40,000	32,000	36,000	36,000	0	32,000	20,000
criophilum Castr.	2,000	2,000	8,000			8,000	32,000	160,000	64,000	112,000	8,000	16,000	80,000	72,000	76,000	60,000	88,000	72,000	60,000
	2,000	6,000	12,000	0	0	24,000	48,000	432,000	120,000	216,000	16,000	48,000	208,000	192,000	240,000	180,000	184,000	192,000	136,000
criophilum f. volans (Sch.)	0	6,000	0	0	8,000	16,000	208,000	112,000	12,000	40,000	8,000	40,000	120,000	120,000	16,000	20,000	32,000	24,000	0
curvisetum Cleve	2,000					4,000		64,000			8,000	24,000	800				4,000	4,000	4,000
	6,000	0	0	0	0	8,000	0	304,000	0	0	72,000	120,000	8,000	0	0	0	40,000	16,000	12,000
decipiens Cl.	200	6,000	4,000		20,000	24,000	48,000	64,000	28,000	40,000	20,000	800		16,000	20,000	12,000	28,000	8,000	28,000
	400	26,000	12,000	0	44,000	76,000	240,000	304,000	72,000	176,000	60,000	3,200	0	24,000	56,000	48,000	80,000	16,000	72,000
densum Cleve	6,000	6,000	4,000	100	800					8,000				16,000				8,000	
	14,000	22,000	4,000	200	1,600	* 0	0	0	0	28,000	0	0	0	64,000	0	0	0	32,000	0
diadema (Ehr.)						4,000												4,000	
	0	0	0	0	0	12,000	0	0	0	0	0	0	0	0	0	0	0	16,000	0
dichaeta Ehr.		2,000				8,000	48,000	32,000	8,000	120,000	64,000	8,000					80,000	4,000	4,000
	0	4,000	0	0	0	16,000	144,000	80,000	24,000	336,000	304,000	16,000	0	0	0	0	260,000	8,000	16,000
didymum Ehr.		4,000			4,000	8,000	64,000	16,000		28,000	12,000		800		8,000	4,000	20,000	400	400
	0	16,000	0	0	8,000	20,000	240,000	96,000	0	104,000	72,000	0	3,200	0	32,000	16,000	80,000	1,600	400
difficile Cleve					4,000						8,000							4,000	
	0	0	0	0	8,000	0	0	0	0	0	32,000	0	0	0	0	0	0	12,000	0
furca Cl.	200																		4,000
	600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,000
pelagicum Cl.		2,000	4,000			8,000	16,000			16,000	8,000								4,000
	0	4,000	12,000	0	0	56,000	336,000	0	8,000	32,000	40,000	0	0	0	0	0	0	0	12,000
pendulum Kars.	0*	4,000	4,000	0	0	12,000	64,000	192,000	20,000	0	12,000	8,000	24,000	16,000	4,000	0	8,000	12,000	8,000
peruvianum Btw.	0	400	0	0	20,000	0	0	0	4,000	192,000	4,000	0	0	16,000	12,000	0	0	12,000	8,000
pseudocrinitum Ostenf.									4,000					8,000	4,000				
	0	0	0	0	0	0	0	0	16,000	0	0	0	0	32,000	16,000	0	0	0	0
scolopendra (Cleve)			12,000		4,000	4,000	3,200	112,000		8,000	28,000			800	8,000		20,000	20,000	20,000
	0	0	116,000	0	80,000	40,000	52,800	928,000	0	76,000	288,000	0	0	11,200	64,000	0	184,000	208,000	188,000
sp.	10,000	8,000	60,000		32,000	60,000	336,000	160,000	64,000	272,000	32,000		48,000	72,000	40,000	36,000	32,000	72,000	60,000
	10,000	24,000	76,000	0	80,000	144,000	592,000	272,000	184,000	312,000	52,000	0	56,000	120,000	92,000	52,000	88,000	176,000	100,000
teres Cl.							48,000												
	0	0	0	0	0	0	176,000	0	0	0	0	0	0	0	0	0	0	0	0
(X)			4,000					1,600											
	0	0	20,000	0	0	0	0	12,000	0	0	0	0	0	0	0	0	0	0	0
Corethron valdiviae Karsten	0	0	0	0	20,000	0	0	0	400	0	0	0	0	0	0	0	0	0	0
Coscinodiscus granii Gough	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0
radiatus Ehr.	0	400	800	0	0	0	0	0	400	800	400	800	800	0	400	1,600	1,600	400	800
sp.	0	0	400	0	400	0	0	0	4,000	0	400	800	0	0	0	4,000	1,200	400	0
Dactyliosolen antarcticus Castr.		2,000	2,000		8,000			16,000	8,000		8,000		8,000		4,000	4,000	400	12,000	4,000
	0	8,000	8,000	0	36,000	0	0	64,000	16,000	0	16,000	0	8,000	0	16,000	8,000	800	52,000	12,000
Ditylium sp.	2,000	0	400	0	0	0	0	0	0	0	400	0	800	1,600	0	4,000	8,000	800	0
Eucampia zoodiacus Ehr.	2,000		4,000														4,000		
	4,000	0	16,000	0	0	0	0	0	0	0	0	0	0	0	0	0	20,000	0	0
Eupodiscus argus (Ehr.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0	400
Fragilaria sp.	0	0	0	0	0	0	6,400	0	0	0	0	0	0	0	0	0	0	0	0
Grammatophora marina (Lyng.)	0	0	0	0	0	0	0	0	0	0	1,200	0	24,000	0	0	0	0	0	0
Lauderia borealis Gran.	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lithodesmium undulatum Ehr.	600	2,000																	
	2,000	2,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Navicula sp.	0	0	0	0	0	4,000	16,000	0	4,000	0	4,000	0	0	0	0	8,000	0	0	0
Nitzschia longissima (Breb.)	0	4,000	4,000	1,000	8,000	64,000	336,000	240,000	184,000	164,000	104,000	88,000	176,000	560,000	88,000	328,000	220,000	266,000	320,000
pelagica	0	0	0	0	0	124,000	592,000	160,000	4,000	4,000	304,000	120,000	128,000	16,000	32,000	40,000	20,000	4,000	0
pungens (Grun.)		24,000	20,000	4,000	44,000	310,000	880,000	1,520,000	232,000	160,000	280,000	960,000	192,000	304,000	136,000	360,000	840,000	240,000	152,000
	0	56,000	48,000	7,000	144,000	600,000	2,320,000	4,400,000	600,000	424,000	820,000	1,960,000	424,000	848,000	368,000	740,000	1,960,000	600,000	280,000
seriata Cl.	4,000		4,000		4,000	104,000	320,000	176,000	16,000	12,000	160,000	208,000	72,000	304,000	32,000	8,000	140,000	128,000	120,000
	8,000	0	8,000	0	16,000	272,000	1,360,000	608,000	36,000	20,000	490,000	736,000	256,000	880,000	88,000	28,000	640,000	408,000	272,000
Planktoniella sol (Wallich)	200	200	0	0	0	1,200	0	1,600	800	0	0	800	800	0	4,000	800	4,000	4,000	0
Pleurosigma elongatum W. Sm.	2,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhizosolenia alata Btw.	4,000	12,000	24,000	0	28,000	32,000	32,000	48,000	20,000	4,000	68,000	40,000	80,000	48,000	20,000	24,000	68,000	52,000	32,000
calcar avis Schuetz	62,000	650,000	272,000	8,000	608,000	76,000	304,000	144,000	28,000	36,000	60,000	40,000	108,000	144,000	68,000	84,000	140,000	88,000	52,000
cylindrus (Cl.)	0	0	0	0	0	0	0	0	0	0	12,000	8,000	0	0	4,000	0	8,000	12,000	0
hebetata (Bail.)	0	*4,000	*8,000	0	0	*8,000	†48,000	†3,200	*16,000	*8,000	*8,000	*32,000	*40,000	0	*16,000	*12,000	*24,000	*40,000	*28,000
obtusa Hensen	0	10,000	0	1,000	28,000	4,000	64,000	64,000	24,000	20,000	80,000	48,000	80,000	64,000	32,000	8,000	80,000	48,000	8,000
robusta Norm.	0	0	0	0	0	0	0	0	0	0	800	0	800	0	400	0	0	0	400
stolterfothii Perag.	0	0	0	0	0	0	0	1,600	0	0	0	8,000	0	0	0	0	0	0	0
styliformis Btw.	0	2,000	16,000	0	12,000	16,000	0	16,000	4,000	4,000	20,000	32,000	16,000	16,000	4,000	8,000	12,000	12,000	8,000
Stephanopyxis palmeriana (Grun.)											400					4,000			
	0	0	0	0	0	0	0	0	0	0	1,600	0	0	0	0	16,000	0	0	0
Thalassiosira condensata Cleve											4,000								
	0	0	0	0	0	0	0	0	0	0	40,000	0	0	0	0	0	0	0	0
gravida Cleve								3,200			400								
	0	0	0	0	0	0	0	9,600	0	0	800	0	0	0	0	0	0	0	0
subtilis (Ostenf.)			400			800		1,600	1,200	800			800		4,000	400	4,000		4,000
	0	0	6,000	0	0	26,000	0	30,400	15,200	7,600	0	0	10,400	0	100,000	3,200	16,000	0	180,000
acuta Karsten	2,000	8,000	28,000	100	28,000	124,000	1,840,000	1,088,000	64,000	92,000	610,000	640,000	328,000	128,000	168,000	116,000	300,000	92,000	56,000
frauenfeldii (Grun.)		8,000	4,000		28,000	40,000	176,000	224,000	8,000	60,000	200,000	152,000	104,000	32,000	24,000	24,000	160,000	44,000	40,000
	0	22,000	12,000	0	88,000	96,000	368,000	592,000	24,000	128,000	430,000	432,000	216,000	80,000	56,000	68,000	440,000	100,000	104,000
longissima Cl. & Grun.	200	6,000	1,200	0	40,000	16,000	112,000	176,000	0	52,000	28,000	24,000	56,000	56,000	36,000	12,000	32,000	20,000	12,000
nitzschioides Grun.						8,000	32,000	16,000	400	16,000	8,000	16,000			4,000	8,000	8,000	8,000	12,000
	0	0	0	0	0	28,000	128,000	32,000	1,600	64,000	24,000	72,000	0	0	20,000	24,000	24,000	48,000	36,000
Totals—Diatoms	154,200	930,000	808,000	17,300	1,410,000	2,096,400	11,084,800	11,302,400	1,711,200	2,804,400	4,439,600	4,941,600	2,614,400	3,500,800	1,724,900	1,941,600	5,164,000	2,702,000	2,050,000
Totals—Chaetoceros	24,400	36,200	108,000	100	76,800	160,800	900,800	821,200	204,000	660,000	264,000	128,000	177,600	192,800	164,400	132,000	300,000	224,400	200,400
	55,000	137,000	324,400	200	313,600	549,800	3,174,400	3,544,000	628,000	1,752,000	1,292,000	627,000	619,200	627,200	569,600	396,000	1,092,000	793,600	632,400
No. of Species	22	32	30	6	26	34	30	33	37	31	44	29	32	24	33	30	36	38	32
Ceratium arietinum Cl.	0	0	400	0	0	0	0	1,600	0	0	0	0	0	0	0	400	0	0	0
belone (Cl.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0	0	0
breve (Ostenf et Schm.) Sch.	0	400	400	0	0	0	0	1,600	400	0	400	800	0	0	400	0	400	0	1,200
extensum Gour.	0	0	400	0	0	0	0	1,600	0	0	0	0	0	0	0	0	0	0	0
furca (Ehr.) Clap. Lachm.	12,000	400	0	100	800	400	0	3,200	400	0	400	0	8,000	0	0	0	1,200	400	400
fusus (Ehr.) Clap. Lachm.	400	2,000	400	1,000	1,600	4,000	16,000	16,000	0	0	800	0	0	800	400	800	0	0	0
inclinatum (Kof.)	0	200	1,200	100	4,000	0	0	0	0	400	2,000	0	0	0	0	0	0	0	0
intermedium Jörg.	400	0	0	0	800	0	0	0	0	0	0	0	0	800	0	0	0	0	0
kofoidii Jörg.	0	200	1,200	1,000	800	400	1,600	0	0	0	400	1,600	0	0	0	400	0	0	0
lamellicorne Kof.	0	0	0	0	0	0	0	0	0	0	0	0	0	800	400	0	0	0	0
longipes Bailey	0	200	0	0	0	0	0	0	400	400	400	0	0	0	0	0	400	0	0
macroceros (Ehr.) Cl.	0	200	0	0	400	400	0	1,600	0	400	0	0	0	0	0	0	400	0	0
massiliense (Gour.)	400	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
molle	0	0	0	0	0	0	0	0	0	0	0	0	1,600	0	0	400	0	0	0
pentagnum Gour.	0	0	400	0	0	400	0	16,000	0	400	0	0	800	0	400	0	1,600	0	400
trichoceros (Ehr.) Kof.	0	0	0	0	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tripos (O. F. M.) Nitzsch	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	400	4,000	0
Dinophysis acuminata Clap. Lachm.	400	0	0	0	0	0	0	0	0	0	0	800	0	0	0	0	0	0	0
homunculus Stein	4,000	4,000	4,000	1,000	2,000	1,200	0	32,000	800	800	4,000	4,000	1,600	800	8,000	8,000	800	800	0
rotundata Clap. Lachm.	200	200	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0
schütii Murr. u. Whitt.	0	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0
Gonyaulax polyedra Stein	1,000	0	0	0	0	0	16,000	0	0	0	0	0	0	0	0	0	0	0	400
polygramma Stein	0	0	0	0	0	0	0	0	0	0	0	0	800	0	0	0	0	0	0
spinifera Clap. Lachm. Dies.	0	0	0	100	400	4,000	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnodinium lohmanni Pauls	200	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peridinum cerasus Pauls	0	0	800	100	800	0	0	0	0	0	0	0	0	0	800	8,000	1,200	400	4,000
crassipes Kof.	6,000	200	400	200	400	400	0	0	4,000	0	1,200	800	1,600	2,400	8,000	800	1,200	800	800
depressum Bail.	600	0	0	0	0	0	0	0	0	0	0	16,000	0	0	0	0	0	400	400
divergens Ehr.	2,000	400	400	0	4,000	800	0	0	1,200	400	800	1,600	800	1,600	800	4,000	3,600	12,000	1,200
granii Ostf.	0	0	0	100	0	400	0	0	0	0	0	0	0	0	0	0	4,000	400	0
oceanicum Vanh.	2,000	200	0	1,000	400	0	0	0	4,000	400	0	0	800	0	0	400	400	800	0
pellucidum (Bergh.) Schütt	4,000	400	0	200	0	0	16,000	1,600	1,200	0	1,200	0	0	0	400	800	0	1,600	0
pentagonum Gran.	0	0	0	100	0	0	0	0	0	0	0	0	0	0	800	400	400	0	0
sp.	0	4,000	400	1,000	0	400	0	0	800	800	0	1,600	1,600	2,400	800	0	2,000	0	0
steinii Jörg.	2,000	0	0	0	0	400	1,600	1,600	0	0	0	0	0	0	0	1,200	0	0	800
Phalacroma rudgei Murr. Whitt.	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	400	0	0
Podolampas palmipes Stein	200	0	200	100	4,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prorocentrum micans Ehr.	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyrocystis lunula Schütt	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triposolenia bicornis Kof.	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	800	0	0
Totals—Dinoflagellates	36,200	13,200	11,600	6,100	21,600	13,600	51,200	78,800	13,200	4,800	12,000	12,800	17,600	9,600	21,200	26,000	19,200	21,600	9,600
No. of Species	17	15	15	14	15	13	5	10	9	10	11	8	9	7	11	13	16	10	9

* = (ss)
† = (h)