a sample to Professor Jacob Berzelius, the famous Swedish chemist, at Stockholm, but none of their answers were especially illuminating. In spite of this disappointment he showed in his book an extensive knowledge of the literature of the physiology of digestion, and by his researches he is clearly a pioneer. The most important of his findings have been corroborated by Pavlov and others. Small matter is it that he failed to realize that contractions were associated with the pangs of hunger or that the seat of hunger was in the nervous system. He did not discover the existence of reflex or psychic secretion, or that of a continuous and constant secretion, or comprehend the function of saliva in digestion. He also missed the storage function of the stomach, but he paved the way for these and other findings by subsequent investigators.

His remaining years are soon recorded. He resigned from the army in 1839, as Lovell's successor. Dr. Thomas Lawson, not discerning properly the importance of Beaumont's investigations, had ordered him sent to Florida. The acceptance of this post was obviously impossible, so Beaumont, resigning from the army, settled in St. Louis. Here he soon acquired an extensive practice and was busily engaged therein until an accident hastened his death, which occurred on April 25, 1853. His remains rest in the Bellefontaine Cemetery in St. Louis, but his fame belongs to the world.

The following estimate of him was written by one who knew him well:

> He was gifted with strong natural powers, which, working upon an extensive experience in life, resulted in a species of natural sagacity, which, as I suppose, was something peculiar in him, and not to be attained by any course of study. His temperament was ardent, but never got the better of his instructed and disciplined judgment, and whenever or however employed, he ever adopted the most judicious means of attaining ends that were always honorable. In the sick-room he was a model of patience and kindness; his intuitive perceptions, guiding a pure benevolence, never failed to inspire confidence, and thus he belonged to that class of physicians whose very presence afford nature a sensible relief.

May this appropriately inscribed tablet recall to coming generations in Plattsburgh the memory of this most distinguished man, for here he entered the army, here he began the practice of medicine among its inhabitants, here he married his wife and here he conducted two of his now world-famous series of experiments upon the physiology of digestion.

TEN YEARS OF STATISTICAL STUDIES OF MARINE PHYTOPLANKTON AT THE SCRIPPS INSTITUTION OF OCEANOGRAPHY

By Professor WINFRED EMORY ALLEN
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INTRODUCTORY

THIS work was begun in July, 1919, at the invitation and recommendation of Dr. W. E. Ritter, at that time director of the Scripps Institution for Biological Research which later became the Scripps Institution of Oceanography of the University of California. My preliminary survey of possibilities in the summers of 1917 and 1918 had indicated that diatoms and dinoflagellates constituted material fairly favorable for statistical studies, and that arrangements for handling this material effectively could be made more satisfactorily than for any other organisms in the ocean plankton. My original assumption was that the work should be carried with a continuity as high as practicable over a period of at least ten years.

PURPOSES

The fundamental purpose in mind at the beginning of these investigations was to obtain definite series of records of distribution in time and space of diatoms and dinoflagellates as major groups of microplankton organisms. Incidental to the accumulation of such records and consequent to appropriate stages in that accumulation an indefinite number of dependent and interdependent aims was recognized. As examples of these a few may be mentioned as follows:

To determine relative prominence of constituent organisms in general or in particular localities.
To estimate ranges of productivity of particular localities or depth levels or time periods.
To characterize fluctuations in character of populations.
To identify observable causes of specific prominence.
To identify normal trends and periodic series in natural history of the oceanic complex.
To determine observable interrelationships of organisms and their environment.
To determine observable influences involved in stabilizing or destabilizing such interrelationships.
To identify indicators of environmental influences.
To identify food chains.
To identify injurious species of diatoms and dinoflagellates.

SOURCES OF MATERIAL

My original intention was to confine investigations mainly to Southern California material, on the assumption that local collections could be more certainly obtained with a continuity sufficient to be dependable for distributional studies. But, for a number of reasons, material from other regions has accumulated to an extent more than half that from Southern California sources. One series of collections in the East Pacific was carried as far south as Callao, Peru, one extended across the Pacific to Australia, two or three short series were obtained in the Hawaiian region, several in the Alaskan region, several between San Francisco and Puget Sound and several south of San Francisco to the Gulf of California. Alongshore stations for daily collecting have been occupied ten years at La Jolla, nearly ten years at Pt. Hueneme (near Ventura), six years at Oceanside, two years at Balboa (south of Long Beach), four years at Farallone Islands and three years at Scotch Cap Light in the Aleutian Islands.

A much larger number of collections has been obtained inshore than was taken offshore or on the high seas because of the greater ease of maintaining continuity in the series. Judging from the willingness to cooperate shown by officials and officers of the U. S. Navy, U. S. Coast and Geodetic Survey, U. S. Bureau of Lighthouses, mercantile vessels and private yachts, it would have been easy to obtain surface collections by institution methods in numbers of thousands per year for the past ten years. Some of these would have had continuity to an important degree though not so dependable as that of the daily collections at inshore stations. But the laboratory resources of the institution have been too narrowly limited to encourage their accumulation.

Relatively few series of collections for phytoplankton study have been obtained from levels below the surface of the sea. Most of these have been from stations near La Jolla and San Diego, but a few to depths of sixty meters have been made as far north as Santa Barbara by the institution boat and in Monterey Bay by Dr. H. B. Bigelow. Certain series at La Jolla have been carried to a depth of one hundred meters.

NUMBERS OF CATCHES

A few series of collections have been short, including only twenty to fifty catches, but most have included from one hundred to six hundred catches. The total number of catches obtained in the ten years by the measured water method has reached almost twenty thousand. Of these, over twelve thousand have been taken in the Southern California region, nearly two thousand in Alaskan waters, about four thousand from central California to Puget Sound and over one thousand from other regions. Reports have been written and published for studies of about twelve thousand catches.

Relatively few of these catches have been large, probably not a hundred reaching one million cells per liter, and probably not a thousand reaching one hundred thousand cells per liter. However, it should be noted that any method involving rapid filtration may permit escape of large numbers of smaller diatoms and dinoflagellates, especially in thin or median populations.

METHODS OF COLLECTING AND EXAMINING MATERIAL

From previous experience with fresh-water plankton and with preliminary studies on marine plankton it was recognized at the first that methods of collecting distinctly different from those of the tow-net must be adopted. After several weeks of study and experiment it was decided to use the method of filtering a measured volume of water by pouring it through a small conical net of No. 25 bolting silk (diameter of mesh openings about 50 to 100 micra). This method has been used almost exclusively in obtaining phytoplankton material for the institution since September, 1919. At the surface level the selected quantity of water has been dipped up by a pail at fixed stations and by a canvas bucket from steamers at full speed. At subsurface levels closing bottles have been used, mainly those designed by Kofoid or by Allen.

Centrifuges have been used to some extent, mainly for records of volume. In one series no filtration or condensation was attempted, the abundance of diatoms being so great that it was easier to estimate numbers by examination of the water as dipped from the surface of the sea. At present a series of collections parallel to the regular La Jolla pier series is being obtained by allowing the plankton material to settle in one liter of sea-water after adding a killing fluid.

The Allen closing bottle of five liters capacity was originally designed for use by hand from a rowboat, but it was found so convenient and satisfactory in routine boat work with hoisting equipment that it has been used regularly for phytoplankton for the last three years. A series of subsurface catches at fifteen depths from surface to one hundred meters has been obtained with it in thirty-two minutes.

No method of collecting plankton can be completely satisfactory for all purposes, or for all of the diverse components of a mixed population. In choosing the methods finally adopted as standard I recognized four desiderata: tolerable accuracy, sim-

plicity, speed of operation and low cost. For material appropriate to its uses the measured volume, silk filtration method has proved to be not only many times as accurate as the tow-net, but for diatoms it gives results well within the limits of error of sampling. The simplicity, speed and low cost of the method have all proved to be extremely valuable for most important reasons: *i.e.*, collecting could be done by many different kinds of people, it could be done under very difficult conditions, it could be done in many different places and it could be maintained with high degrees of continuity.

Aside from study necessary for identification of specimens, the method of examination of material has consisted mainly of the enumeration of individual colonies and cells in a selected fraction of a catch in a Sedgwick-Rafter counting cell. From this enumeration estimated numbers per liter have been calculated and the results tabulated and otherwise recorded for interpretation. Since cells and colonies of any species differ markedly in size and since this difference is even greater between representatives of different species and genera, it seems to be fairly obvious that such census taking does not reveal the amount of food for fishes and other animals available in a sample of sea-water, and that it gives no idea of differences in mass production in different waters sampled. However, it seems equally obvious that if large numbers of cells (even though small in size) are being produced there must be some support for production in the water sampled. Furthermore, the census records afford a basis for comparison of conditions of prominence of different species, and they avoid the inclusion of unrecognizable débris which must occur in strictly volumetric studies. The census-taking method of study of plankton material is onerous, time-consuming and otherwise disagreeable, but in my experience it seems to be far superior to other methods of investigation in plankton ecology, although volumetric and cultural studies may be made to yield valuable supplementary information.

RESULTS OF INVESTIGATIONS

In my opinion, one of the most important results of these ten years of work is the showing that a great deal of highly valuable scientific investigation of marine organisms can be done with simple equipment and at low cost.

In a particular locality seasonal distribution of microplankton organisms may differ widely from year to year, and the relative numbers of representatives of component species may differ widely from month to month and year to year.

In general, diatoms have been found much more abundant than dinoflagellates, but this numerical relationship is sometimes reversed for a considerable period. Furthermore, small dinoflagellates show heavier losses than diatoms at the practicable speed of filtration.

Maximum abundance of both diatoms and dinoflagellates tends to occur in spring but it may occur at another season in certain years in particular localities.

Abundance is usually very low in May, August and December, the condition having fewer exceptions for August than for the other two months.

Very low abundance of diatoms and dinoflagellates or relatively high abundance of diatoms may occur in any month in Southern California, but very high abundance of dinoflagellates has been observed only in or near the summer season.

Certain species of diatoms have been found in all regions of the East Pacific from Peru to Alaska, but others seem to be confined to narrower limits of latitude.

While largest catches of diatoms have been obtained from rather high latitudes, some almost as large have been obtained along the California coast, and in all regions the localities of high abundance are near localities of low abundance. Furthermore, collections from higher latitudes have not yet had continuity sufficient to show that the annual total of production is greater than it is in low latitudes.

In the summer season certain species of diatoms have been found only at depths below twenty meters, while other species have been found only at depths above that level.

In the summer season (at least) the greatest abundance of diatoms seems to occur more frequently at depths from twenty to thirty-five meters below the surface than at levels above or below those limits.

Under certain conditions the abundance of diatoms tends to show negative correlation with the abundance of sunlight.

As yet no large catches have ever been obtained as far as one hundred miles from shore.

Nearly all species of diatoms recorded in these studies seem to be able to tolerate a wide range of temperature conditions. Apparently, most of them have similar tolerance for the normal extremes of salinity and a number of other physical and chemical conditions.

In the main the more spinose and attenuate specimens of diatoms seem to occur at lower levels where temperatures are relatively low and viscosity relatively high, thus failing to support the postulate of some investigators that tenuosity is an adaptive response to diminishing viscosity. I incline to think

it an adaptive response to feeble light, the attenuate form affording best conditions for absorption and utilization of such light.

Comparisons of pier series with those made offshore by boat indicate that inshore stations are fairly representative in showing seasonal trends of surface distribution of diatoms and dinoflagellates in a particular region.

Comparisons of surface series of collections with those taken from depths down to one hundred meters indicate that abundance at the surface may be widely different from that at several or all other levels at a particular time, although, in general, those localities more productive at the surface seem to be more productive in total.

It seems certain that a frequency of collecting of once in twenty-four hours is not high enough to yield a dependable basis for solving some localized problems of the microplankton. For some of these a frequency as high as six-hour intervals may be necessary.

Less than twenty species of diatoms included in five genera have been prominent in the institution records, although the total number of species recorded is considerably more than one hundred.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE NEW VOLUME OF SUMMARIZED PROCEEDINGS

THE Summarized Proceedings of the American Association for the Advancement of Science for the period from June, 1925, to June, 1929, was published October 15. It is four years since the preceding volume appeared, which was for the period from 1921 to 1925. While the new book contains much information about the association and its activities in the period reported, yet the part that will be most frequently used by most readers will probably be the Directory of Fellows and Other Members, which occupies 988 of the 1,192 pages.

This membership list is now the most up-to-date and the most nearly complete address list of American science workers and others interested in the advancement of science. It gives, in a single alphabet, the name and address of every person who has been enrolled in the American Association at any time between June, 1925, and June, 1929. About 21,000 names are included. Names of fellows are each preceded by an asterisk and names of endowment members are printed in large and small capital letters. Higher university degrees (M.A., Ph.D., etc.) are shown, together with the university that conferred each degree and the year it was conferred. Each entry includes the membership formula, which indicates one or more of the following association records: (1) year of election to membership; (2) year of election to fellowship, and year of election to (3) life membership or (4) sustaining membership. For the names of those who have resigned or have died since June, 1925, the formula shows also the year of resignation or the year of death in each instance. Finally, the formula for each member shows the section or sections of the association in which the member is most interested. This part of the book will be almost indispensable to many men and women of science and to others as well. The publication represents an important service performed by the association in the interest of intercourse and cooperation among American scientists and between them and the public.

The Proceedings part of this volume includes general records, such as the constitution and by-laws, the list of officially associated organizations, the complete roll of the presidents of the association, the roll of vice-presidents, secretaries and treasurers for the period 1925–29 and resolutions on general affairs adopted since June, 1925. It also includes list of officers and committees for each year reported and for each meeting in the period, and references to SCIENCE for association announcements, reports, etc., and for presidential, vice-presidential and other addresses given at the meetings and published in the official journal. With the Summarized Proceedings and the corresponding volumes of SCIENCE one has the proceedings of the association from June, 1925, to June, 1929.

An interesting graph is given, showing the annual rate of increase in association membership for the period from 1920 to 1928. On September 30, 1920, the total enrolment was 11,442 and this had increased to 18,462 by September 30, 1929.

The new volume may be secured from the permanent secretary's office, in the Smithsonian Institution Building, Washington, D. C., at a price of $3 to members of the association, or $4 to others. For cloth-bound copies, as long as the limited supply lasts, the price is $4 to members, $5 to others.

BURTON E. LIVINGSTON,
Permanent Secretary

HOTELS FOR THE DES MOINES MEETING

THE local committee for the approaching Des Moines meeting of the American Association and associated societies has furnished the following list of