

SCRIPPS INSTITUTION OF OCEANOGRAPHY

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LA JOLLA, July 1, 1928.

*To the President of the University.*

SIR: I beg leave to transmit the following report of the Scripps Institution of Oceanography for the year 1927-28.

*Work on the boat "Scripps"—*

Dr. E. G. Moberg was in charge of the scientific work on the "Scripps" and also its navigating officer. During July, 1927, the boat was moored off the Institution's pier and during this period collecting trips were made about twice a week to two stations located five and ten miles from shore. On August 2 the boat was moored in San Diego Bay and collecting trips were continued, although at less frequent intervals, until December 1. On each visit to a station temperatures and water samples for physical and chemical studies were obtained from about twenty levels from the surface to near the bottom. Also about fifteen plankton samples were taken between the surface and the 100-meter level by means of a closing bucket. The boat was used for scientific work on twenty-one days and a total of about 1700 samples for various purposes were collected.

During the first part of 1928 it was necessary to make certain repairs to the boat, the most important of which was the replacing of three fuel tanks having a total capacity of about 1200 gallons. Several alterations and additions to the scientific collecting gear were also made. It now includes a drum equipped with 1900 meters of  $\frac{3}{16}$ " phosphor-bronze cable for general collecting work, and a Kelvin sounding machine for measuring depth and taking bottom samples. Power is furnished by a gasoline engine in the afterhold.

*Physical oceanography and marine meteorology.*—These investigations were in charge of Dr. George F. McEwen, who was assisted by Captain S. W. Chambers throughout the year, by Miss Dorothy Curtis from July until March 31, and by Mr. Burt Richardson from June 15 to 30.

*Barometric pressure and surface temperatures over the North Pacific.*—Surface temperatures over the North Pacific, averaged by months and five-degree quadrangles, published by the Imperial Marine Observatory at Kobe,

Japan, for the five-year period 1916 to 1920, were plotted on charts, one for each month, and gaps in the data were filled by interpolation. Investigations of the distribution of departures from the five-year mean with respect to time and distance along the course of the Japan current were made in order to estimate the velocity of the current.

*Vertical gradients of temperature and salinity.*—It was thought advisable to make an extensive numerical application of a theory of vertical temperature and salinity gradients in relation to solar radiation and evaporation before publishing the derivation of the theory which has been referred to in previous reports. Computations were made for weekly average temperatures from spring to autumn at Lake Mendota and for ocean temperatures and salinities at station 1, ten miles west of La Jolla. A detailed derivation of the theory, including tabulations of various functions needed in applications, was completed, making such modifications as the test computations suggested. A paper, "An Analysis of Temperature Changes in Lake Mendota regarded as Effects of Penetrating Radiation, Surface Loss of Heat, and Turbulence," was read before the National Academy.

*Observations at Murray Reservoir.*—Serial water temperatures and meteorological conditions were observed weekly at Murray Reservoir. These were accompanied by observations on an insulated floating evaporation pan.

*Oceanographic and meteorological data.*—The salinity of 5167 sea-water samples was determined in the Institution's laboratory during the year, and 15,320 records of ocean temperatures and 6979 records of winds and meteorological conditions at sea were received. The only serial temperature and salinity records were those obtained from the Institution's boat "Scripps," on which 1605 serial temperature readings were made and the same number of water samples taken for salinity determinations.

*Tabulation of data.*—Data from shore stations have been averaged by weeks and months as usual. Surface data furnished by Naval and other ships have been averaged by months and thirty minute sections and tabulated as usual on special forms. Serial temperatures and salinities at stations 1 and 2, respectively ten and five miles west of La Jolla, have been averaged by two-week intervals for each depth.

*Interrelations between the sea and atmosphere with reference to seasonal weather forecasting.*—A tentative program was prepared involving observational and theoretical investigations of evaporation from the sea to be carried out by Dr. N. W. Cummings from July 15 to September 15; and by Dr. McEwen and Mr. Burt Richardson from June 15 to September 15. Suggestions were prepared for beginning on July 1 a direct attack by Dr. A. F. Gorton on the problem of seasonal forecasting.

*Chemical investigations—*

These investigations were in charge of Dr. E. G. Moberg, who was assisted throughout the year by Miss Maurine Leslie, and by Mr. H. F. Blum from July 1 to September 2, 1927.

The routine work consisted of analyzing the water samples collected by the "Scripps" and daily samples from the surface and bottom at the Institution pier for phosphate, silica, hydrogen ions, and oxygen. Nitrate has not been determined during the past year because of difficulties in preparing a satisfactory reagent. Similar difficulties have been experienced in other laboratories. In this laboratory a considerable amount of time has been devoted to improving the technique and this work is still in progress.

Dr. D. M. Greenberg of the Department of Biochemistry of the University of California and Dr. R. A. Holden of the University of Cincinnati spent some time in the laboratory during May and June working on problems in chemical oceanography. Dr. Greenberg applied to sea water a rapid and sensitive method for determining calcium and determined the vertical distribution of calcium at the ten-mile station. He also studied the nature of the buffer effect of sea water under various conditions. Dr. Holden made some attempts at ascertaining the quantity of iodine in sea water. The results indicate either that the iodine content in this locality is lower than has been reported for other localities or that the results of previous work are erroneous.

During the year a paper on the relation of the vertical distribution of diatoms to the chemical composition of water was prepared for publication in the *Proceedings* of the National Academy of Sciences.

*Biological investigations—*

*Diatoms and dinoflagellates.*—Professor W. E. Allen continued in charge of the investigations on these groups of organisms.

During the year about 2100 catches of microplankton were added to the Institution's series of pier and boat collections and about 300 catches to temporary or discontinuous series. Most of these were taken in southern California waters but some were obtained as far away as the Aleutian Islands.

About 2000 catches were studied during the year, most of them taken in preceding years. Seven reports on work with phytoplankton were published during the year, five by Professor Allen, one by Mr. Ralph C. Lewis, and one by the two jointly. One of the papers by Professor Allen includes a summary of five years of boat work in southern California waters. Much of his time during the year was devoted to the preparation of a summary of five consecutive years of work at southern California piers, which was ready for press at the close of the year.

Mr. H. M. Buley, a graduate assistant, was in residence most of the year. Besides helping with routine work, he conducted a valuable research on the feeding habits of the California mussel, giving special attention to its relation to phytoplankton.

Professor Allen made for the International Fisheries Commission at Seattle, a study of winter collections of microplankton taken in Alaskan waters in 1927-28 by the Director of the Commission, Dr. W. F. Thompson.

A somewhat similar study was made of a series of seventeen very heavy catches of diatoms taken on May 16, 1928 off Gray's Harbor, Washington, by Dr. Parker D. Trask, a research associate of the American Petroleum Institute.

*Zooplankton*.—During the year a paper entitled "The Periodic Occurrence of Copepoda in the Marine Plankton of two successive years at La Jolla, California," by Dr. C. O. Esterly, was published as Bulletin 14 of the Institution's Technical Series.

*Fishes and Peromyscus (deer-mice)*—

The following is a report on the investigations, in charge of Dr. F. B. Sumner, on these organisms:

1. The small, South American, fresh-water fish, *Lebistes reticulatus*, is being raised in considerable numbers in the constant temperature room which was equipped last year for this purpose. It is being subjected to various altered conditions of environment: sea water in full strength and in various dilutions; black, white, and mixed backgrounds; and (to be commenced shortly) extremes of temperature.

2. Studies of selective elimination by various lethal agents (asphyxiation, transfer to fresh water, parasitism) have been conducted by Mr. Ancel B. Keys on the local marine fish, *Fundulus parvipinnis*. The results were embodied in part in a master's thesis, while the effects of parasites on viability were made the subject of a special paper. A new laboratory room has been equipped for physiological studies of fishes, and apparatus for biochemical work has been provided (partly constructed by Mr. Keys himself).

3. Studies of color change in flatfishes, commenced by Dr. Sumner eighteen years ago, are being continued with Mr. Keys' assistance.

4. Genetic and ecological studies of deer-mice have been continued, largely with the support of the Carnegie Institution of Washington. These include: (a) a two-months' field trip to Florida and Alabama, during which some 450 living mice were trapped and (mostly) sent to La Jolla; (b) the using of some of these for breeding experiments, and all, ultimately, for biometric study; (c) preparation of 800 skeletons; (d) preparation of 400 skins; (e) measurements and computations based upon material and data obtained during the preceding three years.

*Foraminifera and marine bottom deposits—*

The Director of the Institution continued his studies of the genera of larger foraminifera and during the year prepared several papers for publication. He was assisted throughout the year by Mrs. E. G. Moberg, who also finished one paper for publication. Mr. G. Leslie Whipple assisted with the investigation during July, 1927, and from May 15 to June 30, 1928. The collections have rapidly increased in size and for several families are the best in the United States.

Marine bottom deposits were studied at the Institution by two visitors, Dr. Parker D. Trask and Mr. Louis A. Thayer; notes on whose work are given under "Visiting scientists." Assistance in the investigation of marine deposits as possible source beds of petroleum, under the auspices of the American Petroleum Institute, was continued.

Arrangements were made for increased attention to bottom deposits at the Institution, beginning July 1, 1928.

*Visiting scientists—*

The following is a list of visiting investigators who worked at the Institution during the year, together with the subjects on which they were engaged:

Professor C. M. Child, University of Chicago; physiological investigations, mostly on the hydroid *Corymorpha*, July 1–Sept. 16, 1927, and the end of June, 1928.

Professor J. W. E. Glattfeld, University of Chicago; preparation of manuscript on organic chemistry, July 1–Sept. 28, 1927.

Professor George W. Bartelmez, University of Chicago; vertebrate anatomy, July 1–Sept. 28, 1927.

Professor Bruce L. Clark, University of California; foraminifera, July 1–29, 1927.

Mr. A. M. Adamson, Commonwealth fellow, University of St. Andrews, Scotland; protozoa, July 5–Aug. 17, 1927.

Professor V. E. Shelford, University of Illinois; ecology, Aug. 10–17, 1927.

Dr. Parker D. Trask, research associate, American Petroleum Institute; marine sediments as possible source beds of petroleum, Aug. 13, 1927–June 13, 1928.

Professor H. S. Reed, Citrus Experiment Station, University of California, use of library and conferences, Sept. 7–18, 1927.

Mr. H. R. Seiwel, biologist of yacht "Carnegie," Carnegie Institution of Washington; study of methods of chemical examination and plankton investigation for use on yacht "Carnegie," Sept. 20–Dec. 12, 1927.

Miss Edna M. Fisher, Museum of Vertebrate Zoology, University of California; assisting in Dr. Sumner's studies of *Peromyscus*, Dec. 6, 1927–March 6, 1928.

Dr. H. G. Schenck, Stanford University; foraminifera, Dec. 22–25, 1927.

Mr. Louis A. Thayer, assistant, American Petroleum Institute; marine sediments off the coast of Oregon, Feb. 2–9, 1928.

Professor K. Hirasaka, Imperial University of Formosa; marine biology, Feb. 7-8, 1928.

Mr. A. E. S. Pedersen, Aartens, Denmark; botanical collecting, March 5-12, 1928.

Mr. Donald H. Fry, California Fish and Game Commission; life-history of the California spiny "lobster," May and June, 1928.

Dr. R. A. Holden, University of Cincinnati; chemical studies of sea water, May and June, 1928.

Dr. G. Lunde, Oslo, Norway; iodine in the flesh of fish, June 26, 1928.

Dr. D. M. Greenberg, University of California; amounts of calcium in sea water, June 1-30, 1928.

Besides those listed above others consulted the collections, especially those of foraminifera, at the Institution and conferred with members of the staff regarding a variety of special problems.

A number of important visitors came to discuss plans for special researches or plans for cooperative enterprises. These included Dr. W. A. J. M. van Waterschoot van der Gracht, chairman of the committee of American Petroleum Institute on marine sediments as possible source beds of petroleum; Dr. John C. Merriam, president of the Carnegie Institution of Washington; Professor R. A. Millikan, of the California Institute of Technology; Professor F. R. Lillie, of the University of Chicago; Dr. H. B. Bigelow, of the Museum of Comparative Zoology, Harvard University; Professor C. McLean Fraser and Professor C. H. Hutchinson, of the University of British Columbia; and Dean J. N. Cobb, of the College of Fisheries, University of Washington.

#### Lectures by visitors—

Lectures were given at the Institution during the year by the following visitors: Professor A. C. Lawson, University of California; Professor J. W. Gregg, University of California; Mr. A. M. Adamson, St. Andrews, Scotland; Professor C. M. Child, University of Chicago; Professor J. W. E. Glattfeld, University of Chicago; Professor George W. Bartelmez, University of Chicago; Mr. G. G. Glick, San Diego; Dr. Parker D. Trask, research associate, American Petroleum Institute; Mr. H. R. Seiwel, Carnegie Institution of Washington; and Dr. N. W. Cummings, San Bernardino, California.

#### Students—

The students registered at the Institution during the year, with their subjects, were as follows:

Horace Buley; phytoplankton and the food of the California mussel, July 1, 1927-May 26, 1928.

Ancel B. Keys; effect of lethal conditions on *Fundulus* and other physiological studies of fishes, Aug. 21, 1927-June 30, 1928.

Maurine Leslie; variation in oxygen content in water at the seaward end of the Institution's pier, July 1, 1927-June 30, 1928.

Ralph C. Lewis; food of the California sardine, July 1-Sept. 17, 1927.

Marion Wilcox Moberg; Tertiary foraminifera from Trinidad and the southern United States, July 1, 1927–June 30, 1928.

G. Leslie Whipple; foraminifera, July 1–Aug. 3, 1927, May 15–June 30, 1928.

Mr. Ora L. Huddleston, a student in the Department of Physiology in Berkeley, worked on vestibular phenomena of sharks from July 1–Aug. 10, 1927, and from Dec. 8, 1927–Jan. 5, 1928. Mr. Henry E. de Feo, also of the Department of Physiology, was with Mr. Huddleston from Dec. 10–31, 1927. Mr. J. J. Karol, registered in the Department of Zoology, worked with Dr. Sumner on *Peromyscus* from July 14, 1927–June 30, 1928. Miss Kathryn McGee, who had completed her junior year at the University of California at Los Angeles, studied foraminifera at the Institution from June 16–30, 1928. The Director of the Institution supervised a study of foraminifera by Mr. M. Natland, a student in the senior class at Pomona College.

*Attendance of members of the Institution's staff at scientific meetings—*

The Director of the Institution and Dr. McEwen attended the annual meeting of the Section of Oceanography, American Geophysical Union, in Washington, D. C., during April. The Director was chairman of the Section of Oceanography and he, jointly with Dr. H. H. Kimball, chairman of the Section of Meteorology, arranged a symposium on the interrelations between the sea and the atmosphere, at which several important papers were presented. Dr. McEwen contributed two papers and he also presented one at the annual meeting of the National Academy. The Director and Dr. McEwen read a paper on "Seasonal Rainfall Forecasts" for the Pacific Coast states before the Economic Research Council of the California Development Association in Los Angeles on June 2. Papers by five members of the staff were given at the meeting of the Pacific Coast division of the American Association for the Advancement of Science at Pomona College during June; and a general discussion of problems of the oceanography of the Pacific was led by the Director of the Institution.

During April Dr. Moberg gave a lecture in Berkeley on the relations to the growth of diatoms of chemical substances in solution in the sea water in the southern California region. Numerous papers or addresses on the work of the institution were given during the year by members of the staff before different bodies in southern California, in response to invitations. The manifestations of interest in the activities of the Institution were gratifying.

*Additions to scientific equipment.*—The principal addition during the year to the scientific equipment of the Institution was the outfitting of a laboratory for the study of marine sediments. Additions to the equipment and alterations on the boat "Scripps" have already been mentioned.

*Improvement of grounds.*—The construction of roads mentioned in last years' report was completed. The planting of trees and shrubs was continued according to plans already announced. The appearance of the Institution's grounds is slowly but steadily improving, notwithstanding the adverse conditions due to sea winds, arid climate, much poor soil, and many pests, both animal and plant.

*Library.*—Two hundred thirty-three books were added to the library, bringing the total to 10,385. Catalogued reprints number 12,903, 859, having been added during the year. Charts to the number of 479 have been catalogued and filed in the chart case. A complete set of the "Siboga" Expedition reports was purchased and a set of the Sunset edition de luxe of William Leon Dawson's *Birds of California*, illustrated by Major Allan Brooks, was presented to the Library by Miss E. B. Scripps.

*Museum, Aquarium, and Supply Department*—

Mr. P. S. Barnhart, curator of the Biological Collections, reports as follows:

*Museum.*—There has been considerable growth in the collections of the museum during this year. The addition of a new case made possible the completion of the Kelsey-Baker collection of mollusks. This collection now contains over 4000 species of shells from the Pacific region.

Twenty-three fishes were mounted and five plaster casts made of fishes, the skins of which were too tender for mounting. This makes a total of thirty-four mounted skins and six plaster casts of fishes in the museum exhibit. To exhibit these specimens properly two of the museum cases were furnished with painted canvas for backgrounds.

Wooden strips were placed along the shelves holding the bottled biological collections so that in case of earthquakes, the bottles would not be so liable to fall and be broken.

Dr. Wm. E. Ritter's collection of ascidians and the Ellis Michael collection of chaetognaths were turned over to the care of the curator. The question of more room for storage of the biological collections must now be faced. The collections are growing, as is to be expected, and additional room must be found for them.

*Aquarium.*—Since the aquarium was first opened, glass pipette squirters have been used for the water supply to the tanks. These were a source of constant trouble and waste of water owing to the fact that their points were easily broken. One year squirters made of black tin pipe were tried but these soon wore out in the salt water and were not satisfactory. As lead pipe of such small diameter was not purchasable, the curator this year made a mould and manufactured lead pipette squirters. These have proved entirely satisfactory as they use a minimum of water, do not wear out, and require but little attention.



Five of the new cement aquaria have cracked and broken in several places and will have to be replaced in the near future.

The rust in the water supply of the aquarium and laboratory rooms is becoming worse, clogging the pipes, soiling the tanks, and clouding the water. Research workers have even resorted to carrying water for their experiments from the end of the pier. Pure water is needed in the laboratory as well as the aquarium.

A total of 1075 fishes representing 54 species and 655 invertebrates representing 20 species were collected and exhibited.

*Supply Department.*—Sales of the supply department amounted to \$647.74. This includes two lots of fishes furnished to the Steinhart Aquarium of San Francisco.

*Exhibit at San Diego County Fair—*

At the invitation of Mr. J. G. France, San Diego County Commissioner of Horticulture, the Scripps Institution put in an exhibit at the annual county fair held in Balboa Park in September, 1927. Although the labor and expense were considerable, the attention which the exhibit attracted from the public seemed to make it well worth while.

*Special acknowledgments—*

The Institution has continued to receive assistance in its work during the past year from most of those who aided it during the preceding year, namely, the Naval transports plying between Bremerton, Washington, and the Canal Zone; the Submarine Division of the Navy, in command of Rear Admiral Ridley McLean; the United States Naval mission in Peru and the Peruvian Navy; the United States Naval Attaché in Chile and through him the Grace Steamship Line; the officers of the Coast and Geodetic Survey in command of vessels operating along and off the west coast and in Hawaiian waters; the Bureau of Lighthouses; and the Los Angeles Steamship Company.

*Gifts and special contributions—*

For the year 1927–28, the Institution received gifts as follows:

Miss Ellen Browning Scripps for the salary of the Director and general purposes, \$9000; supplemental contribution for general purposes, \$7500; special contribution toward improvement of grounds, \$450; total, \$16,950. Mr. R. P. Scripps contributed for general purposes, \$5000.

The Director of the Institution contributed \$750 toward the maintenance and improvement of the grounds.

Because of their interest in the endeavor being made at the Institution to find a basis for forecasting at the beginning of a rainy season whether the rainfall of that season may be average or above or below average in amount, several organizations combined and raised a fund of \$6000 to be used in extending the investigations of the Institution on

that and immediately pertinent subjects. The contributors to the fund were as follows:

Los Angeles Bureau of Power and Light, San Diego Consolidated Gas and Electric Co., Los Angeles Gas and Electric Corporation, San Joaquin Light and Power Corporation, Great Western Power Company, Coast Counties Gas and Electric Company, The California Oregon Power Company, Southern California Edison Company, Coast Valleys Gas and Electric Co., Western States Gas and Electric Co., Pacific Gas and Electric Co., and Southern Sierras Power Company.

Most of this amount was carried forward for expenditure during the year 1928-29. It should be remarked, in this connection, that the investigations should be conducted over a number of years, at least ten, in order to find out what the probabilities may be; and, if the results are successful, arrangements should be made for the establishment of a continuing service.

*Needs of the Institution—*

Several urgent needs were stated in the final section of the report for last year and they will not be repeated here; but other matters will be mentioned. There should be two additions of members, with faculty rank, to the staff of the Institution, one a specialist on marine sediments and the other, a specialist on zooplankton. It is with profound regret that the death of Dr. C. O. Esterly on August 10, 1928, is reported. The sad event occurred after the close of the period covered by this report; but it leaves the Institution without an authoritative investigator of zooplankton.

Since the investigations conducted at the Institution are varied and cover a number of fields of science that bear on the study of the sea, the library facilities need to be increased. Borrowing books from other libraries, even the University library, has been unsatisfactory. At present the sum of \$1200 is allotted for subscriptions to periodicals, the purchase of new books, and for binding, but for the past two years it has been somewhat increased by transfers from the emergency and contingent fund. The allotment should be increased to \$1800 or even \$2400 per year, so as to make possible the purchase of some older literature, as well as that of current publications.

Another need of the Institution, not mentioned in previous reports, is additional protection of the bulkheads on the sea front of its property. Plans for this have been made and an estimate of the cost, \$3000, submitted to the President.

Respectfully submitted,

T. WAYLAND VAUGHAN,  
Director, Scripps Institution of Oceanography  
University of California.