

OCEANOGRAPHIC RESEARCH AT THE SCRIPPS INSTITUTION OF OCEANOGRAPHY

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Improvements--During the past year, by means of funds contributed by R. P. Scripps and from the estate of Miss Ellen B. Scripps, the Scripps Institution of Oceanography has been able to replace the gasoline-engine on its boat Scripps with a Diesel engine, and to make numerous improvements. Now, living conditions on the boat are better than they have been before and the boat is equipped to do all of the ordinary oceanographic work to a depth of about 5000 meters. Henceforth, it will be possible to make expeditions to a distance of between five and six hundred miles offshore.

Expeditions and oceanographic data--During the past year, in addition to numerous short trips offshore from San Diego or La Jolla, one cruise was made on the Scripps from La Jolla to San Clemente Island, thence to Santa Catalina and Balboa, and back to La Jolla. A series of stations was occupied for various oceanographic purposes, one of which included the collection of core-samples of bottom-deposits for chemical and bacterial investigation. R. H. Fleming spent about three months aboard the naval vessel Hannibal in the Gulf of Panama and off the coast of Costa Rica. He assisted in making oceanographic observations and collecting water-samples at 127 stations. While aboard the vessel he made numbers of chemical analyses for oxygen and phosphate, and collected surface plankton-samples. A report on the results is in preparation. Roger Revelle was aboard the United States Coast and Geodetic Survey steamer Pioneer for ten days during July and assisted in making nine vertical sections for salinity and temperature off Point Arguello. He also made oxygen-sections at each station occupied and collected bathypelagic organisms to study the interrelations between the vertical distribution of zooplankton and the oxygen-content of the water.

The quantity of oceanographic data received at the Institution during the past year is given in Table 1.

Table 1--Oceanographic data received at Scripps Institution of Oceanography,
April 1933 to April 1934

Source	Salinity	Water-temperature	Air-temperature	Wind
U.S. transports.....	0	4333	769	4333
U.S. lighthouse-tenders.....	192	965	765	965
U.S. Coast and Geodetic Survey vessels <u>Scripps</u>	(273) ^a (287)	(273) (287)	0 0	0 0
<u>Shore-stations from La Jolla to Scotch Cap</u>	2610	2610	365	1880
Grace Line vessels from Valparaiso to Central America.....	0	1975	1975	0
U.S.S. <u>Ramapo</u> and <u>Hannibal</u>	(1050)	(1050)	0	0
Supplementary data off Lower Califor- nia, Central, North, and South Amer- ica. <u>Velero III</u> , <u>Mazatlan</u>	118 ^b	173 ^b	0	101
Totals.....	4530	11,666	3874	7279
Grand total.....			27,349	

()^a = sub-surface data; b = various depths

In addition to the data indicated in Table 1, the Institution has a sea-water thermograph installed on the U.S. Lighthouse-Tender Lupine and on the U.S. Naval Tanker Ramapo. Two of the three thermographs installed on Panama Pacific Line steamers plying between New York and San Francisco were provided by the Scripps Institution, and arrangements have been made to receive photostat copies of all of their records. A recording current-meter of the pendulum-type has been designed for use on the sea-bottom and an experimental model is under construction.

Physical oceanography and marine meteorology--Dr. McEwen continued his studies of vertical and horizontal circulation in the sea along and off the west coast of the

United States, making use of data on winds as a cause, and the distribution of temperature and salinity as effects, of circulation. The results of this investigation which has been a long-continued one have been submitted for publication. Dr. McEwen carried on investigations of the amount of water each storm supplies to a water-shed in connection with the California Forest Experiment Station at Glendora. It is expected that this project will be a long-continued one--ten or fifteen years. The investigations on seasonal weather-forecasting have been continued in spite of the very much-reduced financial support.

In connection with the investigations on sediments at the Scripps Institution, certain statistical problems have been studied and progress has been made in their solution. Some of these problems are closely related to the differentiation of species and sub-species by appropriate statistical treatment of the measured characters. A number of numerical tables have been prepared for convenience in application, and a valuable collection of references, abstracts, and reprints dealing with modern statistical methods has been made.

H. R. Byers continued his researches on the air-masses of the North Pacific and he has prepared an extensive paper which has been accepted for publication in the Scripps Institution Bulletin, technical series. He also completed the manuscript of an article entitled, "Equivalent temperature as a physio-climatic element."

Chemistry--The work in the Chemical Laboratory has largely dealt with substances and conditions in sea-water that have been previously investigated. The chlorinity, plant-nutrients, oxygen, and the various components of the buffer-mechanism have been determined on samples collected regularly at the Institution's Pier as well as on samples collected from various depths off the coast of Southern California by the boat Scripps.

In a previous report the Institution's investigation of the buffer-system or the hydrogen-ion regulating mechanism of sea-water has been mentioned. During the past year a paper on this subject has been completed, and within a few weeks will be published in the technical series of the Bulletin of the Scripps Institution under the authorship of Moberg, Greenberg, Revelle, and Allen.

Further laboratory-studies of some of the components of the buffer-system have been in progress throughout the year. For example, water-samples have been analyzed for boron and titratable base, including a series of surface samples collected by the U.S.S. Ramapo, between the California Coast and the Philippines, and several vertical series taken by Messrs. Fleming and Revelle on the Hannibal and Pioneer, respectively. It was found that for all the localities and all the depths represented the ratio of both boron and base to the chlorinity was practically constant.

A study of importance in comparing the results of determinations of titratable base or alkalinity obtained by different methods was carried out in cooperation with Dr. P. E. Mitchell of Brown University. The base-content of a number of sea-water samples was determined both by Dr. Mitchell's modification of Thompson and Bonnar's method, and by the direct titration-method used in this Laboratory. The results were found to agree within the limits of the errors of the methods.

Microbiology--Dr. C. E. ZoBell, in charge of microbiology at the Scripps Institution, reports that a large proportion of the bacteria in the sea are able to ammonify numerous substances. Five new species have been isolated which produce ammonia from low concentrations of urea in sea-water. Nitrosifiers and nitrifiers have been recovered with regularity from bottom-deposits in relatively shallow water, but similar methods have failed to reveal their presence at depths greater than 500 meters. Nitrate-reducers are encountered very infrequently and they are functional only under unusual conditions. Observations on the influence of temperature, organic matter, pH, redox potentials, and salinity on the activities of nitrifying and denitrifying bacteria indicate that in the sea the redox potential is perhaps the most important factor.

Analyses of over 40 bottom-deposit samples from depths to 1300 meters show the existence of a large and varied microflora which is elastically active against cellulose, starch, and proteinaceous substrates. Aerobes predominate, but the ratio of anaerobes to aerobes increases with the depth of the core-strata. The reduction potential of most of the cores approaches that of the hydrogen-electrode and in vitro

hydrogen overvoltages may be produced due to microbial action. Sulphate-reducing bacteria are common in the mud-samples.

It has been found that while immediately following initial isolation marine bacteria have specific sea-water requirements, they are readily acclimatized to become physiologically indistinguishable from fresh-water species. At least 88 new bacterial types from the sea have been characterized.

Miss Esther C. Allen has noted that the usual sequence of events in the fouling of submerged surfaces is first the adherence of bacteria and kindred growths, followed by the attachment of barnacles, Bryozoa, hydroids, etc. Bacteria and, to a lesser extent, diatoms play an important rôle in the fouling of marine structures.

In collaboration with Nelson A. Wells, the etiological agent of a highly fatal infectious dermatitis of Fundulus parvipinnis and other marine fishes has been isolated and identified as Achromobacter ichthyodermis, n.sp., and a paper published on the results.

Phytoplankton--Prof. W. E. Allen has continued his studies of phytoplankton of the La Jolla region, devoting most of his time to the preparation of the manuscript of a report on the results of ten years of daily collection at the end of the Institution Pier. Professor Allen has continued studies of fouling organisms along the lines initiated several years ago by Prof. Wesley R. Coe of Yale University. Miss E. E. Cupp has completed a manuscript entitled "A critical study of certain distinguishing characters in three closely allied plankton species of the diatom genus Nitzschia and their relations to certain environmental conditions." Miss Cupp has also prepared a report on the plankton-samples collected by the Velero III between San Diego and Panama.

Foraminifera--T. W. Vaughan during the year published a number of papers on fossil foraminifera. A publication of the Scripps Institution Bulletin, technical series, entitled "The temperature- and depth-distribution of some recent and fossil foraminifera in the Southern California Region" is one of significance both to students of the ecology of marine organisms and to geologists. During the year Earl Myers succeeded in completely working out the life-history of a local species of foraminifera known as Patellina corrugata. A short note entitled "Multiple tests in the foraminifera" was published in the Proceedings of the National Academy of Sciences (v. 19, No. 10, pp. 893-899, 1933). The complete report is now ready for publication and the results have been presented by Prof. C. A. Kofoid at the recent meeting of the National Academy.

Physiology of marine invertebrates--Notes on the work done during the past year are as follows. During the last twelve-month period an investigation has been made by Dr. D. L. Fox and Dr. G. W. Marks on the digestive enzymes of the plankton-feeding Mytilus californianus, with a view to determining the food that it can utilize and must remove from the sea. Its fecal ribbons have been examined for correlative information. The findings from these investigations will be correlated with Buley's studies of the gastric contents and Miss Austin's studies of other features of this mollusk. Studies on the effect of oxygen in the inactivation of catalase are being continued, using a number of marine animals and plants. A paper dealing with the subject entitled "The inactivation of mussel catalase by oxygen" appeared in the Journal of Biological Chemistry (v. 103, p. 269, 1933).

Another investigation in progress is concerned with the amounts of dissolved copper in sea-water, the tolerance of a number of marine mollusks for this toxic action, and the possible accumulation of it by the animals.

The mussel has in its digestive tract an enzyme or enzymes capable of hydrolyzing the poisonous glucoside amygdalin, with the production of a reducing sugar (glucose) and free hydrocyanic acid. Out of 69 bacteria, six actinomyces, three molds, and two yeasts investigated, two-thirds of the bacteria, and all the other forms excepting one of the yeasts, possess the ability while living to produce HCN from amygdalin. The mussel enzyme hydrolyzes amygdalin in the absence of microorganisms. A paper dealing with the subject has been prepared.

In cooperation with Dr. F. B. Sumner an investigation of considerable length concerning the carotenoid pigments in certain marine fishes has been completed and published under the title "A study of the variations in the amount of yellow pigment (xanthophyll) in certain fishes and of the possible effects upon this of colored backgrounds" (J. Exp. Zool., v. 66, p. 263, 1933).

During the year seven articles have been published from the section of physiology, two are in press, another has been prepared for publication, and three are in the process of preparation.

Fish-biology--The work in fish-biology consisted in a continuation of studies of the relations of marine fishes to their environment. The chief subjects of investigation were as follows: (1) The yellow (carotenoid) pigment of fishes, which is partly responsible for the striking adjustments of these animals to the color of their surroundings in nature, was investigated by Dr. Sumner, in cooperation with Dr. Fox of the physiology section.

(2) Studies were carried out by Dr. Sumner upon the relations of different parts of the visual field to the color responses of fishes. A new technique was devised, whereby the animals were forced to look through transparent caps which were fitted over the eyes, these caps being variously colored or partly obscured by opaque areas.

(3) Investigations of the oxygen-consumption of fishes were continued by N. A. Wells. The relations of the metabolic rate to activity, temperature, season, size, sex, and some other factors were determined in part, and certain phases of the work were brought to a definite conclusion.

(4) Certain diseases of fishes were investigated by Mr. Wells in collaboration with Dr. ZoBell of the section of microbiology, as has already been stated.

Marine bottom-deposits--During the year two rather large undertakings have been brought to completion. One of them is the study by E. M. Thorp entitled "Calcareous shallow-water marine deposits of Florida and the Bahamas," and the other is an investigation by Roger Revelle on the deep-sea bottom-samples collected by the Carnegie. These two investigations will merely be mentioned here, as it is intended to submit abstracts of the results obtained for inclusion in the report of the Committee on Sedimentation, Division of Geology and Geography, National Research Council. During the year much attention has been paid by several members of the staff of the Institution to oxidation and reduction in the ocean. This subject is a meeting ground of oceanography, geology, chemistry, and a considerable range of biological phenomena; therefore, the members of the staff of the Institution representing each one of these sciences have cooperated in the investigation.

Dr. Robley D. Evans, assisted by Arthur Kip, is making a study of the radioactive substances in sea-water and in the bottom-deposits off the coast of Southern California. They are also making similar analyses of core-samples of deep-sea sediments kindly supplied by Dr. Ph. H. Kuennen from the collections made by the Willebrord Snellius in the East Indies, and by the Hydrographic Department of the Imperial Japanese Navy obtained by the vessel Mansyu in the southwest part of the North Pacific.

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(B) INSTITUTIONS ON THE ATLANTIC SIDE OF CANADA AND THE UNITED STATES

INTRODUCTION

C. O. Iselin

This section of the report is confined mainly to the physical investigations in progress during 1933. Information has been received from the following major institutions located on or near the Atlantic seaboard: (1) Fishery Research Commission, Newfoundland; (2) Biological Board of Canada; (3) Woods Hole Oceanographic Institution; (4) Bingham Oceanographic Foundation; (5) United States Bureau of Fisheries; (6) United