

UNIVERSITY OF CALIFORNIA
BERKELEY

SCRIPPS INSTITUTION FOR BIOLOGICAL
RESEARCH

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LA JOLLA, CALIFORNIA, July 1, 1919.

To the President of the University,

SIR: My report for the year July 1, 1918, to June 30, 1919, is presented herewith.

RESIDUES OF THE INSTITUTION'S WAR WORK

Some of the fruits, both in experiences and discoveries actually realized, and in prospective significance, of the Institution's war-work, deserve mention.

It can not be justly claimed that our efforts in connection with the fishing industries of southern California have had much to do in determining the magnitude and direction of the developments in this district, during the period of the war especially.

The 28 canneries, the 600 fishing boats, and the 2000 fishermen engaged in the fishing businesses of the district last season, came into being because of the general food demands of the time, and the belief by those concerned that the natural supply of fish warranted this amount of effort.

Similarly the failure, in large part, of the tuna "catch" last season (9000 tons, 1918, as compared with 17,000 tons, 1917) was due to natural and industrial circumstances inherent in the situation itself, and upon which science, at least in the present state of its hold upon the problems presented, could have very little effect.

But the activities of the Institution in connection with the industries, particularly that of Captain Crandall as Fish Administrator under the United States Food Administration, that of Mr. R. A. Coleman, as Assistant of the Federal Bureau of Fisheries, assigned to work at the Institution, and that in the domain of oceanography under the lead of Dr. McEwen, put us in possession of knowledge which should be of high value, on both the business and the scientific sides, for the future of the fishing industries. Under the first mentioned caption would come information about the fishermen themselves—their nationalities, skill, habits, methods of work, etc.; and about tolls and other charges paid by American fishermen for fishes taken in Mexican waters.

Under the second head, special mention may be made of indications bearing on the difficult but important problem of the influence which conditions of the sea have upon the movements and other habits of commercial fishes. Increased knowledge of the distribution of these fishes, especially as to relative abundance in waters off the United States and off Mexico, has been secured.

Important experiences have been had by the fishing industries in the matters of quality of product and of finding and holding markets. But the hard problems here belong primarily to the United States Bureaus of Fisheries and Chemistry, so far as science is concerned, and only in a very subordinate way can the Institution be concerned with them.

With the integrated activity of all the agencies naturally involved—the fishermen, the canners, and the fresh fish dealers; the agencies of industrial science of the Federal and state governments; and those of research in pure science appurtenant to oceanic fisheries (under which head the Scripps Institution falls)—there can be no doubt about the future importance of the fisheries of southwestern Pacific North America.

Although the kelp industry, which reached so remarkable a development under war conditions, has at present no outlook comparable with that of the fishing industry, much of interest,

scientific in any case, and economic, should future needs make it so, has been learned about the species of plant chiefly involved (*Macrocystis pyrifera*).

Dr. R. P. Brandt's two years of botanical study of it has established these facts: The plant grows most vigorously from December to March, and is practically dormant during July and August; low temperatures of the water, strong currents and brisk winds favor the development of the kelp beds; storms and heavy seas usually keep the beds thinned out during the period of most vigorous growth; the plant is subject to a bacterial disease known as black rot, the infection attacking the leaves after they reach and rest upon the surface of the water.

The life history of the individual plant has been followed in general outline, from the microscopic spore stage, to the full-sized stage having a length of fifty feet and more. The spores are mostly borne on leaves at the base of the plant, and though produced throughout the year, are chiefly liberated during the season when the plant is in most active growth. Young plants occur mainly in the spring, and are readily obtainable in abundance among the holdfasts of the old plants, where the spores and sporlings have attached themselves after their brief period of free swimming life. They reach full size and sporulation maturity within a year. The individual plant reaches a limit of growth, this being determined by the exhaustion, so to speak, of the terminal fission lamina from which alone new leaves are produced.

Dr. Brandt has devoted much time to the question of a sexual phase in the life cycle of this species, but so far has been unable to demonstrate such a phase.

The "stock," about 800, of white mice which the Institution had on hand as a result of its enterprise in supplying these animals for the medical service of the Army, became almost valueless when the war ended. However, by an arrangement with the Hooper Foundation for Medical Research, the Institution escaped with a comparatively small loss, which it gladly assumed as part of its war activities.

OCEANOGRAPHY AND MARINE BIOLOGY

The main interest and effort in this department have centered during the year in the extension of work on ocean temperatures and densities, with special reference to the bearing of information thus obtained on the problem of seasonal and "long range" weather forecasting. To extend the range of field data, arrangements have been made with local agencies for data-collecting at Pt. Arguello, Santa Barbara, Avalon, and Hueneme. One temperature observation and one water sample a day are taken at each of these points, under instructions from Dr. McEwen, the water samples being sent to the Institution once a month. In addition, the Hopkins Laboratory of Stanford University, at Pacific Grove, is, through the coöperative spirit of its director, Dr. W. K. Fisher, furnishing still more extensive data on the conditions of the sea at that point.

The suggestion that the similarity of conditions of the sea at La Jolla during the summer of 1918, to its unusual conditions of the summer of 1917, might be followed, as the 1917 summer was, by a winter of deficient rainfall, was, through coöperation with the Chamber of Commerce of San Diego, brought, by circular letter, to the attention of several hundred men of the Pacific States, who have special industrial and business interests in the amount and distribution of winter rains. Although the precipitation during the winter of 1918-19 was more ample and more favorable to crops than that of the previous winter, it was still somewhat deficient in total for the state as a whole, and its distribution was apparently somewhat abnormal. A detailed study of the year's records for the district, in meteorology and oceanography, is being made jointly by Mr. H. F. Alciatore, Government Weather Bureau forecaster at San Diego, and Dr. McEwen. Until this is completed we shall not know whether or not there was any relation between the climatic conditions of the last winter and the oceanic conditions of last summer similar to that which characterized the previous winter and summer. An Institution bulletin on the results of this study will be issued later, this to be a sort of companion to Bulletin No. 7 by Dr. McEwen, published in November, 1918.

Some progress has been made during the year on the problem of correlating oceanographic conditions with the conditions shown by the organisms which inhabit the waters. But the phenomena in this field are so complex as to be amenable to only the most extensive and exact observations. Experience and results already obtained justify the belief that if the work is continued and expanded on such lines as are now being followed, important results will come finally; first, probably, in correlating oceanic conditions with the conditions presented by the minute, free living organisms, and later with those presented by the larger animals, fishes with the rest. In this connection should be mentioned the high importance of extensive, trustworthy statistics on the "catches" of the important food fishes. It is well that the Fish and Game Commission of California is turning some of its resources and efforts in this direction. But the coöperation of the fisheries interests themselves is essential.

As indicative of the grounds for believing that important results are possible from researches in this domain, may be mentioned the seeming fact, as indicated by such cursory information as is available, that during the summer of 1918, when the temperature of the water and other oceanic and atmospheric conditions of the whole southwestern maritime district were somewhat more equatorial in character than usual, various of the fishes which visit the district in summer extended their range somewhat farther northward than usual. The plankton work of the year has been directed more specifically than heretofore upon this problem—that, namely, of the seasonal, monthly, and daily distribution of the minute floating fauna and flora, in their relation with oceanographic and meteorologic conditions.

Especially to be mentioned in this connection is the work on the diatoms by Mr. W. E. Allen. This is especially noteworthy, I say, because although this group of one-celled plants is undoubtedly the most important of all from the standpoint of the fundamental food supply of the ocean, until the last two years it has had no place in the Institution's research programme. Mr. Allen's work during the summer months of 1917 and 1918 has produced a large amount of qualitative and quan-

titative data, which, now that Mr. Allen is to become a permanent resident member of the research force of the Institution, will be extended and elaborated, and will, it is confidently anticipated, advance importantly our understanding of the seasonal cycles and interdependences of the sea and its life in this district.

Mr. Michael has continued, though with some interruptions, his work on the statistical handling of plankton data, and Dr. Esterly has added greatly to his already large accumulations of quantitative data on the copepods of the plankton.

After two years of constant, patient work on the taxonomy as well as on the seasonal distribution of the caudate tunicates, the appendiculariae, of the district, Dr. Essenberg is now coming in sight of a natural publishing place.

Such laboratory work as the director has been able to do during the year has been devoted to these animals and some almost startling observations on the propagative methods of one of the species have been partly worked out. The completion of the study is awaiting new material.

Of more than passing interest from the standpoint of the general scientific principles cardinal to the Institution under its present management, has been the publication during the year of two papers, one technical, the other general, by Dr. Esterly. The technical paper, *Reactions of Various Plankton Animals with Reference to Their Diurnal Migrations*, presents in detail the data and reasoning of the author's efforts to show how the results of field and statistical methods of studying the group of plankton animals with which he is occupied, are related to the results of laboratory experimentation on the behavior of the same organisms. The other paper, *Field Research and Laboratory Experiment: Their Places in Ascertaining and Explaining Habits in Nature* (Bull. No. 4, Scripps Institution) is a more general, semipopular discussion of the very live and practical methodological question of bringing together, or integrating, investigations of natural phenomena *in nature*, and *in the laboratory*.

HEREDITY AND ENVIRONMENTAL INFLUENCE

At no time since the investigations in this department, under the direction of Dr. Sumner, have been in progress, have the results actually in hand and almost in hand, been more varied and significant than just now. These may be enumerated in Dr. Sumner's own words:

(1) Continuation of rearing races from other sections of the state differing widely in climate. In case of the desert race, *P. maniculatus sonoriensis*, this has now reached the sixth cage-born generation, without evident change of type in the direction of the local subspecies.

(2) Measurement and statistical study of considerable collections from four new localities, making eight from which representative collections have thus far been taken. It is of interest that three collections of mice made in territory assigned to "*rubidus*" show that this "race" is not homogeneous, but undergoes gradations from north to south. On the contrary "*gambeli*" is nearly (though not wholly) uniform throughout a very wide area. Specimens from Calistoga, Napa County, resemble, on the average, those from La Jolla (500 miles distant) much more nearly than they do ones from Duncan Mills, near the mouth of the Russian River, only 27 miles away.

(3) Exact measurements continually reveal further differences between the various races and between the sexes within a race. Detailed comparisons of these races with one another, as well as the determination of coefficients of correlation within a single race make it evident that some of the differential characters have varied independently of others. On the other hand, it has become equally evident that these various distinguishing "characters" are not "unit characters" in the Mendelian sense.

(4) Hybridization experiments have been continued, and at length fairly large and fairly normal lots of first and second generation hybrids have been obtained, representing two different crosses between subspecies. My first impression that there is no demonstrable Mendelian segregation in such crosses is, on the whole, confirmed. The various characters in respect to which the subspecies differ, seem about as likely to be less variable as more variable in the second hybrid generation.

(5) The work with mutations has progressed, being now conducted jointly with Mr. Collins. One entirely new mutant (a true albino) has appeared, and experiments have been performed in crossing two of the original color mutations (yellow and pallid), with the result of obtaining typical dihybrid ratios.

(6) Work has gone far in the preparation of a report upon the results of trapping in various parts of the state, and upon the meteorological and

botanical data which have been gathered at various stations since the present project was begun.

(7) About 900 additional skeletons have been prepared from specimens comprised in the newer collections, as well as from hybrids.

(8) Experiments upon the limitations of selection, with reference to length of tail, were begun in collaboration with Mr. Collins.

(9) Experiments in feeding and care of mice were continued, with a view to eliminating abnormalities of growth and structure. Part of our earlier difficulties seem to have been thus eliminated.

(10) Experiments upon guinea-pigs, bearing upon the possible transmission of the effects of specific muscular activity, still occupy a very limited portion of our time.

In addition to the researches of this list in which Mr. H. H. Collins has collaborated, he has been occupied alone upon the following, as thesis work for the doctor's degree.

(1) On development and growth of hair; moulting and replacement of hair, natural and induced; inheritance of color differences within a single subspecies; microscopic studies of different types of hairs; analysis of color components, by means of a color-wheel.

(2) Studies of growth, by measuring and weighing immature mice at definite intervals.

SCIENTIFIC AND EDUCATIONAL MISCELLANY

The joint study of statistical methods as applied to certain types of problems in natural science, upon which Messrs. McEwen and Michael have been engaged for a number of years, has been brought to completion this year, and, with an introduction by the director, has been accepted for publication by the American Academy of Arts and Sciences.

An encouraging indication of the usefulness of attention given by members of the Institution to methods is found in the coöperation sought with them by scientists not connected with the Institution. Reference has already been made to the joint work of Dr. McEwen and Mr. Alciatore, U. S. weather forecaster at San Diego. But this has gone considerably farther than the single matter previously mentioned. Mr. Alciatore has found McEwen's methods and suggestions useful for handling some of his own particular climatological problems.

There has also been helpful coöperation in the matter of methods between investigators of the Citrus Experiment Station at Riverside, and those of the Scripps Institution.

During the year Mr. Michael's report for the U. S. National Museum on the Chaetognatha collected during the Philippine cruise of the Bureau of Fisheries steamer *Albatross*, 1907-1910, has been published. Of general and possibly practical interest in this study, the author calls attention to the evidence furnished by the animals studied by him as well as that furnished by other groups, that the pelagic fauna of the Philippine and adjacent western Pacific regions is quite different from that of the San Diego and adjacent eastern Pacific fauna, the former being predominantly equatorial, while that of the California-Mexican seas has a distinctly Arctic and Subarctic cast. The possible connection of this with the character and abundance of the fish fauna of the California region is referred to by Mr. Michael.

The educative value of the public aquarium and museum of the Institution deserves mention. More than five thousand people visited these during the year.

The entire scientific personnel of the Institution attended the Pasadena meeting of the Pacific Division, American Association for the Advancement of Science, June 19 to 22, 1919, six of the members, Messrs. Allen, Esterly, McEwen, Michael, Ritter, and Sumner having places in some of the programmes.

It is with no little satisfaction that I am able to record that members of the Institution had a rather prominent part in planning and carrying out the two symposia, one on "The Exploration of the North Pacific Ocean," the other on "Scientific Education in a Democracy," which were prominent features of the meetings.

The increasing number of calls upon the director for popular talks and writing are of such character as to indicate that his long continued teaching and preaching of the biological doctrine of "seeing life whole," is beginning to have some effect on the mind of the rank and file, as well as on that of professional scientists. His major production, so far, *The Unity of the Organ-*

ism or the Organismal Conception of Life, has come from the press, in two volumes, within the last four months.

The library has been increased by about 1000 volumes during the year, the present total being approximately 6700. Many of the additions this year were obtained from the general University Library, where they were duplicates.

A MOVE IN THE INTEREST OF THE FUTURE OF THE INSTITUTION

Through a proposal and an arrangement made by President Wheeler of the University, the Director was enabled to appear at a joint meeting of representatives of the Regents and Faculties of the University, and present a number of statements and recommendations concerning the Institution.

The following are extracts from a statement and recommendations concerning the Scripps Institution for Biological Research presented at a joint meeting of the Committees on Finance, and on Curriculum and Degrees of the Regents of the University, and representatives of the Research Board of the Academic Senate, held in San Francisco, January 14, 1919:

1. *Aim of the Presentation from the Standpoint of the State and the University of California.*—To make more effectual than it has been heretofore for the people of California, the great natural heritage of California as a maritime district.

Although California has an ocean coast line of 800 miles, or more than that of any state except Florida, and although its whole physical existence is more uniquely influenced, probably, than that of any other district in the United States by its proximity to the ocean, exceedingly little cognizance has been taken of these facts in the scientific and educational undertakings of the State.

2. *Scientific and Economic Ideas Basal to the Recommendations.*—What is presented under this head may take the form of a justification of the present tendency to substitute the phrase "Use of the Sea" for "Freedom of the Sea" in discussions of political, judicial, and economic problems of the sea.

Hitherto such discussions have regarded the sea primarily in its capacity as a highway for travel, and as an arena for warfare. To these conceptions of the use of the sea must be added, when the subject is approached from a broadly scientific standpoint, these other uses:

(a) The sea as a producer of things (food, clothing, articles of fine and industrial art, agricultural fertilizers, etc.), essential to civilized man. In restricted localities and under special conditions ocean fisheries have long received some consideration in politics and law. But growth of world population, of economic problems resulting therefrom, and of scientific and industrial knowledge is bringing to clear light the necessity of regarding the water areas of the earth, along with the land areas, as universal sources of the organic products indispensable to world civilization.

(b) The oceans as basal factors in the physical environment of peoples. Reference is specially made to the influence of the oceans on the climate, temperature, winds, water precipitation, etc., of contiguous lands.

(c) The great oceanic areas and basins as fields in which the natural and irresistible impulsion of civilized man to adventure and discovery, and to the interpretation of natural phenomena of cosmic scope. The part played by the sea in determining the psychological and philosophical types of civilization and of peoples has been too little recognized heretofore.

3. *Recommendations Concerning Scientific Exploration and Research in the North Pacific.*—(a) Concerning expansions of the present marine work of the Scripps Institution *alone*: To include pelagic or open ocean diatoms, \$6000 per year. To include the bacteriology and chemistry of the open ocean, \$5000 per year. For computers and technical assistants, \$2000 per year. These recommendations have in view investigation of the basal food supply of all marine animal life, and the measure of fertility of this oceanic area. The diatoms with other groups of microscopic plants of the surface waters play the role for the sea, generally speaking, of the grasses of the lands; while problems of bacterial life of the sea, and those of the chemistry of the water, correspond in large measure to the problems of the land as dependent on soil bacteria and humus.

Much of the research needed in these subjects is so far local that it can be carried on to good purpose by the Institution without special coöperation of other agencies. Not so with the next mentioned subject.

(b) Results of the oceanographic studies heretofore prosecuted by the Institution, reveal the importance of recognizing the California Current as the natural oceanic unit-area for the exploration of which the Institution is near the coast line center. The approximate extent of this area is from Cape Fairweather on the Oregon Coast to Cape San Lucas and Mazatlan on the Mexican coast; i.e., from about 1000 miles north of San Diego to about 600 miles south of that point. The seaward extension of the area is approximately 500 miles at the north, and 1500 to 2000 miles at the south.

Adequate exploration, physical and biological, of this area would require the constant operation of one, and for part of the time two, well appointed vessels, for a considerable term of years.

Such an enterprise is altogether too large for any agency less than the United States Government, and I recommend that the University join with

other agencies in attempting to induce the Federal Government, perhaps through a bureau of scientific research of the Navy Department, to furnish, equip, and man, vessels adequate for the investigation. But steps should also be taken through the national government to utilize lighthouses, light ships, merchant ships, and other available agencies for gathering certain kinds of data.

As already indicated, the Scripps Institution is near the coastwise center of the oceanic area which may be called the area of the California Current, and hence the Institution might well be made the operative center for the field and laboratory investigations of this area.

But of still broader scope, and to a large extent independent of this investigation, I further recommend:

(c) That the University join with other scientific organizations and agencies in an attempt to induce the United States Government to undertake exploration and research in the North Pacific generally for the purpose of extending knowledge on the following subjects particularly:

(i) The whole water circulatory system of the area, with special reference to the relation of the Japan Current to the California Current.

(ii) The meteorology of the oceanic area.

(iii) The organic productions of the oceanic area as dependent upon the basal processes in the so-called metabolism of the sea.

(iv) The animal and bird life of the oceanic area with a view to securing requisite scientific knowledge by 1926 (the date of expiration of the existing international treaty for preserving the northern fur seals and sea otters) to serve as a basis for a similar international convention for preserving and utilizing all species of these animal classes which have now or promise to have in the future, economic significance.

(v) The fishes proper of the oceanic area in such ways and to such extent as the United States Bureau of Fisheries may indicate.

4. *Recommendations Concerning the Educational Functions of the Scripps Institution.*

(a) Creation of the position in the scientific staff of the Institution of an educational, or public informational secretary, the chief function of which would be to make available as far as possible the results of the technical researches of the Institution, for educating the general public in the fields of science cultivated by the Institution, the chief medium for this purpose to be the public press.

5. *Recommendation as to the Future Administration and Policy of Institution.*—That a permanent board or committee on policy be created, this to be composed of Regents of the University and representatives from the academic side of the University. The nominally existing standing committee of the Regents of the Scripps Institution, and the present research board of the academic senate is suggested as a personnel of the new board, but both number of members and personnel of the board may be left for

later determination, the main points to be (a) the creating of the board; **and** (b) its containing the two elements, i.e., representatives of the administrative and the academic sides of the University.

I am able to record, with very great satisfaction, that three moves have already been made in the direction of carrying out these recommendations: (1) The Institution has been able, through increased appropriation by the State Legislature for operating expenses, and by certain readjustments of its budget, to create a new research position for the phyto plankton. (2) Recognizing the desirability of expanding the Institution's work at sea in accordance with the recommendations touching this matter, Mr. E. W. Scripps is making his large seaworthy yacht *Sanwan* available for certain phases of exploration which the Institution has never before been able to carry out. (3) Of special importance, the Regents of the University have taken a first step toward carrying out the recommendation relative to a board of policy for the Institution.

Respectfully submitted,

WM. E. RITTER,
Director.