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*Biological Research at the Scripps Institution  
of Oceanography*



DR. CLAUDE E. ZOBELL

## BIOLOGICAL RESEARCH AT THE SCRIPPS INSTITUTION OF OCEANOGRAPHY

DR. CLAUDE E. ZOBELL

*In Charge, Biological Program*

At the time his retirement from the University of California becomes effective in August 1936 Dr. T. Wayland Vaughan will leave to his successor, Dr. Harald U. Sverdrup, a scientific organization which has expanded rapidly during his administration to include all aspects of oceanographic research. Since his appointment as director of the Scripps Institution of Oceanography in February 1924, Dr. Vaughan has gradually developed an extensive research program in biological oceanography. Being himself an authority on corals and foraminifera and recognizing the importance of all biological entities in the metabolism of the sea, Dr. Vaughan has devoted particular attention to biological research. He has been instrumental in assembling a staff of well-trained biologists who are working cooperatively with the chemical, physical, geological and dynamical oceanographers to advance our knowledge of the "other two-thirds of the world," the ocean. While it has been the policy of the Institution to allow the staff members a high degree of freedom in the selection of problems for investigation, it has been the common objective of all to contribute to the science of the sea and its relation to man.

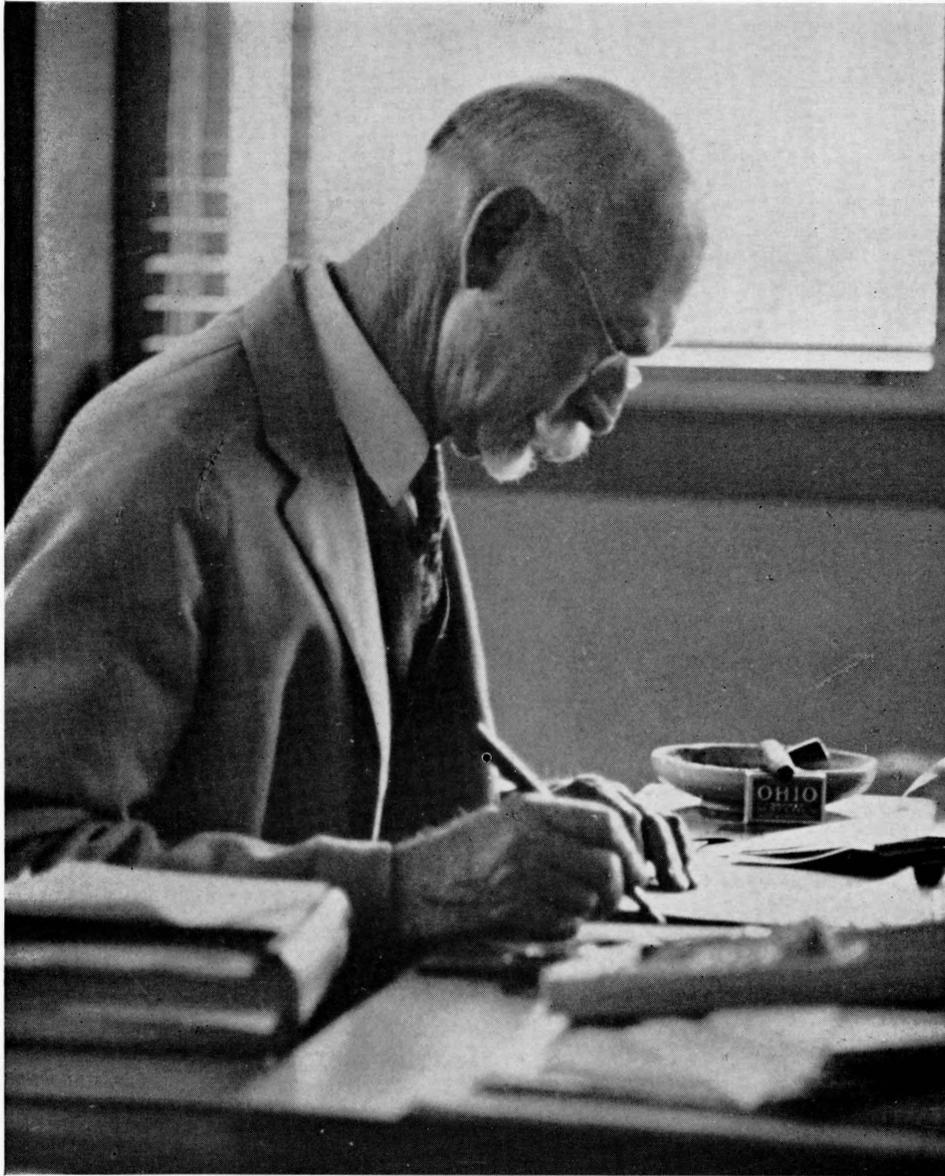
During the directorship of Dr. Vaughan the biological research program has been expanded and improved in several ways. Additional personnel has been appointed to provide specialists in bacteriology, fishes and other vertebrates, invertebrates, paleontology, physiology, phytoplankton and zooplankton. More adequate laboratory facilities have been made available as described in THE COLLECTING NET (8:2-7, 1933). The supply of running sea water has been enlarged and improved in quality. By the installation of diesel engines in the boat *Scripps* its cruising speed and range and its safety have been increased, thereby extending its usefulness for the collection of samples and oceanographic data. The laboratory quarters as well as the living accommodations on the boat have been remodeled and an electrically-operated hoisting device installed with enough cable to take water and bottom samples and temperature records from depths as great as 4500 meters and enough large cable to dredge to depths of 1000 meters. Perhaps the greatest improvement during Dr. Vaughan's administration has been made in the library which now contains over 14,600 volumes, 1100 charts and 30,000 pamphlets. He has contributed to the Institution his own personal collection of 1800 volumes and 6000 reprints of

relevant literature besides numerous periodicals. The library subscribes to 74 periodicals and receives 236 others on an exchange basis besides 18 periodicals which are presented as gifts. Reports on nearly all of the important oceanographic expeditions have been or are being obtained. Although there is still much to be desired, the Scripps Institution library is one of the finest of its kind in the world.

The broad scope of the research program in biological oceanography may be judged from the following summary of projects upon which work has been done during the year.

Dr. Martin W. Johnson, who has recently taken charge of the zooplankton work, has published a report on the seasonal migration of the wood-borer, *Limnoria lignorum* in northern waters. Likewise he has completed a paper on the developmental stages of the oceanic copepod, *Eucalanus elongatus* var. *bungii*. Additional study is being made on the status of the varieties of this species collected at various stations from Panama to the Arctic Ocean. Dr. Johnson is continuing his observations on the zooplankton off the California coast with particular reference to seasonal production, relation to the oxygen minimum layer and other environmental factors. Cultural experiments to determine the life cycle of the littoral copepod, *Thisbe*, and of the pelagic copepod, *Tortanus discaudatus*, are in progress. Investigations of the fouling organisms in the Institution's salt-water system are being continued.

In collaboration with N. A. Wells and later with Peter Doudoroff, Dr. F. B. Sumner, in charge of biology of fishes, has continued the investigations on the respiratory metabolism of marine fishes with special reference to its relation to their susceptibility to certain anaesthetics and lethal agents. Investigations on the quantitative study of melanin production in fishes as influenced by varied conditions of background and incident light have been commenced. The intake and output of water and salts by euryhaline fishes in different concentrations of sea water is being studied. In collaboration with D. L. Fox, the influences of certain stimuli on the accumulation of carotenoids in the tissue of fishes are being investigated. Professor R. B. Cowles from the University of California at Los Angeles devoted part of last summer to special investigations on fishes and Dr. B. M. Allen from the same University has been



**DR. T. WAYLAND VAUGHAN**

Retiring director of the Scripps Institution of Oceanography, who recently received the Agassiz medal from the National Academy of Sciences, and LL.D. degrees from the University of British Columbia and the University of California in recognition of his outstanding work as an investigator and organizer.

continuing his studies on the hypophysis of fishes at the Institution.

Percy S. Barnhart, curator of the biological collection, has completed a monograph on "Marine fishes of Southern California" which is illustrated by 292 figures. In the aquaria tanks about 855 fishes and several hundred invertebrates including over 50 species have been exhibited. A large collection of mounted fishes has been on exhibit in the California State Building at the San Diego Exposition. Various shells, corals, mounted fishes and other marine organisms have been added to the Institution's fine museum collection during the year.

Professor W. E. Allen is continuing his observations on the number and kind of phytoplankton collected daily from the piers at the Institution and at Point Hueneme. He has such data for fifteen consecutive years. A report covering certain general features in the studies of the first ten years has been published. He has also prepared a report covering the outstanding results of the study of the diatom collections obtained by Dr. Roger Revelle on his mid-Pacific cruise on the *U. S. S. Bushnell* in 1934. A taxonomic report on the diatoms from the Sea of Java has been published in collaboration with Dr. E. E. Cupp. The pertinent results of the experimental studies on "fouling organisms" carried on in cooperation with Dr. W. R. Coe of Yale University have been submitted for publication. Miss Sonia Ladoff from the Allegheny High School of Pittsburgh has been making observations on the plankton, algae and other microorganisms of the Pacific coast.

Dr. E. E. Cupp has completed a paper entitled, "Seasonal distribution and occurrence of marine diatoms and dinoflagellates at Scotch Cap, Alaska." She has given particular attention to the centrifuge method of phytoplankton analysis. The effect of low concentrations of deuterium oxide on the growth of two species of the marine diatom genus *Nitzschia* has been investigated and a paper on this subject in collaboration with Dr. Fox and Dr. McEwen has been published.

Although not a staff member, M. L. Natland has continued to work with the Institution in a study of the ecology of the living foraminifera in the Gulf of Catalina. Dr. Vaughan assisted by Dr. W. S. Cole and U. S. Armstrong has completed several papers on fossil foraminifera. Particularly meritorius has been the work on the stolon systems of the foraminifera as a criterion for their classification. Dr. Shoshiro Hanzawa from the Tohoku Imperial University has been studying the orbitoidal foraminifera in collaboration with Dr. Vaughan, and F. B. Tolman spent several days studying the Institution's foraminifera collection. Dr. Earl H. Myers, now professor

of zoology at Compton Junior College, has continued his work on life cycles in the foraminifera.

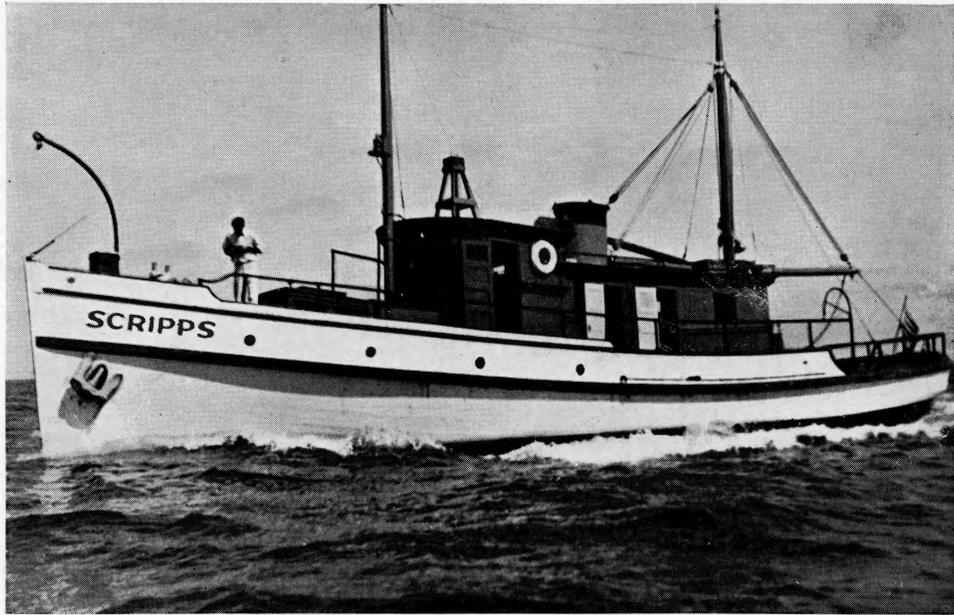
In the physiological laboratories, Dr. D. L. Fox is pursuing studies on the carotenoid pigments of marine organisms. In collaboration with Dr. Sumner it has been demonstrated that certain optical environmental factors affect the amounts of xanthophyll stored by *Girella nigricans*, and



**DR. HARALD U. SVERDRUP**

Famous oceanographer and Arctic explorer, who becomes director of the Scripps Institution September 1, 1936.

that *Fundulus parvipinnis* lost none of its xanthophyll when maintained for long periods on a carotenoid-free diet and increased its quantities of xanthophyll when fed either the latter carotenoid or carotene. Jointly with Dr. Young it has been found that certain surf perches selectively absorb only one of the three different carotenoids in a species of shrimp which the perches consume. A xanthophyll ester is hydrolyzed in the gut, stored in a re-esterified condition in the skin and fins, and any excess temporarily stored in an unesterified condition in the rectal segment of the gut.



**"SCRIPPS," THE INSTITUTION'S FLOATING LABORATORY**  
Which is used for the collection of specimens and oceanographic data.



**PRINCIPAL BUILDINGS OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY**  
Showing the pier which extends 1000 feet out to sea.

Dr. Fox has published results indicating that heavy water has little or no influence on the activity of certain enzymes. Working with Dr. R. Craig a slight enhancement by heavy water of the enzymatic hydrolase of starch was observed. Dr. Fox, Dr. E. E. Cupp and Dr. G. F. McEwen report that heavy water seems to retard the growth rate of the diatom, *Nitzschia bilobata*, but apparently stimulates that of *N. closterium*. A 64 page paper on the habitat and food of the California sea mussel has recently been published. Prior to his resignation in October, Dr. G. W. Marks made important contributions to our knowledge of the catalase of marine animals and plants as well as on the comparative copper content of various marine mollusks.

In microbiology, Dr. Claude E. ZoBell has continued his studies on the measurement of the oxidation-reduction potentials of sediments as influenced by bacterial activity. The O/R potentials of strata from different depths as well as the vertical distribution of aerobes and anaerobes has been published. Assisted by D. Q. Anderson, the vertical distribution and relative abundance of bacteria in marine sediments which activate the following physiological processes of oceanographic significance have been estimated:—ammonification, nitrate-reduction, denitrification, nitrification, urea-fermentation, cellulose-decomposition, chitin-digestion, fat-hydrolysis, sulfate-reduction, starch-hydrolysis, and various hydrolytic processes. It has been found that bacterial activity as manifested by CO<sub>2</sub> evolution, NH<sub>3</sub> production, NO<sub>3</sub> reduction and bacterial multiplication is greater in small than in large volumes of sea water because of the periphytic habits of marine bacteria. The investigations of Miss W. A. Landon indicate that mussels, barnacles and other marine animals can subsist on a bacterial diet. Mrs. C. Feltham has continued the work on the specificity of marine bacteria. Miss Helen Mathews, a summer visitor from the University of British Columbia, finds that the types of bacteria found in air are indicative of whether air masses are of marine or terrestrial origin. Mrs. Alice Callaway is working on the filter-ability of bacteria and the osmotic

pressure tolerance of marine *vs.* freshwater forms. An autochthonous bacterial flora in Great Salt Lake has been demonstrated by the direct microscopic procedure in collaboration with W. W. Smith of the University of Utah. Dr. Blodwen Lloyd spent several months at the Institution while on sabbatical leave from the Royal Technical College of Glasgow studying denitrification and the factors which influence the activity of bacteria in stored sea water.

Dr. R. T. Young, a visiting scientist who has been working in the Institution laboratories during the last two years, has been especially interested in parasites. He has collected and preserved for future reference a large number of cestodes from fishes and birds. The life histories of the trematode, *Levinsella* sp., from the godwit (*Leimosia fedoa*) and an indeterminate trematode from the surf perches (Embiotocidae) have been partially determined. A fork-tailed cercaria from the Bering sea has been described. Dr. Young is also investigating the influence of pH, distilled water and various salt solutions on fish to determine the cause of their death. Various pathological effects including chemical changes in the blood which may induce asphyxia have been observed but it is not known yet whether these effects cause death or if they are merely incidental.

La Place Bostwick, a special resident investigator, has published the results of his successful cultivation of pearls in abalones. Dr. Chin Chih Jao of the Rockefeller Foundation in Natural Sciences devoted several months to the study of local sea-weeds and to learning modern oceanographic methods. Professor Loye Miller from the University of California at Los Angeles has taken advantage of the cruises of the boat *Scripps* to collect data on near-shore birds. Harold Pratt and Irving McClurkin, both from the University of Colorado, have been studying the invertebrates of the intertidal zone.

During the year 22 papers have been published on subjects appertaining to biological oceanography, eight others have been accepted for publication and a dozen are in preparation.