Bindup

THE SCRIPPS INSTITUTION OF OCEANOGRAPHY

FROM 1933 - 1938, INCLUSIVE

H. U. Sverdrup
Director

Equipment.-

On November 13, 1936, the Institution's boat "Scripps", which in 1934-35 had been completely overhauled and re-equipped, was lost by explosion and fire. On April 5, 1937, Mr. R. P. Scripps bought the 104-foot schooner "Serena" which after remodelling he gave to the Institution. On transfer the name was changed to "E.W.Scripps." In addition to the crew, the "E.W.Scripps" can accommodate a scientific party of six, it contains adequate laboratory space both on deck and below deck, and carries two winches for oceanographic work, one provided with 2,000 feet of 5/32-inch wire rope and one provided with 2,000 feet of 3/8-inch wire rope. The normal cruising radius under power is 2,000 miles, but this can be considerably extended by taking fuel on deck and by using the sails.

Expeditions and Oceanographic Data.-

From June, 1935, until November, 1936, the "Scripps" occupied a number of oceanographic stations in the waters near the coast of southern California between San Diego and Santa Barbara. In 1937 when the Institution had no vessel at its disposal three cruises were made in cooperation with the California State Fisheries Laboratory, using their vessel, the "Bluefin." Nearly thirty stations were occupied on each cruise along four lines running at right angles to the coast.

The lines were 70 miles apart and 160-180 miles long, the northern beginning off Port San Luis and the southern off San Diego. In 1938 all these stations were occupied by the "E.W.Scripps" on six cruises in alternate months from February to December, except when in April and October bad weather prevented the completion of the work. On the "Bluefin" cruise observations were made at standard intervals down to as low as 2,000 meters, but on the"E.W.Scripps" cruises the work was confined to a depth of 600 meters. On the latter cruises quantitative catches of phytoplankton were made at seven depths at all stations,and vertical hauls of zooplankton were conducted on all cruises except the first one.

In 1933, 1934, and 1935 the U.S.S."Hannibal" occupied a large number of oceanographic stations in the Gulf of Panama and off the coast of Panama and Costa Rica. In 1933 R. H. Fleming of the Institution's staff spent about three months aboard the "Hannibal" as special observer. In 1934 the U.S.S."Bushnell" occupied 18 stations between Adak, Aleutian Islands, and Pearl Harbor in the Hawaiian Islands. Roger Revelle of the Institution's staff accompanied the "Bushnell." In November, 1936, 10 stations were occupied by the U.S.S."Louisville" between San Pedro and Pearl Harbor. This work was in charge of E. G. Moberg of the Institution's staff.

In addition, the Institution has received subsurface data from various stations close to the American coast occupied by vessels of the U. S. Coast and Geodetic Survey. About forty subsurface data were obtained by the "Velero III" in 1934-35 from the area off the coast of Peru in about latitude 10°S. A large number of surface data have been submitted to the Scripps Institution.

Physical Oceanography.-

The above-mentioned data have all been discussed and published or prepared for publication except those of 1938, which are under preparation. The "Bluefin" observations in 1937 and the observations of the "E. W. Scripps" in 1938 have shown that off the coast of southern California a big eddy appears to be present during the greater part of the year. This eddy is especially well developed during the period of upwelling when the offshore branch of the eddy carries cold upwelled water towards the south, whereas the inshore branch carries water of higher temperature towards the coast, but this inshore branch reaches only to the Channel Islands.

In order to explain the observed distribution of temperature and salinity it appeared necessary to assume that an intensive quasi-horizontal mixing takes place, at least down to a depth of 500 meters. This process of mixing can be dealt with as a process of diffusion, by introducing a coefficient of diffusion of the order of magnitude 10^6 cm^2/sec. It is probable that this mixing is maintained by eddies of dimensions up to 10 or 20 km and that the velocities may be up to 20 or 30 cm/sec. Measurements of current by F. P. Shepard and Roger Revelle by means of a meter suspended on a tripod only 21 cm from the bottom show that irregular currents having velocities up to 20 cm/sec are found near the bottom at depths between 50 meters and 800 meters. The presence of such irregular currents at these depths may be considered a confirmation of the conclusions as to eddy motion based on distribution of temperature and salinity.

E. C. LaFond has conducted a study of relation between coastal surface temperatures and sea level and has shown that low surface temperature corresponds to low sea level and vice versa. By means of oceanic data off the coast it has been established that variations in sea level are closely associated with changes in the distribution of density of the coastal waters.

It is therefore possible that the records of sea level can be used in the study of coastal currents.

In 1936 a series of measurements of penetration of light was made by means of a photo-cell, and in the summer of 1937 a Pettersson transparency meter was constructed and tried out. This instrument was used in August, 1938, for measuring at about 20 stations the transparency of water at different depths between the surface and 60 meters. This work was conducted by R. T. Young, Jr., Worcester Polytechnic Institute.

G. F. McEwen and his associates have continued their study of forecasting seasonal air temperatures and precipitation on the basis of cycles and correlation with ocean temperatures. The public interest in these forecasts has warranted their annual publication. Averaging and plotting of sea-surface temperatures by months and one-degree squares in the Pacific Ocean have been continued. The method for computing ocean currents by means of sea-surface temperature has been further developed. A study of the energy relations between the sea surface and the atmosphere has been completed and by means of local observations of the vertical temperature gradient in the sea, together with the distribution of solar radiation and the amount of radiation penetrating the sea surface the resulting evaporation from the sea has been computed. Methods for use in summarizing numerical field data have been critically examined.

Several applications of statistical methods to biological problems have been developed by Messrs. McEwen and Gordon. Mr. Gordon has developed a new method for computing "most probable" bacterial populations from the results of successive ten-fold dilutions of the sample. It is believed that tables based on the new formula will give

better agreement with experimental results than Halvorson and Ziegler's tables which are now in use.

~~The studies conducted by Mr. McEwen and associates will be enlarged upon by Mr. McEwen who will submit a special outline of his researches.~~

Chemistry.-

The work in the chemical laboratories in charge of E. G. Moberg, has to a great extent dealt with routine determinations of salinity, oxygen, phosphates and various components of the buffer mechanism. Determinations have been made on samples regularly collected at the Institution's pier as well as on samples obtained on the above-mentioned cruises.

Further investigations of the buffer system of the sea have been conducted by D. M. Greenberg, of the University of California, Berkeley, Esther Allen and Messrs. R. H. Fleming and R. Revelle, and later by Mr. John Lyman. 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 P. H. Mitchell of Brown University.

Considerable attention has been devoted to the atmospheric nitrogen content of sea water and experiments have been made to determine nitrogen by means of the Van Slyke blood-gas apparatus. It is believed that a method has been devised that will prove practicable in laboratories on shore and possibly also on board ship.

A method for detecting small differences in the carbon dioxide content of the air that may be correlated along the coast with the direction of the wind has been developed, and a rapid and scientific method for determining arsenic was applied to sea water by T. H. Winnick, University of California, Berkeley.

With the assistance of the Works Progress Administration workers numerous determinations of the fixed nitrogen content of bottom samples from various parts of the Pacific were made and a number of water samples were analyzed for organic and ammonia nitrogen and for calcium. Various methods for determining iodine in sea water were tried by W. L. Burdick and J. Cunningham. By means of one of these methods accurate information regarding the iodine content of a number of samples was obtained not only from the surface but from depths down to about 1,000 meters. A study of methods for the determination of manganese and iron in sea water has also been begun. Robley D. Evans made a study of the radioactive substances in sea water, in marine plants and animals and in the bottom deposits off the coast of Southern California.

Submarine geology and marine sediments.-

In 1935 F. P. Shepard of the University of Illinois undertook dredging for rocks from the walls of the submarine canyons near La Jolla, and in 1938 this work was continued and greatly extended through a grant from the Geological Society of America by means of which Mr. Shepard had the use of the "E. W. Scripps" in alternate months. Large quantities of rocks were brought up from a number of localities, cores of bottom sediments up to 12 feet in length were obtained and detailed soundings were made in many areas. Roger Revelle of the Institution's staff took part in this work and conducted simultaneously laboratory studies of bottom sediments. A large amount of mechanical analyses of sediment samples collected by the "Scripps" off the Southern California coast were completed. The results show distinct relation between the grain

size of the sediments and the topography of the bottom. Similarly, the amount of organic nitrogen in the samples which were determined in the chemical laboratory showed distinct relation to the configuration of the bottom. Revelle completed his discussion of the bottom samples collected by the "Carnegie" during her work in the Pacific. Together with R. H. Fleming measurements were made of the variation with depth of the currents close to the bottom. It was found that in shallow water the profile of the current near the bottom corresponded closely to the velocity profile which has been established in laboratories as characteristic for flow over a rough surface. Miss Stina Cripenberg of Helsingfors, Finland, was in 1937-38 engaged in studies of the carbon content of sediments.

Marine microbiology.-

C. E. ZoBell, in charge of the bacteriological studies, has continued his work on bacteria in sea water and in bottom deposits. Five new species have been isolated which produce ammonia from low concentrations of urea in sea water. 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. Multiplication, proteolysis, carbohydrate-fermentation, ammonification, and nitrification in marine bacteria have been observed at 0° to -2°, C, which indicates that bacteria are functional at the low temperatures encountered in the deep sea.

Assisted by D. Q. Anderson the vertical distribution and relative abundance of bacteria in marine sediments which activate a number of different physiological processes of oceanographic significance have been

estimated. It has been shown that bacteria have a great capacity to affect in marine bottom deposits the O/R potentials which are of bacteriological, geological, and chemical significance.

Assisted by Mr. Sydney Rittenberg, a micro-asbestos calomel half-cell has been prepared for measuring the O/R potentials of anaerobes in oval tubes. The device makes it possible to study the influence of bacteria upon the O/R potential and also to study the influence of O/R potentials upon the activity of the bacteria.

Chitin-digesting bacteria have been found to be quite widely distributed in sea-water and bottom-deposits. They were found in abundance in the digestive organs of squid, thereby indicating that they may aid marine animals in the digestion of the resistant chitin which constitute the exoskeletons of most crustacea. Lipoclastic bacteria which liberate higher fatty acids from lipins and utilize the glycerol have been demonstrated in marine materials. These, together with those which create extremely reducing conditions, may account for the formation of long-chain hydrocarbons found in petroleum.

Mrs. C. B. Feltham has continued the experiments on the bacterial nutrition of marine organisms. Mussels have thrived for 14 months in the dark on a diet consisting exclusively of bacteria.

The importance of the presence of solid surfaces to which bacteria can attach themselves has been examined. It is believed that the low number of bacteria per unit volume in the ocean is associated with lack of surfaces per attachment. For further studies of the abundance of bacteria an improved bacteriological water sampling bottle has been perfected.

Phytoplankton.-

W. E. Allen has continued the daily collections of phytoplankton from piers at Scripps Institution and Point Hueneme more than 100 miles

further north. The microscopic work and preliminary calculations have been completed up to 1937 and cover now a period of 18 years. A large number of surface plankton catches have been obtained from various vessels, the collections have all been examined and the results published. The surface and sub-surface collections of phytoplankton which were made on the 1938 cruise of the "E. W. Scripps" have been studied and show especially that the abundance of diatoms may be as great at a distance of 180 miles from the coast as close to the coast.

Miss Easter E. Cupp has analyzed a number of phytoplankton catches by means of the centrifuge method and has spent the greater part of her time in preparing a taxonomic paper on plankton diatoms of the Southern California region.

Foraminifera.-

T. W. Vaughan published a number of papers on fossil foraminifera. E. H. Myers has succeeded in working out the life history of a local species of foraminifera known as Patellina corrugata, and has extended his studies to another form in which the cycle in all respects conforms to that of Patellina. M. L. Natland has continued his studies of the ecological relations of the foraminifera in the Gulf of Catalina.

Zooplankton.-

Martin W. Johnson has been engaged partly in the study of the life history of certain copepods and partly in studies of the geographic distribution of copepods and other forms of zooplankton. Among others the development stages of the oceanic copepods Eucalanus elongatus has been completely worked out and a report has been published on the distribution

in the Pacific of the varieties of this form. The large amount of collections which were made by the "E. W. Scripps" in 1938 is being examined with the assistance of C.C. Davis. C. R. Monk has continued a systematic and distributional survey of the harpacticid copepods of the Pacific coast.

Physiology of Marine Organisms.-

D. L. Fox has in collaboration with G. W. Marks and others concluded a study on the habitat and food of the California sea mussel. Further work on the mussel has been made possible by assistance from the Works Progress Administration. Experiments dealing with the biochemical effects of hypotonic and hypertonic solutions of sea water upon tissues have been conducted. It has been established that the mussel propels water through the gill chamber at an average rate of 2.5 l/hr. One of the chief lines of research has been the study of various carotenoid pigments in marine materials and marine animals, with special reference to nutrition. Part of this study, that dealing with carotenoid pigments in marine fishes, has been undertaken in cooperation with F. B. Sumner. The characteristic absorption curves of different pigments have been established spectroscopically.

Biology of fishes.-

F. B. Sumner has continued his studies of the protective value of color changes in fishes, and has experimentally established that fish-eating birds catch a much greater proportion of those fishes which do not harmonize with the background. The work of F. B. Sumner and his collaborators has, however, mainly dealt with the quantitative determination

of the amount of pigments formed in fishes which have been subjected to different conditions both as regards color of background and incident light. It was found that the amount of melanin extracted from a given lot of fishes bears an inverse relation to the albedo of the background, probably varying inversely as the logarithm of the albedo. Intensity of incident light also played a part in determining the production or loss of melanin, but under the degrees of illumination employed so far, the influence of this factor was small in comparison with that of the albedo of the background. A series of experiments have been commenced with a view to discovering some of the physiological differences between fishes which have been acclimatized to widely different temperatures.

P. S. Barnhart has completed a monography, Marine Fishes of Southern California, illustrated by 292 figures.

Studies on "fouling growth."

In 1937 cooperation was established between the U.S.Navy Bureau of Construction and Repair and the Scripps Institution in order to study the organisms which cause fouling growth on ships' bottoms. These studies form a continuation of work which was conducted at the Institution over a long period of years but which had to be discontinued because of other pressing demands. Mr. W. F. Whedon who has been engaged by the Bureau of Construction and Repair to carry on these studies has been engaged mainly in examinations of the primary film formed on submerged surfaces.

Publications.-

In the year 1933-38 265 papers have been published. A partial list follows shich includes only papers dealing with general aspects of oceanographic problems or with conditions in the Pacific Ocean.

Publications on general aspects of oceanographic problems and on conditions in the Pacific Ocean.

W. E. Allen.

1933. Surface phytoplankton obtained by the Templeton Crocker Expedition of the California Academy of Sciences of 1932. Trans. Amer. Micr. Soc., vol.52, pp.101-102.

1934. Marine plankton diatoms of lower California in 1931. Botanical Gazette, vol.95, pp.485-492.

1934. The primary food supply of the sea. Quart. Rev. of Biol., vol. 9, pp. 161-180.

1935. (and Easter E. Cupp) Plankton diatoms of the Java Sea. 127 species and varieties, 48 pls. Bull. du Jardin Botanique de Buitenzorg. In press.

1936. Occurrence of marine plankton diatoms in a ten-year series of daily catches in southern California. Amer. Jr. Botany, v.23, no. 1, pp.60-63, 1936.

1937. Plankton diatoms of the Gulf of California obtained by the G. Allan Hancock Expedition of 1936. Univ. So. Calif., Publ., vol.3, no. 4, May, 1937.

1938. The Templeton Crocker Expedition to the Gulf of California in 1935 - The phytoplankton. Amer. Micros. Soc., Trans., vol.57, pp.328-35, Oct., 1938.

1938. Surface distribution of marine plankton diatoms in the Panama region in 1933. SIO Bull., tech.ser., vol.4, no. Dec., 1938.

Barnhart, P. S.

1936. Marine fishes of southern California. With 292 figures. 209 pp. 1936.

Byers, Horace R.

1934. The air masses of the North Pacific. SIO Bull., tech. ser., vol.3, no.14, pp.311-54.

Coe, W. R., and W. E. Allen.

1937. Growth of sedentary marine organisms on experimental blocks and plates for nine successive years at the pier of the Scripps Institution of Oceanography. SIO Bull., tech.ser., vol.4, no. 4, pp. 101-36, 1937.

Cupp, E. E.

1934. Analysis of marine plankton diatom collections taken from the Canal Zone to California during March, 1933. Amer. Micr. Soc., Trans., vol. 53, pp. 22-29, 1934.

Cupp, E. E. (continued)

1937. Seasonal distribution and occurrence of marine diatoms and dinoflagellates at Scotch Cap, Alaska. SIO. Bull., tech. ser., vol. 4, no. 3, pp. 71-100, April 22, 1937.

1938. (and W. E. Allen) Plankton diatoms of the Gulf of California. Hancock Exped., vol. 3, no. 5, pp. 61-99, Aug., 1938.

Doudoroff, P.

1938. Reactions of marine fishes to temperature gradients. Biol. Bull., vol. 75, pp. 494-509, Dec., 1938.

Evans, Robley D., Arthur F. Kip, and E. G. Moberg. The radium and radon content of Pacific Ocean water, life and sediments. Amer. Jour. Science, vol. 36, pp. 241-59, Oct., 1938.

Fleming, R. H.

1934. U.S.S. "Hannibal" and salinity data. In Dynamic oceanographic data for the Central Eastern Pacific Ocean, and Surface Temperature and Salinity data for the Eastern Pacific Ocean Collected by U.S.Naval Vessels. Hydrographic Office Bull.212, pp. 1-38, 1954.

1938. Tides and tidal currents in the Gulf of Panama. Jour. Marine Research, vol. 1, pp. 192-206, Dec., 1938.

Fleming,R.H. (and R. Revelle) Physical processes in the ocean. In press: Symposium on recent sediments. Amer. Assoc. Petrol. Geol.

Fox, D. L.

1936. Further studies of the carotenoids of two Pacific marine fishes, Fundulus parvipinnis and Hypsypops rubicunda, and of a marine annelid, Thoracophelia sp. Nat. Acad. Sci., Proc., vol.22, no. 1, pp.50-54, 1936. (Jan.)

1936. (and G. W. Marks, F. O. Austin, H. M. Buley) The habitat and food of the California sea mussel. SIO Bull., tech. ser., vol. 4, no. 1, pp. 1-64, 1936. (June)

1936. (and E. E. Cupp, G. F. McEwen) Low concentrations of deuterium oxide and the growth of marine diatoms. Soc. Exper. Biol. & Med., Proc., vol. 34, pp. 575-81, 1936.

1936. Structural and chemical aspects of animal coloration. Amer. Naturalist, vol. 70, pp.477-93, 1936.

1937. Carotenoids and other lipoid-soluble pigments in sea and in deep marine mud. Nat. Acad. Sci., Proc., vol. 23, no. 6, pp.295-301, 1937.

Gordon, R. D.

1938. Note on estimating bacterial populations by the dilution method. Nat. Acad. Sci., Proc., vol.24, pp. 212-15, May, 1938.

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Jacobs, W. C.,

1937. Preliminary report on a study of atmospheric chlorides. U.S.Dept. Agric., Weather Bureau. From Monthly Weather Review, vol. 65, pp. 147-151, 1937.

Johnson, M. W.

1935. The developmental stages of Labidocera. Biol. Bull., vol. 68, no.3, pp. 397-421, 1935.

1936. Pachyptilus pacificus and Centraugaptilus porcellus, two new copepods from the North Pacific. SIO Bull., tech.ser., vol.4, no.2, pp.65-70, 1936.

1937. The developmental stages of the copepod Eucalanus elongatus Dana var. Bungii Giesbrecht. Amer. Micr. Soc., Trans., vol. 61, no. 1, pp. 79-98, 1937.

1937. The production and distribution of zooplankton in the surface waters of Bering Sea and Bering Strait. In U.S.Coast Guard, Rept. Oceanographic cruise U.S.Coast Guard Cutter "Chelan" 1934-37, pt.2, pp.45-82, 1937.

1938. Concerning the copepod Eucalanus elongatus Dana and its varieties in the northeast Pacific. SIO Bull., tech.ser., vol.4, no. 6, pp. 165-80, 1938.

McEwen, G. F.

1936. Hydrographic sections and calculated currents in the Gulf of Alaska, 1929. Intern. Fisheries Comm., Rept. no.10, pp. 1-32, 1936.

1936. Problems of long-range weather-forecasting for the Pacific Coast. Amer. Geoph. Union, Trans., 17th Ann. Meet., 1936, pp.486-91, 1936.

1938. Modern dynamical oceanography: an achievement of applications to ocean observations of principles of mechanics and heat. Amer. Phil. Soc., Proc., vol.79, no.2, p.145-66, June, 1938.

1938. Some energy relations between the sea surface and the atmosphere. Jour. Marine Research, vol. 1, no. 3, pp. 217-38, Sept. 1938.

Observations on temperature, hydrogen-ion concentration, and periods of stagnation and overturning in lakes and reservoirs of San Diego County, California. In press: SIO Bull., tech. ser.

Marks, G. W.

1938. The copper content and copper tolerance of some species of mollusks of the southern California coast. Biol. Bull., vol.75, pp.224 - 37, Oct., 1938.

Myers, Earl H.

1935. The life history of Patellina corrugata Williamson, a foraminifer. SIO Bull., tech. ser., vol.3, no. 15, pp.355-92.

1935. Morphogenesis of the test and the biological significance of dimorphism in the foraminifera Patellina corrugata Williamson. SIO Bull., tech. ser., vol.3, no. 16, pp.393-404.

1935. The biology of the foraminifera as exemplified in Spirillina vivipara Ehrenberg, sponsored by Arthur Earland, F.R.M.S. to Philos. Trans. Roy. Soc. London, Ser. B. Oct. or Nov.

1936. The life-cycle of Spirillina vivipara Ehrenberg, with notes on morphogenesis systematics and distribution of the foraminifera. Roy. Microsc. Soc., Jour., vol.56, pp. 120-46, 1936.

1938. The present state of our knowledge concerning the life cycle of the foraminifera. Nat. Acad. Sci., Proc., vol. 24, pp. 10-17, Jan., 1938.

Natland, Manley L.

1933. The temperature-and-depth-distribution of some recent and fossil foraminifera in the southern California region. SIO Bull., tech. ser., vol. 3, no. 10, pp. 225-230.

1938. New species of foraminifera from the west coast of North America and from later Tertiary of the Los Angeles Basin. SIO Bull., tech. ser., vol. 4, no. 5, pp. 137-64, Feb., 1938.

Revelle, Roger

1934. Physico-chemical factors affecting the solubility of calcium carbonate in sea water. Jour. Sed. Petrology, vol. 4, no. 3, pp. 103-110.

1935. Preliminary remarks on the deepsea bottom samples collected in the Pacific on the last cruise of the "Carnegie." Jour. Sed. Petrology, vol. 5, no. 1, pp.37-39.

(and F. P. Shepard) Sediments off the California coast. In press: Symposium on recent sediments. Amer. Assoc. Petrol. Geol.

Marine bottom samples collected in the Pacific Ocean by the "Carnegie" on its seventh cruise. In press: Carnegie Inst. Wash.,

Sumner, F. B.

1934. Studies of the mechanism of color changes in fishes. James Johnstone Memorial Volume, Lancashire Sea Fisheries, Liverpool, England, pp. 62-80, 1934.

1934. Does "protective coloration" protect? Results of some experiments with fishes and birds. Nat. Acad. Sci. Proc., vol. 20, pp.559-64, 1934.

Sumner, F.B. (continued)

1935. Evidence for the protective value of changeable coloration in fishes. (II) Amer. Naturalist, vol. 69, pp.245-66. 1935.

1935. (and D. L. Fox) Studies of carotenoid pigments in fishes. II. Investigations of the effects of colored backgrounds and of ingested carotenoids on the xanthophyll content of Girella nigricans. Jour. Exper. Zool., vol. 71, pp. 101-23, 1935.

1935. (and D. L. Fox) Studies of carotenoid pigments in fishes. III. The effects of ingested carotenoids upon the xanthophyll content of Fundulus parvipinnis. Nat. Acad. Sci., Proc., vol. 21, pp. 330-340, 1935.

1935. Studies of protective color change. III. Experiments with fishes both as predators and prey. Nat. Acad. Sci., Proc., vol. 21, pp. 345-53, 1935.

1937. (and P. Doudoroff) Some quantitative relations between visual stimuli and the production or destruction of melanin in fishes. Nat. Acad. Sci., Proc., vol. 23, pp. 211-219, 1937.

1938. (and P. Doudoroff) Some experiments upon temperature acclimatization and respiratory metabolism in fishes. Biol. Bull., vol. 74, pp. 403-29.

1938. (and P. Doudoroff) Some effects of light intensity and shade of background upon the melanin content of Gambusia. Nat. Acad. Sci., Proc., vol. 24, pp. 459-63, Oct., 1938.

1938 (and P. Doudoroff). The effects of light and dark background upon the incidence of a seemingly infectious disease in fishes. Idem, pp. 463-66.

Sverdrup, H. U.

1937. On the evaporation from the oceans. Jour. Marine Research, vol. 1, pp.3-14, Nov., 1937.

1938. On the process of upwelling. Jour. Marine Research, vol. 1, pp.155-64, April, 1938.

1938. On the explanation of the oxygen minima and maxima in the oceans. Jour. du Conseil, vol. 13, pp. 163-72.

Oceanic circulation. In press, Fifth International Congress Applied Mechanics, Proc.

(and R. H. Fleming) The waters off the coast of southern California March to July 1937. In press, SIO Bull., tech. ser.

Thorp, E. M.

1935. Calcareous shallow-water marine deposits of Florida and the Bahamas. Carnegie Inst. Washington, Papers from the Tortugas Laboratory, Publ. no. 452, pp.37-143, Dec., 1935.

Vaughan, T. W.

1933. The biogeographic relations of the orbitoid foraminifera. Nat. Acad. Sci., Proc., vol. 19, pp. 922-38. 1933.

1934. Present trends in the investigation of the relations of marine organisms to their environment. Ecological Monographs, vol. 4, pp. 501-22.

1937. Tertiary larger foraminifera of southwest Ecuador. In Sheppard, "Geology of south-western Ecuador." Thomas Murby, London. pp. 150-175, Jan., 1937.

1938. (and W. S. Cole) Tripladelphidina veracruziana, a new genus and species of orbitoidal foraminifera from the Eocene of Mexico. Jour. Paleont., vol. 12, pp. 167-69, March, 1938.

Wells, Nelson A.

1935. The influence of temperature upon respiratory metabolism of the Pacific killifish, Fundulus parvipinnis. Physiol. Zool., vol. 8, pp. 196-227.

1935. Variations in the respiratory metabolism of the Pacific killifish, Fundulus parvipinnis, due to size, season, and continued constant temperature. Physiol. Zool., vol. 8, no. 3, pp. 318-336, 1935.

Whipple, G. L.

1934. Larger foraminifera from Vitilevu, Fiji, in H.S. Ladd, Geology of Vitilevu, Fiji, Bernice P. Bishop Museum Bull., 119, pp. 141 - 154.

Young, R. T., Jr., and Robert D. Gordon. Report on the penetration of light in the Pacific Ocean off the coast of southern California. In press. SIO Bull., tech. ser.

ZoBell, C. E.

1934. (And C. B. Feltham). Preliminary studies on the distribution and and characteristics of marine bacteria. SIO Bull., tech. ser., vol. 3, no. 12, pp. 279-295. 1934.

1934. Microbiological activities at low temperatures with particular reference to marine bacteria. Quart. Rev. Biol., vol. 9, no. 4, pp. 46-66. 1934.

1935. (and George F. McEwen) The lethal action of sunlight upon bacteria in sea water. Biol. Bull., vol. 68, no. 1, pp. 93-106. 1935.

1935. (and Esther C. Allen) The significance of marine bacteria in the fouling of submerged surfaces. Jour. Bact., vol. 29, pp. 239-51. 1935.

ZoBell C. E. (continued)

1935. The assimilation of ammonium nitrogen by Nitzschia closterium and other marine phytoplankton. Nat. Acad. Sci., Proc., vol. 21, pp.517-22. 1935.

1936. (and D. Q. Anderson) Vertical distribution of bacteria in marine sediments. Amer. Assoc. Petrol. Geol., Bull., vol. 20, pp. 258-69.

1936. (and D. Q. Anderson) Observations on the multiplication of bacteria in different volumes of stored sea water and the influence of oxygen tension and solid surfaces. Biol. Bull., vol. 71, pp. 324-42. 1936.

1938. Studies on the bacterial flora of marine bottom sediments. Jour. Sed. Petrol., vol. 8, pp. 10-18, April, 1938.

1938. (and Sydney Rittenberg) The occurrence and characteristics of chitino-clastic bacteria in the sea. Jour. Bacter., vol. 35, pp. 275-87, March, 1938.

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1938. (and J. H. Long) Studies on the isolation of bacteria-free cultures of marine phytoplankton. Idem,

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