

OCEANOGRAPHY IN THE PHILIPPINES¹

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Oceanography, as the study of the sea in all its aspects, is the meeting ground of various sciences that deal with the sea. In the special physical, chemical, and biological fields, oceanography is of very recent development in the Philippines. The first scientifically significant study of our waters was made in 1874 and 1875 by the globe-encircling *Challenger* expedition; the latest is that of the *Galathea* in 1951. Up to the intensive survey here of the *Spencer F. Baird* in 1947-49, only three foreign expeditions of similar nature (not including the Japanese-sponsored ones) have visited our shores, namely, the *Planet* in 1912, the *Dana* in 1929, and the *Snellius* in 1929-30. All others have only served in a general way to establish gross features of the ocean bottom and the general distribution of certain physical and chemical properties. Miguel Selga, S. J., former director of the Philippine Weather Bureau, has made a fine chronological compilation of these contributions to the oceanography of the Philippines, starting from Magellan's historic "first sounding" of the Pacific in 1521 up to the beginning of the present century.

Among the most noteworthy expeditions of the sixteenth century that made definite contributions to Philippine hydrographic knowledge, Selga mentions the *Nuestra Señora de Buena Esperanza* (1587) which obtained astronomically determined positions for several places of the Islands, particularly the Pratas Shoal and the Babuyan Islands, and that of the *Desire* (1588) under Thomas Fuller, who made detailed observation of heights, soundings, latitudes and distances of certain places like Cape Espiritu Santo, Sibuyan Island, Panay, Negros, and Mindanao. In the seventeenth century Hernando de los Rios Coronel, inventor of the *astrolabe*, sent to Madrid from Manila a map he had drawn of Formosa Island, Luzon, and China, and wrote important sailing directions for the Manila-Nueva España (1605) and Acapulco-Manila (1611) routes.

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In 1662 a Dominican priest of Manila, Ignacio Muñoz, prepared a book on navigation as well as a series of hydrographic charts which was exaggerated as the best representation ever made at that time of all the oceans that have been navigated. Francisco Ignacio Alzina, S.J., after 30 years of missionary work in the Visayan Islands, left in 1668 a manuscript report containing, among various subjects, a detailed account of the tides and currents of the region. The outstanding expedition of the period was that of the *Cygnet* (1688) in southern Mindanao where William Dampier was the first to describe in the English language the havoc done on the bottoms of ships by the *teredo* of our coasts.

In the eighteenth century two officers, Francisco Diaz Romero and Antonio de Chandia, jointly published a Philippine map in 1727. In 1734 Pedro Murillo Velarde, S.J., published a hydrographic map of the Philippine Islands which became popular and which served for more than a century as the basis for subsequent maps by European geographers. This map showed the reef of rocks on the China Sea where the English ship *Scarborough* struck on September 12, 1748, fourteen years after its publication. This shoal has since been known as the Scarborough Shoal. In 1762 William Nicholson, master of the *Elizabeth* belonging to the British fleet that captured Manila, made a hydrographic map of Manila Bay and Cavite harbor that presented the configuration of the shore line with such exactness and the depths with such accuracy that it can still be used for vessels in entering the bay. The map also gives tidal data and bearings of the dangerous San Nicolas Shoal. In 1789 an expedition under Captain Alejandro Malaspina left Spain on a five-year scientific world cruise to collect botanical and zoological specimens and to study the navigation, meteorology, and hydrography of the various oceans. The corvettes *Atrevida* and *Descubierta* belonging to the expedition reached the Philippines early in 1792 and made astronomical, magnetic, meteorological, hydrographic and gravity observations at several places. Captain Jose Espinosa, one of the officers of the expedition who published an account of events therein, later became the Chief of the Hydrographic Service in the Philippines, upon the recommendation of Governor Aguilar of the Philippines in 1796 in connection with the formation of a Hydrographic Atlas on the occasion of the opening of the port of Manila to foreign ships and the occupation of the Singapore

At the beginning of the nineteenth century the ship *Santa Lucia* commanded by Riquelme surveyed the Scarborough Shoal, and the ship *Magallanes* did hydrographic work in the Bashi Channel. In 1808 William Dalrymple, navigator turned hydrographer, published several maps, charts, routes, sailing directions, and narratives of voyages over the Pacific. A French chart of the Basilan Strait was drawn by the French pilot Philibert on board the *Rhone* in 1819. In the same year, Mallat published a map of the Sulu Archipelago and a book dealing with Philippine hydrography. The United States Exploring Expedition under Captain Charles Wilkes visited the Philippines in 1841 and 1842 and made some observations on meteorology and hydrography. In 1843 the British ship *Samarang* under Captain Edward Belcher reconnoitered Philippine seas, made several magnetic observations at Manila, Cavite, and Zamboanga, and determined astronomical latitudes and longitudes and magnetic variation and dip at several places. From 1850 to 1873 three English expeditions visited Philippine shores. The *Royalist* under Bate surveyed the western coast of Palawan and adjacent reefs (1850-54), the *Rifflemann* under Reed surveyed the Balabac Strait (1868-69), and the *Nassau* under Chimmo reconnoitered the eastern coast of Palawan and surveyed part of the Sulu Archipelago, obtaining some values of temperature of the deep waters.

In 1874 and 1875 the famous British *Challenger* expedition, perhaps the most comprehensive exploration of the sea in its physical and biological aspects that has ever been attempted by any single agency, called at several Philippine ports during its circumnavigation of the world (1872-76). Special investigations of chemical, physical, and biological conditions were conducted. Soundings and temperature observations were made in the Sulu Sea and deposits were trawled from the bottom in the Visayan region. In addition, magnetic, meteorological and astronomical observations were attempted. In 1879 the *Derrotero del Archipelago Filipino* or the Coast Pilot, based upon the hydrographic survey of Montero, the investigations of Spanish naval officers, the British survey of the Balabac Strait, Palawan and Jolo, and the survey of the island of Isabela de Basilan by the French navy, was published by Camilo de Arana. The work referred mainly to tides and tidal streams, depths, water temperatures, and variations of the compass. In 1881 the United States undertook two important hydro-

graphic investigations related to the oceanography of Philippine waters. The first was for the preparation of new large scale charts of the China Sea; the second, for the accurate and modern redetermination of the latitude and longitude of points to which capes, islets, towns, and lighthouses had been previously referred. The gunboat U. S. S. *Palos* transported the officers and instruments from port to port.

At the turn of the century, from 1907 to 1909, the U. S. Fisheries steamer *Albatross* was actively engaged in securing hydrographic, dredging, and physical records of almost all the seas of the Philippine Islands and adjacent waters. In 1907 the German survey vessel *Planet* made 36 depth determinations from southeast Mindanao to the eastern coast of central Luzon and by a network of soundings in four cross-sections discovered a trough which proved to be the deepest bottom of any ocean in the world, from 8,000 to 9,000 meters in depth. Later, in 1912 the same vessel sounded 32,078 feet about 40 miles off the north coast of Mindanao. In 1927 another German vessel, the cruiser *Emden*, explored the same region using echosounding apparatus and correcting for temperature, salinity, and pressure conditions. It made several hundred soundings 46 of which exceeded 10,000 meters, and recorded the deepest part of the world, 10,793 meters or 35,410 feet, 40 miles east of Northern Mindanao. In 1929 the Danish steam vessel, the R. S. S. *Dana*, on an oceanographic voyage around the world stopped at the Philippines and made observations of temperature, salinity, and oxygen content in the south China Sea and in the Sulu Sea. In 1930 the 1,055-ton Dutch steam vessel, H. M. S. *Willebrord Snellius*, while engaged in oceanographic research in the seas of the East Indies, visited the Western Pacific and made several soundings of the Philippine Deep. Records are available of Japanese oceanographic investigations made in and around Philippine waters from 1934 to 1943, involving several observations of temperature, salinity, oxygen, nutrient salts, and pH up to about 1000 meters. It is worthy of note that earlier surveying ships of the Imperial Japanese Navy, particularly the *Manshu*, the *Yamato*, and the *Musashi*, engaged for several years in biological and hydrographic investigations of the southwestern sector of the North Pacific Ocean, and that bottom deposits of the Philippine area are contained in the map prepared of these reports by Hanzawa of the University of Sendai. Various cutters of the U. S. Coast and

Geodetic Survey operated in Philippine waters before the Pacific War, charting our coast and doing various other hydrographic work. Prominent among these were the *Marinduque*, the *Fathometer*, and the *Pathfinder*. The work has been taken over by the various survey ships of the Philippine Bureau of Coast and Geodetic Survey.

In July and August of 1951 the *Galathea*, a 1,630-ton Danish Navy corvette, on a two-year round-the-world deep-sea research expedition (1950-52), made intensive studies of the Philippine Deep. The survey was chiefly biological in nature, although hydrographic and magnetic work was also attempted. Bottom sediments and samples of marine life at the immense depths were hauled to the surface. This is the first time scientific studies with modern methods and equipment have probed down to 35,000 feet below the sea. Among the many scientists on board under Dr. Anton Bruun during its stay in Philippine waters were three Filipino specialists from the Philippine Bureau of Fisheries.

Prior to 1947 no single office in the Philippines was directly responsible for the collection and compilation of physical, chemical, and biological oceanographic data. The Philippine Weather Bureau, through its marine meteorology section, still collects and compiles sea temperature data from reports of commercial vessels, but reports are wholly confined to observations of surface values. This is more or less a continuation of the work done in 1920-31 when Selga compiled about 4,000 observations of sea surface temperatures in the Philippines, collected from the log-books of ocean-going, commercial steamships, U. S. Army-Navy transports, interisland vessels, and cutters of the U. S. Coast and Geodetic Survey. The Philippine Bureau of Coast and Geodetic Survey, which is charged with the duty of surveying the coasts of our Archipelago, sounding its oceans, and charting its bays, also collects at its tidal stations sea water samples and analyses them for salinity, but observations are also limited to the surface waters. At present the Bureau of Fisheries is the only entity of the Philippine Government amply equipped in materials and men for the physical, chemical, and biological study of our seas.

Early in 1947, under the terms of the Philippine Rehabilitation Act of 1946, the U. S. Fish and Wildlife Service, through its Philippine Fishery Program, began an oceanographic investigation of Philippine waters that is said to be the most inten-

sive survey ever attempted in the history of the science. In two years its exploratory fishing and research ship, the *Spencer F. Baird*, a converted diesel electric tug of 800 tons gross with two 950 horsepower engines, explored an area of 810,000 square miles of Philippine seas, occupying no less than 526 oceanographic stations averaging 1,500 meters in depth, some going as deep as 2,000 meters. Serial observations were made of temperature, salinity, oxygen, phosphates, silicates, nitrates, nitrites, pH and alkalinity, and the enormous amount of data collected are now being reduced and interpreted by the U. S. Fish and Wildlife Service. When the Philippine Fishery Program closed its office in 1950 it left with the Philippine Bureau of Fisheries, among various items, a compact set of oceanographic gear, equipment and supplies, as well as the research and exploratory vessel, the *David Starr Jordan*. Realizing the importance of continuing the work started by the U. S. Fish and Wildlife Service, the Bureau of Fisheries has set up a hydrology section within its division of fish culture and fisheries biology. Technical men trained in oceanography by the U. S. Fish and Wildlife Service in its offices in the Philippines and in the United States have been detailed to this section. The *David Starr Jordan*, a 50-foot, 125-horsepower diesel type vessel, has been rigged and equipped for oceanographic work, and since February of 1951 it has been exclusively used for periodic monthly oceanographic surveys of Manila Bay. The hydrology section has also begun piecewise surveys of important fishing grounds, like Malampaya Sound and the Visayan Shelf. It is deemed that its oceanographic studies will help solve some of the vital problems of Philippine fisheries. Its wealth of collected data alone will be a definite contribution to oceanographic knowledge.

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