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Oceanography—A Definition for Academic Use[1]

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The earliest non-governmental programs in oceanography in the United States—and still the most comprehensive—are those of the Woods Hole Oceanographic Institution and of the Scripps Institution of Oceanography of the University of California. When these were established they were independent of other institutions of science, except administratively, and were physically separated from them. Thus, there was no occasion to define oceanography in relation to the specific activities of other scientific fields.

In recent months increasing thought has been given to the importance of our marine environment and to more effective means of studying it. Oceanography is the center of interest of a committee of the National Academy of Sciences; the President's Science Advisory Committee is deeply concerned with its problems; Congress is considering suitable legislation; and President Kennedy has stated that we have neglected oceanography.

What is oceanography? Where does it fit in relation to other sciences? Who are the oceanographers? These questions might well be asked. Their answers become more and more important as emphasis on the subject increases.

Several recent publications deal with these questions [*Committee on Oceanography*, 1960; *Committee on Education and Recruitment*, 1960; *Fleming*, 1957]. Although each of these is enlightening from one point of view or another, none of them suggests specifically how oceanography fits into the departmental system of organization which is so common on college campuses. The definition to be presented here was made for this particular application. It may have value in other regards.

Prior to 1949, when the Department of Oceanography was established on the campus at Texas A and M College, there was no existing academic oceanography department with a rounded program in the different aspects of the subject. We probably have the longest experience with such a program of research and training under the full set of categories; biological, chemical, geological, meteorological, and physical oceanography—together with their engineering counterparts—as I outlined them earlier [*Leipper*, 1950]. Further, it appears that we initiated the tendency in this country toward joint development of oceanographic and meteorological research and training, beginning the full Ph.D. program in meteorology in 1956 and changing the Department name to include meteorology at that time. There is now a strong trend toward the development of similar programs in a number of other institutions. Consideration of the definitions under which we have developed thus may be of general interest and applicability.

Definition of field—Oceanography may be defined as the study of the oceans in all their aspects. The oceans and their bounding media are considered as a unified dynamic system, the study of which may be approached from the points of view, and with the techniques of, the various pertinent basic sciences.

Oceanographer—An oceanographer is a person thoroughly trained in one of the pertinent basic sciences, or in engineering, who has learned to apply his specialty in the marine environment (which requires a combination of principles and methods and a certain body of knowledge unique to oceanography) and who has an interest in and at least an elementary knowledge of each of the marine sciences.

Subdivisions of Oceanography—(*a*) Biological oceanography is the study of the oceans as they pertain to life in the sea, including both plants and animals.

[1] Contribution from the Department of Oceanography and Meteorology, The Agricultural and Mechanical College of Texas.

(*b*) Physical oceanography is oceanography which considers primarily ocean waves and water movements, transformations of energy, and the physical characteristics of sea water.

(*c*) Geological oceanography is oceanography which deals chiefly with the relationships between the land, the ocean bottom, and the oceans, and which includes studies of beach erosion and sedimentation, determination of bottom topography, and the interpretation of marine deposits.

(*d*) Chemical oceanography is the study of the oceans as a chemical system. It considers the chemical constituents of the sea and the chemical reactions which take place within it. It includes determinations of the amount of various constituents present, development of methods of extraction, and studies of corrosive effects.

(*e*) Meteorological oceanography is oceanography which involves the winds and weather over the sea, as, for example, the study of ocean waves and currents set up by the wind, or the climate as determined by evaporation and conduction from the sea surface.

Relation of oceanography to the basic sciences and the marine sciences—The oceans, being simply one of the geographical portions of the earth, form a region in which most, if not all, of the basic sciences may apply. For example, the molecular theories of chemistry and physics, the techniques of the calculus and other mathematical subjects, the physiology of marine organisms, and the geological structures underlying the waters, all pertain in ocean analyses. Oceanography thus needs the accumulated knowledge of the basic sciences and of engineering. The application of these fields to the marine environment without extensive modification of their methods or techniques constitutes what may be called marine science. The marine scientist may isolate a problem such as the classification of marine plants and solve it by methods which are standard in the pertinent basic field.

The unification or integration of the marine sciences—together with the addition of a specific body of knowledge about the oceans as such—constitutes *oceanography*. The oceanographer deals with the ocean as a whole, considering the interaction of all the various factors which may be operating simultaneously.

Discussion—In defining oceanography the key words are those which state that the oceans are considered as a *unified dynamic medium*. A marine scientist, as distinguished from an oceanographer, may not need to consider them thus but may isolate a problem, such as the determination of the chemical contents of a certain bottle of sea water, and work upon it without reference to its source.

A most important characteristic of the oceanographer is his breadth of interest in marine subjects. However, the complexity of problems in oceanography is great and he must also specialize in one aspect of oceanography if he is to make satisfactory progress.

From the point of view of education, the modifying words biological, chemical, etc., as used at Texas A and M College, carry several implications. They imply that the oceanographer in the aspect denoted has a standard background training in that aspect extending when feasible to the M.S. level or beyond, that he continues to study and to maintain contacts in this background science, and that the research which he conducts involves the relationship of this science to oceanography.

For many purposes oceanography is considered a subdivision of geophysics. Some parts of oceanography obviously fall here but the biological phase would not systematically be included. For this reason, among others, there has been a tendency to use 'earth sciences' as a more inclusive grouping which includes oceanography as a component.

In some parts of the world there is a tendency to speak of oceanography as including only the physical and meteorological phases. True, there are some marine problems which may be resolved by considerations lying only within these two areas, such as studies of certain tidal phenomena. However, programs organized under this concept of oceanography would not satisfactorily provide for an effective approach to other problems of the sea, the majority of which involve a close interaction between the life sciences and the physical sciences. It seems that work included entirely within physical and meteorological fields, but concerning the oceans, might more properly be called marine physics than oceanography.

Each of the scientific aspects of oceanography may be considered to have an engineering counterpart where the backgrounds might be re-

spectively: wildlife management or fisheries management (possibly extending the reasoning a little) for biological oceanography; civil, electrical, or mechanical engineering for physical oceanography; geological engineering or petroleum engineering for geological oceanography; chemical engineering for chemical oceanography; and meteorological engineering for meteorological oceanography.

In defining the subdivisions of oceanography there are certain highly important words. For biological oceanography one is 'life *in* the sea' as opposed, for example, to life *from* the sea. In geological oceanography, dealing 'with *relationships*' or *interactions* should be emphasized. For chemical oceanography the key words may well be '*oceans as a chemical system.*' For physical and meteorological oceanography there seem to be no such terms which readily may be singled out.

It may clarify the definition if all sciences are divided into two categories. First the 'subject' sciences which concern the study of basic laws or principles and secondly the 'object' sciences which concern the study of things. In the object category with oceanography would then, for example, fall meteorology—the study of the atmosphere, and geology—the study of the solid earth. The 'subject' sciences must provide the basis for all work in these 'object' sciences and yet the properties of the objects to be studied are such that intensive specialized attention must be given them if they are to be understood. Oceanography is a good example of an 'object' science.

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