mission to a Ph.D. program in Fisheries, Marine Biology and Oceanography. This program will start in 1959.

An educational program has one basic and necessary ingredient—students. A good faculty and well equipped library and laboratory facilities are of little use if students cannot be induced to use them. The shortage of scientists of all kinds is too familiar a complaint to dwell long upon here, but it can be said with much truth that the shortage is more severe in fisheries and other marine sciences than in most other areas. The reason for this is a compound of salaries, which are lower than those for men of comparable training, and a general unfamiliarity on the part of students with the very existence, let alone the satisfactions, of fisheries science as a career. The situation is being improved by an increasing salary scale, wider information about the profession and increasing financial aid for fisheries students. It is significant that industry recognizes the problem of attracting able men to the marine science profession, and Texas A & M lists three industrial fellowships. Of particular interest to the fishing industry of this area are the Shrimp Association of the Americas Graduate Fellowships, which were set up at the University of Miami this year by the joint shrimp industries of Mexico, Florida and Texas. This type of foresightedness on the part of industry is bound to have far reaching good effects.

The past decade has shown a substantial increase in the awareness of need for fisheries education in this area, with marine courses being added in many Universities and teaching and research facilities being greatly increased. There is every reason to believe that this trend is gathering strength and we can hope for much greater progress in the decade ahead.

A Decade of Progress in Fishery Biology of the Gulf and Caribbean Area

PAUL S. GALTSOFF

Fish and Wildlife Service
Woods Hole, Mass.

THE OFFICERS of your organization asked me to discuss at your opening session the progress made during the past decade in the studies of biological problems pertaining to the fisheries of the Gulf and Caribbean area. I am very happy to address this meeting today because the Gulf and Caribbean Fisheries Institute, inaugurated in 1948, was a major factor in this progress. In his welcoming speech, Dr. F. G. Walton Smith, the chairman of the inaugural session said: ". . . The Institute . . . seeks to bring together first of all fishermen, the fish dealers, the fish processors; secondly, the fishery biologists, technologists and economists; and thirdly, the conservation administrators of the fisheries. In this manner it is believed that the several groups of persons . . . may have an opportunity of broadening their horizons and of seeing their problems in a truer perspective against the background of fisheries as a whole." Those of us who have followed the growth and activities of the Institute have no doubt that this particular aim, outlined by its originator, has been fulfilled. The Institute has provided the means of understanding and communication between

the specialists and laymen. This contact is frequently lost because of the rapid progress of scientific knowledge, the usage of new terminology, and the peculiarities of scientific thinking which are not always comprehensible to the general public.

The second meeting of the Institute, held here in Miami in 1949, inaugurated a project of summarizing the knowledge regarding the Gulf of Mexico. Thanks to splendid cooperation of many members of the Institute and of affiliated organizations, this project was completed and resulted in the publication in 1954, by the Fish and Wildlife Service, of a book entitled, "Gulf of Mexico, Its Origin, Waters and Marine Life." Information contained in this book makes a convenient stepping stone for making an appraisal of the progress attained during the intervening years.

Let us consider first what conditions are essential for success of any research project and let us determine whether they are present in the Gulf area. Fishery biology is a branch of applied science which combines several disciplines, including oceanography, geology, zoology, botany, mathematical statistics, physiology, ecology, biochemistry and technology. Fishery investigations cannot be conducted in the quietness of a laboratory away from the sea. They require shore installations, adequate floating equipment and trained personnel capable and willing to spend many days at sea. There are now several places along the Gulf coast and in Cuba where facilities for marine research are available. It is true that only some of these institutions have at their disposal funds and vessels large enough to extend scientific operation to a considerable distance from home ports. Others are primarily engaged either in teaching or in research dealing with local problems. Progress of scientific research depends on the availability of well trained scientists, interested in fishery biology as a scientific career. This human material is being provided by several local institutions affiliated with the colleges and universities of the Gulf area. The ever increasing number of students receiving training in The Marine Laboratory of the University of Miami and in other scientific establishments along the Gulf coast, constitutes the cadre of scientists for the expanding research program.

Shore laboratories, adequate floating equipment, and sufficient funds are naturally the prerequisite conditions for the progress of scientific research; they do not constitute, however, a creative force which stimulates scientific thinking and brings about the solution of a scientific problem. Originality of thought among the young scientists should be encouraged at every step of scientific thinking and more time should be devoted to theoretical considerations underlying research problems and to critical definitions of specific research problems. There is always a danger that the neglect in theoretical thinking and in formulation of a research problem may lead to repetitious and wasteful accumulation of observations. High academic standards maintained by principal educational institutions of the Gulf area constitute a guarantee that this is not the case.

It is obvious, of course, that sufficient background information is needed before an attempt is made to outline a more complex analytical study. The last ten years of research yielded abundant results pertaining to living resources of the Gulf. The following are probably the most spectacular results. Exploratory fisheries operations conducted by the Fish and Wildlife Service research vessel *Oregon* by using various types of gear in depth from 10 to 250 fathoms yielded 630 species of fish, of which number 10 species were new. Among the

crustacea two new genera and sixteen new species of decapods and three new species of stomatopods were described and the collection of various mollusks provided interesting facts about their distribution. It is clear from the results of this work that our knowledge of Gulf fauna is incomplete, even with reference to the important species of fish and Cephalopods.

Knowledge of the life history of a commercial species of fish or shellfish constitutes a basis for formulating sound management of the resource. Studies of black mullet, *Mugil cephalus,* in Florida conducted by C. P. Idyll and J. W. Sutton of The Marine Laboratory of the University of Miami, have demonstrated that in each area of the Florida coast the fishery is largely dependent on its own stock, that fishing has a considerable effect on the local population of fish, and that east coast, west coast and northwest coast populations are biologically different from one another and therefore should be treated as distinct groups as far as regulation of fishery is concerned.

The migration of the giant bluefin tuna and related species was the object of studies of the Miami Laboratory, Woods Hole Oceanographic Institution, the Laboratory in Bimini and other organizations. Marked hooks were used for tagging and interesting observations on migration of this fish as they moved north from the Florida Straits to Nova Scotia were made from airplanes. Study of the biology of these fishes is by no means complete, but a better understanding of their movements and spawning habits has been attained.

New data to the life history of the sailfish, *Istiophorus americanus,* in Florida waters, together with the observation on spawning habits and methods of feeding, have been added independently by J. W. Gehringer of the U. S. Fish and Wildlife Service and by Gilbert L. Voss of the Miami Laboratory. The fish was found to be extraordinarily fertile, the gonads yielding from 2.3 to 4.6 million eggs.

With reference to purely estuarine fishery, the seasonal movements and growth of the Atlantic croaker, *Micropogon undulatus,* in Lake Pontchartrain were studied by R. D. Suttkus of the Zoology Department of Tulane University. Although this species contributes only about 600,000 pounds of meat annually or less than one quarter of one per cent of total fish production in the Gulf and eastern Florida, the fishery is quite important for local communities on the shores of Lake Pontchartrain.

Detailed ecological study of the fishes in the vicinity of Cedar Key, Florida, made by George K. Reid of A. & M. College of Texas, added considerably to the knowledge of speciation, biology, movements, and feeding habits of 122 species of local fishes. This type of work is a desirable continuation of ecological studies of Gulf fishes initiated in 1938 by G. Gunter.

Among the many studies of invertebrate populations of the Gulf, mention should be made of the monographic treatment of the taxonomy of *Cephalopoda* by G. L. Voss. This study has increased the list of known species of these mollusks in the Gulf from 26 to 42 and added one new genus and four new species. It is of interest to note that only less than 10 per cent of the species recorded are endemic, the remaining being either circumtropical warm water forms or those of North Atlantic origin. This conclusion is of interest from the point of view of zoogeography, especially if one compares the Gulf Cephalopod fauna with that of the Mediterranean which has been noted for the number of endemic species.

Our knowledge of the distribution and ecology of marine borers of the family *Limnoridae* (*Isopoda*) in North and Central America was much augmented by comprehensive treatment of the subject by R. J. Menzies of the Lamont Geological Observatory. Studies of the biology and physiology of shipworms, *Teredo, Bankia* and *Phyloteredo,* made in The Miami Marine Laboratory provided scientific foundation for the development of control measures. Practical implication of this type of study is self-evident.

It is a well established fact that shrimp populations make regular inshore and offshore migrations and that estuaries along the coast of the Gulf are the nursing grounds where juvenile shrimp feed and grow before setting their course to the open sea. The full importance of the estuarine period of life and the dependence of shrimp on certain types of food is not, however, fully understood. Likewise, further ecological studies are needed to determine the effects of competition of shrimp with noncommercial animals and the effects of biological associations between shrimp and other animals during their estuarine and oceanic periods of life. The work conducted during the past decade was primarily of exploratory nature; successful attempts were made in locating new shrimp grounds and in determining the size of stock available to the fishery. In the course of these investigations a new resource consisting of royal red shrimp, *Hymenopenaeus robustus,* was discovered by the Gulf Fisheries Exploration and Gear Unit of the U. S. Fish and Wildlife Service at Pascagoula. This red shrimp provides a new, tasty variety to the existing shrimp industry. It is worth mentioning here also a theoretical study made by James B. Higman of the University of Miami Marine Laboratory, of the behavior of pink groove shrimp, *Penaeus duorarum,* in electrical field. The experiments showed that interrupted direct current caused the shrimp to move toward the anode. At present the findings have no practical application because power requirements are too large, but the experimentations along this line are of value because of the possibility of using electric currents in directing the movements of shrimp toward traps or nets.

Spiny lobster fishery is of great importance to the Caribbean area. Success of the fishery is much dependent on a knowledge of the behavior and movements of the crustacean. This information was obtained by tagging experiments conducted by C. P. Idyll and Charles Dawson of the Miami Laboratory. It was found that adult *Panulirus* migrates along the shores of the coast of Florida, covering the distances varying from a few to almost a hundred miles. Development of the lobster was studied by John B. Lewis of Miami, who gave detailed description of the eleven developmental stages and found that pelagic lobster larvae, *Phyllosoma,* drift northward from the tip of Florida and are dispersed in the open ocean by the prevailing currents.

A new chapter in the study of plankton has been written by Dr. Hilary B. Moore and his associates at Miami in the analytical studies of the zooplankton of the Florida Current and the determination of the physical factors which control its vertical distribution. John B. Lewis made a study of standing crop and of the environmental conditions affecting zooplankton, 40 miles east of Miami. His observations disclosed small seasonal changes, marked diurnal migrations and extreme deficiency of water both in the inorganic phosphorus and inorganic nitrogen.

Shellfishery research of general interest was concerned primarily with the studies of *Dermacystidium,* which is claimed to cause widespread epizootic

in the Gulf and South Atlantic waters. Valuable contributions about the pathology and life history of this fungus-like parasite of oyster made by Sewell Hopkins, Sam Ray and others, greatly advanced our knowledge about the disease affecting a large percentage of oyster population in southern waters.

Sponges from the eastern part of the Gulf of Mexico were identified, and some of them redescribed by the foremost authority on this group M. W. de Laubenfels. The list indicates 52 species, of which 11 species are new.

For some strange reason, marine fungi have failed to attract the attention of microbiologists. Very little is known about this important group of organisms capable of producing specific and highly potent chemicals. This gap has been partially filled by the work of S. Meyers on the marine fungi of Biscayne Bay and by observations of T. W. Johnson on the development of common brackish water species, *Leptosphaeria discors*.

Local surveys of the Cedar Key area, Tampa Bay and Biscayne Bay, conducted by the Miami Laboratory, provided better understanding of the ecological conditions in these areas. The data are most useful for the management of local living resources and for the control of pollution.

The problem of the Red Tide is of paramount importance to coastal communities of the Gulf States. Practical consideration demands that some effective method of controlling the disastrous outbreaks of blooming caused by *Gymnodinium* and associated organisms be found and applied to prevent the spreading of red water. On the other hand, it is doubtful that a satisfactory method of control can be formulated without an understanding of the basic conditions which cause the overproduction of *Gymnodinium* and other toxic microorganisms. Federal, state and private organizations continued to work on this problem, which fundamentally is the problem of oceanic productivity. The organism responsible for the outbreak was identified and cultured. Oceanographic conditions preceding the outbreak were studied and attempts were made to correlate the Red Tide phenomenon with the pattern of movements of coastal waters, with the phosphorus and nitrogen contents of sea water, with the composition and abundance of plankton preceding the outbreaks, etc. Several theories and hypotheses were advanced, but the problem of Red Tide is still far from being solved. Time does not permit me to discuss in any detail the present status of these studies.

An interesting suggestion regarding the conditions which may stimulate the Red Tide was made by H. T. Odum, J. B. Lackey, I. Hynes and N. Marshall in a joint investigation sponsored by the University of Florida and Duke University. On the basis of the data accumulated during the outbreak of Red Tide of 1952 to 1954, the authors attached significance to the differences in the N/P ratios in various harbors and bays and suggested that "there is a possibility that the increasing multiple pollution of the shallow coastal estuaries and land drainage may be producing a higher incidence of the Red Tide phenomenon than might otherwise occur." It is clear that Red Tide is a very complex phenomenon, in which several environmental factors combine to produce a sudden outbreak. It appears to me that the key to the solution of the problem, and therefore to the practical method of controlling it, lies in the studies of the growth requirements of Red Tide organisms, of their associations with other microorganisms, and in the biochemistry of the toxin.

Industrial and sewage pollution of harbors and bays continued to be a public menace threatening both health of human population and the existence of

coastal living resources. Surveys made during the past ten years by public health authorities showed that for some time the Galveston Bay and the Mobile Bay were grossly polluted and that shellfish from these areas became unfit for human consumption. Extensive pollution of Biscayne Bay has been also demonstrated by the survey conducted by the Miami Laboratory. Only enlightened public opinion may stop this willful destruction of our water bottoms and shores. Methods of combating pollution are too well known and require no special scientific studies. It can be added, however, that two additional sources of pollution threaten our inshore waters—namely, the ever increasing amount of detergents which find their way into natural waters and the disposal of radioactive wastes. Biologists and state conservation officials should be on guard of this new danger.

As it is apparent from my brief review of scientific achievements in fishery biology, the work carried on during the past decade dealt primarily with fact finding, description of the existing resources and in operational studies.

Scientific research of the Gulf biological problems has not yet advanced far enough to give an explanation of the many peculiarities of the Gulf. One of the intriguing questions regarding the biology of the Gulf is concerned with the low productivity of its fishery resources, which at present yield annually only about one-quarter of a million pounds of fish meat. What are the reasons for such low production? At present no adequate explanation can be advanced. It is known, however, that the central and deep portion of the western part of the Gulf is almost barren in comparison with the eastern part. Hydrographic studies carried on by A & M Texas Foundation show the existence of a hydrographic barrier which separates the surface waters of the Gulf into two distinct parts. How this hydrographic peculiarity affects the abundance of fish life of the Gulf area is not known. The more productive areas of the Gulf are found at the Campeche Bank on the south, at several red snapper banks in the northwestern part and on the broad shelf extending along the west coast of Florida. It is reasonable to assume that the movement of water masses contribute the primary factor determining the productivity of the various parts of the Gulf, but it is a challenge to fishery biologists of today and tomorrow to determine the nature of interaction of various factors and their combined effects on productivity.

Science cannot progress without the means of communicating its findings to other scientists and laymen. The Gulf area is lucky that the establishment of the "Bulletin of Marine Science of the Gulf and Caribbean" provides this outlet for publication of scientific findings and theories. Likewise, a series of popular pamphlets issued by the Miami Laboratory, the publication of the "Proceedings of the Gulf and Caribbean Fisheries Institute" and the attractive issues of the "Sea Frontiers," issued by the International Oceanographic Foundation, fulfill the essential task of keeping the general public informed about the goals and achievements of scientific research. Institutions sponsoring these publications and the officers engaged in writing, editing, and publishing these journals deserve our deep thanks. Their unselfish efforts are dedicated to the idea of promoting human welfare through conservation and better utilization of living resources of the ocean. I wish to express my appreciation for their valuable efforts and achievements.