

the requirements for a hospital room. Each cabin has three berths, lockers, bureau, and lavatory. These facilities, as others, can be expanded to carry a larger crew if so required.

This is but a brief resume of the facilities and equipment of the ALBATROSS IV. At the moment, perhaps its best feature is that it is capable of severely challenging an experienced fishery scientist to realize its full potential as a scientific tool.

The Shellfish Research Program of The Public Health Service

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Abstract

The Public Health Service has for almost fifty years participated with the States in a program designed to insure that oysters, clams, and mussels will not serve as a vector of disease. The Public Health Service has carried on a research program in support of this program, and for several years maintained a small microbiology laboratory at Pensacola, Florida. A new shellfish research center, which will have a staff of about 35, is being constructed at Dauphin Island, Alabama. This facility will carry on research projects in estuarine microbiology, the presence of chemicals in shellfish, biologically-active agents in marine organisms, and the influence of commercial practices on the quality of shellfish as marketed. Emphasis will be placed on the development of a practical system for shellfish depuration. On a longer range basis it is probable that the research program will be extended to encompass the broader areas of environmental oceanography and marine food protection with investigations ordinarily directed toward the public health elements of these fields.

TO UNDERSTAND THE PAST RESEARCH PROGRAMS of the Public Health Service and to better understand our probable future course of action, it is desirable to have an understanding of the role the Public Health Service has in the shellfish sanitation field and of the areas of our research interests. Discussions of the Public Health Service's shellfish sanitation activities have been presented before many health oriented groups; however, it has been our experience that it is not generally well understood by the conservation or the fishery research agencies.

The objective of the Cooperative State-PHS-Industry Program for the Certification of Interstate Shellfish Shippers may be stated simply as the assurance that shellfish—fresh or frozen oysters, clams, and mussels—shipped in interstate commerce will be safe to eat. This concern stems from the fact that these species of shellfish (a) ordinarily grow only in estuarine areas where, under certain conditions, they may be subject to varying degrees of pollution with domestic sewage; (b) are filter feeders; and (c) are eaten whole. In addition, these shellfish have the unusual ability to concentrate certain highly toxic materials such as paralytic shellfish poison or other industrial or agricultural chemicals. These factors, plus the fact that they may get only superficial cooking, give shellfish an unusual potential for the transmission of diseases and poisons.

This particular program was organized in 1925 after a sequence of disastrous experiences had shown that more conventional sanitation measures, principally plant inspections and bacteriological examinations of the packed product, were not effective in providing the desired public-health protection. A program was therefore devised under which the Public Health Service develops uniform standards, carries on research projects in support of such standards, evaluates and endorses State programs based on these uniform standards, and publishes a list of State certified shippers.

Under this Cooperative Program, the States accept the major responsibility for: sanitary and bacteriological surveys of estuarine areas; the designation of those areas from which shellfish may be safely harvested; the prevention of harvesting from areas of unsatisfactory quality; the inspection of harvesting and packing operations; and the issuance of numbered yearly certificates of shippers meeting the required standards.

The role of industry is less well defined than that of the States, but is of significant importance to the effective operations of the Cooperative Program. Essentially, industry accepts the premise that supervision of the entire shellfish industry in all producing States is necessary for the effective protection of the industry in any single State, and they therefore agree to support and to cooperate with the program. This is an almost unique arrangement between the federal agencies and a food processing industry.

The role of the Public Health Service includes standards development, research, program evaluation, and publication of a list of shippers. The entire certification program is based on the premise that each producing State will adopt uniform sanitation standards and that they will enforce these standards according to minimum levels. The Public Health Service has, since 1924, been responsible for the development of these standards and for the continuing evaluation of the several State programs to assure that reasonably effective administrative levels are maintained. As an integral part of the standards development process, the Public Health Service has carried on a program of research over the years. This program has been aimed largely at the development of suitable analytical procedures, the exploration of relationships between the number of bacteria present in shellfish and shellfish growing waters, and the influence of commercial handling practices on the gross bacteriological quality of the product. Some assistance has been rendered to the States in planning or carrying out sanitary and bacteriological studies of shellfish producing areas. Finally, the Public Health Service publishes a semi-monthly list of all shippers certified by the States under this program. Canadian shippers have been included in this program since its conception in 1924, and have since 1948 been included under provisions of a formalized agreement between the two countries. A similar agreement was concluded between Japan and the United States on October 24, 1962.

The shellfish sanitation research program, exclusive of research grants, has been carried out at a small shellfish sanitation laboratory successively located at Woods Hole, Massachusetts; Pensacola, Florida; and Purdy, Washington, and through another small research group (5 persons) at Cincinnati, Ohio. The laboratory group has been concerned largely with problems of microbiology whereas the Cincinnati group has focused their attention largely on chemicals of various types in shellfish. The shellfish sanitation laboratory, presently located at Purdy, Washington, has a staff of seven, including three professional micro-

biologists. Present studies are related to the microbiology of commercial West Coast species and the perfection of suitable laboratory methodology. The laboratory is also working closely with the State control agencies and with the Province of British Columbia and the shellfish industry in cooperative projects in the investigation of bacterial levels found in shellfish as they reach the markets.

The Cincinnati, Ohio operation, formerly a segment of the food chemistry group, has been primarily concerned with the chemistry of paralytic shellfish poison. This has led to the development of a reliable bioassay procedure which has been adopted as an official method by the Association of Official Agricultural Chemists. The group has also been doing considerable work in the development of a chemical assay procedure and has undertaken a cooperative study of this method under AOAC auspices. The chemical assay procedure is somewhat cumbersome and has not yet replaced the bioassay. The group is presently working on the extraction of a new supply of purified poison from several tons of highly toxic clam siphons obtained from Alaska.

A second program carried on in cooperation with the Fish and Wildlife Service has been related to the unexpected presence of large concentrations of zinc and copper in oysters from a specific area in Chesapeake Bay. Another project has been related to the development of an assay procedure for herbicides in shellfish and the development of a simple chemical test indicative of the time-temperature relationships under which shucked oysters have been stored.

The impact of these two small research efforts has been extended substantially by the cooperative projects which have been developed between the Public Health Service, other interested U. S. and Canadian federal agencies, and several of the States. These cooperative projects have included the development of bacteriological standards for shucked oysters. This particular project has been continuing for at least six or seven years. The work on these standards led rather naturally to the development of another massive series of laboratory studies designed to identify the bacteriological indices of pollution which would be acceptable to the many shellfish production areas in the country. These studies led to the general conclusion that the modified Eijkman method for the enumeration of fecal coli is preferable to any other presently available system. Comparative studies of coliform-E.C. levels were undertaken in polluted and non-polluted shellfish production areas over a large geographic range extending from Prince Edward Island through Mobile Bay to Puget Sound. The results of these studies were reported at the 1961 Shellfish Sanitation Workshop.

The several studies of the sanitary quality of areas in which shellfish have been involved in the transmission of infectious hepatitis is another example of cooperative projects. Studies of this nature were undertaken in Pascagoula, Mississippi, and in the Greenwich Cove area of Connecticut.

As was mentioned previously, the infectious hepatitis outbreaks identified with shellfish focused attention on the inadequacy of our research programs and led to the administrative decision to seek support for additional shellfish sanitation research centers in the principal shellfish growing areas. The site selection of the proposed centers obviously required considerable compromise since it was not possible to establish centers in each State or regional area, yet it was recognized that environmental conditions in the South were substantially different from those which prevail in the North and that it was not practical to

carry on valid research of southern shellfish species in northern areas.

In selecting the sites for the two research centers, consideration was given to a number of factors including: physical location in or near areas used for the commercial production of shellfish; an estuary free from nearby sources of domestic or industrial wastes and reasonably far removed from sewage treatment facilities; convenience to public transportation; location relative to the PHS Regions to be served; proximity to other research installations, particularly those engaged in marine research; and the availability of property without cost to the federal government. In addition, consideration was also given to our somewhat longer range plans under which we hope to establish additional research centers or field laboratories in major production areas.

As a result of careful analyses of the many factors and the review of available properties, it was decided to establish the North Atlantic Research Center on the University of Rhode Island campus. This center will also provide related technical services to those States comprising the Public Health Service Regions I, II, and III, that is, from Maine through North Carolina. In the south it was decided to establish a research center on Dauphin Island, Alabama, adjacent to the State's Department of Conservation new seafood laboratory. Construction of the two centers was started early in July, 1962. The Gulf Coast facility should be available for occupancy by May with the Northeast facility being available during the first week in July, 1963. It is anticipated that the majority of the staff will have been engaged by the time the facilities are available for occupancy, and in some cases will be employed well in advance of these dates in order that they may be used on cooperative research projects with the States agencies.

The Gulf Coast Research Center will be a single-story masonry structure with approximately 10,000 square feet of laboratory space. The research center will accommodate a total staff of 35 persons, of whom approximately one half may be considered as in the professional category. These will include marine biologists, microbiologists, biochemists, oceanographers, sanitary engineers, and perhaps a sanitarian or food technologist. In addition to usual laboratory facilities, the research center will be provided with a wet lab having a continuous sea water pumping system capable of 450 gallons per minute. Heat exchanger equipment with a capacity of 25 gallons per minute will regulate the sea water at a temperature range of 50 F to 77 F.

Because this research center has been established under the auspices of the Cooperative Certification Program, the major part of its research efforts will be directed towards exploring the many problems relating to the production of shellfish that will be entirely safe to eat. In general, this will lead to the establishment of research projects in shellfish depuration, estuarine microbiology, shellfish microbiology, shellfish biochemistry, biologically active substances in shellfish, and the influence of commercial practices on the final sanitary quality of the products. The terms "applied research" and "basic research" are dangerous to use; however, it is anticipated that the types of projects which will be undertaken at this center will cover the entire research spectrum ranging from those essentially of development to others, which might, in any frame of reference, be catalogued as basic research. It will be the responsibility of the research center director and the chief of the research section to establish a reasonable administrative balance between the various elements.

The study of shellfish depuration processes will probably have first priority

in view of the very nearly impossible technical problems of keeping shellfish production areas free from sewage pollution. The dangers which are inherent in even causal pollution was demonstrated rather forcefully in Florida during the 1961-1962 packing season when a number of cases of typhoid fever were traced to pollution of a shellfish bed by a tonger who was subsequently shown to be a carrier. Depuration has, of course, been practiced in a number of European countries for many years with apparent success; however, it has not enjoyed the same success in the United States. The objective of the research group at the Gulf Coast Research Center will be first to attempt to identify those factors which regulate the levels of physiological activity of shellfish under artificial holding conditions and to develop necessary equipment for a depuration plant which will be both technically and economically practical. It is anticipated that this problem will be undertaken by a team consisting of a marine biologist, biochemist, microbiologist, and mechanical or sanitary engineer. A parallel research group will be established at the Northeast research center to undertake a similar study of depuration processes with those commercial species of shellfish found in that area.

Second in order of priority will be studies relating to the survival of viruses under estuarine conditions and their possible accumulation and survival in shellfish. The relationship of such studies to the infectious hepatitis incidents are quite apparent. There is certainly an urgent need for laboratory confirmation of the results obtained through the engineering studies in these areas.

Other microbiological studies will be directed towards the survival of other microorganisms in the estuaries, their accumulation in shellfish, and the ratios of accumulations under varying conditions of salinity and temperature. The problem of the presence of chemical compounds in shellfish, and perhaps in other marine foods, has been a matter of growing concern to control officials and it is anticipated that projects in this area will be undertaken. Specifically, we are concerned with the presence of such materials as carcinogens from oil fields and refinery operations, insecticides of various kinds, and in industrial wastes from the many chemical industries located on the Gulf Coast. Projects will probably be directed towards: development of suitable analytical procedures; surveys of areas heavily concentrated with industry; and the uptake studies of controlled aquatic conditions.

The study of biologically active agents in shellfish and other related marine foods is perhaps the most glamorous of the several research areas. There is, for example, evidence of penicillin in shell oysters, broad spectrum antibiotics in oysters and other shellfish, and an antiviral agent in conch which is specific for the polio virus. In addition, much remains to be learned of the red tide and its toxicity mechanisms.

The influence of commercial handling practices on the sanitary quality of shellfish will constitute an important area of investigation. This appears to be particularly important in view of the changing trade channels which have resulted in an increasing quantity of southern shellfish being marketed in areas in the far North. In addition to studies related to the oyster industry, it seems probable that some studies will be made of sanitation problems which are peculiar to the crab and scallop industries.

In South Carolina, it is expected that a research project will be initiated on the so-called "hot dip" method of shucking. It is expected that biochemical studies will be made to determine if major changes take place in the oyster

during this type of shucking procedure. Microbiological studies will be undertaken to determine the extent or decrease of the bacterial flora during the operation, and plant sanitation studies will be made to gain information as to the problems of time-temperature controls. This shucking method appears to be very promising and, if widely adopted, might add another element of safety to the shellfish industry.

In establishing the research centers, adequate recognition was given to the occasional needs of the States for assistance in planning sanitary surveys and in interpreting results which are obtained in such studies. It is recognized that few States have ready access to oceanographers. Thus it is anticipated that oceanographers and sanitary engineers will be assigned to this facility for the specific purpose of assisting States in planning sanitary surveys and interpreting results. In a few instances, it may also prove desirable to work with the State in making surveys in specific areas or situations.

The relationship of the Gulf Coast Shellfish Sanitation Research Center to the plans of the Public Health Service, particularly the Division of Environmental Engineering and Food Protection, under the long range plans approved by the Interdepartmental Committee on Oceanography should also be of interest to this group. As many of you know, an Interagency Committee on Oceanography has been established under the Chairmanship of the Honorable James H. Wakelin, Jr., Asst. Secretary of the Navy. This Committee, charged with the design and overall oceanographic research program for the Federal government, is responsible to the Federal Council for Science and Technology which in turn is headed by Dr. Jerome Wisner, Special Assistant to the President for Science and Technology. The Department of Health, Education, and Welfare is represented on the Interagency Committee by Assistant Surgeon General Harry Hanson. Admiral Hanson is an engineer and is extremely interested in the development and application of the environmental sciences. The oceanographic research plans for fiscal year 1963 relate most of the oceanographic research plans of the Service to Objective 6 of the Committee, that is, to determine the effect of radioactivity and pollution on the physical, chemical, geological, and biological properties of the oceans. It might be argued that this particular area of activity should be more properly classified under Objective 2. "To Determine the Interrelationships of the Oceans and Atmosphere." The following paragraph is quoted from the fiscal year 1963 ICO pamphlet "Oceanographic Research in the Federal Government" as indicative of the PHS interests in this field.

"Fundamental to the safe disposal of wastes in the marine environment is the full understanding of the effects of such wastes on marine organisms; also any interactions between waste materials and the physical and chemical properties of sea water. This includes toxic effects on the marine organisms; concentration of toxic chemicals and pathogenic organisms in the food chain of edible marine food resources; the mechanisms causing paralytic shellfish poisoning and poisonous fish; understanding of the biology of marine organisms which may lead to their control in assimilating pollutional materials; the survival rate of pathogenic organisms in the marine situation; generic studies of marine organisms which may lead to new knowledge of human life and health; and studies to determine any medically or pharmacologically important substances which may be produced by marine organisms."

The Federal Interagency Committee is presently engaged in preparing a 10-year research program in environmental oceanography. As in the case of the 1963 program, the Public Health Service will present what it considers an adequate program. We will make every effort to coordinate our efforts in

this field with those of our other Federal agencies, with state universities, and other official agencies.

Research grants are another important element in the overall Public Health Service's research program. This program, a portion of the very large system of research grants in health-related fields, is administered by the Research Grants Branch of the Division of Environmental Engineering and Food Protection (similar Branches are also situated in the other operational Division). Under the grant mechanism, funds can be made available to universities and other similar research institutions for studies which are health related. At the present time this Division is supporting approximately \$300,000 worth of such research projects. These range from topics such as "Microbiological Relationships in Shellfish and Shellfish Growing Waters" to "Minamata Disease." The research grants mechanism has proven to have considerable merit and it seems likely that this program will be continued. There is in fact justifiable hope that it will be expanded in areas such as marine sanitation where its support has been provided only in recent years.

In conclusion, a new era seems to be dawning in the field of marine food sanitation research in which funds will be made available for additional research by universities and other private foundations, and in which the Public Health Service will take a more active role through the establishment of a multi-discipline research facility. We appreciate that the success of this facility will depend in large measure upon its acceptance by other members of the scientific community in the area, and by types of communication which may be established in the scientific community. We are most hopeful that this organization will be accepted as a permanent element of the research fraternity of the Gulf and Caribbean area and that exchanges of information will be mutually beneficial to all persons engaged in this area of research.

REFERENCES

ANON.

1962. ICO Pamphlet No. 5, Oceanographic Research in the Federal Government, Fiscal Year 1963.

Expanded Research on Gulf of Mexico Shrimp Resources¹

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Abstract

Given impetus through action taken in 1959 by the Gulf States Marine Fisheries Commission to reinforce a resolution it had passed 5 years earlier, the Federal program of research on shrimp supporting commercial fisheries in the Gulf of Mexico has since undergone considerable expansion. This is reflected in the size of its budget which in Fiscal Year 1959 stood at about \$200 thousand but today, Fiscal Year 1963, amounts to nearly \$750 thousand.

¹Contribution No. 170 of the Bureau of Commercial Fisheries Biological Laboratory, Galveston, Texas.