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ACTIVITIES OF THE GULF COAST RESEARCH LABORATORY DURING FISCAL YEAR 1978–79: A SUMMARY REPORT

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ADMINISTRATION

Construction of a new facility, the Toxicology Building, was initiated and completed on the main campus of the Gulf Coast Research Laboratory (GCRL) during the year. The building design was based in part on the Environmental Protection Agency (EPA) Toxicology Laboratory, Gulf Breeze, Florida, and the Bionomic Toxicology Laboratory at Pensacola, Florida. The building, designed and constructed at a cost to the Laboratory of \$230,000, contains about 3,700 sq. ft. on three levels, and provides separate areas for maintaining stock experimental animals, algal culturing, bioassaying and storage.

The Laboratory senior staff constitutes an advisory council that reviews toxicological research proposals, contributes to the experimental design and, when applicable, participates in the studies.

The annual operational budget consisted of \$2,100,000 in State-appropriated funds, \$1,140,226 in sponsored research and auxiliary funds, and \$25,000 in Library Improvement Funds allocated by the 1978 State Legislature.

BOAT OPERATIONS

The boats used to provide essential services include the 65-foot R/V GULF RESEARCHER, used in both the Laboratory's research and educational programs; the 38-foot steel trawler HERMES, used principally in the educational program; three diesel-powered cabin workboats; and some half-dozen Boston Whalers and other miscellaneous smaller craft powered by gasoline motors. The larger vessels are operated by six full-time boatmen, two of whom are licensed Masters for vessels of up to 100 gross tons. The Boston Whalers and other miscellaneous smaller boats are operated by scientists and technicians to meet the needs of some Laboratory research projects.

During the year ended June 30, 1979, R/V GULF RESEARCHER was at sea for 89 days and 39 nights. The HERMES spent 50 days at sea and the smaller boats made innumerable trips over the same period.

RESEARCH

ANALYTICAL CHEMISTRY SECTION, Dr. Thomas F. Lytle, Head

Heavy Metals in St. Louis Bay (Funded by E. I. duPont de Nemours & Company, Inc. [Du Pont]): Because heavy metals pose a potential threat to estuarine waters whether

coastal areas are developed industrially or residentially, an assessment of heavy metals has been conducted in St. Louis Bay where very little of either type development exists. Heavy metals have been examined in as many ecological components of the bay as possible. Of primary concern to those interested in discharge limitations is the level of trace metals in the water column. This segment of the study, which gathered samples every two months for a year, was further divided into particulate and soluble heavy metals. To gain some perspective into the retention of heavy metals in the bay, sediments collected twice throughout the bay were also analyzed for heavy-metal content. An organism collection was designed based on the criteria that the species contribute significantly to the biomass of the bay, be it a resident species or of commercial importance. Depending upon the criteria met, either whole animals or edible portions were chosen for analyses.

The metals chosen for analysis were: copper, chromium, cobalt, nickel, zinc, cadmium, iron, titanium, vanadium, mercury, arsenic, selenium, antimony, strontium, molybdenum, beryllium, lead and also cyanide. All care was taken to avoid contamination in the collecting process, in sample preparation and in analysis. The only sample collection not totally successful was that of fish. However, oysters, clams and some fish species were found in adequate numbers to give some idea of heavy-metal content in the living segment of Bay St. Louis.

It had been hoped that the newly developed flameless techniques for atomic absorption could be used on all metals in the water samples. A great deal of time was devoted to adapting these techniques to the various matrices found in Bay St. Louis water. Though very sensitive and direct, flameless techniques at the present time are not suitable to apply to numerous metals in great numbers of samples of varying composition. Lack of reproducibility, tremendous analysis time, and cost indicated that these highly praised techniques are best used on single sample, single metal problems. At present, the analyses are being concluded, and a final report is in preparation.

Nutrients in St. Louis Bay (Funded by Du Pont): A sampling program was concluded in December 1978 to survey nutrients and other water-quality parameters in St. Louis Bay water to assess the distribution (laterally, vertically and temporally), source, and fate of these parameters. The choice of station locations was closely coordinated with other investigators at the Laboratory and associated projects

to maximize data usability. The parameters chosen for study were: orthophosphate, total phosphorus, nitrate, nitrite, ammonia, chloride, sulfate, suspended solids, turbidity, alkalinity, and silica. Samples collected for inorganic and organic carbon were forwarded to the GCRL Environmental Chemistry Section for analyses.

Most methods used in analysis, collection and sample handling were of EPA origin. Some methods required slight modifications to permit their application to coastal waters. At the present time, all analyses are complete and a comprehensive data report is in preparation. Included will be: comparison of 1978 data with water-quality data from as early as 1966; comparison with the Pascagoula River and Back Bay of Biloxi; intercorrelation of parameters; distribution as a function of salinity; proximity to proposed effluent sites; and season and trends within the phosphorus and nitrogen groups of nutrients.

The Fate of Pollutants in Mississippi Sound (Funded by Mississippi-Alabama Sea Grant Program [M-ASGP]): This is a cooperative study with the Environmental Chemistry Section. Its objectives are as follows: to document the present load of pollutants in the rivers and estuaries of Mississippi Sound; to gain a historical perspective of pollution in that area by vertically profiling the pollutants in the sediment column; to look at the distribution throughout the Sound as a function of sediment type and mobility; to assess the dangers of dredging in locales of high sediment pollution; to use key pollutants as indicators to trace pollutant movements; to educate the public to the current pollution situation in Mississippi Sound; and to gain a means of predicting impact on Mississippi Sound under a wide range of environmental conditions.

Since Pascagoula River is the most industrialized area along the coast, first efforts are being exerted there. This investigation is profiling the water quality in the Pascagoula River area. Included in the parameter list are: nitrate, nitrite, ammonia, orthophosphate, total phosphorus, suspended solids, turbidity, silica, phenols and Kjeldahl nitrogen. If phenol levels warrant, more sophisticated techniques will be developed to detect individual phenol components. Presently an attempt is being made to use phenolic aldehydes as tracers of paper mill waste movements. If successful, this will provide a certain degree of prediction in examining pollutant movements in rivers. All data will be used ultimately in helping the State and local governments develop proper land utilization plans for the coastal zone.

BOTANY SECTION, Dr. Lionel N. Eleuterius, Head

Salt Marsh Vegetational Studies (Funded by GCRL): Quantitative information is being accumulated on the relationship of marsh acreage versus open water in Davis Bay, a very productive estuarine system. In addition, the total area drained and amount of rainfall will be determined in this study of an entire estuarine ecosystem from the plant

ecology viewpoint. A detailed vegetative map is being prepared as well as a map of the standing crop of all marshes surrounding Davis Bay. Vegetational structure of other Mississippi salt marshes is being determined. This study will reveal the vegetational and ecological attributes of a very productive estuarine system and may have far-reaching consequences.

Populational Studies on Salt Marsh Species (Funded by GCRL): This ongoing research is presently concentrated on the salt marsh rush *Juncus roemerianus*. Considerable population information has been gathered on the species and a portion of it is now in manuscript form. The ultimate goal is to document the distribution and the vegetative growth pattern of the major salt marsh species inhabiting the tidal marshes in Mississippi. Such populational studies are of considerable importance in relation to ecological work since ecotypes, single sexes, may dominate or compose large tracts of tidal marsh. Taxonomic work was also initiated as part of this study.

Ecological Studies on Seagrasses and Salt Marsh Species (Funded by GCRL): This work involves synecological studies where more than one species compose the vegetation. Included in this study is consideration of the hydraulic aspects of flooding various salt marsh zones done in cooperation with the Physical Oceanography Section. Grand Bayou, a high-salinity marsh dominated by *Juncus roemerianus* on Deer Island, Mississippi, has been tentatively selected for this portion of the study. Tidal inundation and discharge rates can easily be established because of the small, contained ecosystem represented in Grand Bayou. A paper on tidal inundation and exposure has been prepared and accepted for publication. Quantitative data on plant productivity and the nutritive discharge of detritus and other water-quality parameters will be assessed on the discharge and on the rising tide. The nutrients of Grand Bayou salt marshes in relation to flood and ebb tides and the flux of soil-water salinity have been determined and manuscripts are in preparation.

Studies of other ecological aspects of tidal marshes have been initiated. Biotic effects are also considered. Flowering phenology has been determined and a paper is in preparation. A graduate student completed thesis research on the response of the snail *Littorina* to the manipulation of salt marsh vegetation.

Autecological Studies on Vascular Plants of Mississippi Salt Marshes (Funded by GCRL): This project is essentially an extension of populational studies, in that ecological parameters such as soil nutrients, soil-water salinity, elevation, and other chemical and physical aspects of habitats (i.e., soil texture, evaporation), and the life history of the plant including germination are considered.

Progeny and Genetic Studies on the Salt Marsh Rush, Juncus roemerianus (Funded by GCRL): This work entails ongoing research begun several years ago. Plants have been grown from seed for several years to obtain Mendelian ratios, establishing the genetic mechanism responsible for the

sexual distribution found in this rush species. The work constitutes an effort to obtain basic information on this species which dominates Mississippi marshes. During the past year, controlled crosses between known parental types have been achieved and their seeds are presently being germinated. Hopefully, they will produce mature plants in less than the 2 years required under field conditions.

An apparatus has been constructed in the greenhouse that can extend or shorten the photoperiod exposure to induce flowering. Also, experiments have been conducted dealing with the physiological requirement of a cold period, known as vernalization, to induce flowering in this rush. If flowering can be induced, the growth and flowering cycle can be accelerated.

An Illustrated Guide and Key to Salt Marsh Plants (Funded by M-ASGP and GCRL): The purpose of this work is to prepare an illustrated guide and key to the salt marsh plants of Mississippi. It entails about 180 line drawings and scientific descriptions of local species of vascular plants. Keys to families, genera and species are being prepared.

A Phytosociological Study of Horn and Petit Bois Islands (Funded by National Park Service, U.S. Department of Interior): This work was completed in 1978, data analysis and the final report completed in early 1979. Phytosociological sampling was used to obtain information on community composition and successional patterns and interrelationships between the plant communities on these islands. Significant products resulting from the work were large format maps, produced in seven colors, that delineated the major vegetational features of Petit Bois and Horn islands. They will be of considerable value in the proper management of the islands and invaluable as baseline data for future scientific studies.

St. Louis Bay – Botanical Survey and Plant Ecology of Salt Marshes and Submerged Meadows (Funded by Du Pont): This work was completed in 1979 and the report is in the final stages of preparation. Vegetational mapping and community composition of salt marshes and submerged grass beds were documented. Standing crop, annual production and chemical characterization of indicator plants and associated soils were determined as part of a baseline environmental study.

Physiological Studies on Salt Marsh Plants (Funded by GCRL): Several experiments (cause and effect) were carried out in the greenhouse during fall, winter and spring. Modifications are needed to lower temperatures in the greenhouse before experiments can successfully be conducted during the summer. The effect of deficient nutrients, toxic levels of heavy metals, and the effects of different water levels have been determined. These data are presently being analyzed.

Nutrient Enrichment Studies in Salt Marshes and Seagrass Beds (Funded by GCRL): This project involves several field experiments utilizing fertilizer. One study was completed by a graduate student and a thesis prepared on the

work. Another study entails nutrient loading of several different marsh types. The latter study has been in progress for several years and was previously a part of the general ecology studies described above. Two forms of nitrogen were applied to seagrass beds and the response observed. Further work is needed.

Herbarium Collection of the Coastal, Estuarine and Marine Flora (Funded by GCRL): The herbarium of the Botany Section presently houses about 20,000 specimens of plants. Most of the collections have been made locally since 1970, and probably compose the most thorough collection of plants found in the northern Gulf of Mexico. Most of the herbarium specimens have been identified but only a few have been mounted on herbarium sheets. The herbarium is presently being organized and specimens cataloged systematically. Duplicate specimens are exchanged with other herbaria throughout the United States, England, Europe, Australia and South America for collections of their coastal, marine and estuarine plant specimens. The herbarium serves as a teaching and research collection and currently includes spermatophytes, algae and fungi. Additional space is needed for an expansion of the herbarium.

Tropic versus CONUS Military Materials and Equipment Evaluation Test (Funded by U.S. Army): A new experimental study was initiated in the spring of 1979 to determine the effect of environmental factors on various military materials and equipment. This work is part of a nationwide military program.

Studies on Plant Colonization on Dredge Spoil (Funded by GCRL): A considerable amount of information was compiled over several years on plant colonization on dredged material. In addition, some information on plant succession has also been gathered. A more intense effort has recently been initiated because many years of observation have allowed insights otherwise unobtainable.

Productivity and Decomposition Studies on Salt Marsh Plants (Funded by GCRL): Several studies were completed on this aspect of salt marsh research. In addition to estimates of standing crop, two regeneration studies were concluded. Manuscripts have not been prepared on these projects, but the data have been analyzed. Assessment of decomposition was determined using nylon bags and new methods developed within the Botany Section. Further work is needed.

ECOLOGY SECTION, Dr. Robert A. Woodmancee, Head

Phytoplankton Productivity in St. Louis Bay (Funded by Du Pont and GCRL): Phytoplankton productivity is a fundamental community process of primary significance to the aquatic food chain. It is affected by a number of naturally occurring variables and is sensitive to a variety of unnatural environmental perturbations. The photosynthetic rate of phytoplankton is being measured at six locations in St. Louis Bay by both the dissolved oxygen and radioactive carbon techniques, and is being related to light intensity,

temperature, nutrients, chlorophyll, community composition and grazing pressure.

Environmental Baseline Survey of St. Louis Bay: Benthic Study (Funded by Du Pont and GCRL): Thirteen months of benthic infauna and epifauna collections were completed in December 1978 as part of the Laboratory's baseline environmental survey of St. Louis Bay. Benthic animals from these collections were identified and the data subjected to statistical analyses. The analyses, which included multilinear regression and cluster analysis, were done by the Laboratory's Computer Section, the data processing center at Texas A&M University, and the Ecology Section's mini-computer.

Monthly sampling for benthic infauna has been continued at the same locations during the first half of 1979. Specimens from these collections have been partially processed and stored at the Laboratory. Results of this continued study will be used in conjunction with the first year's work to investigate seasonal cycles and year-to-year changes in the benthic infauna of St. Louis Bay.

Seasonal and Spatial Changes in the Macrobenthos of Simmons Bayou, Mississippi (Funded by GCRL): Analysis of the results of the 1976-77 benthic study of Simmons Bayou was completed. This study showed the adverse effects of a dead-end canal on both benthic infauna and water quality. A paper reporting these findings, entitled "Macrobenthos of Simmons Bayou and an Adjoining Residential Canal," by James T. McBee and Walter T. Brehm has been accepted for publication in *Gulf Research Reports*.

A Study of the Zooplankton and Floating Components of the Water Column from the Surface to 1,200 Meters at OTEC Sites in the Northern Gulf of Mexico and Eastern Caribbean Sea (Funded by Department of Energy, Ocean Thermal Energy Conversion [OTEC] Program, Lawrence Berkeley Laboratory): A project to collect zooplankton and hydrographic data at possible OTEC sites in the Gulf of Mexico was initiated in June 1978. The current study is a continuation of the original contract which involved the collection and analysis of zooplankton from an OTEC site south of Mobile, Alabama. It was expanded to include limited assistance with similar work at the Punta Tuna, Puerto Rico, OTEC site. Data are reported to the Lawrence Berkeley Laboratory, University of California. These data should provide the OTEC Program with some of the necessary biological data for proper design and environmental assessment of an offshore thermal energy conversion plant.

ENVIRONMENTAL CHEMISTRY SECTION, Dr. Julia S. Lytle, Head

Development of High Resolution Glass Capillary Gas Chromatographic Analysis Coupled with Data System (Funded by GCRL): Environmental pollution studies require constant updating and modification of accepted procedures to adequately deal with the complexity of separations and identifications of environmental pollutants. Recent improvements in gas chromatography demonstrated a need to make

certain modifications to section procedures. Sample introduction into open tubular columns requires many special considerations that are not necessary for the larger packed columns. If the sample was to be introduced by the conventional microsyringe, the open, tubular glass capillary columns would be overloaded. To update section chromatographic capabilities, the Perkin-Elmer 3920 gas chromatograph was converted to accept glass capillary columns using a split injection method. This system has been interfaced with a Perkin-Elmer Sigma 10 data system using special programmed calculation procedures. The Sigma 10 is also equipped with basic, a powerful programming tool for calculations such as merging of data from several chromatographic runs, statistical analyses and automatic parameter updating for methods developed in the laboratory. This combination has proven to be the essential component necessary to investigate a wide variety of environmental pollutants with a high degree of credibility. In performing analyses of environmentally significant molecules present in trace levels, the analyst is constantly seeking to extend the range of analyses to lower and lower concentration levels with accurate measurement. Intensified research efforts by national and state governments have led to intercalibration studies to assess the accuracy and precision of the data obtained.

Petroleum Uptake by Marsh Plants (Funded by GCRL): Field experiments were designed to study the uptake of petroleum by marsh plants and to establish phylogenetic ties through hydrocarbon synthesis. *Spartina alterniflora*, *Juncus roemerianus* and *Scirpus robustus* stands were chosen for these studies. Three types of crude oil were placed around the root systems by routine inoculations into the sediment with a 100-ml syringe. After periods of 2 months and 6 months, tips of the plants were cut from each experimental plant and analyzed for high molecular weight hydrocarbons. Three separate experiments were carried out during different growth seasons, differentiating between maturation stages of individual plants. In each experiment, *Juncus roemerianus* absorbed crude oils into its tissue and *Spartina* and *Scirpus* did not. Not only did *Juncus* absorb petroleum hydrocarbons, but it produced almost equal amounts of alkenes and alkanes. Alkenes were almost absent in the other marsh plants. Biosynthesis of alkanes is not entirely understood and is even less understood for alkenes. By looking at various maturity stages in *Juncus*, insight has been gained into this biosynthesis. Some of the uptake experiments are presently being repeated and expanded to include uptake of naphthalene and octadecene, an aromatic and an alkene compound. It is possible that *Juncus* could serve not only as a contributor of food for estuarine nursery grounds but also act as a buffer and absorb hydrocarbons to lessen the effect of oil spills.

The Fate of Organic Pollutants in Estuaries and Rivers Emptying into the Mississippi Sound (Funded by M-ASGP and Du Pont): This study is a cooperative effort with the

Analytical Chemistry Section. The organic pollutants have been isolated and characterized; the trace metals and nutrients will be examined by the Analytical Chemistry Section. The object of the study thus far has been to document the hydrocarbon and total organic carbon levels in Bay St. Louis, Biloxi River and Bay, and the Pascagoula River system.

In view of ever-expanding development of the coastal zone, continuing pollution assessment is proposed to deal with the following issues of environmental concern:

1. The present conditions of Mississippi Sound and adjacent bays and rivers need careful documentation to determine just where emphasis should be placed in future monitoring efforts.
2. The sources of pollutants should be located and dispersal of pollutants documented. The mechanisms responsible for transport and deposition of pollutants in any area of the Sound must be known for various environmental conditions. Prediction of the fate of materials discharged into the Sound system may then be possible.
3. The public should be made aware of the present and future dangers of pollution to water resources of the state. Only an informed public will be willing to take action to prevent future detriment to the environment and insist upon clean-up procedures.
4. Guidelines for proper development of the coastal zone should be facilitated by a thorough knowledge of potential impacts of pollutants at any location in Mississippi Sound.

This study has two distinctly related areas of research. Trace metals to include such elements as copper, cadmium, zinc, nickel, manganese, silver, cobalt, lead and iron will be examined in all sample types used in the study. Their known toxic nature, stability and numerous sources warrant attention in any pollution study. Hopefully, the data gained here will also be useful in predicting the fate of radionuclides as well. Among the organic pollutants being studied are hydrocarbons which can result from petroleum pollution. Fatty acids and alcohols, not occurring extensively in petroleum, may be used as tracers of natural organics in the Sound, as well as providing additional information on the composition of organic constituents of sediments and water.

Both water samples (surface and bottom) and surface sediments were collected routinely at each sample site. Since trace metals and organics both are generally associated with fine-grain materials when in a nondissolved state, suspended material was examined separately from dissolved components and grain size analysis of sediments conducted. This may provide correlations to clarify sources of deposited pollutants and to assess the importance of suspended materials in transporting pollutants. Other studies have indicated the importance of trace metal-organic associations in water and sediments; therefore, this relationship will be examined as closely as possible. Where more appropriate, laboratory conditions will replace natural ones in trying to

elucidate the character of this relationship.

Studies of Chemical Constituents of Primitive Plants (Funded by GCRL): Chemotaxonomic and geochemical studies are continuing on primitive plants. In the past, studies have been completed on ferns, mosses, fungi and lichens. The present study includes lilies, rushes, sedges and grasses. There are two purposes of the study. One purpose is to investigate the distribution of biosynthetically related compounds, hydrocarbons and fatty acids, relate them to a series of ancient plants, and determine what chemical changes took place in the evolution of plants. The other purpose is to establish hydrocarbon and fatty acid distribution patterns which can help in identifying natural source materials and their environments, and distinguishing them from pollutant sources.

Sediment High Molecular Weight Hydrocarbons in Bay St. Louis (Funded by Du Pont): During the past decade there has been an increasing concern over the possible effects of petroleum hydrocarbons in the marine environment. Because of this concern, a great amount of research is in progress on the biogeochemistry of these compounds. National agencies are initiating hydrocarbon baselines to be made on areas of potential oil pollution that would be subject to economical and environmental stress. With the building of a large Du Pont plant, it was determined that hydrocarbon baseline information was essential. To document present levels of hydrocarbons (aliphatic and aromatic) in St. Louis Bay, 13 stations were chosen for sediment studies to assess the hydrocarbon levels from the rivers and from known sites of possible hydrocarbon inputs, as well as correlate with other sediment studies made on the same stations. Sediments were collected during the first month of the study and hydrocarbon analyses made. These same stations were sampled during September, nine months after the first collection, and again analyzed.

In an effort to use hydrocarbon data to detect the presence of petroleum pollution, parameters have been derived from gas chromatographic data which can be used to indicate the presence of petroleum hydrocarbons. Thirteen of these parameters were measured in all sediments analyzed. Thus changes in these parameters can be detected by measuring the same parameters at any later time and can, therefore, establish both qualitatively and quantitatively the addition of petroleum influx to these sediments.

FISHERIES MANAGEMENT SECTION,
Mr. William J. Demoran, Head

Oyster Resource Assessment and Monitoring Segment of the St. Louis Bay Baseline Survey (Funded by Du Pont): This study involved the mapping of existing oyster reefs to determine their present condition as to productivity, natural mortality, spawning and setting, and predators with emphasis on the incidence of one known disease that affects oysters along the Gulf coast. Historical and recent salinity data were

analyzed to determine what effect they had on oyster growth in the Bay. The final report for this project is in preparation.

A Survey and Assessment of Reef Shell Resources in the Mississippi Sound (Funded by the Mississippi Mineral Resources Institute): This project involved locating and mapping deposits of ancient oyster shells buried under the floor of Mississippi Sound. The quantity of shell material was estimated and the value of this resource determined at current market prices.

Oyster Resources Damage (Funded by GCRL): Section personnel documented the damage to oyster resources caused by spring flooding from Pearl River and opening of the Bonnet Carré Spillway. The study provided the basis for the Bureau of Marine Resources' application for unmatched federal funds to rehabilitate the damaged oyster reefs. The Bureau received \$600,000 in federal funds under Public Law 88-309, Section 4-B. Section personnel planned and supervised the oyster rehabilitation project. In addition, proper documentation of the resource damages made it possible for oystermen and oyster dealers to apply for and receive loans from the Small Business Administration at an interest rate of 7-3/8%.

FISHERIES RESEARCH AND DEVELOPMENT SECTION,
Dr. Thomas D. McIlwain, Head

ANADROMOUS FISHES:

Rearing and Stocking Striped Bass – Mississippi Gulf Coast (Funded by National Marine Fisheries Service [NMFS], U.S. Fish and Wildlife Service and GCRL): The third segment of the project dealing with the rearing and stocking of striped bass was begun in September 1978. The objectives of this program were to establish, by rearing and stocking, a striped bass population in Biloxi Bay; to stock sea-run striped bass and determine their success; and to establish a source of fry from Mississippi brood fish.

Approximately 393,800 striped bass of South Carolina origin were stocked into Biloxi Bay. Some 56,700 of these fish were reared from eggs taken from Mississippi brood fish. The U.S. Fish and Wildlife Service provided 200,000 two-inch fingerlings from their hatchery at Meridian, Mississippi, and the remaining 193,800 were reared at GCRL from fry received from South Carolina.

All spawning of Mississippi brood fish was done at the Mississippi Game and Fish hatchery facility on the Ross Barnett Reservoir. Brood fish were collected from the Pearl River near Jackson, Mississippi, by Mississippi Game and Fish Commission personnel.

About 28,150 sea-run striped bass fingerlings were reared from fry provided by the State of Virginia. These fingerlings were stocked into the Bay of St. Louis.

A total of 258 striped bass stocked in previous years were returned to project personnel. Over 400 stripers,

weighing from 3/4 to 5 pounds, were tagged with Floy T-Bar tags and released. Three tags have been returned. Returns indicate little movement, although with so little data, it would be dangerous to generalize.

A sampling program is in progress to check for natural reproduction of previously stocked bass and for occurrence of juvenile striped bass, to monitor previously stocked striped bass and continue assessing the results of all bass-stocking programs previously carried out in this area.

Sport Fishing Analysis of St. Louis Bay (Funded by Du Pont): Data collection for this project was completed in December 1978. The work entailed gathering data on total effort expended and total harvest of sport fish caught in St. Louis Bay. Data were gathered on species composition, seasonal and numerical abundance, as well as on size composition, method of capture, and catch per unit of effort. Data analysis is complete and a final report is in preparation.

A Proposed Mississippi Marine Finfish (Selected) Fishery Management Plan (Funded by M-ASGP): A management plan for selected Mississippi marine finfish was developed and adopted by the Mississippi Marine Conservation Commission (MMCC). This was a cooperative effort with the University of Southern Mississippi (USM). A working group comprised of personnel from GCRL, USM, MMCC and Sea Grant Advisory Service, held workshop sessions each month. The MMCC selected ten species for inclusion in the plan and appointed a 12-member advisory committee to provide input from recreation and commercial fishermen, processors and consumers.

*Description and Comparison of the Eggs, Larvae, and Young of the Yellow Bass, *Morone mississippiensis*, with Striped Bass, White Perch, and White Bass* (Funded by GCRL): Adult yellow bass have been collected in coastal Mississippi streams. Through temperature and photoperiod manipulation an attempt is being made to spawn these fish. The resulting eggs and larvae are being described and compared to the eggs and larvae of striped bass, white perch, and white bass.

Food Habits and Feeding Selectivity of Larval Striped Bass under Intensive Culture Conditions (Funded by GCRL): Several types of live foods, as well as several types of prepared dry diets, are being tested as food for larval striped bass being reared under intensive culture conditions. To date, the most effective food has been weed zooplankton. No prepared diets have proved satisfactory. This is the second year of a three-year project.

COMMERCIAL AND RECREATIONAL FISHES:

Fishery Monitoring and Assessment (Funded by NMFS and GCRL): The annual report for segment two of this project (October 1977–September 1979) was submitted on schedule. All scheduled monthly samples were collected and processed. Verified data were stored in the Laboratory computer. Selected analytical programs were used to write and publish reports on the relative abundance, size, growth,

and distribution of harvestable species each month.

Cooperative efforts continue to expand the fishery data base for use in achieving optimum production from Mississippi fishery resources through effective management planning and implementation. Information provided to the Mississippi Marine Conservation Commission (MMCC), Mississippi Marine Resources Council (MMRC), National Marine Fisheries Service, Gulf States Marine Fisheries Commission, Gulf of Mexico Fisheries Management Council (GMFMC), fishermen, fishery industries, and various other State and Federal agencies contributed to a progressively improved scientific basis for Mississippi marine fishery management.

Special shrimp sampling provided the MMCC with a scientific basis for seasonal and areal opening and closing of shrimp fishing seasons. The shrimp fishing community provided cooperative sampling effort with commercial fishing gear and boats. Several new areas in State waters were added to the established sampling program. Experimental and commercial sampling showed almost identical results. The Commission opened the season June 15, after examining predicted dates and considering economic and social factors. Continued monitoring was carried out after the season opened. Results indicated that predictions from the sampling program were accurate.

With the possible exception of croakers, all resources monitored in this project appear to be in good condition. Spotted seatrout and redfish provided good recreational catches and record volume of commercial redfish landings. A record catch of gulf menhaden was landed in 1978. Monitoring of juveniles indicated a good crop for 1979. Through June, the 1979 season Mississippi landings showed a 29% increase over 1978. There was little change in fishing effort.

Specimens collected in this project were provided to students and other agencies on request. The by-catch of the special shrimp sampling program was studied and, along with monitoring samples collected since the fishing season opened, will be researched for a master's thesis.

Fisheries Planning (Funded by GCRL, NMFS, MMCC and GMFMC): Active participation in fishery management planning activities of all concerned agencies in the Gulf of Mexico and several professional societies provided for effective input of Mississippi's interest in all Gulf of Mexico fishery management planning activities. Project personnel served in numerous important positions including chairmanship and membership in key committees.

Environmental Baseline Survey of Bay St. Louis, Nektonic Macrofauna (Funded by Du Pont): This segment of the multidisciplinary study of St. Louis Bay provided for collection and study of the nektonic fauna of the bay. Sampling was completed in December 1978 and all samples were collected on schedule. Laboratory processing was completed as originally scheduled. Verified data for all collections were stored in the GCRL computer. Data analyses were carried out during the remainder of the contract period.

Environmental Baseline Survey of Bay St. Louis, Nektonic

Macrofauna (Funded by GCRL): This project is a continuation of the study initiated with Du Pont funding. The regular sampling program was carried out through June 1979, and is expected to continue through September. This will provide two full years of data and strengthen the baseline data base for management.

ICHTHYOPLANKTON:

Cooperative Billfish Study (Funded by M-ASGP and GCRL in cooperation with NMFS): Billfishes are important in sport and commercial fisheries of the Gulf region but little is known about their life history, biology, stock size or potential yield. Their larvae could provide a useful tool for estimating biomass and yield of adults, but the larvae of blue marlin, white marlin, and sailfish are difficult to separate from each other. This project initiated a study to resolve problems involved with identification of larvae of these three species from the Gulf of Mexico and adjacent areas in the Atlantic. Once the larvae of various billfish species can be identified, their abundance in the plankton can be determined and related to size of adult spawning stocks.

The Role of Mississippi Sound in Recruitment to Sport and Commercial Fish Stocks (Funded by M-ASGP and GCRL): Mississippi Sound, located within the "fertile fisheries crescent" in the northeastern Gulf of Mexico plays a potentially important role in recruitment to sport and commercial fish stocks. Understanding the interactions among fish spawning, early life history patterns, and the environment of Mississippi Sound can lead to predictive capabilities related to effects of alteration of circulation patterns and introduction of pollutants on recruitment success, and in turn provide useful information for management purposes.

This three-year study focuses on the pelagic early life stages of fishes, the most critical period in the life history of a species. It is during that period when year-class strengths and subsequent recruitment to fishable stocks are most likely determined. Objectives are to evaluate the importance of Mississippi Sound as a spawning and/or larval fish nursery area, to examine mechanisms of transport of fish eggs and larvae into and within estuarine nursery areas, to examine distribution patterns of pelagic young of important species, and to assess potential relationships between circulation patterns and survival of pelagic young and in turn future recruitment success.

Larval Fish Collection (Funded by GCRL): Work has begun to establish a good regional collection of identified larval fishes from the northern Gulf of Mexico. Increased recognition of the importance of knowledge of the early life history of fish has created a need to know and identify the early pelagic stages. The collection will be useful as a reference source to other researchers studying the early life of fishes in the northern Gulf. It will also be a source of material for studies of larval fish systematics as well as a teaching tool for graduate students interested in early life history research.

The major initial source of material will be collections presently available at GCRL, as well as those planned for the future. Additional sources are also being sought. Preliminary acquisitions include over 50 identified species or species groups.

GEOLOGY SECTION, Dr. Ervin G. Orvos, Head

Offshore Barrier Island Study (Funded by GCRL): This ongoing study is aimed at understanding the geologic history, genetic conditions, and present state of the six major Mississippi-Alabama barrier islands and the minor ones in Pelican Bay, Alabama. Three coreholes were drilled across Mississippi Sound in 1978, along a transect between Bayou la Batre area (Alabama) and western Dauphin Island. At the same time, two additional coreholes were drilled in the Sound near eastern Petit Bois Island. Dredge samples from bottom sediments of the western Mississippi Sound were obtained from several locations for analysis. The Mississippi National Guard provided periodic photographic coverage of certain island sections, allowing monitoring of changes over a short period of time. Monthly photographic reconnaissance flights over the Pelican Bay islands were also made during the spring-summer of 1979. Parts of the accumulated findings are being organized and processed for later presentation at professional meetings and for publication.

Santa Rosa Island and Sound (Funded by GCRL): Study of the island, its lagoon and adjacent bays continued with granulometric and micropaleontological analyses of drill core material provided by the U.S. Army Corps of Engineers, testing laboratories and GCRL drillings. Complete sediment sequences of 15 coreholes from Santa Rosa Sound were provided by the Corps, while the Section drilled an additional 15 shallow coreholes on the island and adjacent mainland areas. Comparison between this island and the Alabama-Mississippi barrier islands has major significance in understanding their formation and development conditions, as well as the Holocene evolution of the whole northeastern Gulf coastal zone.

Origins of Lake Pontchartrain and Surrounding Holocene Areas (Funded by GCRL): The organization of available research material was concluded and some of the results presented at the fall 1978 meeting of the Gulf Coast Association of Geological Societies. Two papers have also been published on the subject.

Holocene Geology of Hancock County Marshland (Funded by GCRL): Earlier obtained research material was organized; it provided the basis for a paper, prepared in conjunction with the Botany Section, for publication in *SIDA Contributions to Botany*.

Pleistocene Stratigraphy of Hancock County (Funded by GCRL): Detailed study continued of field samples and earlier drill material. New core material from four drillholes on the National Space Technology Laboratories site was obtained from the U.S. Army Corps of Engineers. Five additional coreholes were drilled by the Geology Section. The research

is aimed mainly at establishing the influence of late Pleistocene marine transgressions in the Hancock County area.

Pleistocene Development in Southeastern Louisiana (Funded by GCRL): Field and laboratory work continued. Research results from the fossil-rich Tunica Hills (Mississippi-Louisiana) creek terrace sequence have been prepared and accepted for publication in *Quaternary Research*.

Beach Sand Analysis (Funded by GCRL): Granulometric analyses were performed on numerous samples and a report on the results was provided to the Physical Oceanography Section.

Sound Sediment Granulometry (Funded by GCRL): Granulometric analyses, related to various oyster reef areas, were performed on samples for the Fisheries Management Section. Samples were also processed for the Oyster Biology Section.

St. Louis Bay (Funded by Du Pont): Monthly sediment analyses of collected Bay samples were performed on this project. Numerous additional samples were analyzed from various marsh areas along the northern Bay shores for the Botany Section. A report on the project has been submitted. After completion of the Du Pont project, sample analyses continued on a monthly basis for GCRL.

MICROBIOLOGY SECTION, Dr. David W. Cook, Head

Viral Evaluation of Prohibited Oyster Growing Waters (Funded by M-ASGP): This joint project with the University of Southern Mississippi is designed to assess the relationship between numbers of pollution-indicator bacteria in the water and the level of viruses found in oysters. GCRL is responsible for water- and oyster-sample collections and bacteriological analysis. Data produced will be available to State and Federal regulatory agencies for use in assessing present-day water quality standards.

Environmental Baseline Survey of St. Louis Bay: Microbiological Investigations (Funded by Du Pont): Water samples from 14 stations in the Bay and adjacent rivers are being collected at 2-week intervals and analyzed for coliforms and fecal coliforms. These data will document the present-day levels of sewage pollution in the Bay. Each month, water samples collected at 22 stations are analyzed for microbial biomass using adenosine triphosphate (ATP) methodology. These data will be correlated with phytoplankton counts and productivity measurements.

Populations of selected groups of bacteria are being studied in sediments from seven locations around the Bay. Metabolic activity rates and total biomass are being determined.

Environmental Baseline Survey of St. Louis Bay: Pesticide Analysis (Funded by Du Pont): In this project, continued from last year, water samples were collected bimonthly from eight stations, sediment samples bimonthly from 11 stations, and oyster samples quarterly from two stations within St. Louis Bay. All samples were extracted and are currently being analyzed by gas chromatographic methods for

chlorinated hydrocarbon insecticides and polychlorinated biphenyls.

Steam Unit to Aid in Oyster Shucking. Part II. Microbial and Organoleptic Tests of Oysters Exposed to Steam (Funded by MMRC): When oysters are exposed to moderate temperatures, the adductor muscle relaxes, making the oyster easier to open. Investigations were carried out in cooperation with an oyster processor to determine if the heating process affected the microbiological or organoleptic quality of the oyster. Evaluations of the treatment on drip loss and shelf life of shucked oysters were also made.

A Study of the Genus *Bacillus* in Marine and Estuarine Sediments (Funded by GCRL): Monthly sampling of sediments from St. Louis Bay has continued to yield large numbers of *Bacillus*. Over 1,000 cultures have been collected and are being identified in order to better understand the distribution, taxonomy and ecology of the genus *Bacillus* in estuarine sediments.

Toxicity Testing: Inter-laboratory Comparison with Marine Animals (Funded by EPA): In conjunction with three contract and two EPA laboratories, GCRL conducted static and flow-through bioassay evaluations for the toxins silver and endosulfan against sheepshead minnows (*Cyprinodon variegatus*), possum shrimp (*Mysidopsis bahia*), and the copepod *Acartia tonsa*. These tests were conducted so that the EPA might gain insight into the expected similarity (or dissimilarity) of data as a function of the performing laboratory. Data generated thus far indicate that the static 96-hour LC₅₀ of endosulfan to *C. variegatus* is 2.2 ppb and to *M. bahia* 1.0 ppb. The static 96-hour LC₅₀ of silver to *M. bahia* was 176 ppb. Under dynamic conditions, endosulfan reflected a 96-hour LC₅₀ of 0.84 ppb to *C. variegatus*.

Effluent Toxicity Evaluation: First Chemical Corporation (Funded by First Chemical Corporation): GCRL has contracted with First Chemical to perform flow-through bioassay tests using the discharge effluent from its Pascagoula, Mississippi, plant. Test species are sheepshead minnows (*Cyprinodon variegatus*) and possum shrimp (*Mysidopsis almyra*). These tests will be conducted quarterly for one year. First-quarter results indicate that for sheepshead minnows, effluent concentrations less than or equal to 90% produced no mortality. For the mysids, mortalities at effluent concentrations less than 75% were not different from the controls. The biochemical oxygen demand, total inorganic and organic carbon, phenols, suspended solids, and total chromium analyses are being determined by the Microbiology, Environmental Chemistry, and Analytical Chemistry sections of GCRL as part of this contract.

MICROSCOPY SECTION, Dr. William E. Hawkins, Head

Studies on Intracellular Parasites and Tissue Responses in Oysters (Funded by M-ASGP and GCRL): These studies continued for the second year. Oysters are being provided by the GCRL staff and the Food and Drug Administration Shellfish Sanitation Laboratory at Dauphin Island, Alabama.

The oysters are being surveyed with light and electron microscopy for intracellular parasites. These parasites are found in inclusion bodies in the digestive gland. In addition, the incidences of inflammatory and hyperplastic lesions are being compared in oysters taken from various locations. The oyster may prove to be a useful indicator organism if a relationship is found between these cellular changes and certain environmental factors.

Histological and Cytological Investigations of Various Organs and Tissues of the Atlantic Croaker (Funded by GCRL): This study is in its second phase which consists of preparation of an atlas of normal croaker histology and cytology. Croaker organs and tissues have been processed, sectioned, and photographed. The results of this study will provide a basis for determining pathological changes that might result from exposure to various toxicants.

Studies on Histopathological Effects of Heavy Metals on Marine Fish (Funded by GCRL): Studies are continuing on the effects of cadmium on tissues of the spot *Leiostomus xanthurus*. Initial efforts were aimed at determining the normal ultrastructure of the kidney and gills of these fish. In these studies, both transmission and scanning electron microscopy have been utilized. It was determined that after a 48-hour exposure of spot tissue to cadmium, the metal accumulated mainly in abdominal viscera and caused severe damage to proximal tubule cells in the kidney.

OYSTER BIOLOGY SECTION, Dr. Edwin W. Cake, Jr., Head

Oyster Depuration in Mississippi: Engineering Assessments (Funded by M-ASGP and GCRL): The second phase of a 3-year study was completed. The study involved a sanitary engineering analysis of a small, pilot-scale, oyster depuration facility operated by the Oyster Biology Section at Point Cadet in Biloxi, Mississippi. Results indicated that water degradation in both open and closed depuration systems was not significant with regard to acceptable levels for waste discharged into receiving waters. In addition, the following conclusions were reached: solids generated during depuration can be removed via conventional gravimetric means; ozonation provided adequate disinfection and reduced degradation of the process water; ozonation will reduce or eliminate the need for wastewater treatment prior to discharge; and closed depuration systems can be operated for extended periods without significant problems and will function adequately in an open mode of operation.

Enhancement of Oyster Production in a Tidal Lagoon in a U.S. Park Service Wilderness Area, Horn Island, MS. (Funded by GCRL): Study participants are attempting to increase the production of oysters in a wilderness lagoon via natural methods including branch culture, shell relaying, and the introduction of brood stocks from nearby island lagoons. All aspects of the study are being conducted with natural materials and without mechanical or motorized equipment as per wilderness guidelines. This is the first year of a two-year study in cooperation with the Gulf Islands National Seashore.

Population Dynamics of Selected Oyster Populations in Mississippi Sound and Adjacent Waters (Funded by Mississippi Bureau of Marine Resources [MBMR] and GCRL): A one-year monitoring program was begun on five of Mississippi's commercial oyster reefs to determine rates of spatfall, growth, natural and unnatural mortality, and the prevalence of oyster pathogens and predators. The study should be the forerunner of an extensive monitoring program for all reefs to produce data needed for proper management of the State's oyster resources.

Development of an Oyster Management Model Applicable to the Mississippi Oyster Fishery (Funded by MBMR and GCRL): During this one-year study the Oyster Biology and Fisheries Management section staffs will acquire and evaluate existing oyster production models for applicability to the Mississippi Sound oyster industry. They will attempt to determine the technical information inputs required to operate such a model and suggest modifications so that the selected model will apply to the State's situation. Data from the monitoring study (see previous project) may be utilized to manipulate the chosen model.

Oyster Depuration in Mississippi: An Evaluation of Off-bottom Relaying for Cleansing Oysters (Funded by GCRL): The first year was completed of a two-year study to compare "offbottom, containerized" relaying with depuration and traditional "onbottom" relaying. Initial results indicated that polluted oysters held in plastic chicken coops cleansed sufficiently within the widely accepted 15-day "relaying" period. The second year of the study will concentrate on system analysis and modification to design the best containerized alternative to onshore depuration and onbottom relaying.

Oyster Mariculture in Mississippi: Seed Oyster Hatchery Operation and Testing (Funded by GCRL): Current experimental oyster mariculture research at the Oyster Biology Research Facility of GCRL at Pt. Cadet, Biloxi, MS, includes, but is not limited to the following projects: seed oyster production (hatchery production); experimental raceway and tank culture of hatchery-reared seed oysters; evaluation of new cultch materials for hatchery-reared seed oysters; operational monitoring and utilization of a low-cost and low-energy greenhouse for oyster culture; design and testing of windmills for pumping and circulating water in mariculture systems; optimization of natural setting versus wild setting; and the feasibility of utilizing natural spatfall to increase seed production using Maheo and shell spat collectors.

Oyster Mariculture in Mississippi: Field Tests with Hatchery-Reared Seed Oysters (Funded by GCRL): These ongoing studies involve the utilization of seed from the GCRL hatchery in various student and staff research including: growth and survival of seed oysters in Mississippi Sound and adjacent waters; and nursery and field techniques for handling spat and seed oysters in the wild.

PARASITOLOGY SECTION, Dr. Robin M. Overstreet, Head

Commercial Fishes of Mississippi: Spawning and Miscellaneous Biological Parameters (Funded by NMFS and GCRL): The first of two tasks in this project was to determine the season of spawning, size of spawning fish, fecundity, and other aspects of reproduction for the spotted seatrout and red drum in Mississippi. The second task involved evaluating specific aspects of migration, feeding, growth, and health of a variety of commercial finfishes and shellfishes.

Digenea from Marine Fishes of the Northern Red Sea (Funded by the Israel Academy of Sciences and Humanities): This long-term project will ultimately produce a monograph on piscine adult digeneans of Red Sea fishes for the *Fauna Palaestina* series. Many specimens already have been collected and more are expected within the next three years. Simultaneous work also is being conducted on other parasites of Israeli fishes, some of which have been implicated in diseases of humans that consume the fish and of fish that are reared commercially.

Pathological Effects of Larval *Thynnascaris Nematodes* in the Rhesus Monkey (*Macaca mulatta*) (Funded by the U.S. Air Force): The primary purpose of the study is to determine the pathological alterations in the alimentary tract of monkeys that have been administered one of the common local larval nematodes.

Studies of Parasites of the Northern Gulf of Mexico Region (Funded by GCRL): Several studies are underway dealing with various different parasitic organisms. These studies deal with the taxonomy, systematics, anatomy, life histories, pathological effects, and control of the organisms. Some of these parasites have been implicated in harm to commercial and recreational fishes. These organisms include microbes, protozoans, metazoans, and even the hosts and potential hosts for the organisms.

Experimental Organism Culture Group (Funded by GCRL): In early 1979, the culture-holding group of the Parasitology Section moved part of its operation into the front section of the new Toxicology Building on the Laboratory's main campus. The purpose of this group is to develop techniques for culturing various freshwater and marine organisms and to supply these organisms to various sections and other State institutions for use in experiments, primarily toxicity testing and parasitological life-cycle studies.

Presently, several species of fishes, algae, copepods, amphipods, and other species are being reared. The facilities include those necessary for algal culturing, spawning fish, and holding fishes and invertebrates.

Toxicity Testing: Inter-Laboratory Comparison with Marine Animals (Funded by EPA): This study was conducted in cooperation with the Microbiology Section (see page 324).

Effluent Toxicity Evaluation (Funded by First Chemical Corporation): This study was conducted in cooperation with the Microbiology Section (see page 324).

Life Cycle Stages of Cyprinodon variegatus to Philadelphia Academy of Sciences for Toxicity Testing (Funded by Philadelphia Academy of Sciences): Eggs, 2-day old larvae, 28-day old juveniles, and adults are being cultured for tests to be conducted by Scott Paper Company of Alabama.

PHYSICAL OCEANOGRAPHY SECTION,
Mr. Charles K. Eleuterius, Head

Hydrographical—Meteorological Atlas of Mississippi Sound (Funded by M-ASGP): Mississippi Sound is one of the most productive estuaries in the world. Results of studies on the hydrography and meteorology of Mississippi Sound and adjacent areas appear in numerous documents. Planners, management authorities, educators, laymen and scientists are confronted with investing considerable time in a review of the literature to obtain fundamental information on the area. Information on the physical-chemical characteristics of Mississippi Sound does not exist at present. A single volume summarizing present knowledge would be a valuable reference.

This research to develop such a reference source involves extensive statistical analysis of existing sets of hydrographic data to determine characteristic seasonal levels and spatial distributions of physical-chemical parameters: pH, temperature, salinity, dissolved oxygen and density. Statistical measures of central tendency and variability of each parameter at four depths will be shown in the form of isopleth charts. Some of the more informative results of remote sensing studies of Mississippi Sound conducted by the Earth Resources Laboratory, National Aeronautics and Space Administration, will be included; also, summarized information on hurricanes, wind, rainfall, air temperature, wave climate, rivers, and physiography of the basin. It is expected that the atlas will go to press by December 1979.

Hydrology of St. Louis Bay (Funded by Du Pont): The water quality of an estuary is dependent upon the character of the waters received and the residence time of waters within the basin. The transport of dissolved or suspended materials, pollutants included, is almost wholly dependent upon the natural circulation of waters. Anomalous perturbations in levels of physical and chemical parameters are only detectable if a baseline or norm has been established.

The objective of the hydrological study of St. Louis Bay was the development of a baseline of hydrographic parameters to serve as an estimate for "normal" conditions. The hydrologic data-collection effort, which was coordinated with the other disciplines participating in the environmental baseline study, obtained measurements of water temperature, salinity, pH, dissolved oxygen, turbidity (depth of extinction of visible light), water color, and currents. In addition, fixed and automated sampling platforms continuously recorded wind speed and direction, water elevations, water temperature, pH, dissolved oxygen and salinity.

Analyses of these data provided information on the vertical structure of the water column, influence of river

flows, circulation patterns, and seasonal trends in the levels of the physical-chemical parameters. This study was the first major investigation of the hydrology of St. Louis Bay. When released, results of the study should prove valuable in the management of this complex estuarine subsystem.

Numerical Model of St. Louis Bay Circulation (Funded by Du Pont): Essential to ascertaining the fate of dissolved or suspended materials in an estuary is an understanding of the natural circulation of the basin waters. A finite-difference numerical model based on the hydrodynamic equations of motion and continuity was applied to St. Louis Bay. The model, which allows for the flooding and subsidence of waters from land areas, accommodates wind stress and includes a quadratic form of bed resistance. A 30-second time step was used to provide the necessary spatial resolution to properly represent the basin geometry and current regime.

The model was tested initially using a simple sine wave as input, then later with the prescribed tidal conditions. Model graphic output consists of computer-generated hydrographs of water elevation and current vector diagrams. Initial test results agreed well with current measurements from the 13 hydrographic surveys conducted in St. Louis Bay. Testing of the algorithms for wind stress and river flow will be done prior to final production runs. The model will be a valuable investigative tool for future investigations of St. Louis Bay.

Hydrology of Mississippi Sound North of Petit Bois Pass (Funded by MMRC): To properly manage the Mississippi Sound estuary, it is important to know the spatial and temporal variability of certain physical-chemical parameters. Previously acquired hydrographic data were analyzed to determine mean levels of water temperature, salinity, pH, dissolved oxygen, nitrite-nitrogen, nitrate-nitrogen, orthophosphate and total phosphate. These seasonal mean levels were displayed in depth-composited isopleth charts. In addition, the statistical distribution of each parameter for each cruise was graphically displayed. The results of this study provided a hydrographic characterization of a previously little studied area of Mississippi Sound.

Development of a Plan for the Exploration of Mississippi's Marine Mineral Resources (Funded by Mississippi Mineral Resources Institute): The judicious exploration and assessment of mineral resources in Mississippi's coastal lands, marine waters, and earth beneath the waters of the estuaries and adjacent continental shelf, require that a plan of study be prepared. This plan, developed in consultation with a geological oceanographer and a geophysicist, and with input from staff members of several Mississippi universities, is intended to eliminate duplication, establish research priorities and promote cooperation among research participants.

Emphasis has been placed on combining sampling where technically and economically feasible. The plan also includes research to ascertain the environmental impact expected in the event a particular mineral resource is developed.

The plan is expected to be completed by October 1979.

Characterization of Tidal Bayous and Development of Statistical Evaluation/Monitoring Techniques (Funded by GCRL): This study involves analysis of four years of almost daily measurements. Baseline conditions on a number of physical-chemical parameters are being established that will assist in recognizing anomalous events when they occur. Monitoring techniques based on multidimensional graphics are being explored as a practical tool for management authorities. Characterization of the tidal bayou by both chemical and physical constituents will be accomplished as part of this study.

Determination of Fundamental Factors Affecting the Hydrodynamics and Ecology of Mississippi Sound (Funded by GCRL): This study is actually an aggregate of investigations that have provided much specific information on Mississippi Sound. The results have been fundamental to furthering an understanding of the hydrodynamics and ecology of the estuarine basin.

Information such as the volume of water, area of the air-sea interface, statistical distribution of depths, classification of Mississippi Sound as to estuary type, geographical definition of Mississippi Sound, and fundamental period of oscillation, have been determined under this broad study. Recently, cross-sectional areas of the passes into Mississippi Sound were determined by a bathymetric survey. Presently, emphasis is on determining the frequency and cause of low-oxygen waters in Mississippi Sound. In addition, vertical gradients in temperature and salinity are being investigated.

The results of all the investigations grouped under this one research caption are providing fundamental information required to address hydrodynamically related problems. Until these fundamental factors are provided, complicated hydrodynamic questions cannot be answered.

PHYSIOLOGY SECTION, Dr. A. Venkataramiah, Head

Seasonal Variations in Glycogen, Total Fat, and Caloric Energies of the American Oyster in the Mississippi Sound (Funded by GCRL): Oyster quality was determined in the past on the basis of glycogen content. The present studies were undertaken to relate oyster (*Crassostrea virginica* Gmelin) quality to seasonal changes in lipids which contribute more to the caloric content. The total lipid and glycogen contents were found to undergo a significant seasonal change in relation to size and sex. Glycogen content was low in July and October, and high in February. Fat content was low in October and high in April. The caloric content of oyster meat decreased in the following order: April, February, July and October. Among the lipid classes, free sterol fraction has yielded the highest calorific energy in both "lean" (October) and "fat" (February) oysters. Phospholipids from lean oysters yielded more calories than from fat oysters. Variations in caloric content seem related to the degree of unsaturation of lipid class.

Seasonal and Empirical Predictions of Meat Growth in Reef Oysters from the Mississippi Sound (Funded by GCRL):

The relationship between shell length and meat weight is used to set minimum-size limits for the harvest of some bivalves. Considerable attention has been paid to this problem in other species of bivalves but not in oysters from Mississippi Sound. Therefore, experiments were made to propose predictive models to describe the relationship between meat weight versus shell length on a seasonal basis. Males and females exhibited a polynomial increase in meat weight as shell length increased. Growth rates of the reef population, as computed from the models, suggest that oyster meats increase in weight from October to April and decrease from April to October. Males seem to lose their weight for a longer duration than females. Meat weight per unit length revealed variations in the oysters. Small males (30 mm) were heavier from July to October, while females of the same size were heavier from October to April.

Effects of Starvation and of Algal Feeding on the Tissue Cholesterol Levels in Penaeid Shrimp (Funded by GCRL): Tissue lipid and cholesterol contents of brown shrimp *Penaeus aztecus* Ives were compared in the laboratory among starved individuals and those fed green algae *Ulva lactuca* and *Enteromorpha* sp. or a pelleted diet. Cholesterol levels seem to vary with size of the shrimp, sex and diet. Shrimp fed a pelleted diet showed an increase in cholesterol content with increased body weight. Females showed a higher cholesterol content in certain tissues than males fed on the same diet. Muscle cholesterol increased linearly with body weight in females, while it was not size-related in males. Starvation did not alter the cholesterol level except in hepatopancreatic tissue. The cholesterol level decreased significantly in shrimp fed on green algae. Extrapolating these results, it was suggested that the bulk of marketable shrimp (60-68 count per pound) have relatively lower levels of cholesterol than was reported in nutritional and medical literature. "Jumbo" shrimp (30 or less count per pound) showed a value close to the reported value. Compared to caviar, organ meats, and eggs, shrimp muscle showed a low cholesterol content.

Toxicity and Impingement-Entrainment Studies (Phase I) for Ocean Thermal Energy Conversion (OTEC) Plants (Funded by Department of Energy [DOE]): In proposed OTEC plants, solar thermal energy of the tropical oceanic surface waters can be converted into electric energy. The energy conversion is accomplished by evaporating ammonia in heat exchangers with the help of thermal energy from the surface water. The vapor drives a turbine attached to an electric generator and the exhaust gas from the turbine is condensed to liquid ammonia with cold water drawn from depths of 2,000 feet or more which is then pumped back to the evaporator.

The problem areas in this technology are: (a) corrosion of heat-exchanger metals; (b) leakage of ammonia into seawater from heat exchangers; and (c) continuous dosing of chlorine into the system to clean the heat exchangers of biofouling and chlorine discharge into seawater. These

components used in OTEC plants have been known to be toxic to marine plants and animals.

The DOE contracted with the Laboratory to study the toxic effects of the three components as well as their synergistic effects on: (a) a commercially important marine fish, and (b) a biologically important species in the marine food cycle. On the basis of findings, recommendations will be made to the DOE concerning lethal levels, incipient lethal levels (beyond which 50% of the test animals will not survive for 96 hours), and sublethal levels of each component to the selected marine animals. Also the DOE will be advised concerning chlorine dosage levels in OTEC plants. Since September 1, 1978, the following conclusions have been made:

A. Mullet (which spawn in offshore waters) and marine copepods (whichever are available in large numbers) or sargassum shrimp were collected as experimental animals. If time permits, both copepods and shrimp will be tested.

B. An experiment was carried out to find out if starvation during bioassay would affect the behavior and survival of test animals. In mullets, no such effect was observed during the 96- and 144-hour bioassay periods.

C. An experiment was carried out to determine the salinity tolerance range of mullet. Mullet (4 to 6 inches) could withstand a 1 to 40 parts per thousand (ppt) salinity range when transferred from a control of 20 ppt. This information permits testing mullet in a common test salinity to which they have been acclimated slowly from their habitat salinity.

D. Collection and maintenance techniques of mullet in the laboratory have been established. After some initial problems, marine copepods and sargassum shrimp were held fairly well for about 2 months.

E. Although bioassay techniques with aluminum and ammonia are fairly well established in other laboratories, chlorine chemistry in seawater is not well understood. It is only in recent years that this line of research has attracted the attention of power-plant operators. The experimental results published from other laboratories raised more questions than provided answers. Therefore, the following tests were made in the laboratory to understand chlorine behavior and standardize techniques for bioassay.

1. Chlorine demand was determined in unconditioned, deionized water (unconditioned water is free from animal contact or their wastes) versus unconditioned seawater. The seawater exhibited a chlorine demand, compared to no appreciable demand in deionized water.

2. Chlorine demand was compared between unconditioned seawater and conditioned seawater. For conditioning the water, mullet, or any one of the experimental species, can be kept in it for varying periods of time and would secrete ammonia or other metabolic wastes. The conditioned water has shown more chlorine demand than unconditioned water.

3. Chlorine demand was determined in relation to 6, 12, 18 and 24 hours of conditioning in seawater. The chlorine demand increased directly in proportion to the

increased conditioning periods with the highest in 24 hours and the lowest in 6 hours.

4. Chlorine demand was determined in relation to the volume of conditioned test media by holding ten fish in each of 5, 10, 15 and 20 gallons of media. It was found that the smaller the volume, the higher the chlorine demand, and vice versa. This is due to the presence in a smaller body of water of higher concentrations of ammonia with which chlorine possibly combines to form some kind of chloramine.

5. Chlorine demand was determined in relation to biomass by holding test animals having volumes of 122 and 152 grams in 20-gallon tanks. A greater amount of chlorine was lost, as expected, in tanks with 122 grams volume than with 152. The loss was attributed to the presence of a lower ammonia level, 0.53 ppm, in the tank with 122 grams of fish in comparison to 0.62 ppm in the second tank.

Bioassay studies with ammonia are near completion and studies with chlorine are in progress. Based on the data, lethal, incipient lethal, and sublethal levels of ammonia for mullet and sargassum shrimp were identified.

SYSTEMATIC ZOOLOGY SECTION, Mr. C. E. Dawson, Head

Systematic Studies on Fishes of the Families Microdesmidae, Dactyloscopidae and Syngnathidae (Funded by the National Science Foundation): Systematic studies continued on fishes of the families Microdesmidae, Dactyloscopidae and Syngnathidae. Review studies on the pipefish genus *Nannocampus* and the polytypic species *Oostethus brachyurus* were completed. Descriptions of several new or little-known Atlantic and Indo-Pacific pipefishes were completed. In addition, a manuscript treating 6 genera and 29 species of American pipefishes was all but completed during this period. In connection with these tasks and other current problems, studies were conducted on these types and other fishes in a number of museums in the United States, Europe, Australia, and New Zealand.

SPECIAL FACILITIES

MARINE EDUCATION CENTER, Mr. Gerald C. Corcoran, Curator

Visits to the Center increased again this year, from 30,155 to 32,754. The increase was not as great as in previous years, which is an indication that the present facility is fast reaching the maximum number of visitors that can be accommodated.

The Curator assisted with a workshop for minority teachers and exceptional high school students on the Gulf Park campus of the University of Southern Mississippi. His presentation centered around the adaptation of saltwater techniques to studies of freshwater animals. Most of the 100 participants were from schools located far from the coast.

The continuing education program designed for teachers had a total of 30 students enrolled during the year, 20 of whom were teachers. "Basic Techniques in Marine Science for Teachers" was the only course offered at the Center during this time.

The student intern program was discontinued this year. In its place a volunteer summer program was initiated. Four students from the seventh through ninth grades assisted in the care and feeding of the exhibited animals and thus were informally introduced to local marine and freshwater species. A similar program is planned for FY 80.

As in past years, the Creative Learning in Unusual Environments (CLUE) groups from Memphis, TN, visited the Center, with a total of six groups participating. Arrangements were made for staff supervision of daytime and nighttime seining on the beach, a boat tour of Biloxi harbor, a visit to Marine Life of Gulfport and a visit to the Center. The Whitehaven Methodist Day School also took advantage of those arrangements for a visit.

A radio program on sharks was presented on Station WGCM, Gulfport. In addition, the Curator appeared on Station WLOX-TV, Biloxi, on 11 different occasions and presented slide programs on local wildflowers, crabs, salt-water fish, freshwater fish and other marine subjects. A weekly program has been suggested.

Personnel at the Center continue to act as consultants to Marine Life of Gulfport on problems of water quality and diseases of marine animals. The same service is offered to local pet shops and individuals. Information on how to start and maintain marine aquariums is provided upon request.

Color slides of poisonous and nonpoisonous snakes of the area were provided for educational purposes to Howard Memorial Hospital of Biloxi and a hospital in New Orleans. The Center was requested to have copies of the slides made that might be retained by the hospitals and used in their continuing education program. Center personnel continue to be called on to identify local snakes for area hospitals providing treatment to snake-bite victims.

Two new publications have been generated at the Center: "Banded Coral Shrimp" and a "Fun Book" for the elementary grades. The coral shrimp pamphlet notes that this animal was first reported from Mississippi waters since establishment of artificial reefs. The "Fun Book" is a coloring book featuring local animals.

THE GUNTER LIBRARY, Mr. Malcolm S. Ware, Senior Librarian

Statistics on the number of persons using the Gunter Library were kept during this year for the first time and the average was found to be 70 per working day.

A total of 257 standing orders were maintained for journals and serials. Three new exchanges of publications were established, and 10 new subscriptions were opened. Back numbers for 35 journal runs were purchased, and 377 volumes were bound.

Significant additions were made to the journal collection through affiliation with the Science Book & Serial Exchange (SBSE). Many individual and collected reprints were received through exchange and donation, and others were acquired through interlibrary loan/photocopy for the various research

sections as follows: Anadromous, 12; Botany, 35; Ecology, 16; Environmental Chemistry, 11; Fisheries, 24; Geology, 45; Library, 12; Microbiology, 27; Oyster Biology, 17; Parasitology, 49; Physical Oceanography, 18; Physiology, 56; and Systematic Zoology, 13.

Total photocopy transactions received numbered 335. There were 119 requests for interlibrary loans from other libraries.

Book purchases numbered 304 this fiscal period and the average cost per volume was \$28.50. Cataloging personnel processed 502 books and 336 reprints. Donations of books, journals, reports, and reprints were received from the following institutions and individuals: University of Southern Mississippi, Department of Geology; National Marine Fisheries Service, Pascagoula Station; Ronald Lukens, Walter Brehm, John Steen, Sandra Sharp, Dr. Gordon Gunter, Dr. Ervin Otvos, Dr. Thomas Lytle, all of the Gulf Coast Research Laboratory; Dr. E. J. Harvey, Gautier, MS; Dr. B. H. Atwell, Earth Resources Laboratory, Slidell, LA; and Dr. P. Isaacson, New York Department of Public Service.

ICHTHYOLOGY RESEARCH MUSEUM, Mr. C. E. Dawson, Head

Three hundred sixty-eight lots, representing approximately 1,200 specimens, were cataloged. This brings the total vertebrate holdings to 16,729 cataloged lots, about 150,315 specimens. Invertebrate holdings are 1,080 cataloged lots, about 3,460 specimens.

Important gifts of specimens, particularly Syngnathidae, were received from museums and research workers in Japan, the Philippine Islands, India, Australia and New Zealand.

Loans were made to a number of U.S. and foreign institutions, and gifts or exchange materials were provided for collections in Mexico, Australia and Belgium. Identifications were provided for fishes sent by a number of U.S. and foreign investigators.

The Gulf Coast Research Laboratory is a member institution of the Association of Systematics Collections.

WATER ANALYSIS LABORATORY, Dr. Thomas F. Lytle, Head

The Analytical Chemistry Section through the Water Analysis Lab is profiling the water quality in the Pascagoula River area. Included in the parameter list are: nitrate, nitrite, ammonia, orthophosphate, total phosphorus, suspended solids, turbidity, silica, phenols and Kjeldahl nitrogen. If phenol levels warrant, more sophisticated techniques will be developed to detect individual phenol components. Presently an attempt is being made to use phenolic aldehydes as tracers of paper mill waste movements. If successful this will provide a certain degree of prediction in examining pollutant movements in rivers. All data will be used ultimately in helping State and local governments develop proper land utilization plans for the coastal zone.

COMPUTER SECTION, Mr. David Boyes, Head

The total number of jobs processed through the Computer Center was 3,079 with the hours run reaching 1312.53. This is a net increase of 35.8% for jobs processed and 21.0% in hours run over last year. The main sections contributing to the job total were: Du Pont Project (1,258 jobs), Oceanography (343 jobs), Finance (273 jobs), Fisheries (166 jobs), Graduate Program (155 jobs), Botany (123 jobs), and Parasitology (76 jobs); with the remaining jobs contributed by other sections.

Pilot Study for Menhaden Catch/Effort Log (Funded by Gulf States Marine Fisheries Commission): The main objectives of this project were: collection of catch/effort logs for the 1978 season; the design of a card format for logs; design of codes for locations, vessels, plants and species; storage of data in a compatible format with NMFS menhaden data; and preliminary analysis of the data base.

This project produced approximately 32,000 cards of data and ran 110 jobs during 1978-79.

PUBLIC INFORMATION/PUBLICATIONS SECTION, Miss Catherine Campbell, Head

During the last half of 1978, section personnel performed primarily publications work. One large project consisted of typing masters for the printing of a colloquium on mackerels held earlier in the year by the Gulf States Marine Fisheries Commission (GSMFC). About 120 pages were set in an 8½-by 11-inch format; this work resulted in the GSMFC publication, *Proceedings: Colloquium on the Spanish and King Mackerel Resources of the Gulf of Mexico*.

The staff also handled the printing of the Laboratory technical journal, *Gulf Research Reports*. After Dr. Harold D. Howse, editor, accepted papers for inclusion in Volume 6, Number 2, of the journal, they were copy edited by the staff for style, consistent usage and other details, then masters were typed in page format for printing the book. Work was completed during November and December; finished copies were received from the printer in late February and approximately 760 copies were mailed by the PI/P staff.

The first manuscript for Volume 6, Number 3, of *Gulf Research Reports* was received by the Section in early March 1979 and was copy edited and printing masters set. Beginning with this issue, the editor adopted deadlines for the submission of manuscripts as follows: August 1 for papers of 10 or more typewritten, double-spaced pages and September 1 for shorter papers.

Early this year, the staff began preparations for printing a new descriptive brochure for the Laboratory. Photographs were made during the summer and fall of 1978 and the booklet was written and edited. During January and February 1979, printing masters were set in 7- x 10-inch format and page layouts were made. The brochure was printed during April.

Twelve issues of the Laboratory newsletter, *Marine Briefs*, were produced and the publication completed its seventh

year and entered its eighth. Staff members wrote and edited copy, took photographs, typed masters for printing and laid out pages for one 8-page, nine 6-page and two 4-page editions. Approximately 3,800 copies were distributed monthly.

During August 1978, the staff edited copy for Marine Education Leaflet No. 10, Polychaetes of Mississippi Sound, set masters and made the layout; it was printed in September. The leaflet was written by Walter Brehm of the Ecology Section. In November, the printing of the summer bulletin describing the academic program was handled by the section, and various other miscellaneous printing needs of the Laboratory were handled as they arose.

During July, August and September of 1978, the section continued to present a public information program entitled "What's in the Gulf for You?" during visits to public libraries along the Mississippi coast. Earlier, in June, visits were made to Pascagoula and Moss Point libraries and, later, to the following libraries: Biloxi, Gautier, City-County (Bay St. Louis), Gulfport-Harrison, West Biloxi and Ocean Springs. A film, "World Beneath the Sea," live exhibits and a staff member were provided by the Laboratory's Marine Education Center (MEC). Section personnel gave out free literature including Marine Education Leaflets, tide tables, shark recipes, marine careers information, and materials published by Sea Grant programs. Library personnel and patrons were made aware of the services and activities available through the MEC, the Laboratory, and Sea Grant. There was interest in continuing the program in the summer of 1979, however, due to the gasoline shortage, it was not offered.

The section provided Laboratory participation in the Mississippi State University-sponsored Harrison County Fair at Edgewater Mall Shopping City in September 1978, and in the Scout Expo '79 at Biloxi's International Plaza and the exhibits of the annual meeting of the Mississippi Academy of Sciences in Jackson, the latter two events in March 1979.

During the spring of 1979, section personnel reworked a display panel located in the Caylor Building foyer, according to a new color scheme and design concept. This 4- x 8-foot exhibit depicts aspects of both the academic and research purposes of the Laboratory.

The section continued to disseminate information of Laboratory activities to the general public.

Thirty-five news releases were mailed to about 50 selected daily and weekly newspapers, television and radio stations, wire services and special correspondents. In addition, approximately 100 pictures were made of small groups of field trip and summer college students and these were sent, with cutlines, to hometown and campus publications throughout the country.

Assistance was provided to a number of outside writers, photographers and television crews who sought to cover activities of the Laboratory. Conducted tours were given by the staff to a dozen high school, college, and professional groups.

The section also obtained Laboratory staff members to serve as speakers for civic clubs and judges for science fairs.

ACADEMIC PROGRAM

NEW AFFILIATE

Eastern Kentucky University in Richmond, Kentucky, affiliated with the Laboratory during the year. The total of out-of-state affiliates is now 39.

SUMMER SESSION, Dr. David W. Cook, Registrar

The 1978 summer academic session involved 91 students registering individually for a total of 120 student courses. Thirty-nine students registered through Mississippi schools, 56 through out-of-state affiliates and four through non-affiliated out-of-state institutions. Courses taught during the 1978 summer session were:

- Salt Marsh Ecology, Dr. Lionel N. Eleuterius, staff
- Marine Microbiology, Drs. David W. Cook and William W. Walker, staff
- Introduction to Marine Zoology, Dr. Buena S. Ballard, Southwestern Oklahoma State University
- Marine Vertebrate Zoology and Ichthyology, Dr. J. William Cliburn, University of Southern Mississippi
- Marine Invertebrate Zoology, Dr. Edwin W. Cake, Jr., staff
- Marine Fisheries Management, Mr. J. Y. Christmas, Jr., staff, and visiting specialists
- Marine Aquaculture, Dr. Edwin W. Cake, Jr., staff
- Marine Ecology, Drs. James T. McBee and Robert A. Woodmansee, staff
- Marine Botany, Dr. R. B. Channell, Vanderbilt University
- Parasites of Marine Animals, Dr. Robin Overstreet, staff
- Special Problems in Marine Science, staff

During the 1978-79 academic year, 35 students earned credit in the course Basic Techniques in Marine Science for Teachers, offered at night at the Marine Education Center located in Biloxi. This course was taught by Mr. Gerald C. Corcoran, staff.

GRADUATE RESEARCH PROGRAM

Courses offered in the Graduate Research Program during this period included: Seminar, Special Problems in Marine Science, Special Topics in Marine Science, and Graduate Research in Marine Science. A total of 72 semester hours credit were earned by these students.

Four new students were accepted into the Laboratory's Graduate Research Program during the year. Three students completed their degrees and three students completed their research projects and returned to their parent campuses for further coursework. Fourteen students in the program were candidates for the master's degree and nine candidates for the doctorate.

Each candidate's name, thesis title, degree sought and home university are listed below according to the senior staff member directing their work:

Dr. Edwin W. Cake, Jr.:

David H. Barnes, "Polychaetes associated with an artificial reef in the north central Gulf of Mexico," M.S., University of Southern Mississippi.

David A. Blei, "A successional study of the hydrozoans inhabiting an artificial reef in the north central Gulf of Mexico," M.S., University of Southern Mississippi.

Alfred P. Chestnut, "Substrate competition between *Crassostrea virginica* (Gmelin) and associated sessile marine invertebrates," Ph.D., University of Southern Mississippi.

William W. Falls, "Food habits and feeding selectivity of larval striped bass, *Morone saxatilis* (Walbaum), under intensive culture," Ph.D., University of Southern Mississippi.

Kenneth Hase, "Enhancement of oyster production in a tidal lagoon in a U.S. Park Service wilderness area," M.S., University of Southern Mississippi.

Katherine A. McGraw, "A comparison of the growth and survival rates of hatchery-reared and natural oyster spat at selected locations in the Mississippi Sound and adjacent waters with comments on the biology of oysters in Mississippi," Ph.D., University of Washington.

John E. Supan, "A comparison of 'off-bottom' relaying of oysters in the Mississippi Sound," M.S., University of Southern Mississippi.

Mr. J. Y. Christmas, Jr.:

James R. Warren, "Changes in the population of the juvenile groundfish, *Micropogonius undulatus*, *Leiostomus xanthurus* and *Cynoscion arenarius*, from Mississippi Sound before and after the opening of the 1979 shrimp season," M.S., University of Southern Mississippi.

Dr. Lionel N. Eleuterius:

James C. Garrison, "Some relationships of salt marsh vegetation to abundance of the marsh periwinkle *Littorina irrorata* Say," M.S., University of Mississippi.

Stephen H. Sky-Peck, "A study of growth and nitrogen content of *Spartina alterniflora* and *Juncus roemerianus* in response to source and concentration of nitrogen," M.S., University of Mississippi.

Dr. Gordon Gunter:

Zubir bin Din, "The food and feeding habits of the common bay anchovy, *Anchoa mitchilli diaphara* Hildebrand," M.S. degree awarded 1979, University of Mississippi.

Dr. Thomas D. McIlwain:

Frederick E. Schultz, "Description and comparison of the eggs, larvae, and young of the yellow bass, *Morone mississippiensis*, with striped bass, *Morone saxatilis*, white perch, *Morone americanus*, and white bass, *Morone chrysops*," M.S., University of Mississippi.

Dr. Robin Overstreet:

Daniel R. Brooks, "Evolutionary history of digenetic trematodes infecting crocodylians, including revision of *Acanthostominae* Poche, 1926 (Digenea: Cryptogonimidae),"

Ph.D. degree awarded 1979, University of Mississippi.

Thomas L. Deardorff, "Nematodes of the genus *Thy-nascaris* Dollfus 1933, (Anisakidea) in the northern Gulf of Mexico," Ph.D., University of Southern Mississippi.

Alan C. Fusco, "The life cycle and development of *Sirocamallanus cricotus*, with notes on the taxonomic status of the genus," M.S. degree awarded 1978, University of Southern Mississippi.

Tom E. Mattis, "Larval development of two trypanorhynch tapeworms from Mississippi Sound," Ph.D., University of Southern Mississippi.

Mobashir Ahmad Solangi, "Pathological changes in some estuarine fish exposed to crude oil and its water-soluble fractions," Ph.D., University of Southern Mississippi.

Dr. A. Venkataramiah:

Ann L. Gannam, "Effect of replacing dietary animal protein with plant protein supplemented by methionine on the growth and survival of Penaeid shrimp," M.S., University of Southern Mississippi.

Shiao Yu Wang, "Studies on the effect of declining oxygen tension on the respiratory rate of brown shrimp, *Penaeus aztecus* Ives in relation to temperature and size," M.S., University of Southern Mississippi.

Dr. Robert Woodmansee:

Zoghlu Kabir, "Relationship between the diurnal vertical migration and egg development in planktonic copepods in Mississippi Sound and adjacent northern Gulf of Mexico waters," Ph.D., University of Mississippi.

John P. Steen, "Factors influencing the spatial and temporal distribution of selected crustacean plankton species in Davis Bayou," Ph.D., University of Mississippi.

Michael C. Torjusen, "The distribution, abundance and feeding habits of larval and juvenile bothid flatfishes of Mississippi Sound and adjacent waters," M.S., University of Mississippi.

SCIENTIFIC FIELD TRIP PROGRAM

As an adjunct to the teaching program, each year the Laboratory provides living accommodations, classroom laboratories, and essential services to visiting scientific field trip groups made up of college and university students and their professors. Such groups may stay for periods of up to several weeks, live in the dormitory, use Laboratory boats to make collections of marine life from the sea and from the beaches of offshore islands, and study their specimens in the classroom laboratories. During the year the Laboratory was visited by 33 field trip groups. The total number of people involved were 470 professors and students who stayed an average length of 4.18 days. Some came as far as 2,000 miles to study the marine life of the Gulf of Mexico.

SPECIAL AND COMMUNITY SERVICES

FISHERY ASSISTANCE

The Biloxi Schooner (Funded by GCRL): A newsletter,

designed especially for the processing segment of the seafood industry, was published monthly. It entered its second volume. The current mailing list is composed of 75 seafood companies and industry-related persons in Mississippi and five other states. Its content is technical in nature relating directly to the business of seafood production. Source material comes from Laboratory research, trade journals, scientific papers, Federal agency publications, and information gathered at seminars, conferences, and trade conventions.

Seafood Merchandising Circular—Oysters (Funded by GCRL): In the previous year an educational fact sheet had been written at the request of a seafood packers association, to help food distributors and retailers better understand the nature of oysters. It was the intent of this fact sheet that better handling and selling would result by making more people in the food distribution chain better acquainted with this highly perishable product. A supply of waterproof paper was located and 3,000 copies were printed and given to oyster packers to put in their boxes of iced oyster jars before shipment to stores throughout the country.

Wastewater Sampling Program (Funded by GCRL): To prepare the seafood industry for strict requirements of water pollution regulations administered by the EPA, this program was set up to test seafood plant wastewater effluent. The objective is to measure the "conventional pollutants" as defined by the EPA. There are limits on the amounts of these pollutants that can be contained in plant effluent if it is discharged into local waters rather than into a sewerage system. If samples tested show that a plant's wastewater contains more than the allowable amounts of pollutants, then a plan is drawn up to help the particular plant lower these levels.

The state pollution control agency operates a wastewater discharge permit system subject to EPA approval; weekly sampling and a monthly report are required. Test results from this sampling program are reported to plant owners, who in turn use these data in their reports to the state. Data are gathered on each product processed. From December through June, 38 complete sample sets were made, which required spending 155.5 hours during 62 visits to the plants.

These data will be of added benefit to the seafood industry in relation to the proposed regional sewerage system being planned by the state and EPA. Eventually that system will require all seafood plants to discharge their effluents into a treatment plant. A sewer-use ordinance will be drawn up setting allowable levels of pollutants entering the treatment plant. Data being accumulated from this sampling program will be of future value in helping to obtain realistic ordinance limitations.

Due to the complexity and potential impact of the EPA's wastewater guidelines, a reference library was started to keep this office informed and serve as a source of information for the seafood industry. The collection now contains a set of the laws, their amendments, and up-to-date rule changes;

a 15-volume collection of documents developed to facilitate compliance of the food industry with the regulations; and research papers and other reference materials that have been developed on the seafood industry.

ADDITIONAL ASSISTANCE

Extensive freezing and packaging experiments for a number of seafood products were begun at the request of a processor. This is a continuing project carried on at the seafood plant. The experiments involve product preparation, freezing time/temperature studies, packaging material evaluation, and quality determination.

Assistance was requested by an industry member who wanted to locate a volume source for several species of fish that were in high demand but could not be supplied locally. A marketing study was done of catch and distribution data from the southeastern states. The study defined a middle-Atlantic coast state as a good source of supply which was also within a reasonably economical transportation range from the Gulf coast. The names of fish dealers in that area were obtained and contact was made.

Three industry members requested assistance concerning a seafood product shipping regulation. A study of published research was done to examine the basis for the regulation and gather support data for any proposed changes. These data were compiled in a statement on the issues involved with the regulation. This matter is currently under consideration by the seafood industry at the national level. This work will carry over into next year.

ENVIRONMENTAL AFFAIRS

The Environmental Affairs Committee is composed of all senior scientific staff members and is coordinated by the Ecology Section. The committee provided an interdisciplinary approach to environmental problems in the wetlands and estuaries of Mississippi, primarily as a service to the Mississippi Marine Resources Council, which partially funded this work. However, the committee also cooperates with other State and Federal agencies on special projects that are not under the direct jurisdiction of the Council. The majority of this work deals with the review of permit requests for work proposed in the wetlands and estuaries. Committee members made comments and recommendations on permit requests. In most cases a site visit was made by representatives of the Committee. Based upon these inputs, a letter to the Council was drafted stating any objections the Committee might have, reasons for those objections, and recommendations that might reduce or eliminate the objections.

The Committee reviewed 54 permit applications during the year. In addition, a statement on the proposed 201 Regional Water Pollution Abatement Plan was drafted and presented at a public hearing convened by the Mississippi Air and Water Pollution Control Commission. Five members of the Committee were also members of the Deer Island

Study Committee which was formed to assess the impact of a proposed skylift transportation system and the potential impact of 600 visitors per hour on the flora and fauna of Deer Island and the surrounding waters.

PUBLIC SEMINARS

The Gulf Coast Research Laboratory hosts a series of staff seminars throughout the year. These seminars are open to the public and speakers include invited scientists as well as officials from various levels of local, state and federal government. The central purpose of the seminars is to promote better dissemination, understanding, and use of scientific information at all levels of society. Seminars presented during fiscal year 1979 were as follows:

"Principles of Health Physics in the Radiochemistry Laboratory" by Mr. Ronald J. Forsythe, Assistant Director, and Mr. Kenneth Waller, Health Physicist, Regulatory Agent, Radiological Health Division, Mississippi State Board of Health, July 11, 1978.

"Planetarium Science" by Mr. Jim McMurtray, Director, STARS Planetarium, July 25, 1978.

"Evolution of Several Marine Invertebrate Groups as Interpreted from the Fossil Record" by Mr. Jim Garrison, Botany Section, Gulf Coast Research Laboratory, July 28, 1978.

"Transport and Fate of Organic Compounds in Rivers and other Gulf Coast Hydroscience Center Research" by Dr. Dave Shultz, U.S. Geological Survey, Research Hydrologist, National Space Technology Laboratories, August 8, 1978.

"Testing Hypotheses of Evolutionary Histories of Parasitic Helminths" by Mr. Daniel R. Brooks, Parasitology Section, Gulf Coast Research Laboratory, August 15, 1978.

"Mississippi Cooperative Extension Service. . . Research and Services" by Mr. Leonard Slade, Jackson County Extension Agent, August 22, 1978.

"Mechanics of Enhanced Recovery" by Mr. Dave Meltzer, Senior Reservoir Engineer, Secondary Recovery Offshore Platforms, Chevron U.S.A., Inc., September 12, 1978.

"Trends in Medical Research" by Dr. James B. Martin, M.D., Ocean Springs, September 26, 1978.

"Salient Vegetative Features of Tidal Marshes and Evolutionary Implications from Plant Autecology" by Dr. Lionel Eleuterius, Head, Botany Section, Gulf Coast Research Laboratory, October 10, 1978.

"Future Plans of Mississippi Power in Developing Energy Reserves" by Dr. Harry H. Bell, Jr., Vice President Engineering and Operations, Mississippi Power Company, October 24, 1978.

"Assembly Line, Modular Production of Ships at Ingalls Shipbuilding" by Mr. A. C. Weeks, Litton Industries, Ingalls Shipbuilding Division, November 7, 1978.

"Hurricane Meteorology and Reconnaissance" by Capt. Jim Perkins, Meteorologist, Keesler Air Force Base, November 21, 1978.

"Ecology of the Birds of Horn and Ship Islands, Mississippi" by Mr. Wayne C. Weber, Department of Biological Sciences, Mississippi State University, November 28, 1978.

"Food and Feeding Habits of the Common Bay Anchovy, Anchoa mitchilli" by Mr. Zubir bin Din, Physiology Section, Gulf Coast Research Laboratory, November 30, 1978.

"Tick-Borne Rickettsial Diseases in Mississippi" by Dr. Lane Foil, Department of Entomology, Mississippi State University, December 5, 1978.

"The Gill Netting-Sport Fishing Controversy in the Mississippi Sound" by Dr. Wendell Lorio, Director, Mississippi State University Research Center, National Space Technology Laboratories, January 16, 1979.

"Gulf Teleost Cell Structure" by Dr. Joe Wharton, Department of Microbiology, University of Mississippi Medical Center, January 23, 1979.

"Marine Advisory Program Activities and Coastal Development" by Dr. David Veal, Mississippi Sea Grant Advisory Service, February 20, 1979.

"Methods of Handling and Shedding Blue Crabs" by Ms. Harriet Perry and Mr. Larry Nicholson, Fisheries Section, Gulf Coast Research Laboratory, March 6, 1979.

"Effects of Changes in Salinity on Biochemistry and Surface Ultrastructure of the Gill of the Mullet, Mugil cephalus" by Dr. Fred Hossler, Department of Anatomy, Louisiana State University Medical Center, March 20, 1979.

"Fish Eggs and Larvae: A Resource Assessment Tool" by Dr. Sally L. Richardson, Fisheries Section, Gulf Coast Research Laboratory, April 10, 1979.

"Present Status of Larval Taxonomy of Myctophid Fishes" by Dr. Muneo Okiyama, Associate Professor, Division of Marine Ecology, Ocean Research Institute, University of Tokyo, April 11, 1979.

"Utilization of Seafood Products" by Mrs. Bertha Fontaine, Seafood Consumer Specialist, National Marine Fisheries Service, April 24, 1979.

"Home Health Service in Jackson County" by Nica Cason, R.N. and Joyce Rivera, R.N., Public Health Nurses, Jackson County Health Department, May 8, 1979.

"Geology of the Gulf Coast" by Dr. Ervin Otvos, Head, Geology Section, Gulf Coast Research Laboratory, May 22, 1979.

"Toxicology Capabilities at the Gulf Coast Research Laboratory" by Dr. William Walker, Microbiology Section, Gulf Coast Research Laboratory, June 5, 1979.

"A Study of Growth and Nitrogen Content of Spartina alterniflora and Juncus roemerianus in Response to Source and Concentration of Nitrogen" by Mr. Stephen Sky-Peck, Botany Section, Gulf Coast Research Laboratory, June 21, 1979.

"Basic Studies in Reproduction Using Nematodes as Experimental Models" by Dr. Eugene Foor, Wayne State University, June 26, 1979.

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