

THE  
WOODS HOLE OCEANOGRAPHIC  
INSTITUTION

REPORT FOR THE YEAR  
1952

1953

## TABLE OF CONTENTS

	PAGE
I. Trustees, as of December 31, 1952 . . . . .	4
II. Members of the Corporation, as of December 31, 1952 . . . . .	5
III. Research Staff . . . . .	6
IV. Director's Report . . . . .	9
V. Treasurer's Report . . . . .	30
Appendix . . . . .	37

## I. TRUSTEES

(As of December 31, 1952)

### *Honorary Trustees*

HENRY B. BIGELOW, Museum of Comparative Zoology, Cambridge, Mass.  
EDWIN G. CONKLIN, Princeton, N. J. (deceased).

### *To serve until 1956*

DETLEV W. BRONK, National Research Council, 2101 Constitution Avenue, N.W.,  
Washington, D. C.  
DANIEL MERRIMAN, Bingham Oceanographic Laboratory, Yale University, New Haven,  
Conn.  
ALFRED C. REDFIELD, Woods Hole Oceanographic Institution, Woods Hole, Mass.  
LAWRASON RIGGS, Room 1722, 120 Broadway, New York, N. Y.  
HENRY L. SHATTUCK, 10 Milk Street, Boston, Mass.  
GERARD SWOPE, JR., c/o International General Electric Co., 570 Lexington Avenue,  
New York, N. Y.

### *To serve until 1955*

J. S. COLES, 85 Federal Street, Brunswick, Maine.  
ALEXANDER FORBES, 610 Harland Street, Milton, Mass.  
ROSS G. HARRISON, Osborn Zoological Laboratory, Yale University, New Haven, Conn.  
MILFORD R. LAWRENCE, Siders Pond Road, Falmouth, Mass.  
HARLOW SHAPLEY, Harvard College Observatory, Cambridge, Mass.  
FRANCIS C. WELCH, 73 Tremont Street, Boston, Mass.

### *To serve until 1954*

CHARLES FRANCIS ADAMS, 15 State Street, Boston, Mass.  
HORACE S. FORD, 77 Massachusetts Avenue, Cambridge 39, Mass.  
ARNAUD C. MARTS, 521 Fifth Avenue, New York, N. Y.  
ALBERT E. PARR, American Museum of Natural History, Central Park West at 79th  
Street, New York, N. Y.  
ATHELSTAN F. SPILHAUS, Institute of Technology, University of Minnesota, Minneapolis  
14, Minn.  
SELMAN A. WAKSMAN, New Jersey Agricultural Experiment Station, New Brunswick, N. J.

### *To serve until 1953*

L. O. COLBERT, 4408 29th Street, N. W., Washington, D. C.  
MARION EPPLEY, Eastover, Newport, R. I.  
FRANK A. HOWARD, 30 Rockefeller Plaza, New York, N. Y.  
THE COMMANDANT (Vice Admiral Merlin O'Neill), U. S. Coast Guard, 1300 E Street  
N.W., Washington, D. C.  
COLUMBUS O'D. ISELIN, Woods Hole Oceanographic Institution, Woods Hole, Mass.  
RAYMOND STEVENS, c/o Arthur D. Little Inc., 30 Memorial Drive, Cambridge, Mass.

### *Ex. Officio*

EDWIN D. BROOKS, JR., P.O. Box 1135, Boston 3, Mass.  
MARY SEARS, Woods Hole Oceanographic Institution, Woods Hole, Mass.  
EDWARD H. SMITH, Woods Hole Oceanographic Institution, Woods Hole, Mass.

## OFFICERS

HENRY B. BIGELOW, Chairman of the Board of Trustees, Museum of Comparative Zoology,  
Cambridge, Mass.  
ARNAUD C. MARTS, President of the Corporation, 521 Fifth Avenue, New York, N. Y.  
EDWARD H. SMITH, Director, Woods Hole Oceanographic Institution, Woods Hole, Mass.  
EDWIN D. BROOKS, JR., Treasurer, P.O. Box 1135, Boston 3, Mass.  
MARY SEARS, Clerk of the Corporation, Woods Hole Oceanographic Institution, Woods  
Hole, Mass.

## II. MEMBERS OF THE CORPORATION

CHARLES FRANCIS ADAMS, 15 State Street, Boston, Mass.  
OLIVER AMES, III, North Easton, Mass.  
PHILIP ARMSTRONG, Medical Center of Syracuse, State University of New York, Syracuse, N. Y.  
HENRY B. BIGELOW, Museum of Comparative Zoology, Cambridge, Mass.  
LINDSAY BRADFORD, 215 East 72nd Street, New York, N. Y.  
DETLEV W. BRONK, National Research Council, 2101 Constitution Avenue, N.W., Washington, D. C.  
EDWIN D. BROOKS, JR., P.O. Box 1135, Boston 3, Mass.  
L. O. COLBERT, 4408 29th Street, N.W., Washington, D. C.  
J. S. COLES, Bowdoin College, Brunswick, Maine.  
EDWIN G. CONKLIN, Princeton, N. J. (deceased).  
THE COMMANDANT (Vice Admiral Merlin O'Neill), U. S. Coast Guard, 1300 E Street, Washington, D. C.  
HARRISON P. EDDY, Metcalf & Eddy, 1300 Statler Building, Boston, Mass.  
MARION EPPLEY, Eastover, Newport, R. I.  
JNO. A. FLEMING, 1530 P Street, N.W., Washington 5, D. C.  
ALEXANDER FORBES, 610 Harland Street, Milton, Mass.  
HORACE S. FORD, 77 Massachusetts Avenue, Cambridge, Mass.  
ROSS G. HARRISON, Osborn Zoological Laboratory, Yale University, New Haven, Conn.  
FRANK A. HOWARD, 30 Rockefeller Plaza, New York, N. Y.  
COLUMBUS O'D. ISELIN, Woods Hole Oceanographic Institution, Woods Hole, Mass.  
MILFORD R. LAWRENCE, Siders Pond Road, Falmouth, Mass.  
LAMAR R. LEAHY, 910 Park Avenue, New York, N. Y.  
ALFRED L. LOOMIS, Room 2420, 14 Wall Street, New York 5, N. Y.  
ARNAUD C. MARTS, 521 Fifth Avenue, New York, N. Y.  
DANIEL MERRIMAN, Bingham Oceanographic Laboratory, Yale University, New Haven, Conn.  
HENRY S. MORGAN, 2 Wall Street, New York, N. Y.  
ALBERT E. PARR, American Museum of Natural History, Central Park West at 79th Street, New York, N. Y.  
ALFRED C. REDFIELD, Woods Hole Oceanographic Institution, Woods Hole, Mass.  
LAWRASON RIGGS, Room 1722, 120 Broadway, New York, N. Y.  
GEORGE H. RICHARDS, 68 Williams Street, New York, N. Y.  
FRANCIS C. RYDER, Massachusetts Institute of Technology, Cambridge 39, Mass.  
MARY SEARS, Woods Hole Oceanographic Institution, Woods Hole, Mass.  
ATHELSTAN F. SPILHAUS, Institute of Technology, University of Minnesota, Minneapolis 14, Minn.  
LYMAN SPITZER, JR., Princeton University Observatory, 14 Prospect Avenue, Princeton, N. J.  
HARLOW SHAPLEY, Harvard College Observatory, Cambridge, Mass.  
HENRY L. SHATTUCK, 10 Milk Street, Boston, Mass.  
EDWARD H. SMITH, Woods Hole Oceanographic Institution, Woods Hole, Mass.  
RAYMOND STEVENS, Arthur D. Little Inc., 30 Memorial Drive, Cambridge, Mass.  
GERARD SWOPE, JR., International General Electric Co., 570 Lexington Avenue, New York, N. Y.  
SELMAN A. WAKSMAN, New Jersey Agricultural Experiment Station, New Brunswick, N. J.  
FRANCIS C. WELCH, 73 Tremont Street, Boston, Mass.  
E. BRIGHT WILSON, JR., Harvard University, Cambridge, Mass.  
WILLIAM D. WINTER, Atlantic Mutual Insurance Co., 49 Wall Street, New York, N. Y.

### III. RESEARCH STAFF (As of December 31, 1952)

#### *Director*

EDWARD H. SMITH

#### *Senior Scientists*

COLUMBUS O'D. ISELIN, Associate Professor of Physical Oceanography, Harvard University and Research Oceanographer, Museum of Comparative Zoology; Senior Oceanographer.

ALFRED C. REDFIELD, Professor of Physiology, Harvard University; Senior Biologist.

#### *Scientists*

ARNOLD B. ARONS, Professor of Physics, Amherst College; Associate in Physical Oceanography.

JOHN C. AYERS, Associate Professor of Oceanography, Department of Conservation, Cornell University; Associate in Marine Biology.

DAVID L. BELDING, Professor of Bacteriology and Experimental Pathology (Emeritus), Boston University; Consultant, U. S. Fish and Wildlife Service; Associate in Marine Biology.

HENRY B. BIGELOW, Professor of Zoology (Emeritus), Harvard University; Associate in Oceanography.

DEAN F. BUMPUS, Oceanographer.

ANDREW F. BUNKER, Meteorologist.

WILLIAM S. BUTCHER, Geologist.

CORNELIA L. CAREY, Associate Professor of Botany (Emeritus), Barnard College; Associate in Marine Bacteriology.

GEORGE L. CLARKE, Associate Professor of Zoology, Harvard University; Marine Biologist. WILLARD DOW, Electronic Engineer.

WILLIAM MAURICE EWING, Professor of Geology, Columbia University; Director, Lamont Geological Observatory; Associate in Geophysics.

CHARLES J. FISH, Professor of Marine Biology, University of Rhode Island and Director, Narragansett Marine Laboratory; Associate in Marine Biology.

FREDERICK C. FUGLISTER, Physical Oceanographer.

BERNHARD HAURWITZ, Professor of Meteorology and Chairman of the Department of Meteorology, New York University; Associate in Meteorology.

JOHN B. HERSEY, Physical Oceanographer.

LOUIS W. HUTCHINS, Director, Bermuda Biological Station for Research, Inc.; Marine Biologist.

BOSTWICK H. KETCHUM, Marine Microbiologist.

JOANNE S. MALKUS, Meteorologist.

WILLEM V. R. MALKUS, Physical Oceanographer.

RAYMOND B. MONTGOMERY, Visiting Professor of Oceanography, Brown University; Physical Oceanographer.

HILARY B. MOORE, Associate Professor of Marine Biology, and Assistant Director, Marine Laboratory, University of Miami; Associate in Marine Biology.

DANIEL R. NORTON, Research Chemist, U. S. Geological Survey, Washington, D. C.; Associate in Chemical Oceanography.

ROY L. RATHER, JR., Associate in Underwater Acoustics.

FRANCIS A. RICHARDS, Chemical Oceanographer.

WILLIAM D. RICHARDSON, Physical Chemist.  
GORDON A. RILEY, Assistant Director, Bingham Oceanographic Foundation, Yale University; Marine Physiologist.  
HELEN M. ROBERTS, Assistant Professor of Mathematics, University of Connecticut; Associate in Mathematics.  
CARL-G. ROSSBY, Professor of Meteorology, University of Stockholm; Visiting Professor, University of Chicago; Associate in Meteorology.  
PER F. SCHOLANDER, Physiologist.  
WILLIAM C. SCHROEDER, Associate Curator of Fishes, Museum of Comparative Zoology, Harvard University; Ichthyologist.  
MARY SEARS, Planktonologist.  
PAUL F. SMITH, Assistant Professor of Oceanography, University of Miami; Associate in Oceanography.  
FLOYD M. SOULE, Principal Senior Oceanographer, U. S. Coast Guard; Associate in Physical Oceanography.  
HENRY C. STETSON, Research Oceanographer and Alexander Agassiz Fellow in Oceanography, Museum of Comparative Zoology, Harvard University; Submarine Geologist.  
HENRY M. STOMMEL, Physical Oceanographer.  
PARKER D. TRASK, Research Engineer, Institute of Engineering Research, University of California; Associate in Submarine Geology.  
HARRY J. TURNER, Marine Biologist.  
ALLYN C. VINE, Physical Oceanographer.  
WILLIAM S. VON ARX, Physical Oceanographer.  
EDMOND E. WATSON, Professor of Physics, Queen's University, Kingston, Ontario; Associate in Physical Oceanography.  
ALFRED H. WOODCOCK, Oceanographer.  
GEORGE P. WOOLLARD, Professor of Geophysics and Engineering Geology, University of Wisconsin; Associate in Geophysics.

*(Research Staff, continued on page 8)*

*Research Associates*

RICHARD H. BACKUS, Research Associate in Marine Biology.  
DUNCAN C. BLANCHARD, Research Associate in Meteorology.  
ROBERT H. BROCKHURST, Research Associate in Physics.  
ELIZABETH T. BUNCE, Research Associate in Physics.  
JOSEPH CHASE, Research Associate in Physical Oceanography.  
FRANK T. DIETZ, Research Associate in Underwater Acoustics.  
HARLOW G. FARMER, JR., Research Associate in Hydraulics.  
DAVID H. FRANTZ, JR., Research Associate in Engineering.  
JOHN F. HOLMES, Research Associate in Engineering.  
HENRY R. JOHNSON, Research Associate in Underwater Acoustics.  
CHARLES H. KEITH, Research Associate in Chemistry.  
SYDNEY T. KNOTT, JR., Research Associate in Underwater Acoustics.  
DONALD P. MARTINEAU, Research Associate in Physical Oceanography.  
FRANK J. MATHER, III, Research Associate in Physical Oceanography.  
KENNETH G. McCASLAND, Research Associate in Meteorology.  
WILLIAM G. METCALF, Research Associate in Physical Oceanography.  
ARTHUR R. MILLER, Research Associate in Physical Oceanography.  
CHARLES B. OFFICER, JR., Research Associate in Geophysics.  
D. JANE ROBERG, Research Associate in Physics.  
JOHN H. RYTHER, Research Associate in Marine Biology.  
HAROLD E. SAWYER, Research Associate in Underwater Acoustics.  
IRVING I. SCHELL, Research Associate in Meteorology.  
WILLIAM E. SCHEVILL, Research Associate in Physical Oceanography.  
KARL E. SCHLEICHER, Research Associate in Physical Oceanography.  
LEVIE VAN DAM, Research Associate in Physiology.  
ARTHUR D. VOORHIS, Research Associate in Underwater Acoustics.  
L. VALENTINE WORTHINGTON, Research Associate in Physical Oceanography.  
RALPH F. WYRICK, Research Associate in Underwater Acoustics.

*Administrative Staff*

EDWARD H. SMITH, Director.  
ALFRED C. REDFIELD, Associate Director  
RONALD A. VEEDER, Assistant to the Director.  
HELEN F. PHILLIPS, Secretary to the Director.  
JOHN MCGILVRAY, Business Manager.  
NORMAN T. ALLEN, Administrator.  
HARVEY MACKILLOP, Controller  
ADRIAN K. LANE, Port Captain.  
DELMAR R. JENKINS, Purchasing Agent.  
OTIS E. HUNT, Laboratory Services.  
JAN HAHN, Public Information.

#### IV. DIRECTOR'S REPORT

##### *Introduction*

DURING the year 1952 the Institution operated pretty close to peace time capacity on many interesting projects, the results of which should add measurably to the accumulation of oceanographic knowledge. More research could have been undertaken with little or no recruitment of additional administrative personnel, but the physical working space of the laboratory, and the operational capabilities of the floating units, were strained about to their limits.

If one were to ask what was the outstanding scientific contribution, or discovery emanating from the research staff of the Institution during the year 1952, it would be difficult, and unfair, to select one over another from amongst a half dozen or more noteworthy achievements.

The year will undoubtedly record from among the list of firsts, the following:

- (a) Trawling far out on the continental slope where some species of fish new to science were caught; and the attending physiological studies carried out on the blood chemistry of deep-living fish.
- (b) Field studies of the Northern Equatorial Current, and the improved exposition of these waters by their chemical and biological indices.
- (c) Operation of an airplane in oceanographic-meteorological work, and the development of techniques and special recording instruments.
- (d) A new conception of the Gulf Stream's flow-pattern as derived from laboratory models and field observations.
- (e) Expedition Ski-Jump II to the North Polar Sea and the basic question of circulation which the data raise.
- (f) The correlation of the number and size of sea-salt particles in clear air beneath clouds, with the number of cloud droplets within the clouds, and with the number and salt content of rain drops falling from these clouds.
- (g) A theory was developed that relates the electric potentials in and about an ocean current in simple fashion to the total fluid transport.

The research program of 1952 in both military and basic oceanography received major support from the U. S. Navy Department's Bureau of Ships, Office of Naval Research, and Bureau of Aeronautics. The State of Massachusetts contributed materially to the shell-fishery investigations. To these several sources due acknowledgment is made.

A noteworthy innovation marked the first visit of the Institution's



Scientific Advisory Committee, when during March it spent three days looking over the laboratory organization; the research program; and interviewing members of the staff.

The activities of the year, and other items of note, are to be found under the headings: Scientific Program, Personnel, Vessels, and Plant. First let us examine the report of scientific accomplishment of which Drs. Iselin and Redfield have prepared a very interesting joint account.

### *Scientific Program*

During 1952 the major effort at sea consisted of two long cruises, criss-crossing the trade wind latitudes of the North Atlantic. During the winter months the ATLANTIS and the ALBATROSS III worked together, while during the summer the former cruised in company with the tug KEVIN MORAN which had been chartered by Columbia University. In the course of these two cruises the ATLANTIS sailed approximately 27,000 miles and thereby secured many temperature and salinity observations from the tropical Atlantic which had previously only been crossed by a few individual profiles. It can now be said that so far as the North Atlantic is concerned the reconnaissance phase has been concluded. Few sizable areas remain that are devoid of temperature and salinity observations.

To summarize all available temperature data, Mr. Fuglister has begun work on a chart of the average temperature at 200 meters. Such a chart was published in 1936 in the Atlas Volume of the METEOR reports. There were then roughly 3000 stations available. It will be interesting to see whether any important differences appear on the new chart which will combine more than 60,000 individual observations.

While these two cruises were exceedingly long for our vessels, and many difficulties and much discomfort had to be overcome, they mark both the end of a long term plan and the beginning of a new one. Having established a reasonably reliable picture of the average current system over the whole North Atlantic basin, we can now turn our main attention to studies of departures from this mean pattern in more limited areas. In short, it is believed that physical oceanography is now ready to take up synoptic problems, and both the development of instruments and the planning of new surveys are being shaped accordingly.

An original objective of the winter cruise was to learn whether or not the current system near the Equator has some of the newly discovered characteristics of the Gulf Stream System. In an area where the currents are gaining energy from the winds are they sometimes narrow and streaky, and do they meander, as is the case farther north? Because of the lack of Loran navigation in the area, the relative weakness of the currents encountered,

their lack of marked thermal structure and the long distances between ports, only marginal success was achieved on these phases of the program. On the other hand, the chemical and biological program, which was at first considered a secondary objective, turned out to be highly productive. The equatorial current originates in the regions of upwelling along the African coast, where the surface waters are greatly enriched with plant nutrients and are the site of intense biological activity. It was possible to trace the movement of this water by means of its biological and chemical characteristics across the Atlantic to within a few hundred miles of the South American coast. Dr. B. H. Ketchum in ATLANTIS and Dr. F. A. Richards in ALBATROSS III deserve great credit for the success of the chemical program. In addition, of course, a large number of temperature observations and soundings were secured from an area where data are old or entirely lacking. The reversing thermometer and the water bottle still seem to be the best approach in areas where we have only a vague understanding of the pattern of the relatively swift and shallow currents.

After the winter work in the trade wind latitudes, the vessels were turned over to Dr. W. M. Ewing in mid-April at Trinidad for the homeward voyage. The plan was to explore the deep geology of the Caribbean and the Gulf of Mexico. However, because of breakdowns and delays, most of his productive observational program lay between Cuba and Bermuda.

As already stated, during the summer the ATLANTIS assisted in a geophysical and geological survey of the trade wind area in cooperation with Dr. W. M. Ewing's group from the Lamont Geological Observatory. At the same time we supplied a team of hydrographic observers who secured temperature and salinity data as opportunity offered. As a result, for the first time we now have a reasonably complete picture of these factors from the summer season in the tropical Atlantic. Previously the distances to be sailed in outflanking the hurricanes had not seemed worth the effort.

In September the ATLANTIS parted company with the KEVIN MORAN and headed south for Rio de Janeiro. This was her first major excursion into the South Atlantic. The return voyage, which lasted until the middle of December with Mr. F. C. Fuglister in charge, was devoted to a study of the currents along the western margin of the Atlantic from the latitude of Rio to that of the Bahamas. While in South Atlantic waters the observational program indeed posed many more problems than were advanced.

The theoretical studies of Mr. H. M. Stommel and Dr. W. H. Munk have led us to expect that along the western shores of each ocean narrow, swift currents, comparable to the Gulf Stream, are to be expected. The fact, however, that the METEOR survey of the South Atlantic failed to put the Brazil Current in the class with the Japan Current, or the Gulf Stream,

could be excused on the grounds that the METEOR stations were too widely spaced to depict a narrow and perhaps widely meandering current along the coast of Brazil. After all, what would we know about the Gulf Stream if we only had a dozen deep temperature stations between the whole of the U. S. coast and Bermuda? Thus on leaving Rio in October the ATLANTIS headed south-eastward, confidently expecting to encounter a marked temperature change that could be identified as the inshore edge of the Brazil Current. It is possible that this section was abandoned too soon, but also on subsequent sections further north nothing comparable to the Gulf Stream was encountered in South Atlantic waters.

Northwestward of the bulge of Brazil the sections were planned to show up another phenomenon predicted by theory. As the Guiana Current crosses the Equator the main thermocline layer should roll over as the direction of the effect of the earth's rotation changes from left to right. This too did not materialize in any obvious or simple manner.

It is probable that the observational program attempted from the ATLANTIS on her return voyage from Rio was entirely too ambitious, but it is also possible that in the North Atlantic we have been studying rather special circumstances of oceanic circulation. In any case, the hope has received a setback that if we knew the surface currents in one ocean rather thoroughly, we could predict the sub-surface thermal patterns in the other oceans.

The net result of the 1952 cruises in equatorial waters, therefore, is that our new observational techniques, which have been so successful from Cape Hatteras northeastward, cannot be immediately applied to other areas. In all probability in enlarging our field of study we must be patient enough to first go through a slow, painful exploratory phase.

Although we have neglected the Gulf Stream during the past year in our field program, there has been much thought and discussion about it in the laboratory. Based largely on the ALBATROSS III observations of the summer of 1951, Mr. F. C. Fuglister has come forward with a new hypothesis as to the best interpretation of the accumulated data. This was published in *Tellus*. His basic idea is that narrow, overlapping streaks of flow, separated by countercurrents, are more common than eddies along the inshore edge of the primary Gulf Stream.

The Gulf Stream studies were reviewed in May at a symposium in Washington, D. C., sponsored by the American Geophysical Union. This was well attended and our ideas were well received. Nine papers were presented. Perhaps the most provocative result of this symposium was that Dr. William L. Ford of Canada pointed out that in our recent Gulf Stream studies we have been neglecting to take into account the small amount of

very fresh and cold water that is sometimes encountered at about 100 meters depth at the inshore edge of the current. This imposes a serious difficulty to Mr. Fuglister's hypothesis, unless it is found that this is easterly moving coastal water that has become entrained in the Gulf Stream in the Cape Hatteras area.

Mr. W. S. von Arx's efforts to reproduce the Gulf Stream System in his rotating basin are meeting with increased success, especially following a visit of Dr. C.-G. Rossby in February. He has completed a manuscript of a preliminary paper describing the results of these model studies.

Strangely enough, the deep temperature and salinity observations made during the last two winters by Messrs. Holmes, Metcalf, and Worthington in the Arctic Ocean are likely to play a considerable part in our thinking about North Atlantic circulation during the next few years. Their stations indicate that quite deep currents exist under the ice, having a transport as great as one-twentieth of the Gulf Stream. These currents clearly must derive their energy from differences in density, rather than from the winds. Thus, just as most investigators had come to the conclusion that the winds are all important, the whole basic question has been opened up again of how much of the energy of the North Atlantic current system comes from the winds and how much from regional density differences maintained by the climate.

During the summer, three new approaches to Gulf Stream problems were attempted. A brief visit of Mr. M. S. Longuet-Higgins of Cambridge University in 1951 stimulated Dr. W. V. R. Malkus and Mr. M. E. Stern to make a new theoretical attack on the character of the induced electrical fields associated with the Gulf Stream's flow. This led to the conclusion that the electrical potential across the Florida Straits would vary with the total transport. In July Mr. G. Wertheim installed electrodes at the terminals of the telephone cables across the Florida Straits, and permission has been granted for daily use of several of the telephone circuits for these measurements. Mr. Paul Smith, who has joined the staff of the Marine Laboratory of the University of Miami, will take over these measurements once the value of this approach has been demonstrated. Here, we hope is an independent method of evaluating the tide gauge observations as a means of measuring long period fluctuations in the flow through the Florida Straits. Thus, we may be able to prove out the value of old data, as well as to introduce a potentially more sensitive new method.

Late in July, using the CARYN and the BEAR, Dr. E. E. Watson and Dr. W. V. R. Malkus compared two different methods of observing the change of velocity with depth across the Gulf Stream. Both methods require a slow but steady motion of the vessel relative to the deep motionless water. Dr.

Watson used a propeller type current meter, while Dr. Malkus towed his new bathypitometer. It is lack of direct observation on the typical velocity profile of the Gulf Stream that makes it difficult to interpret the great mass of G. E. K. records that have been collected in recent years. Mr. W. S. von Arx has completed a paper summarizing this particular problem, which for the time being is making it most difficult to assign reliable values to the towed electrode results.

Finally, a beginning has been made in observing the Gulf Stream from the air. This new approach to Gulf Stream problems grew out of studies of infra-red radiation coming from the sea surface which Mr. H. Stommel has been making. Having become familiar with infra-red detecting devices and some of their limitations, he, and Mr. D. Parson, Jr. saw the possibility of building a radiation detector that would at least roughly indicate sea surface temperature from a low flying plane. Mr. Parson's brilliant adaptation of a standard Golay infra-red detector has resulted in a simple and remarkably versatile device which when flown at an altitude of about 1000 feet is usually able to give the sea surface temperature to within 2°F. Several flights along the inshore edge of the Gulf Stream south of New England have produced most promising results. Once an adequate navigational procedure has evolved it is evident that the changes in the large scale meander patterns can be surveyed on a week to week basis.

Dr. W. S. Richardson, who joined our staff in the Fall, hopes to improve the instrumentation and to take up a general study of the physical chemistry of the sea surface.

The arrival of a PBY airplane in April, on loan from the Navy, not only has permitted wide-spread surveys of sea surface conditions with the new infra-red device, but also made it possible for our group working in marine meteorology to take their observational techniques well out from the land. During June, Mr. A. F. Bunker, Dr. J. S. Malkus, Mr. K. G. McCasland and Mr. C. F. Ronne carried out a highly successful study of trade wind clouds off Puerto Rico. In November a successful flight observed the changes in a cold dry air mass as it moved out across the Atlantic seaboard to Bermuda. The long, patient instrumental development which Mr. McCasland has been mainly responsible for, paid off in a spectacular manner. Not one of the many flights was wasted through instrumental failure.

Mr. A. H. Woodcock and Mr. D. C. Blanchard also have accomplished a great deal of flying in the Hawaiian Islands area in connection with sea-salt nuclei studies. Their observations, in cooperation with meteorologists working for the agricultural laboratories at Hawaii, were completed in July, when Mr. Woodcock went on to Australia to make a series of measurements

there on the effects of the marine environment on rainfall. He returned to Woods Hole in September with material for three important papers.

The emphasis in underwater acoustics during the year was largely on improvements in instrumentation, and on the study and interpretation of accumulated data. However, during the summer, Dr. J. B. Hersey set up an ambitious, new field program, using the CARYN and the BEAR on weekly trips out of Woods Hole. This work continues at year end.

Dr. C. B. Officer, Jr., who joined our group after completing his studies at Columbia, specialized on long range transmission phenomena.

An expedition to Bermuda in the CARYN early in the spring, supplementing a previous one to the San Diego area, added greatly to our knowledge of the acoustical characteristics of whales, both as acoustical targets and as noise makers. Mr. W. E. Schevill is particularly interested in these phenomena.

Beginning in the autumn, Dr. R. H. Backus, a marine biologist, who completed his formal training at Cornell, joined Dr. Hersey's group to devote himself to the echo characteristics of schools of fish, and this at long last appears to be a favorable opportunity to tie together fisheries biology and modern underwater acoustics.

Exploratory fishing was pushed ahead vigorously during the summer. The charter of a local dragger for three one-week cruises enabled Mr. W. C. Schroeder to explore the deep water along the edge of the continental shelf between New York and Nova Scotia. This is a region beyond the depth of commercial fishing. In an area on the Nova Scotian slope an abundant catch of red fish was obtained, the report of which has been given freely to commercial fishing interests. It was also found that lobsters are sufficiently numerous beyond the 80-fathom contour to indicate that a profitable fishery might be developed. At slightly greater depths, numbers of large crabs may also be taken. The collections of fish have included several specimens apparently new to science and will add greatly to our knowledge of the distribution of many known species. In particular these catches have shown that several of a northern origin range southward into this region.

Dr. P. F. Scholander and Dr. L. Van Dam have both done distinguished work on the physiology of marine animals. They are studying the physiological mechanism by which fish secrete gas into the swim bladder in order to maintain their buoyancy at depth. By taking advantage of the deep water fishing expeditions of Mr. W. C. Schroeder, they have been able to extend the depth range at which such studies have been made one hundred fold. The result has been to find that the inert gas nitrogen, in addition to oxygen, is apparently secreted into the swim bladder against great pressure. This is a completely novel finding. Studies of the blood chemistry

of the deep living fish have not shown any unique property which would explain the phenomenon of gas secretion.

Dr. D. R. Norton, who had previously spent two summers at the Institution on Fellowships, has recently become associated with the U. S. Geological Survey where he is charged with developing work in oceanographic chemistry. He comes to our staff on a part time appointment which will permit him to work at Woods Hole during the summer. This arrangement promises to be of great mutual value to the Institution and to the Survey.

The study of shellfish problems, made under contract with the Commonwealth of Massachusetts, is continuing. The original objective was to find practical methods of clam farming. It has now become apparent that clams cannot be grown profitably on open sand flats because of the depredation of predators. This conclusion is confirmed by simultaneous studies by the Fish and Wildlife Service. While this attempt has been abandoned we have learned much about the biology of the conchs and horseshoe crabs, which are the principal predators. Mr. H. J. Turner and Dr. D. L. Belding for a time investigated the possibility of growing clams in artificial ponds where predation and other conditions can be better controlled, by constructing such a pond in a marsh at Cotuit, but the local problems of control proved extremely difficult. During the latter part of the year attention was turned to an extensive study of the clam flats in Boston Harbor. This is the one great area in Massachusetts where clams are still plentiful. Because of pollution clam digging is carefully controlled by the State and there is an extensive record going back over many years which should enable much to be learned about the effect of digging on the maintenance of the clam crop. At the end of the year this study is continuing.

Our present active interest in estuaries was originally stimulated by the necessity of knowing more about the conditions under which shellfish live. The first estuary studies was Barnstable Harbor, where our shellfish studies started. Dr. J. C. Ayers, during the year, completed a report on the hydrography of this harbor

The study of Great South Bay, and Moriches Bay, Long Island, initiated in 1951 for the towns of Islip and Brookhaven, has now been brought to completion. This investigation has provided a hydrographic description of these coastal bays which are typical of the Atlantic coast, and has included the effects of opening and closing of the inlets which frequently occurs in such situations. These particular bays were of interest because conditions developing over many years had rendered them unfit for the growth of oysters. It has become apparent that these bays are now seriously polluted by the great numbers of duck farms which have been installed along their

tributary streams and that this pollution has favored the growth of a peculiar and excessive flora of planktonic algae in the bay water. This situation has provided Dr. F. A. Richards with an unusual opportunity to study the transformations which organic pollutants undergo in natural water bodies.

Dr. J. H. Ryther has also made good use of the situation in the Long Island bays to study the conditions which give rise to the peculiar plankton flora which develops each summer. By comparing the growth of these algae with that of the species more usually found in such bays under controlled conditions of temperature, salinity, nutrient balance, he has found that the phytoplankton which are now found in these bays respond optimally to the conditions now prevalent and thus are able to outgrow the more normal flora. Dr. J. H. Ryther's studies have been supported by a grant from the National Science Foundation.

Oceanographic and geological surveys of the Massachusetts Bay area are continuing under the direction of Mr. D. F. Bumpus and Dr. W. S. Butcher. The field work will be completed by spring and will add much to our knowledge of inshore and estuarine phenomena. Mr. H. Stommel and Mr. H. G. Farmer, Jr., have been writing a major book, "On the Nature of Estuarine Circulation". Their approach is experimental and theoretical, but the two studies complement each other.

The study of estuaries, initiated by the biologists and which appeared to have deflected them in to physical oceanography, has now completed its cycle. Dr. B. H. Ketchum has examined theoretically how to combine the equations for the water exchange in estuaries with the growth and death curves for the floating populations of animals and plants. He has been able to analyze the relative importance of dilution, predation, and natural death on the distribution of coliform bacteria arising from pollution in the Raritan River, and has found that the antibiotic action of sea water is the dominating factor. This work was done under a grant from the U. S. Public Health Service. Mr. John P. Barlow, a visiting investigator in the laboratory, has followed this lead in studying the endemic population of zooplankton in a near-by salt pond. He has shown that the characteristic pond species can maintain themselves only in those parts of the pond where their growth is great enough to over-balance the water movements tending to carry them out to sea. These are brilliant applications of hydrography to biological studies.

As an outgrowth of studies on inshore oceanography such as the Institution has made in the offing of New York, in Raritan Bay and in Great South Bay we are called on increasingly by responsible governmental agencies and civilian organizations for advice on practical aspects of the control of conditions in tidal waters. One of the important areas in this connection is



Delaware Bay where a variety of interests are, at least potentially, in conflict. The bay is the site of a valuable oyster industry. Along the river the community is concerned with the freshness of the water used for industrial purposes and with the problem of waste disposal. Upstream the construction of dams for the diversion of Delaware River water to the water supply of New York City has raised the question of the effects of diversion of the river water on conditions in the lower river and bay. It is clearly important that the hydrography of this area be understood as thoroughly as possible.

During the past year Dr. Ketchum has devoted much time to collecting and analyzing the available data on the region. Mr. A. R. Miller has been "loaned" to Rutgers University and has been engaged in field studies in Delaware Bay being conducted by Dr. H. H. Haskins of that institution. These studies have not been confined to the Bay itself, but have extended offshore where they supplement our knowledge of the general coastal circulation.

Dr. P. D. Trask and Mr. H. C. Stetson have both completed long manuscripts on the sediments of the western Gulf of Mexico. Mr. Stetson's studies of the collections from the eastern Gulf are progressing as rapidly as the analyses of the samples permit.

We are continuing to experience trouble in bridging the gap between the development of new instruments and their use for research purposes. We have three competing designs for deep bathythermographs at present under test. One of them is more than three years old. Mr. Klebba's five-year temperature recorder, although completed more than two years ago, has only recently been set out where useful scientific data can be obtained. His 400-day current meter has yet to be used, although there is some hope that the group at Miami will soon use this excellent instrument. In short, the practical sea-going oceanographer tends to stick to tried and proven methods.

Perhaps worthy of mention is a new camera being built by Mr. L. D. Hoadley for studying sand ripples. This will take 8,000 pictures a few seconds apart so that it should be possible to study the relative importance of long period swell, and bottom currents, in the transport of sand on exposed bottoms. There is hope that this device will be in the water before long. Mr. D. M. Owen has much improved his various cameras and technique during the past year, and an impressive catalog of bottom photographs is now growing.

As a part of the shellfish studies, Mr. Owen has helped Mr. Arthur Posgay in an attempt to determine by photographic means the density of sea scallops on the fishing beds. The object is to gain an estimate of the efficiency of the dredges now in use. The result of one successful cruise has

been encouraging, but it is evident from several failures that more intensive effort and close collaboration between photographer and biologist are necessary if results are to be gained from systematic surveys with the camera which justify the cost and effort.

The wave research group at New York University has been considerably strengthened during the past year and we have agreed to supply some of the much needed open ocean wave records so that the wave forecasting procedures can be improved. The greatest need is for a wave recorder that can be used from our PBY plane. Various schemes are under study, but meanwhile Mr. J. R. Bronk has gone ahead with an upside-down echo sounder which gives promise of recording at least moderate seas and swells in a convenient manner from a ship. Several other possible systems for recording the characteristics of waves in deep water are under active study at the close of the year.

In June the National Research Council sponsored a three-day symposium on needs for new and improved oceanographic instruments. Mr. von Arx, Mr. Vine, and Dr. Hersey each presented a paper. Since practically all aspects of the instrumental needs were discussed, the symposium amounted to a short, intensive course in modern oceanography. Mr. Iselin is serving as one of the editors of the resulting publication in which all twelve papers and the significant discussion will appear.

It would require too much space here to summarize our contribution to the success of this symposium or even to list the instruments that are at present being worked on here. There is no lack of ideas for new instruments. The problem is to persuade the designer or builder of the instrument to use it sufficiently so that it becomes part of the research program. Few instruments are fully developed and put into routine use by the original designer. The "debugging" period is usually a very slow process.

A paper has been prepared by Dr. Redfield on the tidal phenomena of the Woods Hole region. Analysis of the tidal records shows that in Vineyard and Nantucket Sounds the tidal ranges, and the times of high water and slack water as they vary from place to place, are to be explained by the mutual interaction of tidal waves which enter the Sounds from their opposite ends. The interference of these waves also explains the diurnal irregularity of the tide at Woods Hole and certain peculiar features of the Woods Hole tide record and of the flow through Woods Hole Passage.

Forty-three scientific papers have been prepared for publication during 1952. These include two major papers for *Papers in Physical Oceanography and Meteorology*. The monograph "Marine Fouling and Its Prevention", prepared at the conclusion of the War, was published in September by the U. S. Naval Institute. The following publications of the Institution during the past year are listed by contribution number, author, and title:

BIGELOW, H. B., and W. C. SCHROEDER. A new species of the cyclostome Genus Paramyxine from the Gulf of Mexico. <i>Breviora</i> , No. 8: 10 pp., 6 text figs. . . . .	Contr. No. 610
BUNKER, A. F. Measurements of the vertical water vapor transport and distribution within unstable atmospheric ground layers and the turbulent mass exchange coefficient. <i>Pap. Phys. Ocean. Meteorol.</i> , 12 (3): 42 pp., 27 text figs. . . . .	618
BUNKER, A. F. 3.13. Recognition of the presence of convective currents within a non-saturated turbulent layer of the atmosphere. In: International Symposium on Atmospheric Turbulence in the Boundary Layer, Massachusetts Institute of Technology, 4-8 June 1951. <i>Geophys. Res. Pap. Air Force Cambridge Research Center</i> , No. 19: 309-322 . . . . .	572
COLLINS, G. B. Factors influencing the orientation of migrating anadromous fishes. <i>Fish. Bull.</i> 73, <i>Fish. Bull.</i> , <i>Fish and Wildlife Service</i> , 52: 375-396, 7 text figs. . . . .	585
ERICSON, D. B., M. EWING, and B. C. HEEZEN. Turbidity currents and sediments in the North Atlantic. <i>Bull. Amer. Assoc. Petr. Geol.</i> , 36 (3): 489-511, 4 text figs. . . . .	604
FORD, W. L., and A. R. MILLER. The surface layer of the Gulf Stream and adjacent waters. <i>J. Mar. Res.</i> , 11 (3): 267-280, 7 text figs. . . . .	619
HERSEY, J. B., H. R. JOHNSON, and L. C. DAVIS. Recent findings about the deep scattering layer. <i>J. Mar. Res.</i> , 11 (1): 1-10, 3 text figs. . . . .	562
HERSEY, J. B., C. B. OFFICER, H. R. JOHNSON, and S. BERGSTROM. Seismic refraction observations north of the Brownson Deep. <i>Bull. Seismol. Soc., Amer.</i> , 42 (4): 291-306, 14 text figs. . . . .	583
ISELIN, C. O'D. The Gulf Stream system. <i>Proc. Amer. Phil. Soc.</i> , 96 (6): 660-662	612
KETCHUM, B. H., J. C. AYERS, and R. F. VACCARO. Processes contributing to the decrease of coliform bacteria in a tidal estuary. <i>Ecology</i> , 33 (2): 247-258, 4 text figs. . . . .	561
KETCHUM, B. H., and W. L. FORD. Rate of dispersion in the wake of a barge at sea. <i>Trans. Amer. Geophys. Union</i> , 33 (5): 680-684, 3 text figs. . . . .	567
KIERSTEAD, H. A. Bottom pressure fluctuations due to standing waves in a deep, two-layer ocean. <i>Trans. Amer. Geophys. Union</i> , 33 (3): 390-396, 1 text fig. . . . .	582
LAIDLAW, F. B. The history of the prevention of fouling. <i>Proc. U. S. Naval Inst.</i> , 78 (7): 769-779 . . . . .	613
MACHLUP, S. Theoretical model for sound scattering by marine crustaceans. <i>J. Acoust. Soc., Amer.</i> , 24 (3): 290-293 . . . . .	569
MALKUS, J. S. Recent advances in the study of convective clouds and their interaction with the environment. <i>Tellus</i> , 4 (2): 71-87 . . . . .	595
MALKUS, J. S. The slopes of cumulus clouds in relation to external wind shear. <i>Quart. J. Roy. Meteorol. Soc.</i> , London, 78 (338): 530-542, 9 text figs., Pls. 3-4	609
MALKUS, J. S., and A. F. BUNKER. Observational studies of the air flow over Nantucket Island during the summer of 1950. <i>Pap. Phys. Ocean. Meteorol.</i> , 12 (2): 50 pp., 47 text figs. . . . .	617
MALKUS, W. V. R., and M. E. STERN. Determination of ocean transports and velocities by electromagnetic effects. <i>J. Mar. Res.</i> , 11 (2): 97-105, 2 text figs.	608
MATHER, F. J., III. Three species of fishes, Genus <i>Seriola</i> , in the waters of Cape Cod and vicinity. <i>Copeia</i> , 1952 (3): 209-210 . . . . .	599

MATHER, F. J., III. Sport fishes of the vicinity of the Gulf of Honduras, certain Caribbean islands and Carmen, Mexico. <i>Proc. Gulf and Caribbean Fish. Inst.</i> , 4th Ann. Session: 118-129 . . . . .	Contr. No. 611
MATHER, F. J., III, and H. A. SCHUCK. Additional notes on the distribution of the blackfin tuna ( <i>Parathunnus atlanticus</i> ). <i>Copeia</i> , 1952 (4): 267 . . . . .	606
MONTGOMERY, R. B. 2.2. The present position of exchange across the ocean-atmosphere interface. In: International Symposium on Atmospheric Turbulence in the Boundary Layer, Massachusetts Institute of Technology, 4-8 June 1951. <i>Geophys. Res. Pap., Air Force Cambridge Research Center</i> , No. 19: 131-139 . . . . .	576
MOORE, H. B. Physical factors affecting the distribution of Euphausiids in the North Atlantic. <i>Bull. Mar. Sci., Gulf and Caribbean</i> , 1 (4): 278-305, 24 text figs. . . . .	581
PARKER, F. L. Foraminifera species off Portsmouth, New Hampshire. <i>Bull. Mus. Comp. Zool.</i> , 106 (9): 391-423, 6 pls. . . . .	589
PARKER, F. L. Foraminifera distribution in the Long Island Sound-Buzzards Bay area. <i>Bull. Mus. Comp. Zool.</i> , 106 (10): 427-473, 5 pls., 6 tables, 2 text figs. . . . .	590
PARSONS, DONALD, and A. F. BUNKER. 4.4. A recording computer for the direct measurement of the turbulent heat exchange in the atmosphere. In: Symposium on Atmospheric Turbulence in the Boundary Layer, Massachusetts Institute of Technology, 4-8 June 1951. <i>Geophys. Res. Pap., Air Force Research Center</i> No. 19: 369-379 . . . . .	558
PHLEGER, F. B. Foraminifera ecology off Portsmouth, New Hampshire. <i>Bull. Mus. Comp. Zool.</i> , 106 (8): 315-390, 25 text figs., tables . . . . .	591
REDFIELD, A. C. The flushing of harbors and other hydrodynamic problems in coastal waters. In: Hydrodynamics in Modern Technology, Massachusetts Institute of Technology, 1951: 127-135, 7 text figs. . . . .	627
RILEY, G. A. Hydrography of the Long Island and Block Island Sounds. <i>Bull. Bingham Ocean. Coll.</i> , 13 (3): 5-39, 11 text figs. . . . .	578
RILEY, G. A. Phytoplankton of Block Island Sound, 1949. <i>Bull. Bingham Ocean. Coll.</i> , 13 (3): 40-64, 6 text figs. . . . .	579
SCHELL, I. I. Stability and mutual compensation of relationships with the iceberg severity of Newfoundland. <i>Trans. Amer. Geophys. Union</i> , 33 (1): 27-31 . . . . .	574
SCHELL, I. I. The problem of the iceberg population in Baffin Bay and Davis Strait and advance estimate of the berg count off Newfoundland. <i>J. Glaciol.</i> 2 (11): 58-59 . . . . .	594
SCHELL, I. I. On the role of ice off Iceland in the decadal air temperatures of Iceland and other areas. <i>J. du Cons.</i> , 18: 11-36, 1 text fig. . . . .	603
SCHEVILL, W. E. On the nomenclature of the Pacific gray whale. <i>Breviora</i> , No. 7: 3 pp. . . . .	626
SEARS, M. Notes on siphonophores. 3. <i>Nectopyramis spinosa</i> , n. sp. <i>Breviora</i> , No. 3: 4 pp., 1 text fig. . . . .	607
STOMMEL, HENRY. 2.4. Streaks of natural water surfaces. In: Symposium on Atmospheric Turbulence in the Boundary Layer, Massachusetts Institute of Technology, 4-8 June 1951. <i>Geophys. Res. Pap., Air Force Cambridge Research Center</i> , No. 19: 145-154 . . . . .	537
STOMMEL, H., and H. G. FARMER. Abrupt change in width in two-layer open channel flow. <i>J. Mar. Res.</i> 11 (2): 205-214, 3 text figs. . . . .	616

TURNER, H. J., JR. Fourth report on investigations of the shellfisheries of Massachusetts. Comm. Mass., Dept. Conserv., Div. Mar. Fish., 21 pp., 2 text figs.	Contr. No. 615
VON ARX, W. S. Notes on the surface velocity profile and horizontal shear across the width of the Gulf Stream. <i>Tellus</i> , 4 (3): 211-214, 3 text figs.	621
VON ARX, W. S. A laboratory study of the wind-driven ocean circulation. <i>Tellus</i> , 4 (4): 311-318, 4 text figs.	622
WOODCOCK, A. H. Atmospheric salt particles and raindrops. <i>J. Meteorol.</i> 9 (3): 200-212, 16 text figs.	563
WOODS HOLE OCEANOGRAPHIC INSTITUTION. Marine fouling and its prevention. U. S. Naval Inst., Annapolis: 388 pp.	580
WYMAN, J., JR., P. F. SCHOLANDER, G. A. EDWARDS and L. IRVING. On the stability of gas bubbles in sea water. <i>J. Mar. Res.</i> , 11 (1): 47-62, 5 text figs.	600

### *Vessels*

Shortly after New Year's Day, ATLANTIS and ALBATROSS III (a U. S. Fish and Wildlife Service craft) departed from Woods Hole on a cruise to the lower latitudes of the North Atlantic from which they did not return until late May. During the voyage the ATLANTIS suffered two serious accidents, one the loss of the mizzen mast and sail off the mouth of the Amazon, and then a few weeks later, the breaking of the propeller shaft. The second accident fortunately occurred not far at sea from the Guantanamo Naval Base where repairs were promptly effected.

After a six-weeks' overhaul and the fitting of a new spar, the ATLANTIS sailed again the middle of July on another long sea voyage, this one as far south as Rio de Janeiro. She returned from this cruise (No. 180) shortly before the end of the year.

CARYN, except for one voyage to Bermuda in May, sailed on short cruises out of Woods Hole throughout the year.

BEAR, a 100-foot diesel craft, which was chartered for the summer, operated also from the home port, often in company with CARYN. In September they carried out a joint hydrographic reconnaissance of the waters southeast of New England, the offshore stations being located in the northern edge of the Gulf Stream. In November the BEAR was purchased by the Institution under arrangements with the Navy to underwrite the costs over a period of two years.

ALBATROSS III, a diesel trawler, which it will be recalled, was turned over to the Institution's operation by the Fish and Wildlife Service in 1951, was taken back by that Service in June.

Added to our fleet in April was a Navy PBY6A airplane, loaned to the Institution to carry out certain scientific operations at sea. This marks what is believed the first long period assignment of an aircraft to make oceanographic observations. Its first trip was to Puerto Rico where it

carried out observations in Trade Winds belt. In November, and again in December, meteorological flights to Bermuda were made.

No changes took place in the smaller boats of the Institution, — *ASTERIAS*, *MYTILUS*, and *CLAIRE*. *MYTILUS*, which has had its engine removed, remained throughout the year in wet storage.

An addition to the small-craft pool occurred in October when Mr. Samuel A. Peck, a member of the Woods Hole Oceanographic Associates, presented the Institution with a 45-foot twin, gas screw sport-fishing cruiser called *ALLURE*. The gift was accepted with the understanding that if the boat did not prove to be practicable for the Institution to operate, then it would be disposed of as deemed to the best interests of the Institution.

In an effort to relieve the need for additional research vessels for summer work, and to further increase the operational efficiency of the fleet an inspection was made of the motor ship *HAMPTON ROADS* at Norfolk, Virginia, in the Spring of 1952. It was found, however, that after hauling out on the marine railway, the condition of the under parts of the hull did not warrant the expense of repair, and therefore this acquisition was reluctantly abandoned.

Some hopes of new oceanographic construction, nevertheless, were provided by the Geophysics and Geography Committee of the Research and Development Board which met at Woods Hole in June and passed a resolution calling attention to the need for modern designed vessels for oceanography. They requested that a study be made of the problem, and recommendations submitted, which might lead to the desired construction. Later in the year the Institution accepted a contract with the Office of Naval Research to make a report on pre-design studies of superior oceanographic ships for oceanographic research. This engineering study which was sub-contracted to the Marine and Fisheries Engineering and Research Institute Inc., continued at the year's end.

### *Plant*

The largest expenditure of funds for plant improvement during the year pertained to the renovation of the barn on the former Fay property at Woods Hole, whereby this building was converted to a summer-time dormitory. The ground floor contains three apartments, and the second floor eight large rooms for bachelor quarters. Included in the improvements are a basement and attic storage space, and the hard surfacing of the roads leading to the property. We have now provided for living accommodations for students and others who work at the Institution during the summer, and who have limited financial means to pay higher rentals.

Challenger House, which provides rooms the year round for women

working at the Institution, served cafeteria style meals to Institution personnel. Due to the small number of persons patronizing the cafeteria during the winter, however, this service was suspended.

Previous record has been made in last year's annual report of the Navy's desire to erect a new laboratory building on a proposed site adjacent to our main building at the waterfront, Woods Hole. Negotiations between the Navy and the Marine Biological Laboratory (the owner of the site) proceeded slowly during the year. The Navy announced in November, however, that it was taking the land for the site of the new laboratory which the Institution will be asked to operate. In the meantime space continues to be extremely crowded in our buildings and on the restricted water front property, all of which handicaps the efficient performance of work, and also adds materially to the danger of fire.

### *Personnel*

The Research Staff, the heart of the Institution, and responsible for the volume and quality of the productive research, numbered 189. A roster of all the Institution personnel as of July 1, 1952, is shown below. The list for 1951 is included for comparison.

RESEARCH STAFF*	1951	1952
Full time:		
At Woods Hole . . . . .	70	96
Off campus . . . . .	12	6
Part time:		
At Woods Hole . . . . .	40	45
Off campus . . . . .	16	21
Fellowship holders . . . . .	14	14
Visiting investigators . . . . .	9	7
ADMINISTRATIVE STAFF		
Department Heads and Assistants . . . . .	11	11
Secretaries and Clerks . . . . .	24	22
General Maintenance and Service . . . . .	51	55
Crews of Vessels . . . . .	61	41
. TOTAL . . . . .	308	318

\* Includes 59 Staff Appointees and 130 others

The part time members of the research staff, listed above, refer mostly to those who are affiliated with universities and who spend their summers at Woods Hole, often bringing graduate students to work at the Institution.

It is with pleasure that we record the appointment to the research staff of the following:

RICHARD H. BACKUS . . . .	Research Associate in Marine Biology
ROBERT H. BROCKHURST . . . .	Research Associate in Mathematics
ELIZABETH T. BUNCE . . . .	Research Associate in Physics
JOSEPH CHASE . . . . .	Research Associate in Physical Oceanography
FRANK T. DIETZ . . . . .	Research Associate in Underwater Acoustics
WILLARD DOW . . . . .	Electronic Engineer
DAVID H. FRANTZ, JR. . . . .	Research Associate in Engineering
JOHN F. HOLMES . . . . .	Research Associate in Engineering
SYDNEY T. KNOTT, JR. . . . .	Research Associate in Underwater Acoustics
DONALD P. MARTINEAU . . . .	Research Associate in Physical Oceanography
KENNETH G. McCASLAND . . . .	Research Associate in Meteorology
ARTHUR R. MILLER . . . . .	Research Associate in Physical Oceanography
DANIEL R. NORTON . . . . .	Associate in Chemical Oceanography
D. JANE ROBERG . . . . .	Research Associate in Physics
HELEN M. ROBERTS . . . . .	Associate in Mathematics
KARL E. SCHLEICHER . . . . .	Research Associate in Engineering
PER F. SCHOLANDER . . . . .	Physiologist
PAUL F. SMITH . . . . .	Associate in Oceanography
LEVIE VAN DAM . . . . .	Research Associate in Physiology
ARTHUR D. VOORHIS . . . . .	Research Associate in Underwater Acoustics

Mr. Robert C. Moses, Engineer, it is regretted, resigned from the staff during the year.

Dr. Mary Sears of our staff visited Europe during the Fall and represented the Institution at the 50th Anniversary Meeting of the International Council for the Exploration of the Sea at Copenhagen, and also she attended a meeting of the International Joint Commission of Oceanography at Monaco.

Record is made in this section of the action of the Members of the Corporation, at their annual meeting in August, of the establishment of a class of Honorary Trustees. Two members of the Board (Dr. Henry B. Bigelow and Dr. E. G. Conklin) at their own request, were transferred to honorary trustee status. Also should be noted the election of four new members to the Corporation, viz., Dr. J. S. Coles, Mr. Gerard Swope, Jr., Mr. Francis C. Ryder and Dr. E. B. Wilson, Jr.; the first two also being elected to the Board of Trustees.

It is with deep regret that the death in November of Dr. E. G. Conklin, Professor Emeritus of Princeton University, and an Honorary Trustee of the Institution, is recorded. The facts that he was a Trustee of the Institution since its founding, and has given devoted service to the Institution, marks his passing as a distinct loss.

Dr. Athelstan F. Spilhaus, Chairman of the Scientific Advisory Committee visited the Institution March 14-17, and submitted a report of his committee for subsequent action to the Executive Committee.



Captain Adrian K. Lane, who had been Master of Atlantis for more than six years, came ashore on July 8th and became Port Captain of our fleet.

The following persons were awarded honoraria, grants or fellowships, during the year:

ARRHENIUS, GUSTAF	FRODYMA, MICHAEL M.	NORTON, DANIEL R.
AYERS, JOHN C.	HOLMES, ROBERT W.	PLUNKETT, MARY A.
BARLOW, JOHN P.	HUNTSMAN, A. G.	POSTMA, HENDRIK
BURSA, ADAM	LEAVITT, BENJAMIN B.	RILEY, GORDON A.
BUTLER, PATRICK	LIVESAY, ANN	ROSSBY, CARL-G.
CREITZ, GRACE I.	MILLER, ARTHUR R.	SAID, RUSHDI
EWING, W. MAURICE	MONTGOMERY, RAYMOND B.	VAN DAM, LEVIE
FOFONOFF, NICK	NEUMANN, PAUL G.	WATSON, STANLEY W.
FRANCIS, J. R. D.		

It is desired to acknowledge under this section a grant from the Rockefeller Foundation to be used during a period of three years to support two major appointments in the field of marine biology. This has permitted the appointment of Dr. Per F. Scholander, an experienced and able physiologist. The other appointment is pending the selection of a qualified candidate.

The Institution also received a grant from the National Science Foundation for Research Training in Oceanography. This enabled us to award fellowships to eight investigators. Under this arrangement Mr. Patrick Butler of Harvard University, Miss Grace I. Creitz of Moravian College for Women, Dr. Michael M. Frodyma of George Washington University, Dr. Benjamin B. Leavitt of the University of Florida, Miss Ann Livesay of the University of Kentucky, and Dr. Mary A. Plunkett of Vassar College worked for the summer at Woods Hole, while Dr. John P. Barlow was enabled to visit the Oceanographic Laboratory of the University of Washington at Friday Harbor.

The grant from the National Science Foundation relieved the Institution of the expense of its program of summer fellowships for graduate students and junior instructors from the universities and colleges. This program has been one of the most successful means of recruiting oceanographers and disseminating interest in the science.

During the year opportunity has been taken to bring the Institution and its objectives closer into the minds of the community by inviting groups of local people from time to time to inspect the laboratory and visit the research ships berthed at the water front.

Out of this activity and interest has developed a desire on the part of some of these persons who have a sustaining interest in the sea, to seek a

closer and continuing association with the scientific work of the Institution. This development (earlier approved by the Board of Trustees) has led to the establishment of a non-profit organization patterned after the laws of Massachusetts called the WOODS HOLE OCEANOGRAPHIC ASSOCIATES. Mr. Gerard Swope, Jr. was elected president of the Associates at a meeting held in New York, April 24, 1952, and the first annual meeting was held August 16, 1952. At the close of the year a body consisting of an Executive Committee and a membership of some forty odd had become established. Provision has been made in the by-laws for corporate and institutional membership should such an expansion appear indicated at a later date.

The following visitors were among those who spent a day to a few weeks at the Institution at one time or another during the year:

PROF. JOHAN T. RUUD, University of Oslo, Norway  
DR. A. W. H. NEEDLER, Fisheries Research Board of Canada, St. Andrews, N. B.  
DR. D. CARROLL, London University, England  
DR. A. GRZYWIENSKI, Hydrologisches Inst., Austria  
COMMANDANT JACQUES-YVES COUSTEAU, French Navy  
DR. PIERRE DANIEL, Neyrpic Laboratories, Grenoble, France  
PROF. RAMON IRIBARREN-CAVANILLES, Madrid, Spain  
DR. YVES LEGRANDE, Muséum National d'Histoire Naturelle, Paris, France  
DR. GUSTAF ARRHENIUS, Kaggamra, Sweden  
DR. FRITZ GASSMAN, Zurich, Switzerland  
DR. HENDRIK POSTMA, Zoologisch Station, Den Helder, Holland  
PROF. M. FLORKIN, Univ. Liege, Belgium  
DR. A. B. JOLY, Univ. St. Paulo, Brazil  
PROF. S. P. DONTAS, Greek Hydrobiological Inst., Athens, Greece  
DR. G. E. R. DEACON, National Institute of Oceanography, England  
MR. JOHN FRANCIS, Imperial College, London University  
MR. M. S. LONGUET-HIGGINS, Trinity College, Cambridge Univ., England  
DR. ERIK M. POULSEN, I. C. N. A. F., Denmark  
DR. W. R. MARTIN, Fisheries Research Board of Canada, St. Andrews, N. B.  
MR. IAN S. R. MUNRO, C. S. I. R. O., Cronulla, Australia  
DR. ELIO BORGHESE, Univ. Pavia, Italy  
DR. A. CRAYA, Grenoble, France

The persons whose names are listed below were members of the Institution (additional to those otherwise listed) for a period of six months or more during the calendar year 1952.

#### RESEARCH ASSISTANTS, ENGINEERS AND TECHNICIANS

ATHEARN, WILLIAM D.	GESSNER, ROBERT E.	PASLEY, GALE G., JR.
BARBOUR, L. HILLIARD	HAMMOND, WILLIS T.	PINGREE, FREDERICK DEW.
BERGSTROM, STANLEY W.	HAYES, CARLYLE R.	POOLE, STANLEY E.
BERNACHE, BARBARA A.	HEMPSTEAD, MABEL S.	POSGAY, JULIUS A.
BLACK, WILLIAM A.	HODLEY, LLOYD D.	PURINTON, CHARLES S.
BONINI, WILLIAM E.	HODGSON, SLOAT F.	ROSE, JOHN C.
BRAINERD, SUZANNE	HOLLAND, LAWRENCE R.	SHELNUT, EVA M.
CAIN, HENRY A.	ISELIN, COLUMBUS O'D, JR.	SHULTZ, WILLIAM S.
CANGIAMILA, ANGELO	KEEN, D. JEAN	STERN, MELVIN E.
CORWIN, NATHANIEL	KEMP, JAMES M.	STILWELL, JEAN
DAVIS, LEE	LUFBURROW, ROBERT A.	VACCARO, RALPH F.
DAY, C. GODFREY	MCLEOD, JEAN	VOLKMAN, GORDON H.
DUYS, GERRIT, JR.	OWEN, DAVID M.	WAGNER, LANSING P.
EDWARDS, MELVILLE E.	PALMER, HORACE S.	WILLIAMS, NANCY H.
FOSTER, DONALD B.	PARSON, DONALD, JR.	WITZELL, WARREN E.

#### JUNIOR TECHNICIANS AND LABORATORY ASSISTANTS

ANDERSON, NELLIE E.	DAVIS, PRISCILLA A.	PERRY, BARBARA L.
ASH, ADELMA S.	ENGLISH, JEAN	POSGAY, MARJORIE F.
ATWOOD, BARBARA	GALLAGHER, GLORIA	SCHARFF, MARGARET
BOWMAN, PHYLLIS R.	GLAESER, FLORENCE E.	SCHROEDER, ELIZABETH H.
BERGSTROM, EILEEN S.	HOLMES, DORIS M.	SPOONER, JOANNE C.
BROWN, JOAN A.	LAKE, GRACIE T.	TOLLIOS, EVANGELINE P.
COBB, MARY A.	NORTHROP, BARBARA M.	

#### ADMINISTRATIVE AND SECRETARIAL

BACKUS, JEANNE M.	DONALD, MARY	OSTIGUY, BETTY P.
BEHRENS, HENRY G.	DOUTHART, DOROTHY E.	PARKER, EVELYN M.
BROADBENT, MADELINE P.	FERRIS, ALICE H.	SANDBLOM, JOHN D.
BRYANT, EDWIN T.	GRIFFIN, T. S. PERRY	SCHNABEL, DOROTHY L.
CONLAN, MARCUS J.	HATZIKON, KALEROS L.	WILSON, ESTHER N.
CROCKER, MARION W.	MELLOR, FLORENCE K.	YOUNG, ANITA M.
DINGWELL, EVA Z.	ORTOLANI, MARY	

## TECHNICAL SERVICES

ALLEN, JOHN L.	ELDRIDGE, STANLEY N.	RENNIE, THOMAS D.
ARCHIBALD, ROY C.	FISHER, STANLEY O.	RONNE, F. CLAUDE
BAILEY, FRANK A.	GALLAGHER, WILLIAM F.	SPENCER, ALLARD T.
BENNETT, PAUL E.	GASKELL, FRED	SPOONER, CHARLES E.
BLAKE, FORREST W.	GIFFORD, JAMES E.	STIMPSON, JOHN W.
BODMAN, RALPH H.	GRANT, CARLETON	THAYER, LAWRENCE A.
BOWMAN, WARREN O.	HODGKINS, HARRY L.	VAIL, PHYLLIS F.
CARTER, ALWYN L.	HOWLAND, MYRON P., JR.	WALDEN, ROBERT G.
CHUTE, EDWARD H.	KNOTT, WILLIAM D.	WEEKS, ROBERT G.
CONDON, J. WILLIAM	LANE, MARIAN O'D.	WHITNEY, G. G., JR.
DIMMOCK, RICHARD H.	MORRISON, KENNETH	WING, CARLETON R.
DINGWELL, PAUL E.	NELSON, DONA E.	

## MAINTENANCE AND HOUSING

BACKUS, HAROLD	POLLEY, ROBERT E.	STANSFIELD, RICHARD
CHRISTIAN, JOHN A.	SALTHOUSE, JAMES	TURNER, CATHERINE
CROSS, DONALD E.	SODERLAND, IDA S.	WILDE, PHILLIPS B.
HANDY, HARRY H.	SOLBERG, OTTO	WING, NATHANIEL R.
HOWES, ELIJAH S.	SPARKS, ELIZABETH C.	WOODWARD, FRED C. JR.

OFFICERS AND CREW MEMBERS OF VESSELS,  
BOATS, AND AIRCRAFT

ATWOOD, CHARLES F.	ELLIS, KENNETH B.	MYSONA, EUGENE J.
BACKUS, CYRIL	FAY, DONALD H.	ORTIZ, CLEMENTE
BAILEY, JAMES S.	FRENYEA, E. GERALD	PEARSON, ROWLAND
BARSTOW, ELMER M.	GINGRASS, NORMAN	PIERCE, SAMUEL F.
BOSWORTH, RUSSELL E.	HEMPSTEAD, ROBERT L.	PIKE, JOHN F.
BRADEY, JOHN III	KARLSON, ARVID	POOLE, MATHEW A.
BUCK, LEO M.	KIERNAN, CLAYTON F.	RODERICK, MILTON
CABRAL, JOHN V.	L'HEUREUX, RAYMOND E.	ROSE, LAWRENCE
CAVANAUGH, JAMES J.	LAMBERT, JOSEPH L.	ROSS, HAROLD W.
CLARKIN, JAMES J.	LYON, THOMAS	SEIBERT, HARRY H.
COLBURN, ARTHUR D., JR.	MACAULEY, FRANKLIN A.	SHIELDS, WILLIAM J.
COLLINS, JOHN S.	MACKEY, MALCOLM R.	SPEIGHT, CARL W.
CONLEY, WILLIAM J.	MANNIX, PAUL B.	WATERS, FRANCIS V.
COOK, HANS		

April 8, 1953

## V. TREASURER'S REPORT

THE accounts for the year 1952 have been audited by Messrs. Seamans, Stetson & Tuttle, Certified Public Accountants of Boston.

### ENDOWMENT FUND ASSETS AND ENDOWMENT FUND

The Endowment Fund cash plus the quoted market value of the investments in bonds and stocks at December 31, 1952 totaled \$3,600,990.90, an increase of \$235,262.96 over the December 31, 1951 total. Of the total amount, \$1,291.90 was in cash, \$1,202,228 in bonds, a decrease of \$14,024.47 over the book value, and \$2,397,471 in stocks, an increase of \$971,387.90 over the book value.

During the year bonds costing \$381,168.81 were sold or redeemed for \$382,297.26 which, after adding applicable amortization of bond premiums in the amount of \$594.98, resulted in a realized gain of \$1,723.43. Stocks and rights with book or assigned values of \$164,356.06 were sold for \$253,005.30, resulting in a net gain of \$88,649.24. The total net gain from all sales or exchanges amounted to \$90,372.67, thus bringing the accumulated net realized gain to the Endowment Fund to \$224,207.51.

During the year, from the proceeds of the above sales and cash \$507,679.61 was invested in bonds and \$128,240.58 in stocks, leaving \$1,291.90 uninvested at the year-end.

### PLANT ASSETS AND PLANT FUNDS

Plant Assets increased \$100,998.32 during the year. The increase resulted from the following additions to Plant: Laboratory Equipment, \$29,407.49; Library Books, \$1,200.00; improvements to the Homestead property \$23,940.83, and Boats \$46,450. The increase in Boats arose from the gift of the motor-boat "ALLURE", valued at \$47,000, less the book value of \$550 of a small boat sold.

### CURRENT ASSETS AND CURRENT LIABILITIES

Accounts and Notes Payable, plus Unexpended Grants, exceeded Cash and Receivables by \$17,199.86, against a similar figure for last year of \$45,447.17, an improvement of \$28,247.31. The Notes Payable were reduced \$20,000 during the year.

The item "Prepaid Expenses" amounting to \$12,473.79, consists of prepaid insurance premiums and discounted interest on Notes Payable.

Deferred Boat Costs increased from \$70,528.69 at the end of 1951 to \$89,107.07 at the end of 1952. The benefit of these expenses extends over several years, and each year a proportionate part is added to Boat Costs.

During the year \$30,974.92 was thus charged to Current Boat Costs, and \$14,553.30 was added to Deferred Boat Costs, for improvements to the "ATLANTIS" and "CARYN". In addition, \$35,000 was added to Deferred Boat Costs for the purchase of the motor vessel "BEAR".

Included in Deferred Expenses is an item "Maintenance of Homestead, \$536.49". This is the unamortized portion of the cost of repairs and improvements at Challenger Hall, and will be charged to Expense in 1953.

The Account Payable "BEAR" amounting to \$33,000 represents the balance due on the purchase price of the "BEAR" at December 31, 1952, payable in three equal monthly payments.

The Surplus account increased from \$71,190.34 to \$104,636.47. This increase, of \$33,446.13, is shown in detail on the Balance Sheet.

The Housing and Mess were operated at losses of \$5,845.21 and \$3,001.32 respectively, which losses were included in overhead costs. The Hall property produced a net income of \$1,048.49. The three comparable figures for the previous year were: Housing, loss of \$4,067.63; Mess, loss of \$2,975.60; and Hall property, net income of \$2,072.26.

The total income of the Institution from investments after deducting amortization of bond premiums, amounts to \$153,685.24, compared to \$157,333.69 for the previous year. Other income, including grants and fees, brought our total Institution income to \$205,213.08. Institution charges against income, including our share of cooperative projects, totaled \$203,812.72, resulting in an excess of Income carried to Surplus of \$1,400.36.

The Institution does contract work for various governmental agencies on a cost reimbursement basis, and during 1952 received a fee for work under these contracts amounting to \$49,845.21, which amount is included in the Institution income.

In the Income and Expense statement the item "Cooperative Projects, \$3,755.97" represents the expenditures by the Institution on Cooperative Projects, amounting to \$48,820.49, less the total of grants and contributions, amounting to \$45,064.52 received from the following: U. S. Public Service; Commonwealth of Massachusetts; Rockefeller Foundation; National Science Foundation, and E. I. duPont de Nemours & Co. Included in the above is Grants and Fellowships made by the Institution from the National Science Foundation grant of \$5,453.70.

The return on the investments held at the year-end was at the rate of 4.26% on the market value, 5.8% on the book value, and 6.36% on the original book value of the Endowment.

The Balance Sheets and Statement of Income and Expenses are appended.

EDWIN D. BROOKS, JR., *Treasurer*

## BALANCE SHEET

*As of December 31, 1952*

## ENDOWMENT FUND ASSETS

BONDS (LESS RESERVE FOR AMORTIZATION OF BOND PREMIUMS \$1,962.79) .....			\$1,216,252.47	
Quoted Market Value .....			\$1,202,228.00	
STOCKS .....			1,426,083.10	\$2,642,335.57
Quoted Market Value .....			2,397,471.00	
			<u>\$3,599,699.00</u>	
CASH .....				1,291.90
				<u>\$2,643,627.47</u>

*Note:* Bonds having a book value of \$399,829.05 are specifically allocated as collateral on the Institution's indebtedness to The New England Trust Company.

## PLANT ASSETS

LABORATORY PLANT:				
Land .....			\$27,072.32	
Buildings .....			336,564.86	
Laboratory Equipment .....			80,149.12	
Library .....			23,200.00	\$466,986.30
KETCH "ATLANTIS":				
Construction .....			\$218,674.47	
Equipment .....			41,462.50	\$260,136.97
KETCH "CARYN" .....			98,275.43	
MOTOR BOAT "ALLURE" .....			47,000.00	
SMALL BOATS AND EQUIPMENT .....			10,028.85	415,441.25
HALL PROPERTY .....				26,500.00
HOMESTEAD .....				134,552.41
				<u>\$1,043,479.96</u>

## BALANCE SHEET

*As of December 31, 1952*

## ENDOWMENT FUNDS

ENDOWMENT FUND — GENERAL .....	\$2,000,000.00	
ENDOWMENT FUND — FOR UPKEEP OF PLANT .....	419,419.96	\$2,419,419.96
		<hr/>
Add accumulated net gain on securities called or sold		224,207.51
		<hr/>
		\$2,643,627.47
		<hr/> <hr/>

## PLANT FUNDS

PLANT FUND — GENERAL .....		\$687,328.79
PLANT FUND RESERVE — TRANSFERRED IN PRIOR YEARS FROM CURRENT SURPLUS	\$302,152.85	
Add appropriation from Current Funds:		
Laboratory Equipment .....	\$29,407.49	
Improvements to Homestead .....	23,940.83	
Library — Book Purchases .....	1,200.00	54,548.32
		<hr/>
		\$356,701.17
Deduct Book Value of Boat Sold .....	550.00	356,151.17
		<hr/>
		\$1,043,479.96
		<hr/> <hr/>



## BALANCE SHEET

*As of December 31, 1952*

(Concluded)

## CURRENT ASSETS

## CASH:

Main Account .....	\$116,677.35	
Operating Accounts .....	48,415.72	
Office and Boat Funds .....	2,028.92	\$167,121.99
		<hr/>

## ACCOUNTS — RECEIVABLE:

## Governmental Agencies:

Invoiced .....	\$ 37,525.36	
Not Invoiced, Materials and Services ....	\$145,764.05	
Not Invoiced, Use of Boats .....	23,888.97	169,653.02
		<hr/>
		\$207,178.38
Co-operating Institutions .....	8,797.46	
Other Accounts Receivable .....	36,623.73	252,599.57
		<hr/>

SUPPLIES AND WORK-IN-PROGRESS .....	32,718.98
-------------------------------------	-----------

PREPAID EXPENSES .....	12,473.79
------------------------	-----------

## DEFERRED EXPENSES:

Boat Expenses .....	\$ 54,107.07	
Motor Vessel "Bear" .....	35,000.00	
Maintenance of Homestead .....	536.49	89,643.56
		<hr/>
		\$554,557.89
		<hr/>

## BALANCE SHEET

*As of December 31, 1952*

(Concluded)

CURRENT LIABILITIES			
ACCOUNTS — PAYABLE:			
Sundry Creditors . . . . .	\$16,179.05		
Withheld from Employees for Taxes, Insurance, etc. . . . .	11,563.96		
Sundry Accrued Expenses . . . . .	12,719.44		\$40,462.45
			<hr/>
ACCOUNT — PAYABLE "BEAR" . . . . .			33,000.00
NOTES — PAYABLE (SECURED BY BONDS HAVING A BOOK VALUE OF \$399,829.05) . . . . .			340,000.00
UNEXPENDED GRANTS . . . . .			23,458.97
RESERVE FOR EQUIPMENT PURCHASES . . . . .			13,000.00
SURPLUS:			
Periodic Replacement Fund:			
Balance, December 31, 1951 . . . . .	\$143,022.82		
Appropriation, 1952 . . . . .	4,000.00		\$18,322.82
			<hr/>
General:			
Balance, December 31, 1951 . . . . .	\$56,867.52		
Add:			
Excess of Income —			
Exhibit B . . . . .	\$1,400.36		
Gifts . . . . .	1,025.19		
Depreciation			
Charged to Overhead Ex- pense . . . . .	20,315.31		
Adjustments for Prior			
Periods . . . . .	6,705.27	29,446.13	86,313.65
	<hr/>	<hr/>	<hr/>
Total Surplus, December 31, 1952 . . . . .			104,636.47
			<hr/>
			\$554,557.89
			<hr/>

## INCOME AND EXPENSE STATEMENT

*Year Ended December 31, 1952*

## INCOME:

## Investments:

Interest .....	\$ 35,608.58	
Dividends .....	118,720.25	\$154,328.83
		<hr/>
Less Amortization of Bond Premiums .....	643.59	\$153,685.24
Fees on Government Contracts .....		49,845.21
Hall Property (Net Operating Income) .....		1,048.49
Sundry .....		634.14
		<hr/>
		\$ 68,948.68

## EXPENSES:

Operating .....	\$ 86,996.02	
Institution Projects .....	34,347.73	
Co-operative Projects .....	3,755.97	
Operation of Vessels .....	1,741.63	
Interest Paid .....	9,423.05	136,264.40
		<hr/>
		\$205,213.08

## PAYMENT FOR PLANT ITEMS FROM CURRENT FUNDS:

Laboratory Equipment .....	\$29,407.49	
Alterations at Homestead (New Dormitory) .....	16,956.46	
Equipment at Homestead (Challenger Hall and Dormitory) .....	6,984.37	
Library Books .....	1,200.00	
	<hr/>	
	\$54,548.32	
Reserved for Equipment Purchases .....	13,000.00	67,548.32
	<hr/>	<hr/>
Excess of Income to Surplus — Exhibit A .....		\$1,400.36
		<hr/>

## APPENDIX

### ATLANTIS

Cruise No.	Departure and Return	Days Duration	Ports of Call	Scientist-in-Charge
178	15 January		Woods Hole to Bermuda	Ketchum
	19 January	5	Arrived Bermuda	
	22 January		Bermuda to	
	9 February	18	Las Palmas	
	11 February		Las Palmas to	
	21 February	10	Dakar	
	26 February		Dakar to	
	11 March	13	Recife	
	17 March		Recife to	
	12 April	26	Port of Spain	
	17 April		Port of Spain	
	26 April	9	to Guantanamo	
	10 May		Guantanamo to	
179	28 May	18	Woods Hole	Fuglister
	19 July		Woods Hole to Ponta	
180	4 August	14	Delgada, Azores	Heezen
	7 August		Ponta Delgada	
	25 August	18	to Dakar	
	28 August		Dakar to	
	17 September	20	Recife	
	20 September		Recife to Rio de	
	4 October	14	Janeiro	
	14 October		Rio de Janeiro	
	27 October	13	to Recife	
	30 October		Recife to Port	
	22 November	23	of Spain	
	26 November		Port of Spain to	
	7 December	12	St. Georges	
	10 December		Bermuda to	
	14 December	4	Woods Hole	

## CARYN

Cruise No.	Departure and Return	Days Duration	Ports of Call	Scientist-in-Charge
	January	Short Cruises		Hersey & Vine
	February	Short Cruises		Hersey & Vine
C-29	29 March		Woods Hole to Bermuda	Vine
	5 April	8	Arrived Bermuda	
	24 April	20	Arrived Woods Hole	
C-30	28 April		Woods Hole to Boston	Bumpus
	20 May	23	Boston to Woods Hole	
C-31	22 May	3	Short Cruise	Hersey
C-32	18 June	3	Short Cruise	Officer
C-33	26 June	1	Short Cruise	Dietz
C-34	30 June	4	Short Cruise	Hersey
C-35A	8 July	1	Short Cruise	Hersey
C-35B	9 July	1	Short Cruise	Hersey
C-36	14 July	4	Short Cruise	Hersey
C-37	20 July	7	Short Cruise	Watson
C-38	31 July		Hudson Canyon	Leavitt
	12 August	13	Return to Woods Hole	
C-39	August			
C-55	December		Short Cruises	

## ALBATROSS III

Cruise No.	Departure and Return	Days Duration	Ports of Call	Scientist-in-Charge
A-42	24 January		Woods Hole to	Richards
	28 January	4	Bermuda	
	30 January		Bermuda to	
	21 February	22	Dakar, Africa	
	26 February		Dakar to Recife,	
	11 March	14	Brazil	
	18 March		Recife, Brazil to	
	11 April	24	Port of Spain, Tr.	
A-43	17 April		Port of Spain to	Heezen
	23 April	7	Guantanamo Bay	
	7 May		Guantanamo Bay to	
	27 May	20	Woods Hole	
A-44	18 June		Short trips	Hersey
	24 June	Left for Bayonne, New Jersey and returned to Custody of U. S. Fish and Wildlife Service		

## BEAR

July thru December — Short trips to Sea. Scientist-in-Charge — Hersey

## PBY — NO. 46683

PBY — Arrived 19 April 1952. Local flights April and May

Cruise No.	Departure and Return	Days Duration	Ports of Call	Scientist-in-Charge
P-2	18 June	19	New Bedford to Miami Miami to San Juan, Puerto Rico Puerto Rico to St. Croix and St. Thomas to Ramey A. F. B., P. R. to Roosevelt Roads to Jacksonville, Florida to New Bedford Local Flights	Bunker
P-4	7 July August 2 September	1	New Bedford — Cashes Ledge, Maine and return	von Arx
P-6	28 October	3	Otis A. F. B.— Elizabeth City, North Carolina	Frantz
P-9	30 October 5 November	4	Return to New Bedford New Bedford to Kindley A. F. B.	Bunker
	8 November		Bermuda, return to New Bedford	
P-12	24 November	2	New Bedford to Elizabeth City, N. C.	von Arx
	25 November		Return	
P-21	17 December	4	New Bedford — Kindley A. F. B., Bermuda	
	20 December		Return	

## CAP'N BILL II

Cruise No.	Departure and Return	Days Duration	Locality	Scientist-in-Charge
1	20 June 27	7	Atlantic Slope, Hudson Canyon to Veatch Canyon	Schroeder
2	10 July 17	7	Atlantic Slope, Veatch Canyon to Lydonia Canyon	Schroeder
3	23 July 30	8	Atlantic Slope, Lydonia Canyon to offing of LaHave Bank	Schroeder