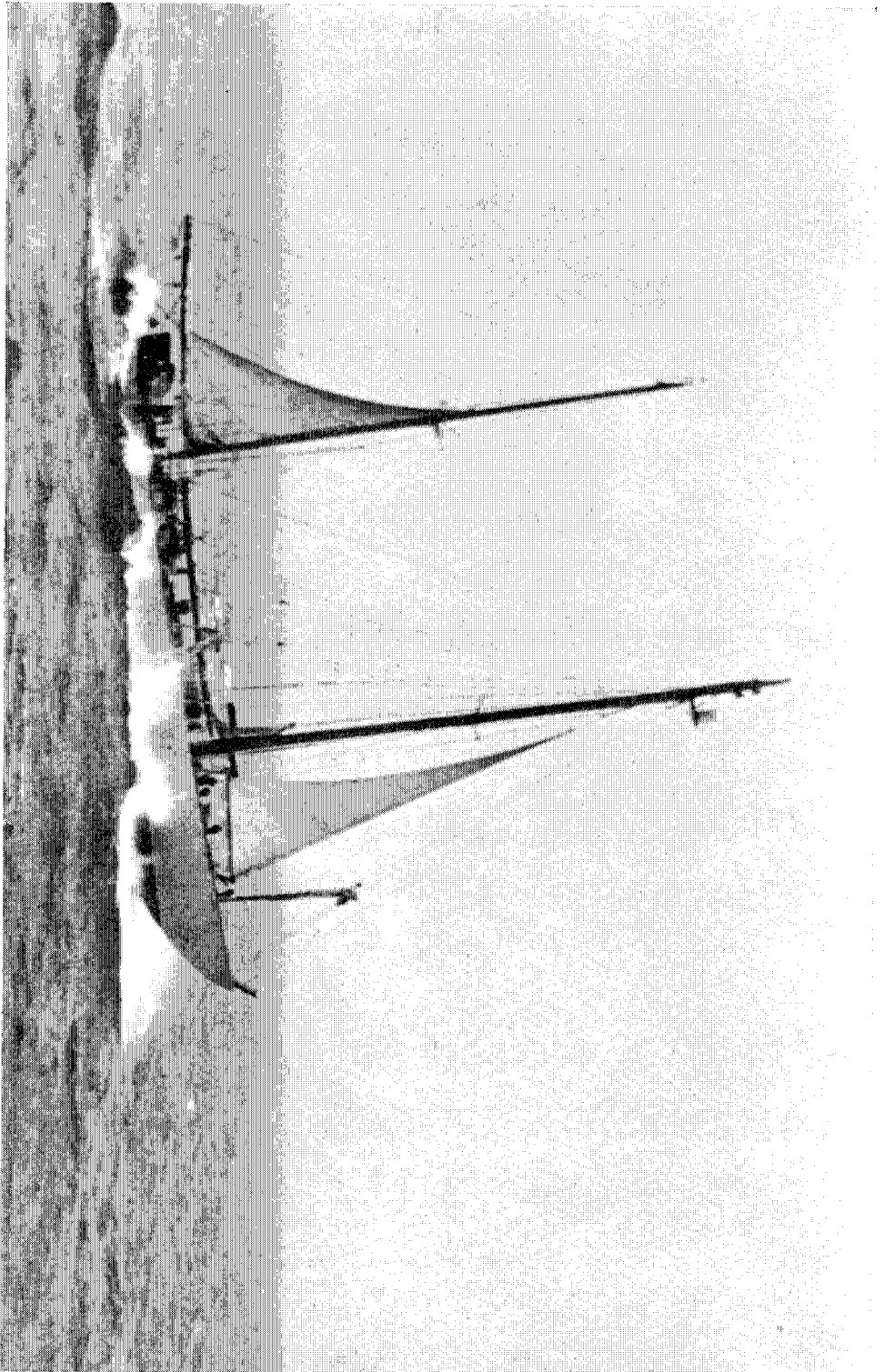


THE
WOODS HOLE OCEANOGRAPHIC
INSTITUTION

REPORT FOR THE YEAR
1950

1951



The Research Vessel ATLANTIS, one of several ships which participated in a synoptic survey of the Gulf Stream, known as Operation Cabot, June 7-22, 1950.

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I. TRUSTEES

(AS OF DECEMBER 31, 1950)

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, Minnesota.
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.

To serve until 1952

HENRY B. BIGELOW, Museum of Comparative Zoology, Cambridge, Mass.
DETLEV W. BRONK, National Research Council, 2101 Constitution Avenue, N. W., Washington, D. C.
DANIEL MERRIMAN, Bingham Oceanographic Laboratory, Yale University, New Haven, Connecticut.
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.

To serve until 1951

E. G. CONKLIN, Princeton University, Princeton, N. J.
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.

Ex. Officio

EDWIN D. BROOKS, JR., P. O. Box 135, Boston 3, 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.
EDWIN D. BROOKS, JR., Treasurer, P. O. Box 135, 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,
New York.
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 135, Boston 3, Mass.
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THE COMMANDANT (Vice Admiral Merlin O'Neill), U. S. Coast Guard, 1300 E Street,
Washington, D. C.
E. G. CONKLIN, Princeton University, Princeton, N. J.
HARRISON P. EDDY, c/o Metcalf & Eddy, 1300 Statler Building, Boston, Mass.
MARION EPLEY, Eastover, Newport, R. I.
JNO. A. FLEMING, 1530 P Street N. W., Washington, 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.
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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,
Connecticut.
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 William Street, New York, N. Y.
MARY SEARS, Woods Hole Oceanographic Institution, Woods Hole, Mass.
ATHELSTAN F. SPILHAUS, Institute of Technology, University of Minnesota, Minneapolis,
Minnesota.
LYMAN SPITZER, JR., Princeton University Observatory, 14 Prospect Avenue, Princeton,
New Jersey.
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, c/o Arthur D. Little, Inc., 30 Memorial Drive, Cambridge, Mass.
SELMAN A. WAKSMAN, New Jersey Agricultural Experiment Station, New Brunswick, N. J.
FRANCIS C. WELCH, 73 Tremont Street, Boston, Mass.

III. STAFF

(As of December 31, 1950)

- 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.
- ARNOLD B. ARONS, Associate Professor of Physics, Stevens Institute of Technology; Associate in Physical Oceanography.
- JOHN C. AYERS, Assistant Professor of Oceanography, Department of Conservation, Cornell University; Associate in Biology.
- DAVID L. BELDING, *Emeritus* Professor of Pathology and Bacteriology, Boston University Medical School; Associate in Marine Biology.
- DEAN F. BUMPUS, Oceanographer.
- ANDREW F. BUNKER, Marine Meteorologist.
- CORNELIA L. CAREY, Associate Professor Emeritus, Barnard College; Associate in Marine Bacteriology.
- GEORGE L. CLARKE, Associate Professor of Zoology, Harvard University; Marine Biologist.
- WILLARD DOW, Research Engineer.
- WILLIAM MAURICE EWING, Professor of Geology, Columbia University; Associate in Geophysics.
- CHARLES J. FISH, Professor of Marine Biology, University of Rhode Island and Director, Narragansett Marine Laboratory; Research Associate in Biology.
- MARIE P. FISH, Research Associate in Biology.
- FREDERICK C. FUGLISTER, Physical Oceanographer.
- BERNARD HAURWITZ, Professor of Meteorology and Chairman of the Department of Meteorology, New York University; Associate in Marine Meteorology.
- JOHN B. HERSEY, Physical Oceanographer.
- LLOYD D. HOADLEY, Research Associate in Engineering.
- JOHN F. HOLMES, Research Associate in Engineering.
- LOUIS W. HUTCHINS, Director, Bermuda Biological Station for Research, Inc.; Marine Biologist.
- BOSTWICK H. KETCHUM, Marine Microbiologist.
- ARTHUR A. KLEBBA, Research Engineer.
- FRANK J. MATHER, III, Research Associate in Oceanography.
- WILLIAM G. METCALF, Physical Oceanographer.
- ARTHUR R. MILLER, Physical Oceanographer.
- RAYMOND B. MONTGOMERY, Visiting Professor of Oceanography, Brown University; Physical Oceanographer.
- HILARY B. MOORE, Associate Professor of Marine Biology, Marine Laboratory, University of Miami; Associate in Marine Biology.
- MARTIN J. POLLAK, Physical Oceanographer.
- ROY L. RATHER, JR., Research Engineer.
- FRANCIS A. RICHARDS, Chemical Oceanographer.
- GORDON A. RILEY, Associate Professor of Biology, Yale University; Marine Physiologist.
- CARL-G. ROSSEY, Andrew MacLeish Distinguished Service Professor of Meteorology, University of Chicago; Associate in Physical Oceanography.
- IRVING I. SCHELL, Marine Meteorologist.

WILLIAM E. SCHEVILL, Associate Curator of Invertebrate Palaeontology, Museum of Comparative Zoology, Harvard University; Associate in Physical Oceanography.
WILLIAM C. SCHROEDER, Associate Curator of Fishes, Museum of Comparative Zoology, Harvard University; Fisheries Biologist.
MARY SEARS, Planktonologist.
H. R. SEIWELL, Physical Oceanographer.
FLOYD M. SOULE, Principal Senior Oceanographer, U. S. Coast Guard; Associate in Physical Oceanography.
ATHELSTAN F. SPILHAUS, Dean, Institute of Technology, University of Minnesota; Associate in Physical Oceanography.
HENRY M. STOMMEL, Physical Oceanographer.
HENRY C. STETSON, Research Oceanographer and Alexander Agassiz Fellow in Oceanography, Museum of Comparative Zoology, Harvard University; Submarine Geologist.
PARKER D. TRASK, Supervising Geologist, State Division San Francisco Bay Toll Crossings; Associate in Submarine Geology.
HARRY J. TURNER, Marine Biologist.
ALLYN C. VINE, Consultant in Oceanography, Bureau of Ships; 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, Associate Professor of Geology, University of Wisconsin; Associate in Geophysics.
L. VALENTINE WORTHINGTON, Physical Oceanographer.
RALPH L. WYRICK, Research Associate in Engineering.

EDWARD H. SMITH, Director.
ALFRED C. REDFIELD, Associate Director.
FRANCIS C. RYDER, Assistant to the Director.
HELEN F. PHILLIPS, Secretary to the Director.
JOHN MCGILVRAY, Controller.
WILLIAM C. SCHROEDER, Business Manager.
NORMAN T. ALLEN, Administrator.
GILBERT OAKLEY, JR., Superintendent of Plant and Vessels.
HARVEY MACKILLOP, Accountant.

IV. TREASURER'S REPORT

THIS is the report of Lawrason Riggs, retiring Treasurer, for the period January 1, 1950 to August 10, 1950, and of Edwin D. Brooks, Jr., succeeding Treasurer, for the period August 10, 1950, to December 31, 1950.

The accounts for the year 1950 have been audited by Messrs. Seamans, Stetson & Tuttle, Certified Public Accountants of Boston.

In accordance with votes taken at the Annual Meeting of the Trustees, August 10, 1950, the Endowment Fund securities, Bank accounts, and the Loan, have been transferred from the Bankers Trust Company, New York, to the State Street Trust Company of Boston, and the Treasurer's office moved from 120 Broadway, New York, to 294 Washington Street, Boston, Mass.

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, 1950 totaled \$3,173,534.23, an increase of \$236,705.32 over the December 31, 1949 total. Of this amount, \$3,670.73 was in cash, \$1,051,054.00 in bonds, an increase of \$4,710.58 over the book value, and \$2,118,809.50 in stocks, an increase of \$605,072.18 over the book value.

During the year bonds costing \$326,552.00 were sold or redeemed for \$327,566.78 which, after adding applicable amortization of bond premiums in the amount of \$1,225.40, resulted in a realized gain of \$2,240.18. Stocks and rights with book or assigned values of \$135,350.91 were sold for \$145,717.15, resulting in a net gain of \$10,366.24. The total net gain from all sales or exchanges amounted to \$12,606.42, thus bringing the accumulated net realized gain to the Endowment Fund to \$144,331.51.

During the year, from the proceeds of the above sales and cash, \$340,507.81 was invested in bonds and \$132,173.45 in stocks, leaving \$3,670.73 uninvested at the year-end.

PLANT ASSETS AND PLANT FUNDS

Plant Assets decreased \$31,734.65 during the year. The decrease resulted from the sale of the power boat BALANUS, having a book value of \$55,649.49, less the following additions to Plant: Library Books, \$800; Laboratory Equipment, \$10,757.69; and improvements to the Homestead property, \$12,357.15. The proceeds of the sale of the BALANUS, \$20,000.00, was added to Surplus. Historically, the original cost of the BALANUS was taken from Current Surplus, and added to Plant. Therefore the proceeds of the sale are credited to Surplus.

CURRENT ASSETS AND CURRENT LIABILITIES

Accounts and Notes Payable, plus Unexpended Grants, exceeded Cash and Receivables by \$72,350.24, against a similar figure for last year of \$95,588.69, an improvement of \$23,238.45. The Notes Payable were reduced \$10,000.00 during the year.

Deferred Boat Costs decreased from \$73,991.54 at the end of 1949 to \$66,628.04 at the end of 1950. The benefit of these expenses extends over several years, and each year a proportionate part is added to Boat Costs. During the year \$26,456.19 was thus charged to Current Boat Costs, and \$19,092.69 was added to Deferred Boat Costs, primarily due to the installation of a new engine for the CARYN.

The Surplus account decreased from \$57,782.76 to \$43,025.93.

The Housing and Mess were operated at losses of \$4,207.49 and \$4,955.07 respectively, which losses were included in overhead costs. The Hall property produced a net income of \$888.18. The three comparable figures for the previous year were: Housing, loss of \$2,034.12; Mess, loss of \$2,875.18; and Hall property, net income of \$1,086.47.

The total income of the Institution from investments after deducting custodian fees and amortization of bond premiums, amounts to \$155,234.84, compared to \$139,170.15 for the previous year. Other income, including grants, brought our total Institution income to \$205,125.00. Institution expenses, including our share of cooperative projects, totaled \$179,633.05, resulting in an excess of income carried to surplus of \$25,491.96, an improvement of \$36,456.66 over 1949, when a loss of \$10,964.66 was charged to surplus.

The return on the investments held at the year-end was at the rate of 4.93% on the market value, 6.11% on the book value, and 6.47% on the original book value of the Endowment.

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

BALANCE SHEET

As of December 31, 1950

ENDOWMENT FUND ASSETS

BONDS (LESS RESERVE FOR AMORTIZATION OF BOND PREMIUMS \$1,763.75)		\$1,046,343.42
Quoted Market Value	\$1,051,054.00	
STOCKS		1,513,737.32
Quoted Market Value	2,118,809.50	
	<u>\$3,169,863.50</u>	
CASH		3,670.73
		<u>\$2,563,751.47</u>

Note: Bonds having a book value of \$413,353.42 are specifically allocated as collateral on the Institution's indebtedness to the State Street Trust Company.

PLANT ASSETS

LABORATORY PLANT:

Land	\$27,072.32	
Buildings	332,202.26	
Laboratory Equipment	32,119.62	
Library	20,800.00	\$412,194.20

KETCH "ATLANTIS":

Construction	\$218,674.47	
Equipment	41,462.50	\$260,136.97

KETCH "CARYN"	98,275.43	
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SMALL BOATS AND EQUIPMENT	10,578.85	368,991.25
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HALL PROPERTY		26,500.00
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HOMESTEAD		100,942.34
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		<u>\$908,627.79</u>
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DEPRECIATION FUND ASSETS:

Cash	\$522.82	
Add Amount Due from Current Funds	4,800.00	5,322.82
	<u></u>	<u>\$913,950.61</u>

BALANCE SHEET

As of December 31, 1950

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		144,331.51
		<hr/>
		<u>\$2,563,751.47</u>

PLANT FUNDS

PLANT FUND — GENERAL			\$640,328.79
DEFERRED ACCOUNT — PAYABLE	\$18,000.00		
PLANT FUND RESERVE — Transferred in prior years from Current Surplus	\$264,033.65		
Add appropriation from Current Funds:			
“Caryn” one-fifth purchase price	\$18,000.00		
Improvements to Homestead	12,357.15		
Laboratory Equipment	10,757.69		
Library — book purchases	800.00	41,914.84	
		<hr/>	
		\$305,948.49	
Deduct book value of “Balanus” sold	55,649.49	250,299.00	268,299.00
		<hr/>	
			\$908,627.79
RESERVE FOR PERIODIC REPLACEMENTS			5,322.82
			<hr/>
			<u>\$913,950.61</u>

BALANCE SHEET

As of December 31, 1950

(Concluded)

CURRENT ASSETS

CASH:

Main Accounts	\$55,555.35	
Operating Accounts	8,583.19	
Office and Boat Funds	974.28	
	<u>\$65,112.82</u>	
Less amount due Depreciation Fund	4,800.00	\$60,312.82

ACCOUNTS — RECEIVABLE:

Governmental Agencies:

Invoiced	\$109,322.30	
Expenditures not invoiced	\$145,984.00	
Use of boats not invoiced	42,287.92	188,271.92
	<u>\$297,594.22</u>	
Co-operating Institutions	13,380.47	
Other Accounts Receivable	21,131.99	332,106.68

SUPPLIES AND WORK-IN-PROCESS	34,787.67
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DEFERRED EXPENSES:

Boat expense	\$66,628.04	
Maintenance of Homestead	2,097.42	68,725.46

PREPAID GENERAL EXPENSE	7,021.84
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UNCOLLECTED GENERAL OVERHEAD, 1950	12,928.55
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	<u>\$515,883.02</u>
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BALANCE SHEET

As of December 31, 1950

(Concluded)

CURRENT LIABILITIES

ACCOUNTS — PAYABLE:

Sundry Creditors	\$74,503.54	
Withheld from employees for taxes, insurance, etc.	6,297.45	
Sundry Accrued Expense	2,000.00	\$82,800.99

NOTES — PAYABLE (Secured by Bonds having a book value of \$413,353.42)		370,000.00
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UNEXPENDED GRANTS:

Wallace and Tiernan Gift	\$1,141.03	
Commonwealth of Massachusetts (Shellfish Propagation)	3,817.54	
United States Public Health Service (Bacteriology of Polluted Waters)	5,031.91	
Barataria Bay Model	1,978.27	11,968.75

DEFERRED RECOVERIES — Book Value of plant items charged to Boat Expense		8,087.35
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SURPLUS:

Balance at December 31, 1949	\$57,782.76	
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Add:

Gift	\$18,000.00	
Sales price "Balanus"	20,000.00	
Excess insurance recovery over replacement cost, "Atlantis" claim	4,883.17	
Book Value plant items recovered through Boat Expense	2,740.44	
Excess of Income	25,491.96	71,115.57
		\$128,898.33

Deduct:

Cost of Plant Assets purchased from Current Funds:

One-fifth purchase price "Caryn"	\$18,000.00	
Improvements to Homestead	12,357.15	
Laboratory Equipment	10,757.69	
Library — Books	800.00	
Uncollected General Overhead to December 31, 1949	43,957.56	85,872.40

Balance, December 31, 1950		43,025.93
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\$515,883.02

INCOME AND EXPENSE STATEMENT

Year Ended December 31, 1950

INCOME:

Investments:

Interest	\$ 32,465.45		
Dividends	124,975.72	\$157,441.17	

Less:

Amortization of Bond Premiums	\$ 908.15		
Custodian Fees	1,298.18	2,206.33	\$155,234.84

Grants:

Commonwealth of Massachusetts (Shellfish Propagation)	\$ 16,182.46		
United States Public Health Service (Bacteriology of Polluted Waters)	17,435.15		
Recovery of Depreciation through Overhead	14,168.18		
Hall Property (Net Operating Income)	888.18		
Sundry	1,216.20	49,890.17	
Total Income			\$205,125.01

EXPENSES:

Operating	\$79,457.83		
Institution Projects	41,066.00		
Co-operative Projects	50,457.07		
Interest	8,652.15	179,633.05	
Excess of Income to Surplus			\$25,491.96

V. DIRECTOR'S REPORT

Introduction

One of the outstanding events of the year from the viewpoint of field activities was the participation of the Institution in the multiple-ship, synoptic survey of the Gulf Stream which covered the period June 7-22. The operation, which included two U. S. Navy ships, and one airplane; a U. S. Fish and Wildlife Service vessel; a corvette of the Royal Canadian Navy, and our own ATLANTIS, was the largest scaled survey ever undertaken of the Gulf Stream. The course and other features of the continually changing circulatory pattern were charted from Cape Hatteras to the Grand Banks. The wealth and detail of the data which were collected will occupy the attention of several of the staff for sometime to come in preparing for publication the scientific results. Preliminary reports of the work have appeared in appropriate journals and in the Press.

Several changes in the administrative officers of the Institution took place during the year. On July 1, Dr. C. O'D. Iselin who had served as Director since 1940, turned over the duties of his office to Dr. Ed. H. Smith in order that he might be freer to devote more of his time exclusively to oceanography and problems related to this field of the science. At the annual meeting of the Board of Trustees in August, Dr. Henry B. Bigelow, the Director of the Institution for its first ten years, and President of the Institution for the succeeding decade, was elected Chairman of the Board, and Dr. Arnaud C. Marts, was elected to fill the vacancy of President. These changes naturally had their reflection, one of which being that the Executive Committee composed of Dr. Arnaud C. Marts, Chairman, Mr. Raymond Stevens, Drs. Alfred C. Redfield, Ed. H. Smith, and Mr. Edwin D. Brooks, Jr., met monthly, throughout the year.

Floating Facilities

ATLANTIS and CARYN were active during the year, the former being absent from Woods Hole a total of 231 days, and the latter 84 days. A table summarizing the sea operations is contained in Appendix I. The collection of field data has been pushed rather strenuously. Such a program has necessitated the crews and scientists to spend more time at sea, often under arduous conditions of stormy weather and rough seas; yet despite these hardships which are unfamiliar to persons living comfortably on shore, the morale of the sea-going personnel has remained good. The frontispiece photograph of the ATLANTIS emphasizes very nicely what she and her crew

are up against, and the importance with which we regard the maintenance of an efficient ship and a contented crew.

ATLANTIS, which received a thorough engine overhaul in the fall, is still the flagship, and although she is quite seaworthy, and well equipped, the continued advances in oceanographic techniques and field equipment are causing cramped quarters and restricted spaces.

CARYN has been improved by the installation of a new engine of double the power of the old one, so that now she is able to keep company with ATLANTIS. For ordinary offshore operations CARYN has adequate fuel capacity, but is short of a supply of fresh water. The cost of CARYN's new engine is being defrayed partly by the cooperative program with Columbia University, and the remainder will be amortized by the Institution.

BALANUS which was chartered by Johns Hopkins University for operations in Chesapeake Bay, became idle again during the autumn, and being of little further use to us, the Executive Committee authorized her sale to a fisherman for the sum of \$20,000.

MENTOR and RELIANCE which are both Navy property, were stripped, and MENTOR deposited to be broken up. RELIANCE at the year-end is still in our custody awaiting final instructions from the Navy as to disposition.

The remainder of the fleet (ASTERIAS, MYTILUS, and CLAIRE) are all small inshore craft.

Shore Facilities

It was foreseen as a result of experience at Woods Hole that the overcrowding of the main building, and the waterfront, handicapped severely the progress and efficiency of the research work. In order to improve conditions, and provide more laboratory space, plans are being formulated for the erection of an additional building, or buildings, at Woods Hole.

The first question which required considerable time and conferences, was the selection of the best site. Three sites have been recommended, viz., the land adjacent to our property now leased from the Marine Biological Laboratory; the Institution lot across the street from our main building; and the Institution's tract which was purchased several years ago from the Fay Estate. The first named site, which from all points of view was superior, has been recommended and negotiations are proceeding with the Marine Biological Laboratory at the year-end.

The Marine Biological Laboratory from whom we had rented the so-called Bar Neck lot and the Penzance Garage at \$6000 per year, increased the price to \$8000 and requested a three-year term lease which has been accepted.

Additional improvements were made to our houses of the former Fay

Estate. Challenger House was repainted and Meteor House winterized and redecorated for the Director who took occupancy on July 1.

If as it appears now, that military installations in the Falmouth area exact an ever-increasing need for more housing, and our own program of activities continues to expand, serious consideration must be given to the utilization of the undeveloped land of the Fay Estate. It is preferable to avoid entering the real estate business, but when commercial local sources do not, or cannot, offer adequate facilities, and the Institution owns a large undeveloped tract, it may devolve upon us, in order to attract desirable scientific talent, either to make available attractive building sites on a cost basis, or build several residences for rental or subsequent sale.

Library arrangements which have been in effect with the Marine Biological Laboratory, continued throughout the year. Due to the general increase in librarian salaries, cost of books, and other materials, we were requested to increase our share of the annual payments from \$800 to \$1,500. The final figure of \$1,200 was agreed upon.

Personnel

The additions to the scientific staff during the year have not been appreciable. Gains have more or less balanced losses. If one compares the records of mid-year 1949 with those of 1950, the number of persons working at the laboratory has remained rather static.

	1949	1950
SCIENTIFIC AND TECHNICAL STAFF		
Full time:		
at Woods Hole	80	82
on Field trips	5	5
Summers only:		
at Woods Hole	33	29
on Field trips	8	10
Working at other institutions	7	18
Fellowships Holders	12	12
Visiting Investigators	13	7
SECRETARIES AND CLERKS	19	17
ADMINISTRATION	10	9
GENERAL MAINTENANCE AND SERVICE	40	36
CREWS OF VESSELS	37	32
	<hr/> 264	<hr/> 257

The following changes of the staff occurred during the year. Dr. Francis A. Richards, who was trained in chemistry at the University of Washington, took charge of the chemical laboratory. Dr. Louis W. Hutchins, who has been with us for several years, accepted on a half-time basis, the director-

ship of the Bermuda Biological Station. This assignment continues the close liaison which has prevailed between the two laboratories. Dr. Raymond B. Montgomery, who two years ago, was appointed a Visiting Professor of Oceanography at Brown University, continued in that position for another year. Dr. Arnold Arons of Stevens Institute of Technology, Dr. George P. Woollard of the University of Wisconsin, Dr. Bernhard Haurwitz of New York University, and Dr. Hilary B. Moore of the University of Miami, Florida, were all engaged at Woods Hole during the summer, bringing several of their students to the laboratory for work and training in one or another forms of oceanography.

The following persons were awarded fellowships by the Institution during 1950:

Mr. ROBERT W. HOLMES	Mr. GEORGE CROMPTON III
Mrs. BETTY L. GEALY	Mr. JOHN A. MACFADYEN, JR.
Mr. EDWARD J. TAYLOR	Mr. KASPAR ARBENZ
Mr. E. L. BOUSEFIELD	Mr. ROBERT V. KROTKOV
Mr. RUSHDI SAID	Mr. ALDEN P. STICKNEY

The following persons were awarded honoraria:

Dr. JOHN C. AYERS	Dr. DANIEL R. NORTON
Dr. WILLIAM M. EWING	Dr. GORDON A. RILEY
Dr. HILARY B. MOORE	Dr. EDMOND E. WATSON

The following distinguished visitors were welcomed at the laboratory for one to several days, or weeks, to consult on scientific matters in their particular fields. Several, on invitation, gave lectures of their work.

Mr. TREVOR BELL, Scientific Attache, Australian Embassy.
 Dr. W. L. FORD, Naval Research Establishment, Halifax, Nova Scotia.
 Dr. KIYOO WADATI, Central Meteorological Office, Tokyo, Japan.
 Prof. A. J. GUILLARD, Leiden University, Leiden, Holland.
 Dr. ILMO HELA, Institute of Marine Research, Helsinki, Finland.
 Dr. E. G. HILL, British Naval Services Mission, England.
 Sir CHARLES WRIGHT, British Naval Services Mission, England.
 Dr. KANJI SUDA, Japanese Hydrographic Office, Tokyo, Japan.
 Dr. YOSHIO HIYAMA, Fisheries Institute, Tokyo, Japan.
 Dr. R. R. LANGFORD, University of Toronto, Toronto, Canada.
 Dr. EMMANUEL FAURE-FREMIET, College de France, France.
 Dr. K. F. WIBORG, Fisheries Directorate, Bergen, Norway.
 Dr. ALBERT DEFANT, Geophysical and Meteorological Institute, Innsbruck, Austria.
 Dr. CHESTER I. BARNARD, President, Rockefeller Foundation.
 Dr. WARREN WEAVER, Director, Natural Services, Rockefeller Foundation.

Under the section devoted to personnel matters should be recorded the formation of a Joint Cooperation Committee, three members being appointed by the Marine Biological Laboratory, and three by the Woods

Hole Oceanographic Institution. This action was initiated by vote of the Trustees of the Marine Biological Laboratory, and concurred in by similar action of our own trustees. The establishment of such a joint committee will assist in the fostering of cordial relations between the two main scientific laboratories at Woods Hole. Plans are already underway for exchanges of amenities on both the student and trustee levels.

The Social Security Act of 1950, another event, whereby coverage for retirement benefits is provided for employees of non-profit organizations was accepted by the Institution the latter part of the year. The Executive Committee acted promptly to assume the Institution's share of the cost amounting to approximately \$3,000, provided that the employees elected to accept their share of the requirements as provided for by the Act. It remained in the above status awaiting a vote of the employees at the termination of the year.

The persons whose names are listed below were members of the Institution for a period of six months or more during the calendar year 1950.

SCIENTISTS, ENGINEERS AND TECHNICIANS

BARBOUR, L. HILLIARD	HAYES, CARLYLE R.	MCCASLAND, KENNETH G.
BERGSTROM, STANLEY W.	HUNT, MARY G.	OWEN, DAVID M.
BUNKER, BARBARA A.	HUNT, OTIS E.	PARKER, FRANCES L.
CLARKE, ARNOLD H.	JOHNSON, HENRY R.	PARSON, DONALD, JR.
CORWIN, NATHANIEL	KEEN, D. JEAN	PEIRSON, JEAN F.
DAVIS, LEE C.	KITTREDGE, CAROLINE F.	PHLEGER, FRED B.
DENMAN, NATHANIEL A.	KNOTT, SYDNEY T., JR.	SHULTZ, WILLIAM S.
DUYS, GERRIT, JR.	LARSEN, EDWARD H.	VACCARO, RALPH F.
FOSTER, DONALD B.	MACAUSLAN, SALLY M.	VOLKMANN, GORDON H.
HALL, HENRY B. S.		

JUNIOR TECHNICIANS AND LABORATORY ASSISTANTS

ALLEN, LOUISE M.	ENGLISH, JEAN	PASLEY, GALE G., JR.
ANDERSEN, NELLIE E.	FISHER, DORIS M.	SCHARFF, EILEEN J.
ATWOOD, BARBARA	HOFFER, ALBERTA	SCHARFF, MARGARET
BROWN, JOAN A.	HODGKINS, HARRIET M.	SHELNUT, EVA M.
CHILDS, SHIRLEY A.	KLEBBA, CONSTANCE F.	TOLLIOS, EVANGELINE P.
CLARKE, GLORIA S.	KNOTT, PRISCILLA A.	VAIL, VIRGINIA
COBB, MARY C.	MASON, BARBARA H.	WILSON, ESTHER N.
DIACO, ELIZABETH S.	MURPHY, ALICE E.	YARNOLD, DOROTHY
DIMMOCK, RICHARD H.		

ADMINISTRATIVE AND SECRETARIAL STAFF

ALLEN, NORMAN T.	DONALD, MARY	ORTOLANI, MARY
BACKUS, JEANNE M.	FERRIS, ALICE H.	OSTIGUY, BETTY P.
BEHRENS, HENRY G.	GRIFFIN, T. S. PERRY	PHILLIPS, HELEN F.
BROADBENT, MADELINE P.	HAHN, JAN	RYDER, FRANCIS C.
BROWN, VIVIEN R.	HALDERMAN, PATRICIA A.	SOUZA, JANE C.
BRYANT, EDWIN T.	LOPES, JEAN C.	SPARKS, ELIZABETH C.
CASILES, PHYLLIS D.	MCGILVRAY, JOHN	WOODWARD, FRED C., JR.
CONLAN, MARCUS J.	MELLOR, FLORENCE K.	YOUNG, ANITA M.
CRAIG, MARGARET W.	OAKLEY, GILBERT, JR.	

SERVICE AND MAINTENANCE STAFF

BAILEY, FRANK A.	GIFFORD, JAMES E.	SOLBERG, OTTO
BLAKE, FORREST W.	HANDY, HARRY H.	SPENCER, ALLARD T.
BODMAN, RALPH H.	HODGKINS, HARRY L.	STANSFIELD, RICHARD
BOWMAN, WARREN O.	LANE, MARIAN O'D.	STIMPSON, JOHN W.
CONDON, J. WILLIAM	MORRISON, KENNETH	THAYER, LAWRENCE A.
DINGWELL, PAUL E.	NICKELSON, ELLEN T.	TURNER, CATHERINE
ELDRIDGE, STANLEY N.	PINGREE, FREDERICK DEW.	WALDEN, ROBERT G.
FISHER, PHYLLIS	RENNIE, THOMAS D.	WHITTEMORE, EUGENE H.
FISHER, STANLEY O.	RONNE, F. CLAUDE	WILDE, PHILLIPS B.
GALLAGHER, WILLIAM F.	SALTHOUSE, JAMES	WING, CARLETON R.
GASKELL, FRED	SODERLUND, IDA S.	WING, NATHANIEL R.
GEGGATT, BARBARA G.		

OFFICERS AND CREWS OF BOATS AND VESSELS

BACKUS, CYRIL	FAY, DONALD H.	PIKE, JOHN F.
BACKUS, HAROLD	HAZELL, RAYMOND A.	POOLE, STANLEY E.
BAILEY, HURLBURT E.	IVERSON, NILS C.	RICHARD, MATHIEW
BAILEY, JAMES S.	KARLSON, ARVID	RODERICK, MILTON
BARSTOW, ELMER M.	LANE, ADRIAN K.	SCHROEDER, JOHN J.
BOSWORTH, RUSSELL E.	LINDQVIST, GUS	SILVA, MANUEL F., JR.
CASILES, DAVID F.	MYSONA, EUGENE J.	SPALDING, OAKES A.
CAVANAUGH, JAMES J.	O'KEEFE, WILLIAM P.	SPOHR, CHARLES D.
COOK, HANS	PIERCE, SAMUEL F.	STARRETT, DONALD A.
EMERY, GEORGE D.		

Scientific Program

While the administrative problems of operating a research laboratory are numerous, especially in the case of one which deals with the ocean and requires the operation of vessels as a major tool of the laboratory, all of

these, however, are secondary to the scientific accomplishments. The following account of activities during the year 1950 reveals the progress that is being made, as here and there our knowledge of such a vast and complex subject as the oceans increases. Since the record of scientific results rests directly on the ability (individually and teamwise) of the investigators themselves, a few words about some of the members of the staff largely responsible for progress, and a description of their particular fields of research, follow.

Mr. Frederick C. Fuglister has continued in a very effective manner to provide the leadership in studies involving the circulation and the distribution of temperature and salinity. More than anyone else at Woods Hole he is responsible for the very successful multi-ship survey of the Gulf Stream (known as Operation CABOT) which took place in June. Dr. Rossby spent a fortnight at Woods Hole in September working with this new material, which is also of significance to upper air meteorology. Roughly speaking, changes which take place in the pattern of flow in the atmosphere in a day are spread out over a week in the ocean. Thus in oceanography there is much more time in which to observe the details of the changes. A large loop south of Halifax, for example, was observed to detach itself from the Gulf Stream during a period of four or five days and become an isolated anti-clockwise eddy, the equivalent of a low pressure area in meteorology.

Dr. Edmond E. Watson, University of Toronto, who has worked at the Institution for many summers as a part-time staff member, made a series of current meter observations in the Gulf Stream to determine the direction and velocity of the current at several depths. Few observations exist on the velocity depth distribution. Further report of this work which is continuing will be submitted later.

Mr. Henry M. Stommel has taken up a study of the ways in which heating progresses downward in the sea; in other words, he would like to be able to explain the development of a thermocline in detail. To date he has been mainly working in a local pond where he finds it easier to control his observations, but where the necessary return flow to the wind induced circulation adds an additional complication. That lines of convergence exist at the surface during times when heating is taking place is becoming more and more evident and is very difficult to explain. The same phenomena have recently been observed at sea.

Dr. J. B. Hersey, who is our leader in underwater acoustics, has managed to find time to make some extremely interesting observations on the frequencies returned from various levels in the sea by biological scatterers. Until now we have only been aware of organisms which scatter 20 kilocycle sound. Other populations exist which return little or no energy at this

frequency, but can be easily detected at considerably lower frequencies. Thus the possibility exists that through acoustics one can learn not only at what depths various parts of the population are concentrated, but also something about the size and possibly the number of animals involved. This seems to be the beginning of the quantitative observation of the larger forms in the sea which to an unknown degree are able to avoid nets. A very nice feature of the sort of biological instrument that now looks feasible is that it would not require stopping the ship and that it would essentially describe the distribution of animals existing in a strip of the ocean several miles wide along whatever tract the ship might travel.

Mr. Arthur A. Klebba has been working on a class of oceanographic instruments which are intended to secure continuous information over considerable periods of time. This is a type of instrument that has been sadly neglected in oceanography in the past. He has developed a cheap and reliable "clock" that will run for periods up to five years, although it is doubtful that we will be sufficiently patient to leave the instrument in operation for quite so long a time. Combined with a simple temperature element his "clock" easily becomes a bottom temperature recorder which should be most useful in fisheries investigations. At present Mr. Klebba is completing a current meter which will record continuously for one year. Again the special feature of the instrument is that its component parts can be cheaply and easily made so that considerable numbers of anchored current meters can be used and so that losses will not be a serious matter.

Mr. William S. von Arx has continued to devote his attention to electromagnetic methods of observing ocean currents. His comprehensive paper on this important subject has now been published. It is interesting that Mr. von Arx spent much time worrying about improving the accuracy of his system and about its limitations. Having finally convinced himself that he thoroughly understood all the factors involved, he began to think about improved navigation. Last autumn he navigated the ATLANTIS back and forth across the Gulf Stream during a period of about ten days entirely on the basis of the signals coming in over his electrodes. At the end of some 1,500 miles, his dead reckoning was only in error by about two miles. Further thought, and tests, has convinced him that he has a new and potentially accurate navigation system within his grasp.

Mr. Alfred H. Woodcock has continued his interesting study of the distribution, size range and role of salt nuclei in the atmosphere. He has turned out several papers on this subject during the past year and more are in various stages of completion. Because of the salt in the air there seems to be important differences between clouds forming over the sea and clouds forming over the land. This is just one of several ways in which

low level marine meteorology differs from land meteorology. The more Mr. Woodcock explores this subject the more convinced he becomes of its importance.

Dr. Arnold B. Arons is spending the first summer at Woods Hole during which he has no responsibilities for work for the Bureau of Ordnance. He has taken a great interest in several of the investigations mentioned above where his knowledge of physical chemistry and mathematics can be brought to bear. At the same time he has been formulating problems in the bio-physics of sea water for which he hopes to be able to undertake measurement programs during the next few years. We are very pleased that Dr. Arons considers it worth his while to take an active part in oceanographic research and to bring some of his students here each summer.

Dr. George L. Clarke has undertaken the writing of a text book on ecology. He has already completed the first draft which he is now in the process of revising. He hopes to have the manuscript essentially complete by early 1951, when he will have leave from Harvard to go abroad in order to learn about the most recent work at first hand.

Dr. H. R. Seiwel secured an important series of surface wave data off Bermuda. During a six week period he observed the whole spectra of wave periods existing in the open ocean in an area where the weather data are particularly complete. The Naval Research Laboratory supplied the vessel and funds for the analysis of the results. The observational technique was such that even the capillary waves were recorded.

Mr. Dean F. Bumpus has continued to study the coastal waters south of Cape Hatteras and has also given some attention to circulation in shallow bays. A study of Great South Bay, Long Island, is being supported by the town of Islip.

Mr. John F. Holmes in a very determined manner attempted in March and April to make a start on the oceanography of the North Polar Basin. The Tenth Rescue Squadron of the Air Force agreed to land him at a number of points on the ice. He successfully arranged for the transportation of his equipment to an air strip on the northern coast of Alaska, but after arriving there he was beset by mechanical failures. Only one landing was made, which was very nearly disastrous. However, Mr. Holmes returned convinced that it is entirely feasible to carry out a program of Arctic oceanography, provided a suitable plane and crew are assigned on a continuing basis to this particular type of operation.

Dr. B. H. Ketchum, besides directing work in bacteriology under a grant from the U. S. Public Health Service, has become much interested in improving the technique of calculating flushing in an estuary on the basis of measurements of land drainage, the tide and the cross sectional

area of the water along the channel. He has revised the tidal prism concept of the engineers so that it now provides reliable estimates of the degree of pollution to be expected at varying distances from the source.

Mr. Henry C. Stetson has very nearly finished working up the considerable collection of bottom cores which he secured from the western half of the Gulf of Mexico several years ago. He is now planning a similar operation in the eastern half of the area, beginning about the middle of January.

At year-end the morale of the staff is high and the incentive to continued valuable results is keen.

VI. PUBLICATIONS

The following forty-six contributions were published during 1950:*

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ARONS, A. B. and D. R. YENNIE. Phase Distortion of Acoustic Pulses Obliquely Reflected from a Medium of Higher Sound Velocity. <i>Jour. Acoust. Soc. Amer.</i> , Vol. 22, No. 2, pp. 231-237. 1950	490
BIGELOW, H. B. and W. C. SCHROEDER. New and Little Known Cartilaginous Fishes from the Atlantic. <i>Bull. Mus. Comp. Zool.</i> , Vol. 103, No. 7, pp. 385-408. 1950	511
BUNKER, ANDREW F. Fluctuations of the Vertical Component of the Wind Associated with the Outflow of Cold Air from a Thunderstorm. <i>Bull. Amer. Met. Soc.</i> , Vol. 31, No. 5, pp. 178-180. 1950	502
CLARKE, GEORGE L. Conservation and the Productivity of the Sea. <i>Gamma Alpha Rec.</i> , Vol. 40, No. 4, pp. 95-101. 1950	520
CLARKE, GEORGE L. and D. F. BUMPUS. The plankton sampler—an instrument for quantitative plankton investigations. <i>Amer. Soc. Limnol. Ocean.</i> , Spec. Publ. No. 5 (revised) pp. 1-8. 1950	530
EWING, MAURICE, J. L. WORZEL, N. C. STEENLAND, and FRANK PRESS. Geophysical Investigations in the Emerged and Submerged Atlantic Coastal Plain. Pt. V: Woods Hole, New York, and Cape May Sections. <i>Bull. Geol. Soc. Amer.</i> , Vol. 61, pp. 877-892. 1950	480
EWING, MAURICE, J. L. WORZEL, J. B. HERSEY, FRANK PRESS, and G. R. HAMILTON. Seismic Refraction Measurements in the Atlantic Ocean Basin (Pt. 1). <i>Bull. Seismol. Soc., Amer.</i> , Vol. 40, No. 3, pp. 233-242. 1950	483
FORD, W. L. Seagoing Photoelectric Colorimeter. <i>Analytical Chemistry</i> , Vol. 22, pp. 1431-1435. 1950	492
HAHN, JAN. Some Aspects of Deep Sea Underwater Photography. <i>PSA Jour. Section B. Phot. Sci. Tech.</i> , Vol. 16, No. 6, pp. 27-29. 1950	508
HAURWITZ, BERNARD. Internal Waves of Tidal Character. <i>Trans. Amer. Geophys. Union</i> , Vol. 31, No. 1, pp. 47-52. 1950	477
HAURWITZ, B. and H. A. PANOFKY. Stability and Meandering of the Gulf Stream. <i>Trans. Amer. Geophys. Union</i> , Vol. 31, No. 5, pp. 723-731. 1950	513
HOUGH, J. L. Pleistocene Lithology of Antarctic Ocean-Bottom Sediments. <i>Jour. Geol.</i> , Vol. 58, No. 3, pp. 254-260. 1950	494
KETCHUM, BOSTWICK H. Hydrographic Factors Involved in the Dispersion of Pollutants Introduced into Tidal Waters. <i>Jour. Boston Soc. Civ. Eng.</i> , Vol. 37, No. 3, pp. 296-314. 1950	515
KNUDSEN, VERN O., ALFRED C. REDFIELD, ROGER REVELLE, and ROBERT R. SHROCK. Education and Training for Oceanographers. <i>Science</i> , Vol. 111, No. 2895, pp. 700-703. 1950	519

* Contribution numbers 475 and 510 were published in 1949.

	Contr. No.
MALKUS, JOANNE STARR. Cumulus, Thermals and Wind. <i>Soaring</i> , Vol. 13, Nos. 9-10, pp. 6-9, 12. 1949	475
MENARD, H. W. Transportation of Sediment by Bubbles. <i>Jour. Sed. Petr.</i> , Vol. 20, No. 2, pp. 98-106. 1950	476
MENARD, H. W. Current-Ripple Profiles and their Development. <i>Jour. Geol.</i> , Vol. 58, No. 2, pp. 152-153. 1950	493
MENARD, H. W. Sediment Movement in Relation to Current Velocity. <i>Jour. Sed. Petr.</i> , Vol. 20, No. 3, pp. 148-160. 1950	512
MILLER, ARTHUR R. A Study of Mixing Processes over the Edge of the Continental Shelf. <i>Sears Found., Jour. Mar. Res.</i> , Vol. 9, No. 2, pp. 145-160. 1950	518
MONTGOMERY, R. B. The Taylor Diagram (temperature against vapor pressure) for Air Mixtures. <i>Arch. Met. Geophys. Bioklim. A. Bd. II</i> , H. 2-3, pp. 163-183 1950	482
MOORE, H. B. The Relation between the Scattering Layer and the Euphausiacea. <i>Biol. Bull.</i> , Vol. 99, No. 2, pp. 181-212. 1950	535
PHLEGER, FRED B. and WILLIAM R. WALTON. Ecology of Marsh and Bay Foraminifera, Barnstable, Mass. <i>Amer. Jour. Sci.</i> , Vol. 248, pp. 274-294. 1950	507
POLLAK, M. J. Notes on Determining the Depths of Sampling in Serial Oceanographic Observations. <i>Sears Found., Jour. Mar. Res.</i> , Vol. 9, No. 1, pp. 17-20. 1950	488
POLLAK, M. J. The Water Structure in the Brownson Deep. <i>Trans. Amer. Geophys. Union</i> . Vol. 31, No. 3, pp. 393-397. 1950	495
PRATT, DAVID M. Experimental Study of the Phosphorus Cycle in Fertilized Salt Water. <i>Sears Found., Jour. Mar. Res.</i> , Vol. 9, No. 1, pp. 29-54. 1950	497
REDFIELD, ALFRED C. Some Applications of Oceanography to Engineering Problems. <i>Jour. Boston Soc. Civ. Eng.</i> , Vol. 37, No. 3, pp. 275-295. 1950	514
REDFIELD, ALFRED C. Hemocyanin. In: Copper Metabolism, A Symposium on Animal, Plant and Soil Relationships, W. D. McElroy and B. Glass, editors, <i>Johns Hopkins University Press</i> , pp. 174-190. 1950	525
REDFIELD, ALFRED C. The Analysis of Tidal Phenomena in Narrow Embayments. <i>Papers in Physical Oceanography and Meteorology</i> , Vol. 11, No. 4, pp. 1-36. 1950	529
SEARS, MARY. Notes on Siphonophores. 1. Siphonophores from the Marshall Islands. <i>Sears Found., Jour. Mar. Res.</i> , Vol. 9, No. 1, pp. 1-16. 1950	481
SEIWELL, H. R. A New Mechanical Autocorrelator. <i>Rev. Sci. Instr.</i> , Vol. 21, No. 5, pp. 481-484. 1950	504
SEIWELL, H. R. Problems in Statistical Analysis of Geophysical Time Series. <i>Sci.</i> , Vol. 112, No. 2905, pp. 243-246. 1950	505
SEIWELL, H. R. Ocean Wave Analyses. In: Symposium on Applications of Autocorrelation Analysis to Physical Problems, Woods Hole, Massachusetts, 13-14 June, 1949. <i>Office of Naval Research, NAVEXOS-P-735</i> , pp. 74-79. 1950	521
SOULE, FLOYD M. and C. A. BARNES. Physical Oceanography of the Ice Patrol Area in 1941. <i>U.S.C.G. Bull.</i> , 31, pp. 1-62. 1950	500
SOULE, FLOYD M., H. H. CARTER and L. A. CHENEY. Oceanography of the Grand Banks Region and Labrador Sea. 1948. <i>U.S.C.G. Bull.</i> 34, pp. 67-118. 1950	467

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SPIILHAUS, A. F., A. EHRLICH and A. R. MILLER. Hydrostatic Instability in the Ocean. <i>Trans. Amer. Geophys. Union</i> , Vol. 31, No. 2, pp. 213-215. 1950 . . .	479
STOMMEL, HENRY. The Gulf Stream. A Brief History of the Ideas Concerning Its Cause. <i>Sci. Mon.</i> , Vol. 70, No. 4, pp. 242-253. 1950	503
STOMMEL, HENRY. An Example of Thermal Convection. <i>Trans. Amer. Geophys. Union</i> , Vol. 31, No. 4, pp. 553-554. 1950	524
TURNER, HARRY J. JR. Report on Investigations of Methods of Improving the Shellfish Resources of Massachusetts. <i>Department of Conservation, Division of Marine Fisheries, Commonwealth of Massachusetts</i> , pp. 1-22. 1949	510
VACCARO, RALPH F., MARGARET P. BRIGGS, CORNELIA L. CAREY and BOSTWICK H. KETCHUM. Viability of <i>Escherichia coli</i> in Sea Water. <i>Amer. Jour. Pub. Health</i> , Vol. 40, No. 10, pp. 1257-1266. 1950	506
VON ARX, WILLIAM S. An Electromagnetic Method for Measuring the Velocities of Ocean Currents from a Ship Under Way. <i>Papers in Physical Oceanography and Meteorology</i> , Vol. 11, No. 3, pp. 1-62. 1950	499
VON ARX, WILLIAM S. Some Current Meters Designed for Suspension from an Anchored Ship. <i>Sears Found., Jour. Mar. Res.</i> , Vol. 9, No. 2, pp. 93-99. 1950	509
WOODCOCK, ALFRED H. Subsurface Pelagic Sargassum. <i>Sears Found., Jour. Mar. Res.</i> , Vol. 9, No. 2, pp. 77-92. 1950	489
WOODCOCK, ALFRED H. Condensation Nuclei and Precipitation. <i>Jour. Met.</i> , Vol. 7, No. 2, pp. 161-162. 1950	501
WOODCOCK, ALFRED H. Sea Salt in a Tropical Storm. <i>Jour. Met.</i> , Vol. 7, No. 6, pp. 397-401. 1950.	528
WORZEL J. L. and MAURICE EWING. Gravity Measurements at Sea, 1947. <i>Trans. Amer. Geophys. Union</i> , Vol. 31, No. 6, pp. 917-923. 1950	543

APPENDIX

ATLANTIS

January–December 1950

Cruise No.	Departure and Return	Days Duration	PORTS OF CALL	Scientist in Charge
160	5 Jan. 6 Mar.	61	Mid-Atlantic Ridge, to Bermuda, Martinique and return to Bermuda.	Mr. I. Tolstoy
161	10 Mar. 20 Apr.	42	To Sea—South of Bermuda and return to Woods Hole.	Dr. J. B. Hersey
162	11 May 19 May	9	To Sea—Continental Shelf off Gay Head.	Mr. A. C. Vine
163	5 June 24 June	20	To Sea—Participation in Operation CABOT—Gulf Stream Survey.	Mr. M. J. Pollak
164	8 July 22 Sept.	77	To Bermuda, San Juan and return.	Dr. M. Ewing
165	16 Oct. 4 Nov.	19	To Sea—Detail Section of Gulf Stream, Montauk-Bermuda Line.	Mr. L. V. Worthington
166	12 Dec. 15 Dec.	3	To Sea—Continental Shelf.	Mr. R. F. Wyrick

CARYN

January–December 1950

C-15	22 May 24 May	3	To Sea—Continental Shelf.	Mr. H. R. Johnson
C-16	3 June 16 June	14	To Sea—Participation in Operation CABOT—Gulf Stream Survey.	Dr. B. H. Ketchum
C-17	19 July	64	To Bermuda, Norfolk, Halifax and return.	Mr. P. C. Wuenschel
C-18	30 Oct. 31 Oct.	2	To Sea—Continental Shelf.	Mr. H. R. Johnson
C-19	5 Dec. 6 Dec.	1	To Sea—Continental Shelf.	Mr. A. C. Vine