THE WOODS HOLE OCEANOGRAPHIC INSTITUTION

REPORT FOR THE YEAR 1940

TABLE OF CONTENTS

I. TRUSTEES

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JOHN A. FLEMING, Carnegie Institution, Washington, D. C.
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To serve until 1941

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COLUMBUS O'D. ISELIN, Woods Hole Oceanographic Institution, Woods Hole, Mass.
LAWRASON RIGGS, JR., 120 Broadway, New York, N. Y.

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T. WAYLAND VAUGHAN, 3333 P Street, Washington, D. C.

III. REPORT OF THE TREASURER

To The Members and Trustees of the
Woods Hole Oceanographic Institution
Gentlemen:

The accounts for the year 1940 have been audited by Messrs. Stagg, Mather & Hough, public accountants.

During the year bonds costing $221,006.50 were redeemed at a net profit (after adding the applicable reserve for amortization) of $2,087.23 and $6,000.00. Commonwealth Edison were converted into 240 shares of common stock.

There was invested $111,070.00 in bonds and $92,546.43 in stocks.

The Special Income Account in which extra dividends are placed increased by $3,847.66.

Out of the appropriation of $4,800.00 for the reserve for periodic replacements a shipyard bill of $3,687.00 was paid, and the balance of $1,113.00 has been added to the Fund.

The Institution is working on two projects for the Government. It received $3,638.33 on Project No. 1 and spent $3,632.68. The credit balance of $5.65 appears in the balance sheet as a reduction of the accounts receivable.

In Project No. 2 the disbursements including accounts payable were $7,638.15, no part of which had been received at the end of the year, nor are any items included in expenses.

Under the contract for Project No. 2 there was receivable for share of expenses of boats and overhead $791.67 per month from October 1, 1940. No part of this was paid in the year and is not included as a receivable. It will be included in 1941 as a receipt.

The gross income on the securities in the Endowment Fund was about .0448 of the cost of the securities and .0472 of their market value at the end of the year.

The total expenses (not including the disbursements for the Government) exceeded the budget by $1,716.66 but were under receipts by $7,267.09.

Summaries of the balance sheet and comparative income and expense statements for 1940 and 1939 appear on pages 6 to 8.

Respectfully submitted,

Lawrason Riggs, Jr.,
Treasurer

BALANCE SHEET

ENDOWMENT FUND ASSETS

	Quoted Market Value		
Endowment fund assets:			
Bonds (less reserve for amortization of bond premiums $5,859.99)	$1,177,027.08	$1,205,307.26	
Stocks	$1,136,382.25	1,224,637.80	
Cash		23,275.00	$2,453,220.06
Reserve fund assets:			
Bonds	$ 8,832.50	$ 8,587.50	
Stocks	13,154.50	19,099.02	
Cash		1,188.38	28,874.90
			$2,482,094.96

PLANT ASSETS

Laboratory plant:		
Land	$ 27,072.32	
Buildings	323,213.12	
Laboratory equipment	21,361.93	
Crew room equipment	557.95	
Library	11,900.00	$ 384,105.32
Ship "Atlantis":		
Construction	$ 218,674.47	
Equipment	27,298.50	245,972.97
Small boat and equipment		6,570.55
		$ 636,648.84
Depreciation fund assets (for periodic replacements):		
Bonds (quoted market value $31,765.00)	$ 32,731.25	
Cash (including $1,113.00 due from current fund cash)	3,596.35	36,327.60
		$ 672,976.44

CURRENT ASSETS

Current Funds—Cash	$ 13,431.84	
Less—Due to special and depreciation funds	4,351.00	$ 9,080.84
Special income assets:		
Investments		
Bonds (quoted market value $23,172.50)	$ 22,797.50	
Stocks (quoted market value $1,107.44)	1,370.38	
Cash (including $3,238.00 due from current fund cash)	4,526.97	28,694.85
Accounts receivable—Navy projects No. 1 and 2	$ 7,632.50	
Interest accrued at date of acquisition on bonds purchased	487.09	8,119.59
		$ 45,895.28
Total assets		$3,200,966.68

DECEMBER 31, 1940

ENDOWMENT FUNDS

Endowment fund—General	$2,000,000.00	
Endowment—for upkeep of plant	419,419.96	
	$2,419,419.96	
Add—Accumulated net gain on securities called or sold	33,800.10	$2,453,220.06
Reserve fund	$ 23,395.57	
Add—Accumulated reserve fund income	5,479.33	28,874.90
		$2,482,094.96

PLANT FUND

Plant fund—General	$ 607,642.13	
Plant fund reserve—Transferred in prior years from current surplus	29,006.71	$ 636,648.84
Reserve for periodic replacements		36,327.60
		$ 672,976.44

CURRENT LIABILITIES AND SURPLUS

Accounts payable		$ 8,511.09
Capital surplus:		
Balance at December 31, 1939	$ 30,117.10	
Add—Excess of income over expenses for the year ended December 31, 1940	7,267.09	37,384.19
		$ 45,895.28
Total funds, current liabilities and surplus		$3,200,966.68

STATEMENT OF INCOME FROM ENDOWMENT FUND INVESTMENTS AND FROM CURRENT ASSETS, AND EXPENSES APPLICABLE THERETO, INCLUDING EXPENDITURES FOR PERMANENT PLANT ADDITIONS

FOR THE YEARS ENDED DECEMBER 31, 1940 AND DECEMBER 31, 1939

Income:						
From endowment funds:						
Interest (including in 1940 special income of $473.39)		$55,276.99			$60,174.44	
Dividends (including in 1940 special income of $3,363.88)		60,258.14	$115,535.13		53,942.52	$114,116.96
Less—Custodian fees and expenses			1,551.38			1,508.94
			$113,983.75			$112,608.02
Contributions received for operating expenses			—			1,633.26
Total Income				$113,983.75		$114,241.28
Expenses:	*Budget 1940*					
Upkeep of plant:						
Upkeep of Buildings and Grounds	$ 6,932.00	$ 7,634.94			$ 7,015.20	
Upkeep of "Atlantis"	7,500.00	10,118.80			9,423.10	
Upkeep of "Asterias"	150.00	182.03			833.91	
Insurance	5,833.00	5,889.89			5,658.17	
Depreciation	4,800.00	4,800.00			4,800.00	
	$ 25,215.00		$ 28,625.66			$ 27,730.38
Operating Expenses:						
Operation of "Atlantis"	$ 31,300.00	$30,406.79			$33,640.26	
Operation of "Asterias"	850.00	671.53			807.32	
Scientists' salaries	26,700.00	26,484.58			26,369.87	
Scientific supplies and equipment	6,000.00	4,950.69			6,013.52	
Traveling expenses	600.00	459.97			1,149.79	
Publications	3,000.00	2,714.71			3,053.37	
Administration	7,535.00	7,603.50			7,640.45	
Amortization of bond premiums	1,600.00	2,634.21			2,242.95	
Contribution to retirement fund	1,550.00	1,493.64			1,576.92	
Miscellaneous (staff meetings and "Anton Dohrn" expenses)	50.00	71.38			—	
	$ 79,185.00		$ 77,491.00			$ 82,494.45
Total expenses	$104,400.00		$106,116.66			$110,224.83
Expenditures for permanent plant additions:						
Additions to library	600.00		600.00			600.00
	$105,000.00			106,716.66		110,824.83
Excess of income over expenses				$ 7,267.09		$ 3,416.45

IV. ELEVENTH ANNUAL REPORT OF THE DIRECTOR FOR THE YEAR 1940

BY C. O'D. ISELIN

Our program of research has not remained unaffected by the war in Europe. It is of course no longer advisable to send the "Atlantis" too far from this coast, but so far this restriction has not been a serious one. Because of the increasing demand for trained meteorologists two of our staff have been asked to take on heavier teaching loads, while several others may at any time be called for active duty with the Army or Navy. Thus at a time when there is an increased demand for our cooperation with various governmental research agencies, we are faced with the temporary loss of some of our trained personnel, both on the "Atlantis" and in the laboratory.

During the past year the Institution's contract with the Bureau of Ships of the Navy Department has been gradually increased so that now a considerable part of our bacteriological and biological effort is directed towards a study of marine fouling organisms. Finally, the decision of the Trustees at their meeting in August to offer our facilities to the government has led to a contract with the National Defense Research Committee and to a considerable expansion of both equipment and personnel.

While these developments were taking place our ordinary oceanographic program was at first only slightly interfered with, but since October the entire time of the "Atlantis" and of several of our staff has been required for the new undertakings.

Equipment

There have been two important additions to our equipment during the past year. First, the Carnegie Institution of Washington turned over to us unconditionally their 70 ft. power boat "Anton Dohrn." While it will be necessary to make some alterations on deck to outfit her for these latitudes, her design and strength of construction are such that she is quite capable of extended offshore voyages during the summer months. Second, a small machine shop has been set up in the basement, so that for instrumental development and repairs we are no longer dependent on commercial companies.

In February the "Atlantis" passed her required Lloyd's survey. This was a complete hull and engine survey, the most thorough we have yet had to undergo. More recently a new bilge and fire pump was installed and in November much of the electric wiring of the main trawl winch was renewed.

Three new bottom sampling devices have been bought: the first, a heavily weighted tube to take the place of the Piggot gun; the second, an ordinary $2\frac{1}{2}$ cu. ft. clam shell bucket of commercial design; and the third, a new Stetson sampler to replace one that was lost.

Minor items of new scientific equipment include 4 reversing thermometers and 3 plankton samplers.

Accidents

In heavy gales last winter the forstaysail boom on the "Atlantis" broke in two and the mizzen boom became badly cracked. A new boom for the jib was made locally and the mizzen boom was very skillfully repaired so that it is now considerably stronger than when new.

Loans

We have borrowed two continuous plankton recorders from Professor A. C. Hardy of Hull, England. These are the first such instruments to be used in this country and they will greatly advance our plankton program.

Library

Our contribution to the library of the Marine Biological Laboratory was the same this year as last, namely, $600. This sum was spent as follows: 39 current journals and monographs were subscribed to; 12 books were purchased; 2 back sets were completed and 2 partially completed; 56 volumes were bound. In addition, 65 current journals were received in exchange for our publications and 11 as gifts. About 305 additional journal numbers and reprints were donated to the library by members of our staff.

Personnel

During the year three new staff appointments were made by vote of the Executive Committee: Dr. Gordon A. Riley as Marine Biologist, Dr. Bostwick H. Ketchum as Associate in Marine Biology and Dr. William Maurice Ewing as Associate in Submarine Geology.

By the end of the year the following assistants and technicians were working specifically under the National Defense Research Committee's contract: Carlyle A. Crecelius, Robert J. McCurdy III, Gilbert Oakley, Jr., Allyn C. Vine and J. Lamar Worzel.

Fellowship holders who worked at the laboratory during the summer were: Dr. A. A. Abramowitz, Mr. John Dobson, Dr. Frederick Phleger, Mr. Andrew P. Stergion, Dr. George Wald and Mr. George C. Whiteley, Jr., Dr. Clinton M. Osborn, Miss Frances L.

Parker, Dr. Theodor von Brand and Dr. John H. Welsh worked under special grants.

There were four assistants to the various staff members and four volunteer workers. Seventeen institutions were represented during the year in the laboratory or on cruises of the "Atlantis." In all about 85 individuals, in addition to the crew of the "Atlantis," have taken part in our program.

Travel

Since September Dr. H. R. Seiwell has been on a visit at the Scripps Institution of Oceanography.

Publications

Number 4 of Volume VII and Number 1 of Volume VIII of "Papers in Physical Oceanography and Meteorology" appeared.

The following contributions were published during the year:

No. 62. H. R. Seiwell. Time Variability of Hydrographic Elements Determining the Dynamic Situation in the Western North Atlantic. Proc. Am. Philos. Soc., Vol. 82, No. 3, pp. 369–394. 1940.

No. 72. James B. Lackey. Some New Flagellates from the Woods Hole Area. The Amer. Midland Nat., Vol. 23, No. 2, pp. 463–471. 1940.

No. 187. J. L. Hough. Sediments of Buzzards Bay, Massachusetts. Journ. Sedimentary Petrology, Vol. 10, No. 1, pp. 19–23. 1940.

No. 215. Floyd M. Soule. Oceanography. Excerpt from International Ice Observation and Ice Patrol Service in the North Atlantic Ocean, Season of 1938. U. S. Coast Guard Bull., No. 28, pp. 113–173. 1940.

No. 231. Charles W. Hock. Decomposition of Chitin by Marine Bacteria. Biol. Bull., Vol. 79, No. 1, pp. 199–206. 1940.

No. 235. R. B. Montgomery. Observations of Vertical Humidity Distribution Above the Ocean Surface and their Relation to Evaporation. Papers in Physical Oceanography and Meteorology, Vol. VII, No. 4, pp. 1–30. 1940.

No. 237. H. R. Seiwell. Anchoring Ships on the High Seas. U. S. Naval Inst. Proc. Vol. 66, No. 12, Whole No. 454, pp. 1733–1740. 1940.

No. 239. Henry B. Bigelow. Medusae of the Templeton Crocker and Eastern Pacific "Zaca" Expeditions, 1936–1938. Zoologica, Vol. XXV (Part 3), pp. 281–321. 1940.

No. 241. George L. Clarke. Comparative Richness of Zoöplankton in Coastal and Offshore Areas of the Atlantic. Biol. Bull., Vol. LXXVIII, No. 2, pp. 226–255. 1940.

No. 242. C. P. Winsor and G. L. Clarke. A Statistical Study of Variation in the Catch of Plankton Nets. Sears Found. Jour. Mar. Res., Vol. III, No. 1, pp. 1–34. 1940.

No. 245. R. B. Montgomery. The Present Evidence on the Importance of Lateral Mixing Processes in the Ocean. Bull. Am. Meteorol. Soc. Vol. 21, No. 3, pp. 87–94. 1940.

No. 246. A. A. Abramowitz, F. L. Hisaw, E. Boettiger and D. A. Papandrea. The Origin of the Diabetogenic Hormone in the Dogfish. Biol. Bull., Vol. LXXVIII, No. 2, pp. 189–201. 1940.

No. 247. Clinton M. Osborn. The Experimental Production of Melanin Pigment on the Lower Surface of Summer Flounders *Paralichthys dentatus*. Proc. Nat. Acad. Sci., Vol. 26, No. 3, pp. 155–161. 1940.

No. 248. Elisabeth Deichmann. Report on the Holothurians, collected by the Harvard-Havana Expeditions 1938 and 1939, with a revision of the Molpadonia of the Atlantic Ocean. Mem. Soc. Cub. Hist. Nat., Vol. 14, No. 3, pp. 183–240. 1940.

No. 249. Mary Sears and George L. Clarke. Annual Fluctuations in the Abundance of Marine Zooplankton. Biol. Bull., Vol. LXXIX, No. 2, pp. 321–328. 1940.

No. 250. W. J. Clench and C. G. Aguayo. Notes and Descriptions of New Deep-Water Mollusca obtained by the Harvard-Habana Expedition off the Coast of Cuba. III. Mem. Soc. Cub. Hist. Nat., Vol. 14, No. 1, pp. 77–94. 1940.

No. 251. Athelstan F. Spilhaus. A Detailed Study of the Surface Layers of the Ocean in the Neighborhood of the Gulf Stream with the Aid of Rapid Measuring Hydrographic Instruments. Sears Found. Jour. Mar. Res., Vol. III, No. 1, pp. 51–75. 1940.

No. 254. Sidney C. T. Hsiao. A New Record of Two Flounders, *Etropus crossotus* Goode & Bean and *Ancylopsetta dilecta* (Goode & Bean) with notes on Postlarval Characters. Copeia, No. 3, pp. 195–198. 1940.

No. 255. Austin H. Clark. The Family Antedonidae in the West Tropical Atlantic. Mem. Soc. Cub. Hist. Nat., Vol. 14, No. 2, pp. 139–160. 1940.

No. 257. Charles E. Renn. Effects of Marine Mud upon the Aerobic Decomposition of Plankton Materials. Biol. Bull., Vol. LXXVIII, No. 3, pp. 454–462. 1940.

No. 258. C. O'D. Iselin. The Necessity of a New Approach to the Study of the Circulation on the Continental Shelf. Trans. Am. Geophys. Union, Twenty-first Annual Meeting, pp. 347–348. 1940.

No. 259. Henry B. Bigelow, Lois C. Lillick and Mary Sears. Phytoplankton and Planktonic Protozoa of the Offshore Waters of the Gulf of Maine. Part I. Numerical Distribution. Trans. Am. Philos. Soc. Vol. XXXI, Part III, pp. 149–191. 1940.

No. 260. Alfred H. Woodcock. Convection and Soaring over the Open Sea. Sears. Found. Jour. Mar. Res., Vol. III, No. 3, pp. 248–253. 1940.

No. 261. C. O'D. Iselin. Preliminary Report on Long Period Variations in the Transport of the Gulf Stream System. Papers in Physical Oceanography and Meteorology, Vol. VIII, No. 1, pp. 1–40. 1940.

No. 262. Lois C. Lillick. Phytoplankton and Planktonic Protozoa of the Offshore Waters of the Gulf of Maine Part II. Qualitative Composition of the Planktonic Flora. Trans. Am. Philos. Soc., Vol. XXXI, Part III, pp. 193–237. 1940.

No. 263. H. R. Seiwell. Preliminary Results of Measurements of Temperature- and Salinity-Variations in the Gulf Stream. Trans. Am. Geophys. Union. Twenty-first Annual Meeting, pp. 349–352. 1940.

No. 265. William J. Clench. A New Bathyaurinia from off Northern Florida. Mem. Soc. Cub. Hist. Nat., Vol. 14, No. 3, pp. 241–242. 1940.

No. 266. G. L. Clarke and D. F. Bumpus. The Plankton Sampler—an Instrument for Quantitative Plankton Investigations. Limnolog. Soc. of Amer., Spec. Pub. No. 5, pp. 1–8. 1940.

No. 268. Theodor von Brand and Norris W. Rakestraw. Decomposition and Regeneration of Nitrogenous Organic Matter in Sea Water. III. Influence of Tem-

perature and Source and Condition of Water. Biol. Bull., Vol. LXXIX, No. 2, pp. 231–236. 1940.

No. 269. Fenner A. Chace, Jr. Reports of the Scientific Results of the "Atlantis" Expeditions to the West Indies, under the joint auspices of the University of Havana and Harvard University. The Brachyuran Crabs. Torreia, No. 4, pp. 2–67. 1940.

No. 274. Fenner A. Chace, Jr. The "Atlantis" Expeditions to the West Indies in 1938 and 1939, under the joint auspices of the University of Havana and Harvard University. List of Stations. Woods Hole Oceanographic Inst. 1940.

No. 278. José T. Acosta. Algunos Foraminiferos Nuevos de las Costas Cubanas. Torreia, No. 5, pp. 3–6. 1940.

No. 279. Alfred C. Redfield and Alice Beale. Factors Determining the Distribution of Populations of Chaetognaths in the Gulf of Maine. Biol. Bull., Vol. LXXIX, No. 3, pp. 459–487. 1940.

No. 280. Claude E. Zobell. The Effect of Oxygen Tension on the Rate of Oxidation of Organic Matter in Sea Water by Bacteria. Sears. Found. Jour. Mar. Res., Vol. III, No. 3, pp. 211–223. 1940.

No. 283. William C. Schroeder. Some Deep Sea Fishes from the North Atlantic. Copeia, No. 4, 231–238. 1940.

Field Work

Operations of "Atlantis" for the year 1939:

Cruise 93: January 3–12; Biological Survey of Georges Bank.

Cruise 94: January 17–March 17; Southward to Gulf Stream waters off Jacksonville, Florida.

Cruise 95: March 21–April 3; Biological Survey of Georges Bank.

Cruise 96: April 17–27; Biological Survey of Georges Bank.

Cruise 97: May 7–16; Biological Survey of Georges Bank.

Cruise 98: May 28–June 8; Biological Survey of Georges Bank.

Cruise 99: June 12–14; Testing the bathythermograph.

Cruise 100: June 18–27; Biological Survey of Georges Bank.

Cruise 101: July 9–17; Deep anchor station south of Montauk Point.

Cruise 102: July 22–27; Seismic experiments in deep water south of Montauk Point.

Cruise 103: July 31–Aug. 6; Southward along the continental slope to Virginia for bottom samples and bottom dredging.

Cruise 104: August 20–29; Survey of an eddy at the edge of the Gulf Stream.

Cruise 105: September 3–8; Anchor station off Georges Bank.

Cruise 106: September 17–28; Seismic experiments in deep water south of Montauk Point.

Cruise 107: October 22–November 1; Gulf Stream section.

Cruise 108: November 21–December 3; Gulf Stream section.

Cruise 109: December 11–13; Testing the bathythermograph.

Summary of observations:

Total distance sailed	14,221
Number of days at sea	226
Deep hydrographic stations	50
Shallow hydrographic stations	298
Bathythermograph lowerings	450
Serial temperature lowerings of internal waves	65
Plankton hauls	733
Blake trawl tows	9
Bottom samples	30

"Asterias" was in use during the summer months for the usual short trips near Woods Hole and in Massachusetts Bay. William McCulley was in charge, assisted by W. K. Maas.

Scientific Program

Signs are multiplying that the recent expansion in physical oceanography may be in danger of running its course. It has become increasingly clear that the technique of water-bottles and reversing thermometers will not answer some of the important problems in which we are most interested. Thus during the last year or two we have been feeling out new approaches. One promising method depends on combining the bathythermograph with a pressure-operated, multiple, water sampling device. Such an instrument has been built by Dr. Spilhaus and operates successfully while the "Atlantis" is at full speed.

While we have great hopes that this instrument will lead to a better understanding of lateral frictional forces and small scale mixing processes, there are other phenomena which will perhaps require different methods. In shallow and weak currents the circulation theorem leads to very unsatisfactory results and it is becoming more and more evident that for hydrographic work on the continental shelf we need a method of measuring mass cross current transfer.

This whole problem has been emphasized by the six surveys of Georges Bank which were made during the past year, and the difficulties we are encountering in this investigation illustrate very nicely the necessity for team-work in oceanographic research.

The Georges Bank program, begun in September 1939, was conceived primarily as a biological project. We undertook to study the factors influencing the survival of haddock during their planktonic stages. While the program is centered around the young haddock, it need not be considered a fisheries investigation. The dangers which

the haddock eggs must survive are typical of those which beset many other groups of marine animals and of course in sampling the haddock eggs we must also sample the whole plankton population. It was decided to pay special attention to the haddock because as a nursery ground for these fish Georges Bank can be considered as a unit. Moreover, in the statistics of the trawler fishery we will have the best sort of information concerning the relative success of the various year classes now being studied in their planktonic stages. Finally, here is an investigation which if repeated for a number of years might throw light on one of the most interesting of oceanographic problems. Is the great variability from year to year in the reproduction of many marine forms mainly due to biological or to physical factors? Are the haddock eggs particularly delicate, are most of them destroyed by enemies or does the success of each year class depend mainly on the current system prevailing over the spawning grounds? The physical oceanographers of course favor a strictly physical explanation, while the biologists are inclined to hunt for biological factors.

To properly analyze the extensive series of plankton hauls made last spring on Georges Bank in the course of the six surveys it is necessary to consider the variations in the currents and to learn whether or not a considerable part of the population of the bank waters was swept off the bank. A preliminary study of the hydrographic data only emphasizes how little the ordinary observations can tell us about the all important lateral movements. In short, the main goal of this biological program will probably not be achieved unless the physical oceanographers can devise a new approach to the problem of circulation in shallow areas.

The Georges Bank surveys are representative of one method of marine biology. Another approach, and one which in the end is bound to yield results, is based on a long accumulation of quantitative records. Dr. Sears has taken charge of this aspect of our plankton program. Already about 1700 cards have been filled out and filed away. About 500 more tows await analysis. We will then have in convenient form information on all available quantitative plankton hauls off this coast since 1929. It is likely that Dr. Sears can show that hauls from certain key stations are representative of the production over wide areas. Thus before long it may be possible to follow the variations in productivity from year to year by means of relatively few tows. The ultimate aim of course is to correlate the changes in the plankton with the variations in the fisheries.

I will mention only one other line of work in which we have been having some success, because it illustrates very nicely how careful

observations at sea can sometimes provide a clue which will open up a whole new field. For some time it has been clear that those who have been developing the theory to account for the transfer of energy between the winds and the sea surface have of necessity had to oversimplify the problem. Then a few years ago Dr. Langmuir called our attention to the lines of gulf weed often seen in mid-Atlantic. People have been looking at gulf weed for centuries and apparently no one ever stopped to wonder why sometimes it was scattered at random and at other times it was collected in long parallel bands extending down wind. Dr. Langmuir suggested alternating bands of convergence and divergence in the surface layer, but such a pattern of flow did not fit in with any known oceanographic theory.

Mr. Woodcock, because he spends so much time on the "Atlantis," seemed the logical person to interest himself in this question and he began to collect observations in the hope that he could correlate the behavior of the gulf weed with the strength of the wind and the distribution of temperature and salinity in the surface layer. But Mr. Woodcock was also interested in bird flight and he had been watching sea birds for several years. He had noticed that the herring gulls exhibit three distinctive flight responses and he had been collecting data on the wind velocity and on the difference in temperature between the air and the water (a measure of convection) in the hopes of explaining these various flight tactics. While watching the gulf weed and gulls day after day it occurred to him that the two phenomena were perhaps connected. When the air was unstable and when the wind was above a certain critical velocity he noticed that the soaring gulls lined up just as the gulf weed does. Apparently at times there are bands of convergence and divergence in the air, extending down wind and similar to the cells in the surface layer of the ocean which are indicated at times by the distribution of the weed. In both mediums the cellular structure is dependent on instability.

Further study of instability in the surface layer of the sea is now in progress, but it is not yet clear how important a part the wind plays in maintaining the vertical circulation. The herring gull observations indicate that there are several critical wind velocities where the whole pattern of turbulence changes in the lower layer of the atmosphere, but in the water such changes are more difficult to observe. At any rate, the experience to date is a good illustration of the progress which is often made in oceanography when physics and biology proceed hand in hand.

V. STAFF

(As of December 31, 1940)

COLUMBUS O'D. ISELIN, Associate Professor of Physical Oceanography, Harvard University, and Assistant Curator of Oceanography Museum of Comparative Zoölogy; Director.

CORNELIA L. CAREY, Assistant Professor of Botany, Barnard College; Associate in Marine Bacteriology.

GEORGE L. CLARKE, Associate Professor in Biology, Harvard University; Marine Biologist.

WILLIAM MAURICE EWING, Associate Professor in Geophysics, Lehigh University; Associate in Submarine Geology.

BOSTWICK H. KETCHUM, Associate in Marine Biology.

RAYMOND B. MONTGOMERY, Lecturer on Maritime Meteorology and Oceanography, Assistant Professor of Meteorology, New York University; Physical Oceanographer.

ALBERT E. PARR, Director of Peabody Museum and Curator of the Bingham Oceanographic Collection, Yale University; Associate in Oceanography.

NORRIS W. RAKESTRAW, Associate Professor of Chemistry, Brown University; Chemical Oceanographer.

ALFRED C. REDFIELD, Professor of Physiology, Harvard University; Associate in Marine Biology.

CHARLES E. RENN, Tutor in Biology and Instructor in Sanitary Engineering, Harvard University; Associate in Marine Bacteriology.

GORDON A. RILEY, Marine Biologist, Yale University; Marine Physiologist.

C.-G. ROSSBY, Professor of Meteorology, Massachusetts Institute of Technology, and Assistant Chief, U. S. Weather Bureau, Washington, D. C.; Associate in Physical Oceanography.

MARY SEARS, Instructor in Zoölogy, Wellesley College; Planktonologist.

H. R. SEIWELL, Physical Oceanographer.

FLOYD M. SOULE, Principal Physical Oceanographer, U. S. Coast Guard; Associate in Physical Oceanography.

ATHELSTAN F. SPILHAUS, Associate Professor of Meteorology, Chairman of the Department of Meteorology, New York University; Physical Oceanographer.

HENRY C. STETSON, Research Associate in Paleontology, Museum of Comparative Zoölogy; Submarine Geologist.

SELMAN A. WAKSMAN, Microbiologist, New Jersey Agricultural Experiment Station; Marine Bacteriologist.

EDMOND E. WATSON, Assistant Professor of Physics, Queen's University; Physical Oceanographer.

DEAN F. BUMPUS, Biological Technician.

CARLYLE A. CRECELIUS, Instrument maker.

SIDNEY C. T. HSIAO, Technician in Physical Oceanography.

ROBERT J. MCCURDY, III, Physical Technician.

GILBERT OAKLEY, Observer.

ELIZABETH ORR, Chemical Technician.

HELEN F. PHILLIPS, Secretary to the Director.

ALLYN C. VINE, Physicist.

CHARLES M. WEISS, Bacteriological Technician.
ALFRED H. WOODCOCK, Oceanographic Technician.
J. LAMAR WORZEL, Physical Technician.

WILLIAM C. SCHROEDER, Business Manager.
ETHELYN T. BIRD, Secretary.
WILLIAM SCHROEDER, Superintendent of Buildings and Grounds.

APPENDIX

Reports of progress by investigators working at the Institution during 1940.

MOULTING IN BLUE CRABS

A. A. ABRAMOWITZ

Removal of both eyestalks, or of the anterior half of both eyestalks resulted in a definite acceleration of moulting. Within the experimental period, all operated animals moulted (some moulted twice) while only a few (twenty per cent) of the control animals moulted. Due to the extreme paucity of animals (the total number obtained all summer was twenty-six) this conclusion in relation to its commercial possibilities should be regarded only as tenative until several large scale experiments can be run.

PRODUCTIVITY OF GEORGES BANK

GEORGE L. CLARKE

An investigation has been begun of the steps in the biological cycle which underlie the productivity of Georges Bank. This bank is an important fishing ground equal in size to the state of Massachusetts and lying east of Cape Cod. During the past year seven cruises were made to Georges Bank and on each occasion a net-work of 21 to 52 stations were occupied over the area. At each station the following work was done: (1) hydrographic measurements for temperature and salinity; (2) transparency measurements; and (3) zoöplankton hauls with the plankton sampler for the smaller organisms and with stramin nets for the larger organisms. Preliminary tests were made for extensive dredging operations over the bank for the investigation of the bottom organisms.

The data obtained on the seven cruises are now in the process of analysis. Preliminary inspection of the material indicates the following: An extensive diurnal vertical migration of certain elements of the plankton takes place. The center of the bank is occupied by certain characteristic species whereas other species dominate the margins of the bank. The plankton reached its lowest ebb in January and became most abundant in June. The type of plankton changed markedly with the season. The eggs of haddock, which is the most important of the commercial fish on the bank, were found in the plankton beginning in March, and their drift to the south and west could be followed until May. Great changes in the phytoplankton were observed seasonally but since no bottom-living plants were detected at any time, the latter evidently do not enter into the economy of the bank. The continu-

ation and the extension of this investigation is planned for the current year.

DEEP SEA SEISMIC METHODS AND BOTTOM PHOTOGRAPHY

W. M. EWING

During the winter on "Atlantis'" southern cruise a number of satisfactory tests of the redesigned seismic equipment were made in deep water. While the timing of the salt releases was not sufficiently dependable to enable us to secure an indisputable record of the thickness of the sediments, the fact that losses of apparatus were trivial indicated the feasibility of gasoline filled floats as a method for taking instruments to the bottom and returning them safely to the surface.

On a summer cruise, with improved salt releases, two complete oscillograph records of explosions at depths of 1800 and 2300 fathoms were finally achieved. There is now little doubt that the equipment is capable of securing a satisfactory seismic profile when the "Atlantis" is next free to resume this sort of work.

While these tests were in progress experience was also gained in the technique of bottom photography. Using flash bulbs and a camera enclosed in a glass chamber, 60 sets of pictures were obtained from the Georges Bank area in depths as great as 200 fathoms. Before the camera chamber failed, several photographs were also made at very much greater depths (2000 fathoms).

STUDIES IN PHYSICAL OCEANOGRAPHY

C. O'D. ISELIN

Further study of the tide gauge method for measuring the strength of currents has not been particularly fruitful. Mean monthly sea level at most tide gauge stations appears to be influenced so much by the local weather that no system of smoothing the data can be depended upon to give a detailed record of the changes due only to offshore currents. Favorably located stations such as Miami and Cat Cay may in the future be expected to give good results when a longer record has accumulated.

Some attention was given to the problem of determining the gradient current pattern in a shallow area such as Georges Bank. It seems clear that the ordinary temperature and salinity data will have to be supplemented by more specialized and detailed observations.

Mr. Woodcock's study of instability at the sea surface and in the lower layer of the atmosphere has continued with excellent results. The general oceanographic significance of his observations is becoming more and more apparent.

STUDIES IN PHYSICAL OCEANOGRAPHY AND METEOROLOGY

R. B. MONTGOMERY

1. Studies of the kinematics and dynamics of the waters in the Straits of Florida were continued. A short report has been published on the sea level difference between Key West and Miami, indicating that its fluctuations do not serve as a useful index of fluctuations in the velocity of the Florida Current.

2. The transfer of carbon dioxide between atmosphere and ocean was investigated.

3. With Mr. Sykes' assistance a table was comupted with the purpose of obtaining more accurate calculations of density from chlorinity determinations.

4. Jointly with Professor Spilhaus, and with the assistance of Mr. Sykes and Mr. Pollak, the preparation of mean isentropic charts of the ocean was initiated.

STUDIES ON THE PIGMENTATION OF FLATFISHES

CLINTON M. OSBORN

During the summer season improvements were made in the techniques used in growing ventral pigment on the summer flounder. Under the most favorable conditions an appreciable growth of melanophores could be detected after 90 hours of experimental treatment. That light is a significant factor in the development of the pigment was indicated in two ways: 1) melanophores failed to develop in areas covered by opaque masks, and 2) melanophores failed to grow on the ventral surfaces of flatfishes kept in total darkness (all other experimental conditions remaining unchanged).

Preliminary denervation experiments indicate that the ventral melanophores develop with equal facility in innervated and denervated areas. This is interpreted to mean that the cells which differentiate into melanophores may do so without stimulation through functional nerve endings.

It is believed that the question as to the origin of ventral melanophores in normally unpigmented areas has been answered by application of the "Dopa" technique. Totally unpigmented ventral scales possess numerous "dopa-positive" cells. Apparently these are the cells which develop melanin *in situ* when subjected to the proper experimental conditions. In nature, however, the ventral integument, although abundantly provided with "Dopa-positive" cells, remains unpigmented due to inadequate stimulation.

CORE FORAMINIFERA FROM THE CONTINENTAL SLOPE

FRED B. PHLEGER, JR.

During the past season additional data have been obtained on the distribution of glacial Pleistocene foraminiferal faunas in the submarine cores, particularly of the Georges Bank region of the continental slope. The faunal work has been put on a quantitative basis and the tabulation of the detailed results is now in progress. The most important tentative result is the recognition of two or more apparent depth zones in the modern, bottom-living assemblage. The interpretation of this result will aid materially in solving problems connected with the Pleistocene history of the ocean, and also the interpretation of marine environments of rocks deposited in the more remote geologic past. The paper now in progress contains data and interpretations on fifty cores, and will be finished in the near future.

During the summer of 1939 it was demonstrated that living pelagic foraminifera could be collected and preserved successfully. This makes possible future investigation of horizontal and vertical distribution of living pelagic types, and this will have an important bearing on the interpretation of the faunas found in all the marine sediments.

CHEMICAL INVESTIGATIONS

NORRIS W. RAKESTRAW

The work on decomposition and regeneration of organic matter in sea water has been continued. The relation of the different parts of the cycle to each other has been studied, and it has been shown that the several stages may proceed simultaneously. A start has been made on the investigation of factors which determine the varying length of the total cycle. The influence of decomposing organic matter upon the dissolved gaseous nitrogen has also been studied, with no conclusive results as yet.

A long-range investigation is also under way to attempt to determine the rate of oxygen consumption in deep sea water, at and below the oxygen minimum layer.

Variations in the gaseous dissolved nitrogen have been followed in stored water over long periods of time, but the relation to other parts of the nitrogen cycle has not yet been definitely established.

OCEANOGRAPHY OF THE GULF OF MAINE

ALFRED C. REDFIELD

During the past season I have prepared and published two papers on the distribution of the plankton collected during a survey of the Gulf of Maine made in 1933–34.

I have also worked on the preparation of a report on the distribution of oxygen in the Gulf of Maine at that time and am making a study of data on the distribution of oxygen in the Atlantic ocean in an attempt to determine the importance of isentropic mixing in the genesis of the layer of minimum oxygen and maximum phosphate concentration.

PHYTOPLANKTON OF GEORGES BANK

GORDON A. RILEY

The first year's work on the phytoplantkon of Georges Bank was largely concerned with the horizontal and vertical distribution of the plankton, and its relations with physical and chemical factors. During the summer months (September, 1939; May and June, 1940) there was a moderately high concentration of both phytoplankton and nutrients (nitrate and phosphate) in the shallow, central portion of the bank, with lesser quantities in the surrounding deeper water. The total quantity of plankton underlying a unit area of surface did not show such a stratification, however. During the January, 1940, cruise the plankton crop was small, showed little horizontal variation, and was concentrated near the surface. The spring diatom burst began in March in the shallow water in the central part of the bank and lasted until May. In the deeper water it began later and did not last as long, but at the height of the diatom burst in April the crop was of the same order of magnitude as in the shallow water.

From statistical analyses of the data it appears that the factors which limited phytoplankton growth on Georges Bank were light and vertical turbulence in winter, and in the summer, nutrients, zoöplankton grazing, and high temperature. The latter exerted a direct effect on the respiratory rate of the plankton and perhaps on flotation, and an indirect effect through its influence on vertical stability and zoöplankton activity. Rough estimates indicate that the mean standing crop of phytoplankton on Georges Bank varied from two to forty grams of carbon per square meter, and the total productivity from practically zero to one gram of carbon per square meter per day.

STUDIES ON FISHES

WILLIAM C. SCHROEDER

1. *The Deep Water Fauna Around Cuba.* The large collection of fishes trawled by "Atlantis" around Cuba in 1938 and 1939 has now been segregated for study and placed in the Museum of Comparative Zoology at Harvard. Some progress has been made on the identifications and descriptions of the sharks and skates.

2. *Migrations of Gulf of Maine Haddock.* A report has been completed based on data obtained during the years 1923–1932.

3. *Fishes of the Western North Atlantic.* In collaboration with Dr. H. B. Bigelow, work was started in the fall of 1940 on the sharks and skates and much progress had been made by the end of the year. Our paper dealing with sharks of the genus Mustelus in the western Atlantic was published in December.

PLANKTON STUDIES

MARY SEARS

1. The reports on the phytoplankton collected in the Gulf of Maine during 1933–1934 were completed.

2. The report on the phytoplankton for the Gulf of Maine as a whole made it clear that the phytoplankton cycle on Georges Bank had not been adequately followed. During the spring (1940), it was feasible to collect phytoplankton samples from this area and these have been studied using the same method as for the earlier collection. The report based on this collection is in progress.

3. The collection of zoöplankton samples along the profile from Montauk Point (or Martha's Vineyard) to the Sargasso Sea (Station B) has been continued, whenever feasible, for the study of the annual fluctuations in the zoöplankton populations of the coastal water and of the annual planktonic cycle of the offshore waters.

4. A collection of plankton made during 1939 in connection with the study of the ecology of the guano birds now being made by the National Guano Administration of Peru has been received for study. In July, the Institution sent two plankton samplers to Peru for use in making further collections.

5. The enumeration and identification of the "Dana" siphonophores has been continued.

INTERNAL WAVES

H. R. SEIWELL

Early in the year two anchor stations were occupied in the axis of the Gulf Stream off Cape Canaveral, Florida, and measurements of temperature, salinity and currents taken continuously over 48 hour periods.

In August I went to the Scripps Institution of Oceanography for a temporary visit in order to complete a statistical and geophysical analysis of internal wave data obtained the previous year in the southern North Atlantic. The results, which among other things, suggest a definite connection between internal wave and tidal mechanisms, will shortly be published.

Since the present international situation may force an interruption of my own research, work on other physical problems in progress last year has been temporarily discontinued in order that summaries and tabulations of the large masses of data on hand could be prepared in forms suitable for future use. A grant from the American Philosophical Society covered assistant expenses for routine computations during the first six months of this year.

During the spring and summer, Mr. Andrew Stergion, while assisting me at the Institution, prepared his thesis for a master's degree in mathematics at Massachusetts Institute of Technology under the joint direction of Dr. George Wadsworth and myself.

PHYSICAL OCEANOGRAPHY OF THE GRAND BANKS REGION AND LABRADOR SEA

FLOYD M. SOULE

During the months of January, February, and part of March, manuscript was completed for the section on oceanography of the U. S. Coast Guard Bulletin No. 29 (season of 1939). Included in this work was an analysis of two profiles of temperature and salinity anomaly to clarify the genesis of the isolated cold water masses frequently found near the Tail of the Grand Banks. Tables of the difference between σ_0 and σ_t for various values of temperature and density, and of σ_0 corresponding to various values of salinity were prepared to facilitate the plotting of lines of equal σ_t on temperature-salinity coordinates. Study of a single survey developed the existence of definite temperature-salinity correlations for the mixed water and Labrador Current water in the Grand Banks region. A comparison between the 1938 and 1939 thermal characteristics of the Labrador Current off South Wolf Island, Labrador, showed an offshore shift of this current

attributed to abnormal winds during the winter of 1938–39. The volumes of flow, mean temperature, and heat transfers of the Current at Cape Farewell were derived from observations made in 1939 and compared with seven previous occupations of the Labrador section and nine previous occupations of the Cape Farewell section.

The months of April, May and June were spent on the oceanographic vessel of the International Ice Patrol Force, the *General Greene*, making topographic dynamic charts of the Grand Banks region. Four surveys resulting in five charts of this area were made,the charts being referred to the 1000-decibar surface and based on 235 oceanographic stations. An additional 21 oceanographic stations were occupied from the surface to as near bottom as was practicable on a short post-season cruise of the *General Greene* along a section from South Wolf Island, Labrador, to Cape Farewell, Greenland, between June 25 and June 29.

A report on the oscillations of the glacier front in Arsuk Fjord, Greenland, covering measurements made by the U. S. Coast Guard between 1931 and 1936 was submitted to the Secretary, International Commission of Snow and Glaciers.

After the return of the *General Greene* to Woods Hole in July, the remainder of the year was devoted to analyses of data collected during the year, and to preparing for publication the oceanographic section of U. S. Coast Guard Bulletin No. 30 (1940 season).

STUDIES IN PHYSICAL OCEANOGRAPHY AND METEOROLOGY

ATHELSTAN F. SPILHAUS

1. A report on the results of a detailed study of the ocean to the depth of 150 meters in the neighborhood of the Gulf Stream was completed and published. The data analyzed in this work were taken on two cruises across the Stream in the summer of 1939. The first section (July 1939) consisted of a stretch of 175 miles with Bathythermograph soundings on an average of every 3 miles taken with the "Atlantis" traveling at full speed. An extremely detailed temperature structure was revealed indicating the presence of eddies of the size of 10 to 15 miles on the northwestern edge of the Stream. The second cruise in the same waters, in August, again showed the presence of eddies of about the size as those observed in July; on this cruise, however, the Pressure Operated Sea Sampler was used with the Bathythermograph and by employing the chlorinities thus obtained the eddies were substantiated by considerations of the temperature-salinity correlation. This work indicated the potentialities of the Bathy-

thermograph and Sea Sampler as oceanographic tools and demonstrated the great advantages of working with the vessel under way.

2. A cruise was completed in September, 1940, for the purpose of obtaining a quasi-synchronous representation of conditions over an area at the edge of the Gulf Stream. For this attempt the Thermographic Sea Sampler (Bathythermograph and Sea Sampler combined into a single unit) was used and about 250 stations were made during the execution of a spiral shaped course covering an area about 400 miles square. Oxygen and chlorinity determinations at seven points between the surface and 150 meters were made at each station. Preliminary analysis of the data points to results of extreme interest.

3. An investigation with Dr. R. B. Montgomery of certain aspects of isentropic analysis in the atmosphere is in progress.

SUBMARINE GEOLOGY

H. C. STETSON

It was found necessary to put in one more summer's field work to furnish more nearly complete data for the study on the sediments of the continental slope and on the seaward extension of the Coastal Plain, which is being undertaken jointly with Dr. Fred B. Phleger. The walls of every canyon from the Corsair Gorge to Norfolk Canyon have now been dredged in many places for outcrops of the Coastal Plain formations and eight that can be identified have been found. Numerous cores have been taken in every canyon as far seaward as they can be traced, as well as in all significant areas on the slopes which lie between. Dr. Phleger's investigations on the foraminifera of the 1939 cores, supported in part from a grant from the Penrose Fund of the Geological Society of America, are ready for publication, but it was thought best to wait until the field work was completed and publish them with my report.

Miss Frances L. Parker has completed her ecologic and quantitative study of the foraminifera of the continental shelf north of Cape Hatteras, and the report only awaits a final revision before publication.

Last spring Dr. M. Juul Hvorslev of the Soil Mechanics Department of the Harvard Engineering School designed a coring tube for us which operates on an entirely new principle. A tripper, operated by a pilot weight which hangs below the coring tube proper, releases it at a regulated distance above the bottom, allowing it to fall freely through the water. The upper end of the apparatus has four steering vanes, like an aerial bomb, and the weight is streamlined. A fall of only eight feet was required to drive the bit into the bottom its full

length of ten feet in any of the sediments encountered on last summer's cruise. This tube, while no more efficient than the Piggot gun, has the advantage of being simpler to operate.

DISSOLVED ORGANIC NITROGEN IN SEA WATER

THEODOR VON BRAND

The method of Krogh and Keys for the determination of dissolved organic nitrogen was tested in view of possible future field work. It was found that in sea water samples stored for a long time in the laboratory the values can be reproduced within reasonable limits of error without great difficulty. In freshly taken sea water the content of dissolved organic nitrogen remains practically unchanged in samples repeatedly analyzed throughout a storage period of about four weeks, provided that at the beginning the organisms had been removed by filtration through a dense glass sinter filter. If the organisms remained in the water, the dissolved organic nitrogen increases considerably. It is believed that the method, if used with necessary caution, will yield valuable results both in field work and in experiments on the decomposition of plankton.

VITAMINS A IN THE EYES OF INVERTEBRATES

GEORGE WALD

The retina of the squid, *Loligo pealii*, contains 1–2 micrograms of vitamin A_1, and about 3 times this quantity of retinene$_1$. No trace of these or other carotenoids occurs in other squid tissues. The vitamin A_1 does not appear to participate directly in the visual processes, since its concentration remains constant in all conditions of light and darkness. Retinene, however, is stored in large amounts in the retina, and in addition is liberated from the photosensitive complex on exposure of the dark adapted squid or the isolated retina to light. Retinene is in this sense the vitamin A of the squid—vitamin A_3. The squid appears to possess the simple visual cycle, visual purple$\rightleftharpoons$ retinene$+$(protein?).

The eyes of green and fiddler crabs (*Carcinus maenas* and *Uca pugnax*) also contain high concentrations of vitamin A_1. No trace of retinene has been found in these eyes.

There is therefore no discontinuity between vertebrates and invertebrates in the occurrence and utilization of vitamins A in the eye. Previous failures to identify vitamins A in invertebrate tissues may be ascribed to their segregation, perhaps exclusive, within the retinal tissues.

STUDIES IN MARINE MICROBIOLOGY

SELMAN A. WAKSMAN, BOSTWICK H. KETCHUM AND CHARLES M. WEISS

During the year 1940, nine investigators in marine microbiology have spent varying periods of time at the Oceanographic Institution. The Bureau of Ships of the U. S. Navy Department has established a project dealing with the study of the fouling of ships' bottoms, and most of the efforts of this group of workers were devoted to the solution of this problem. Dr. Phelps, who carried out most of the work during the summer, resigned on September 1, but is still associated with the project, carrying on experiments at Port Aransas, Texas.

The problems investigated concern the primary film which forms on surfaces submerged in the sea. The bacteria which form the film apparently do not differ from the normal population of the sea water, except in their ability to adhere firmly to a surface. Several types of bacteria have been isolated from panels exposed at Woods Hole, and studies of their physiological nature are being made.

The rate of formation of the films, and the amounts of organic and inorganic substances present in the films differ greatly at various times of year. As would be expected during the colder winter months the films formed slowly, whereas in the summertime the films formed very rapidly. The rate of formation of the film is closely related to the population of bacteria in the water at any given time. It is, therefore, influenced by the nature of the water, latitude and environmental conditions. The rate of formation of the film and its chemical composition are also influenced by the nature of the surface exposed.

Preliminary experiments indicate that the presence of the primary film on painted surfaces interferes with the attachment of barnacles and other macroscopic fouling organisms.

In addition to this project several other problems pertaining to the microbiology of the sea received consideration. It is sufficient to mention the work of Dr. C. Hock on the chitin decomposition by marine bacteria, and of P. Souder on the various types of bacteria found in sea water and in the sea bottom.

DIRECT MEASUREMENT OF CURRENTS

E. E. WATSON

Two short cruises were made for experiments on anchoring the ship and on the use of the recording current meter. On the first cruise the ship was anchored in 1500 fathoms, using a 300 lb. mushroom anchor and 240 ft. of chain, weighing about 600 lb., shackled to a

swivel on the end of the main ship's cable. The action of the chain was satisfactory, but the small mushroom was quite inadequate to keep the ship from dragging. A much larger mushroom or some other type of anchor will be necessary. Current measurements made from the ship while drifting freely on a calm day showed that at each depth the current is remarkably steady. Trouble with the meter circuit developed at depths of 400 meters or more, due to breakdown of the transformer oil into hydrogen and carbon by the tiny spark at the contact breaker in the meter. After various experiments to cure this trouble a type of snap action contact breaker with ratchet drive was designed and built into the meter. A damping disc was built to hang on the cable above the meter and in conjunction with the elastic suspension on deck this minimized the vertical motion caused by the roll of the ship.

The second cruise was made the first week in September, immediately after a storm. A hydrographic section run south from Georges Bank into deep water showed clearly the encroachment of warm Atlantic water onto the southern slope of the Bank. The meter was tested again in deep water and operated satisfactorily with the full 750 meters of cable out, but owing to strong winds there was a considerable wire angle and the actual depth of the meter was uncertain.

In the laboratory a simple towing truck was built for calibrating meter propellors in the tank room.

During the summer Mr. John Dobson assisted in all of the above work.

BOTTOM FAUNA OF GEORGES BANK

GEORGE C. WHITELY, JR.

Meter stramin-net bottom collections made in 1939–40 during winter and spring cruises of the "Atlantis" provided material for examination. In order to find what to expect from the tows, the first that had been made on Georges Bank since 1872, a dozen bottles from each cruise were examined. This preliminary investigation showed that about 18 Amphipod species, 9 Schizopod and 6 Decapod were numerically important.

Detailed numerical analysis of the collection was then begun.