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OF COLUMBIA UNIVERSITY

PALISADES, NEW YORK

BIOLOGICAL OCEANOGRAPHY

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LAMONT-DOHERTY GEOLOGICAL OBSERVATORY
OF
COLUMBIA UNIVERSITY

Palisades, New York 10964

Marine Biology Division

Cruise Report: ATLANTIC TWIN-72-1

Research Document: CU 3222-25

Submitted by J. Hillegas
C. Garside

May 8, 1972

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VESSEL: R/V ATLANTIC TWIN
FROM/TO: January 17, 1972-February 19, 1972
OPERATING AREA: 9-1/2 mi. E. of Gibbs Hill Light, Bermuda

PERSONNEL:	J. Currie, B.S.	Phytoplankton Ecology
	C. Garside, Ph.D. (Chief Scientist)	Hydrography
	A. Hagen	Engineering
	V. Harris (Graduate Student)	Zooplankton Analysis
	J. Hillegas, B.S.	Zooplankton Ecology
	W. S. Hoover (Student)	
	R. Levine (Graduate Student)	
	S. Williams, Ph.D.	Hydrographic Analysis

STATIONS OCCUPIED

<u>Station #</u>	<u>Date</u>	<u>Time</u>	<u>Description</u>
AT-72-1-01	1/22	1020	B.T. cast
-02	1/22	1040	B.T. cast
-03	1/22	1110	Surface temperature bucket
-04	1/22	1125	Hydrocast for nutrients and phytoplankton
-05	1/22	1510	202 μ double net tow
-06	1/22	1901	79 μ double net tow
-07	1/23	0540	B.T. cast
-08	1/23	0620	Hydrocast for phytoplankton and nutrients
-09	1/23	0950	79 μ double net tow
-10	1/23	1335	202 μ double net tow
-11	1/23	1421	1,000 μ single net tow
	1/23	1515	Return to St. Georges
-12	1/24	0906	B.T. cast
-13	1/24	0908	Surface temperature bucket
-14	1/24	0930	Hydrocast for nutrients and phytoplankton
-15	1/24	1128	79 μ double net tow
-16	1/24	1314	202 μ double net tow
-17	1/24	1450	1,000 μ single net tow
-18	1/24	1610	79 μ double net tow
-19	1/24	1717	202 μ double net tow
-20	1/24	1912	1,000 μ single net tow

<u>Station #</u>	<u>Date</u>	<u>Time</u>	<u>Description</u>
<u>AT-72-1-21</u>	1/25	0540	B.T. cast
-22	1/25	0600	Hydrocast for phytoplankton and nutrients
-23	1/25	0847	79μ double net tow
-24	1/25	1000	202μ double net tow
-25	1/25	1138	1,000μ single net tow
	1/25	1230	Return to St. Georges
-26	1/26	1030	B.T. cast
-27	1/26	1054	Surface temperature bucket
-28	1/26	1100	Hydrocast for nutrients and phytoplankton
-29	1/26	1408	1,000μ single net tow
-30	1/26	1530	79μ double net tow
-31	1/26	1645	202μ double net tow
-32	1/26	1915	1,000μ double net tow
-33	1/26	2023	79μ double net tow
-34	1/26	2128	202μ double net tow
-35	1/27	0630	B.T. cast
-36	1/27	0632	Surface temperature bucket
-37	1/27	0645	Hydrocast for phytoplankton and nutrients
-38	1/27	0730	Secchi disc
-39	1/27	0745	Geochem. Randon sample
-40	1/27	0828	79μ double net tow
-41	1/27	0924	202μ double net tow
-42	1/27	1015	1,000μ single net tow

<u>Station #</u>	<u>Date</u>	<u>Time</u>	<u>Description</u>
<u>AT-72-1-</u>	1/27	1100	Return to St. Georges
-43	1/28	0930	B.T. cast
-44	1/28	0940	Surface temperature bucket
-45	1/28	0950	Hydrocast for nutrients and phytoplankton
-46	1/28	1134	1,000 μ single net tow
-47	1/28	1305	79 μ double net tow
-48	1/28	1410	202 μ double net tow
-49	1/28	1455	1,000 μ single net tow
-50	1/28	1548	79 μ double net tow
	1/28	1630	Return to St. Georges: wind 20-25, 40 knots in gusts.
-51	1/29	1130	B.T. cast
-52	1/29	1150	Hydrocast for nutrients and phytoplankton
-53	1/29	1335	1,000 μ single net tow
-54	1/29	1508	79 μ double net tow
-55	1/29	1630	202 μ double net tow
-56	1/29	1737	1,000 μ single net tow
-57	1/29	1916	202 μ double net tow
-58	1/29	2015	79 μ double net tow
-59	1/30	0600	B.T. cast
-60	1/30	0615	Hydrocast for phytoplankton and nutrients
-61	1/30	0845	79 μ double net tow
-62	1/30	0900	Geochem. Radon sample

<u>Station #</u>	<u>Date</u>	<u>Time</u>	<u>Description</u>
AT-72-1-63	1/30	0951	202μ double net tow
-64	1/30	1046	1,000μ single net tow
	1/30	1145	Return to St. Georges
	1/31	1200	Seas 6-10 feet; wind 30, gusting to 40 knots. Cancelled sampling.
-65	2/1	1000	B.T. cast
-66	2/1	1037	Hydrocast for nutrients and phytoplankton
-67	2/1	1434	79μ double net tow
-68	2/1	1530	202μ double net tow
-69	2/1	1635	1,000μ single net tow
-70	2/1	1830	79μ double net tow
-71	2/1	1948	202μ double net tow
-72	2/1	2043	1,000μ single net tow
-73	2/2	0600	B.T. cast
-74	2/2	0610	Hydrocast for phytoplankton and nutrients
-75	2/2	0915	79μ double net tow
	2/2	1030	Return to St. Georges. Seas 10-12 feet; wind 25-30 knots; gales forecast.
	2/3		Winds 25-30 knots in harbor. Cancelled sampling. General maintenance.
-76	2/4	1203	B.T. cast
-77	2/4	1219	Hydrocast for nutrients and phytoplankton
-78	2/4	1346	1,000μ surface tow

<u>Station #</u>	<u>Date</u>	<u>Time</u>	<u>Description</u>
AT-72-1-79	2/4	1400	Secchi disc
-80	2/4	1430	Geochem. Radon sample
	2/4	1500	Return to St. Georges. Seas 8-10 feet; wind gusting to 30 knots.
	2/5		Seas 10-14 feet; wind 25-30, gusting to 40 knots. Cancelled sampling.
-81	2/6	0915	B.T. cast
-82	2/6	0930	Hydrocast for nutrients and phytoplankton
-83	2/6	1115	79μ double net tow
-84	2/6	1215	202μ double net tow
-85	2/6	1310	1,000μ single net tow
-86	2/6	1400	79μ double net tow
-87	2/6	1455	202μ double net tow
-88	2/6	1540	1,000μ single net tow. Winch trouble
-89	2/6	1810	1,000μ single net tow, repeat.
-90	2/7	0600	B.T. cast, winch trouble.
-91	2/7	0645	Hydrocast for phytoplankton and nutrients to 200m.
-92	2/7	0800	Hydrocast for phytoplankton and nutrients, 200-1,000m. Winch only pulling 200 lbs.
-93	2/7	1035	202μ surface net tow
-94	2/7	1052	1,000μ surface net tow
	2/7	1130	Return to St. Georges. Broken injector in winch.

<u>Station #</u>	<u>Date</u>	<u>Time</u>	<u>Description</u>
AT-72-1-95	2/8	1020	B.T. cast, poor trace
-96	2/8	1035	B.T. cast repeat, winch trouble
-97	2/8	1130	Hydrocast for nutrients and phytoplankton; shortened. Repaired injector broken.
-98	2/8	1255	202 μ surface tow
-99	2/8	1315	1,000 μ surface tow
-100	2/8	1325	Geochem. Radon sample
	2/8	1400	Return to St. Georges
	2/9	1645	Replacement injector arrived from N.Y.
			Winds 25-30 knots in harbor, forecast for gusts to 40 knots. Cancelled sampling.
	2/10		Seas 12-14 feet; winds 30-35, gusting to 45 knots. Cancelled sampling.
-101	2/11	0810	Surface bucket for Chl. <u>a</u>
-102	2/11	0820	B.T. cast
-103	2/11	0827	Surface bucket for Chl. <u>a</u>
-104	2/11	0833	Hydrocast for nutrients and phytoplankton
-105	2/11	0920	Surface bucket for Chl. <u>a</u>
-106	2/11	1000	79 μ double net tow
-107	2/11	1052	202 μ double net tow
-108	2/11	1137	Surface bucket for Chl. <u>a</u>
-109	2/11	1145	1,000 μ single net tow
-110	2/11	1300	202 μ net tow for A. Be'.

<u>Station #</u>	<u>Date</u>	<u>Time</u>	<u>Description</u>
AT-72-1-111	2/11	1428	202μ surface net tow
-112	2/11	1440	79μ surface net tow for N ¹⁵
-113	2/11	1454	1,000μ surface net tow
-114	2/11	1500	Geochem. Radon sample
	2/11	1515	Return to St. Georges
-115	2/12	0820	B.T. cast
-116	2/12	0831	Hydrocast for nutrients and phytoplankton
-117	2/12	1020	79μ double net tow
-117a	2/12	1045	Geochem. Radon sample
-118	2/12	1130	202μ double net tow
-119	2/12	1216	1,000μ single net tow
-120	2/12	1310	79μ surface net tow for N ¹⁵
-121	2/12	1310	79μ surface net tow for N ¹⁵
-122	2/12	1321	202μ net tow for A. Be'.
-123	2/12	1428	1,000μ surface net tow
-124	2/12	1446	202μ surface net tow
	2/12	1452	Return to St. Georges
-125	2/13	0610	B.T. cast
-126	2/13	0625	Hydrocast for phytoplankton and nutrients
-127	2/13	0846	79μ double net tow
-128	2/13	0850	Surface bucket for N ¹⁵
-129	2/13	0949	202μ double net tow
-130	2/13	1046	1,000μ single net tow

<u>Station #.</u>	<u>Date</u>	<u>Time</u>	<u>Description</u>
<u>AT-72-1-131</u>	2/13	1140	202μ net tow for A. Be'.
-132	2/13	1224	79μ surface net tow for ¹⁵ N
-133	2/13	1250	1,000μ surface net tow
-134	2/13	1320	Return to St. George. Start packing equipment.

I. THE SAMPLING PROGRAM

The goal of this program was to take a series of samples in the Sargasso Sea off Bermuda to determine the dry weight, carbon and nitrogen dynamics of the food web at the start of the vernal bloom. It was expected that nutrient mixing, phytoplankton growth, and herbivore growth would be observed, and that through frequent measurement of the standing stock of the various "nitrogen pools", rates of flux could be determined.

A. Location

Bermuda was chosen as the base for the sampling program for four reasons. 1) The shore facilities at the Bermuda Biological Station would allow rapid analysis of hydrographic samples and sorting of fresh zooplankton samples for later nitrogen analysis. 2) This station (34° 14' N, 64° 37' W) was occupied on our previous cruises. The dates and station numbers occupied at the Bermuda station for each cruise are respectively: 5/16/68, stations 66-75 (All-68-2); 10/26/68 to 10/28/68, stations 1-16 (Gib-68-1); 1/18/69 to 1/20/69, stations 114-135 (Gib-69-1); 9/7/69 to 9/10/69, stations 57-96 (Roc-69-1); 12/7/69 to 12/10/69, stations 1-16 (Miz-69-1); 1/6/70 to 1/8/70, stations 26-44 (Roc-70-1). 3) The food web in the Sargasso Sea is relatively simple and does not show great fluctuations. 4) Much biological and hydrographic work has been done in the Bermuda area and is reported in the literature.

B. Time of Sampling

From a survey of the previously reported work undertaken in the Bermuda area, it was expected that production would begin to increase during the last week of January. Our sampling program was begun just prior to that time.

C. Depth of Sampling

Samples were taken to 1,000 meters. From previous studies it was determined that the water mass is relatively unmixed below 1,000 meters and that the major part of the biological population is above 1,000 m.

D. Schedule

The program was based on a two day schedule with a day and a half at sea and an evening in port to return samples to the Bermuda Biological Station and for general maintenance.

Two Day Sampling Schedule

Day 1

Sunrise	Leave St. George Harbor
0830	On Station
0830	B.T. cast
0900	Hydrocast
1100	79 μ net tow
1200	202 μ net tow
1300	1,000 μ net tow
1400	79 μ net tow

1500	202 μ net tow
1600	1,000 μ net tow
<u>Day 2</u>	
0600	B.T. cast
0630	Hydro cast
0830	79 μ net tow
0930	202 μ net tow
1030	1,000 μ net tow
1300	Arrive in St. George, drop samples.

The above schedule is the ideal, achieved in only the calmest weather. Frequently problems with ship's motion, equipment and extra sampling extended the time required to accomplish the station work.

II. HYDROGRAPHY

C. Garside, Ph.D., S. Williams, Ph.D.

A. Methodology

A B.T. cast was made to 200 meters on each day that the station was occupied. On Day 1, samples were taken at standard hydrographic depths for nitrate, nitrite, ammonia, silicate, phosphate, dissolved oxygen, pH, alkalinity, salinity, and temperature with 1.7 liter Niskin bottles equipped with reversing thermometers. On Day 2, only nutrients were sampled. Samples were kept in glass bottles for phosphate, nitrate, and ammonia, and in polyethylene bottles for silicate and nitrite, and analyzed within a few hours of reaching shore at the Bermuda Biological Station. Nutrient determinations were made using a

Technicon three channel Auto-Analyzer II. Dissolved oxygen was determined using a modified Winkler method (Strickland and Parsons, 1968). Salinity was determined with a Hytech Model 621 Salinity Conductivity meter. Alkalinity and pH were determined using a Corning Model 12 pH meter.

B. Results

Eighteen nutrient profiles were made, eleven of which, included all parameters. Data will be presented in the Technical Progress Report for 1972.

III. PHYTOPLANKTON ECOLOGY J. Currie, B.S.

A. Methodology

1. Dry weight, Carbon, Nitrogen

On Day 2, samples were taken at standard hydrographic depths with 12 liter Niskin bottles. 3.5 liters from each depth was then prefiltered through a 79 μ mesh, and then filtered through a 0.45 μ , 47 mm diameter preweighed Millipore filter for later dry weight determination. 6 liters from each bottle was filtered through a 0.33 μ , 47 mm glass fiber filter, after pre-filtering through a 79 μ mesh net, for later carbon and nitrogen determinations. All samples were frozen immediately.

2. Taxonomy

On Day 2, samples were taken at standard hydrographic depths for taxonomic determinations.

150 ml were filtered through a 0.45 μ , 25 mm Millipore filter, after prefiltration through a 20 μ mesh, for later examination by electron microscopy. On Day 1 and on Day 2, 500 ml of water taken at standard hydrographic depths were prefiltered through 79 μ mesh and preserved in 2% buffered glutaraldehyde for later examination by light microscope. The samples on the Millipore filters were preserved by drying in a dessicator and glutaraldehyde-preserved samples were stored at 45° F.

B. Results

Seven profiles for dry weight, carbon, nitrogen, and 0.45-20 μ taxonomy and eighteen profiles for 20-79 μ taxonomy were made. Data will be presented in the Technical Progress Report for 1972.

IV. ZOOPLANKTON ECOLOGY

J. Hillegas, B.S., V. Harris, Graduate Student

A. Methodology

1. Dry Weight, Carbon, Nitrogen and Taxonomy

Three nets were used: a double 79 μ mesh net with flared 79-202 μ cod end sieves and paired inner-outer flowmeters, a double 202 μ mesh net with flared 202-1000 μ cod end sieves and paired inner-outer flowmeters, and a single 1000 μ mesh net with flared 1000 μ cod end sieve and an inner flowmeter. Design specifics will be presented in the Technical Progress Report for 1972.

All tows were made vertically at 60 meters/minute from 1000 meters. A Benthos Time Depth Recorder was attached below the weight.

The sample from each net was split with a Folsom Splitter. One half of the sample was preserved in 500 ml of 4% buffered sea water/formaldehyde solution, and the other half was washed with 20 ml of 40% sodium sulfate solution and 20 ml of deionized water to remove salts, and then frozen on a mesh disc corresponding to the mesh of the net.

2. Fresh Sorting

To obtain true measurements of dry weight, carbon, and nitrogen in zooplankton samples in the $> 202\mu$ size ranges, fresh samples were sorted into the most abundant major taxonomic groups.

On Day 2 of the sampling cycle, samples were taken from 1/4 splits of the 202-1000 μ and 1000-10,000 μ size fractions and kept in 900 ml of filtered sea water at ambient temperature and light. The samples were transferred from the ship to the Bermuda Biological Station within four hours of the time they were taken. The 202-1000 μ size fraction was aerated immediately and the 1000-10,000 μ size fraction, being the most perishable, was sorted first.

The sorted major groups from both size fractions were placed on mesh discs corresponding to the mesh size of the nets and washed with sodium sulfate solution and deionized water. The discs were then placed in 2 oz. vials and frozen for later analysis at Lamont-Doherty Geological Observatory.

3. Zooplankton Culturing

The goal of the zooplankton culturing program was to find a herbivore, an omnivore, and a carnivore from the open ocean environment that could survive under laboratory conditions.

Culture specimens were originally taken from 1/4 splits of the $> 202\mu$ size fractions, but few organisms in good condition were found, so short surface tows specifically for culture material were added to the sampling program.

B. Results

1. Dry Weight, Carbon, Nitrogen, and Taxonomy

A total of 96 samples were taken. Daily coverage for the first third of the cruise (1/22 through 1/30) was obtained. Coverage during the remaining part of the cruise was not as complete due to weather and mechanical problems; sampling dates for this period include 2/1, 2/6, 2/11, 2/12, and 2/13. The nets performed according to desing specifications.

2. Fresh Sorting

A total of 14 samples of the 79-202 μ and 10³-10⁴ μ net tows were collected from stations 10, 11, 24, 25, 41, 42, 63, 64, 107, 109, 118, 119, 129, and 130, and these were fresh sorted into the most abundant major groups. Approximately 200 organisms were separated from each 79-202 μ sample; the fresh sorted organisms of this size consisted almost totally of copepods and ostracods. With the 10³-10⁴ μ fraction from 50 to 150 organisms were sorted. Eight different major groups were segregated from this fraction - with copepods being the most abundant.

3. Shipboard Cultures

61 cultures, each consisting of approximately 10 inoculating organisms, were started, but mortality was high and less than a third were shipped in viable condition to Lamont. No organisms survived for more than two months after their return to Lamont.

V. ¹⁵N UPTAKE EXPERIMENTS

Preliminary experiments were done to determine the feasibility of measuring in situ rates of nitrogen flux in a large sampling bag.

Coccolithus huxleyi was grown with ¹⁵N-labeled NaNO₃ as the only nitrogen source. Approximately 500 ml of culture at 4 x 10⁷ cells/l were transferred at ambient temperature and

light to 20 liters of sea water which had been previously filtered through 0.3 μ glass fiber filters. Zooplankters were collected at stations 112, 120, 121, and 132 by 5-minute surface tows with a double or single 79 μ net and 79-202 μ cod end sieves. These zooplankters were added to the filtered sea water at the same time.

The ^{15}N -labeled phytoplankton/zooplankton mixture was incubated for 12-18 hours under aeration at ambient temperature and light in the laboratory at the Bermuda Biological Station.

After incubation the entire 20 liters was poured through a 79 μ filter and then through a 0.33 μ glass fiber filter. The samples on both filters were frozen for later ^{15}N analysis at Lamont.

B. Results

Three ^{15}N uptake experiments were done. Detailed results will be presented in the Technical Progress Report for 1972.

ACKNOWLEDGEMENTS

We are grateful for the interest and cooperation of the scientists and staff of the Bermuda Biological Station and the Captain and crew of the R/V ATLANTIC TWIN without whose help none of this work would have been possible.

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