Cruise Report

W-46

Scientific Activities

Woods Hole - Bermuda - Nova Scotia - Woods Hole

06 June 1979 - 18 July 1979

R/V WESTWARD

Sea Education Association

Woods Hole, Massachusetts

DRAFT COPY

Greater Shearwater

PREFACE

The objective of this cruise report is to compile the data collected by 23 undergraduate students, three staff scientists, and two visiting scientists on cruise W-46 of the R/V *Westward*. The report presents an overview of the cruise with some preliminary interpretation of results. We conducted an array of individual projects, and this report provides space to see how many of our diverse interests mesh.

We accomplished nearly all of the scientific goals we established in our cruise plan. Our success in doing so was largely made possible by a cooperative and interested nautical staff, headed by Captain Richard W. Farrell. Our navigator, Armin Elsaesser, was kind enough to keep a running cruise track for us as well as a complete list of noon, midnight, and station positions. I express my appreciation to each of the nautical staff for their skill and for their efforts in helping us carry out our research.

I am also grateful to a resourceful scientific staff and to our visiting scholars. Assistant Scientist Clifford Low has sailed five times with *Westward*, and each time his contribution to the program has increased in value. He has always brought skill in chemistry, a solid teaching background, a talented guitar, and a fine sense of humor to the program. This time he contributed to our natural history studies by a complete description of a new species: *Stuckus duckus*, the mesopelagic duck. W-46 is Cliff's last cruise with the *Westward*, and he will be sorely missed.

Assistant Scientist Tom Bolmer stepped in at the last minute when our scheduled staff member was stricken with mononucleosis. Tom worked very diligently and conscientiously throughout the cruise. I appreciate very much his efforts.

Visiting scholar Dr. Hugh Bell was with us for the first leg of the cruise. He demonstrated some ancient navigational techniques and delivered an interesting lecture on the history of Bermuda. He seemed very much at home on Westward and found a welcome here.

We were fortunate in having two scientists from the National Marine Fisheries Service participate in our program during legs II and III. Drs. Ron Schlitz and Redwood Wright set out and recovered current drogues for studies on Georges Bank. Ron sailed with us from Bermuda and had many helpful suggestions for our program. Red met us Nova Scotia where he witnessed a "whale dance" designed to bring some large marine mammals in our direction. Later Red was recipient of a "drogue dance" and song to help us recover the current drogues. His warm manner and interest in our program were appreciated by all.

Finally, I would like to thank Sally Kaul, our steward, for supervising the preparation of meals of exceedingly high caliber. The fine quality of the food contributed to an appreciable degree to the high morale and good spirits of this cruise.

This report was prepared mostly at sea. I am writing this preface as we near the Cape Cod Canal on our way to Tarpaulin Cove and Woods Hole. A report such as this is intended to capture the immediacy of first interpretations of the data. As such, it shows the disadvantages of lack of follow-up in library research, professional drafting, and proper reflection on the data. These inherent disadvantages of oceanographic cruise reports have always been offset by the advantages of having all the cruise data in one place, and in the case of the Sea Semester program, the advantage of presenting an overview of the cruise while the memories of it are still fresh.

Mary Farmer
Chief Scientist
W-46
17 July 1979

Table of Contents

INTRODUCTION

This report is the result of the laboratory portion of Introduction to Marine Science (NS 225 at Boston University), which took place on cruise W-46 of the R/V Westward. The itinerary and ship's track (Table 1; Figures 1 and 2) provided the chance for individual student research in a variety of oceanographic field. The emphasis placed on particular areas of study reflects the interest of the staff. Ship's complement is given in table 2.

The academic program consisted of daily lectures and weekly quizzes and a final practical examination by the staff. Student projects consisted of data collection and analysis. Seminars and final papers were completed on the ship, and the abstracts of these projects compose the main body of this cruise report.

Most of the scientific education on the cruise took place during science watch. Students on watch in the laboratory learned the operation of oceanographic equipment, the chemical and biological work-up of samples, and analysis of data. Becoming familiar with specific organisms and proper maintenance of a scientific log were also part of the science watch.

Research conducted during W-46 represents partly the ongoing work of individuals and agencies that have extended their assistance to our students. Scientific operations performed and data analyzed on W-46 are listed in the appendices. Material reported here should not be excerpted or cited without written permission of the Chief Scientist.

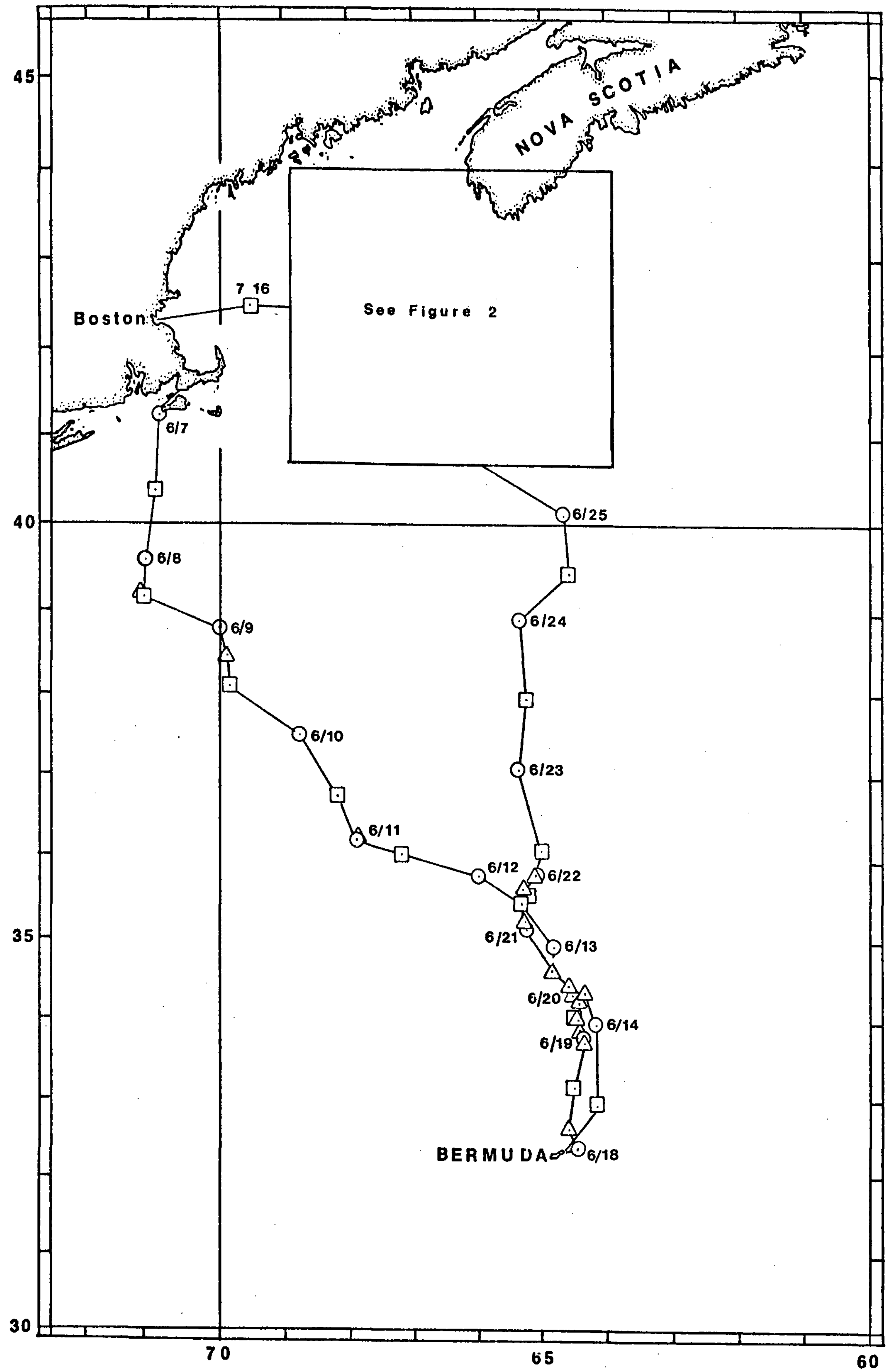


Fig. 1. Track of cruise W-46 of the R/V Westward. See figure 2 for detail of Georges Bank.

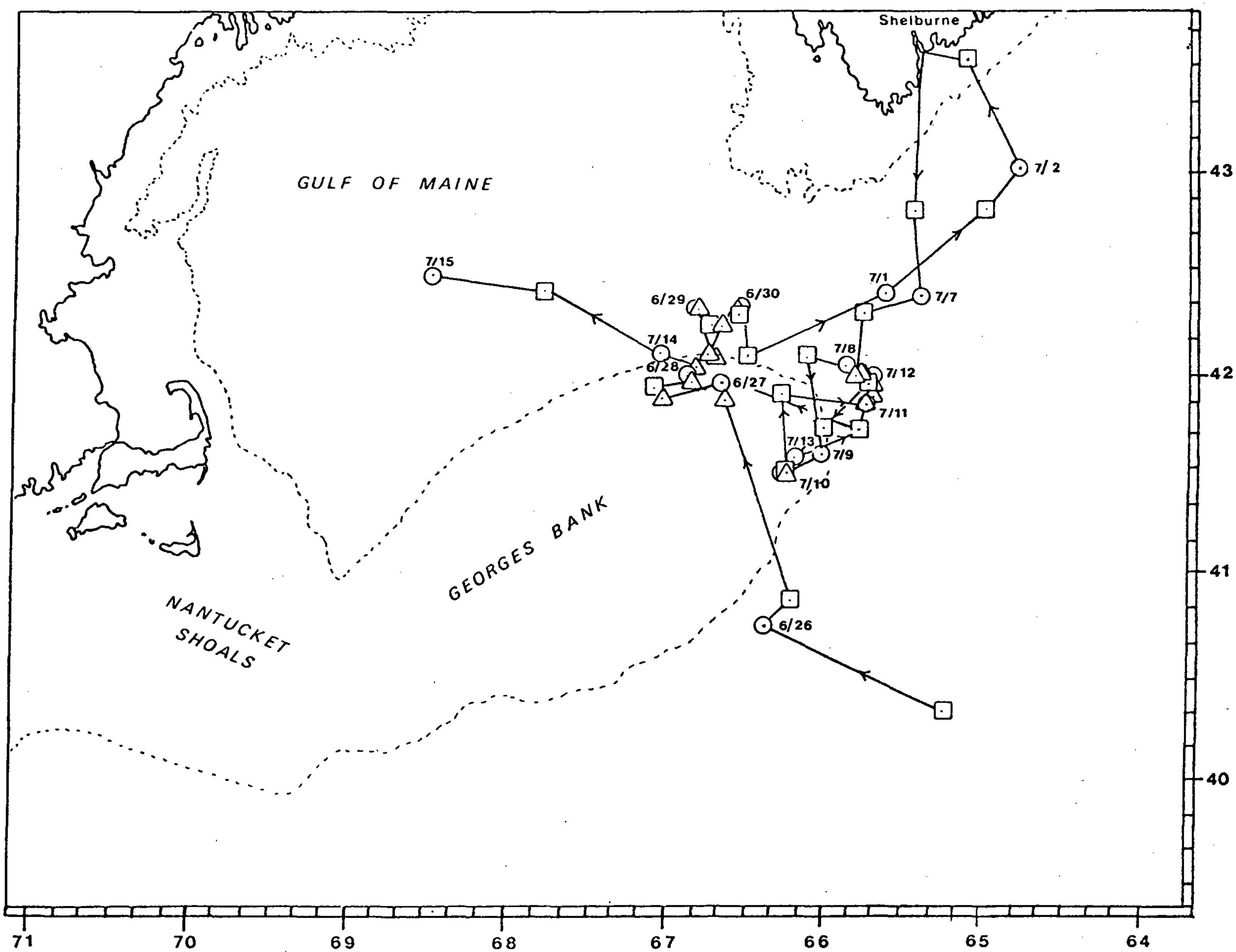


Fig. 2. Track of cruise W-46 of the R/V Westward, Georges Bank detail.

Table 1. Itinerary of R/V *Westward* cruise W-46

	Depart		Arrive	
Leg 1	Woods Hole (Massachusetts)	06 June 1979	St. Georges (Bermuda)	15 June 1979
Leg 2	St. Georges (Bermuda)	18 June 1979	Shelburne (Nova Scotia)	03 July 1979
Leg 3	Shelburne (Nova Scotia)	06 July 1979	Woods Hole (Massachusetts)	18 July 1979

Table 2. Ship's complement for R/V Westward cruise W-46.

Nautical Staff	
Richard W. Farrell, Jr., B.A., Ocean Operator	Captain
Armin Elsaesser, III, B.A., Ocean Operator	Chief Mate
Wm. Jeffrey Bolster, B.A., Inland Operator	Second Mate
Greg Lohse, B.A. Ocean Operator	Third Mate
David Martin	Chief Engineer
Sally Kaul, M.Ed.	Steward
Susan Pilling, B.S.	Assistant Steward (Leg I)
Sally Thomson, B.S.	Assistant Steward (Legs II and III)
Scientific Staff	
S. Tom Bolmer, Jr., B.S.	Scientist - 3
Mary Farmer, Ph.D.	Chief Scientist
Clifford Low, M.Ed.	Scientist - 2
Visiting Scholars	
Hugh Bell, Ph.D. (Leg I)	Maritime History
Ronald Schlitz, Ph.D. (Leg II)	Physical Oceanography
Redwood Wright, Ph.D. (Leg III)	Physical Oceanography

Table 2, continued

Students

Mark D. Aspinwall	Middlebury College, Vermont
Diane M. Biba	University of Illinois, Urbana-Champaign
Frederick A. Bodner	Wesleyan University, Ct.
Nancy J. Cohen	Colorado College
Christelle S. Cook	Connecticut College
Bradley J. Dyer	Stanford University, California
Holly B. Ernest	Cornell University, New York
Stephen A. French	Earlham College, Indiana
Jocelyn E. Gamble	Colorado College
Bert Goldberg	State University of New York at Binghamton
Kathleen F. Lake	Boston University, Mass.
Ann R. Miller	University of Michigan
Agnes Rapoli	Union College, New York
Stacy A. Rappleyea	St. Lawrence University, New York
Barbara J. Robinson	Kenyon College, Ohio
Loren D. Smith	University of Massachusetts
Nora C. Smith	Amherst College, Mass.
Jack A. Sobel	Cornell University, New York
Joel M. Solomon	Colby College, Maine
Mark G. Taggett	De Pauw University, Indiana
Mary A. Voytek	Johns Hopkins University, Md.
Ellen I. Wishinsky	Indiana University
Tso-An Yu	Boston University, Mass.

GULF STREAM RING STUDIES

Introduction and Summary

A Gulf Stream ring is formed when a meander of the Gulf Stream breaks away and swirls either toward coastal waters or into the Sargasso Sea. A ring that enters the cool continental shelf waters carries warm Sargasso Sea water with it and thus becomes a "warm core ring." Likewise, a ring entering the Sargasso Sea carries slope water and becomes a "cold core ring." These rings raise interesting physical, chemical, and biological questions for oceanographers. How long do they swirl (before mixing into surrounding waters? How fast do they move? What happens to the organisms that are trapped in these rings? The Westward had a chance to look at some of these questions on W-46 when a cold core ring off Bermuda was reported on the Gulf Stream Analysis map transmitted to the ship by Fleet Weather Central, Norfolk, Va. (FLEWEACEN NORVA) on 15 June 1979 (figure 3). The abstracts that follow summarize studies that suggest (1) the ring was about two months old (Robinson), (2) it may have been elliptical in shape (Taggett), (3) the ring may sink as it mixes (Biba), (4) zooplankton trapped in ring water died (Gamble), probably by starvation (Rapoli), although there was some evidence of exchange of populations between the ring core and the surrounding Sargasso Sea water (Dyer).

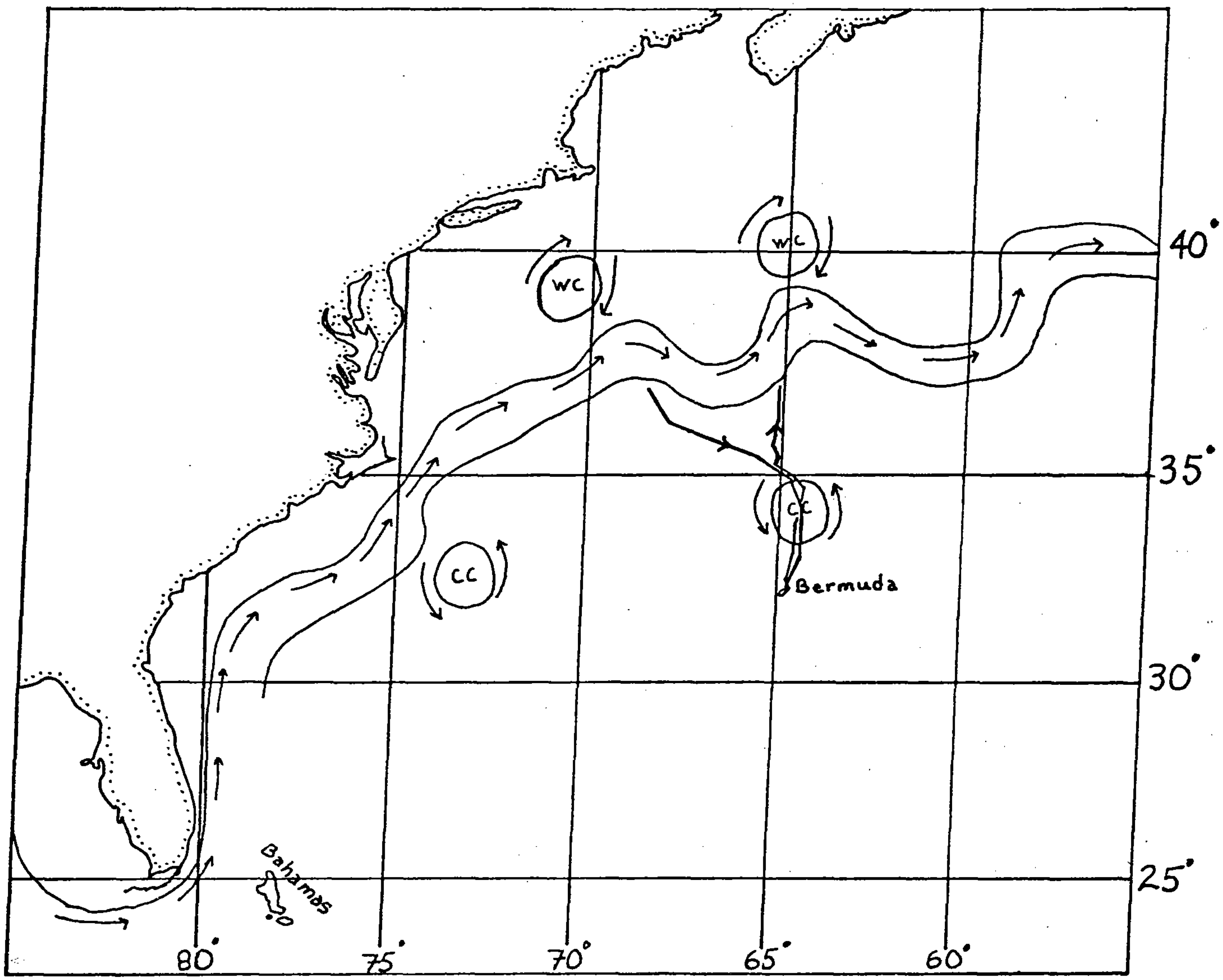


Fig. 3. Cold core ring transected by the Westward during cruise W-46.

The physical characteristics of a cold core ring

Barbara Robinson

Abstract. The purpose of this study was to examine temperature profiles of a cold core ring in an attempt to estimate its width, depth, shape, and age. Expendable bathythermograph (XBT) profiles showed the ring to be approximately 115 miles in diameter, assuming (1) the boundaries to be where the 17°C isotherm rose above 400 meters and (2) that the ship crossed through the center of the ring (figure 4). Areal profiles of the isotherms at 100, 200, and 300 m suggested the existence of a secondary "center" or peak northeast of the actual center of the ring. Hydrocasts showed water as cold as 5°C at 800 meters and suggested that the ring increases in diameter with depth, presenting a conical profile in cross-section. The age of the ring was estimated on the basis of a sinking rate of the 17°C isotherm of 0.6 m per day. The ring by this criterion was approximately 60 days old.

Cold Core Eddy Current Velocities

Mark G. Tagett

Abstract. A cold core eddy has a counterclockwise current. The perimeter, formed by the currents of the Gulf Stream, should move more quickly than the currents at the center. If currents were constant during the eddy's formation, the resulting shape should be circular, or nearly so (figure 3). Information concerning the eddy was obtained by recording a constant dead reckoning position and taking Loran C positions. The data was collected from 13 June, 1979 (0835) until 14 June (1735) on the first track through the ring. A second pass was made from 20 June (0300) until 21 June (2353). The results suggested that the currents at the perimeter were faster than the currents at the center. However, the shape tended to be elliptical instead of circular.

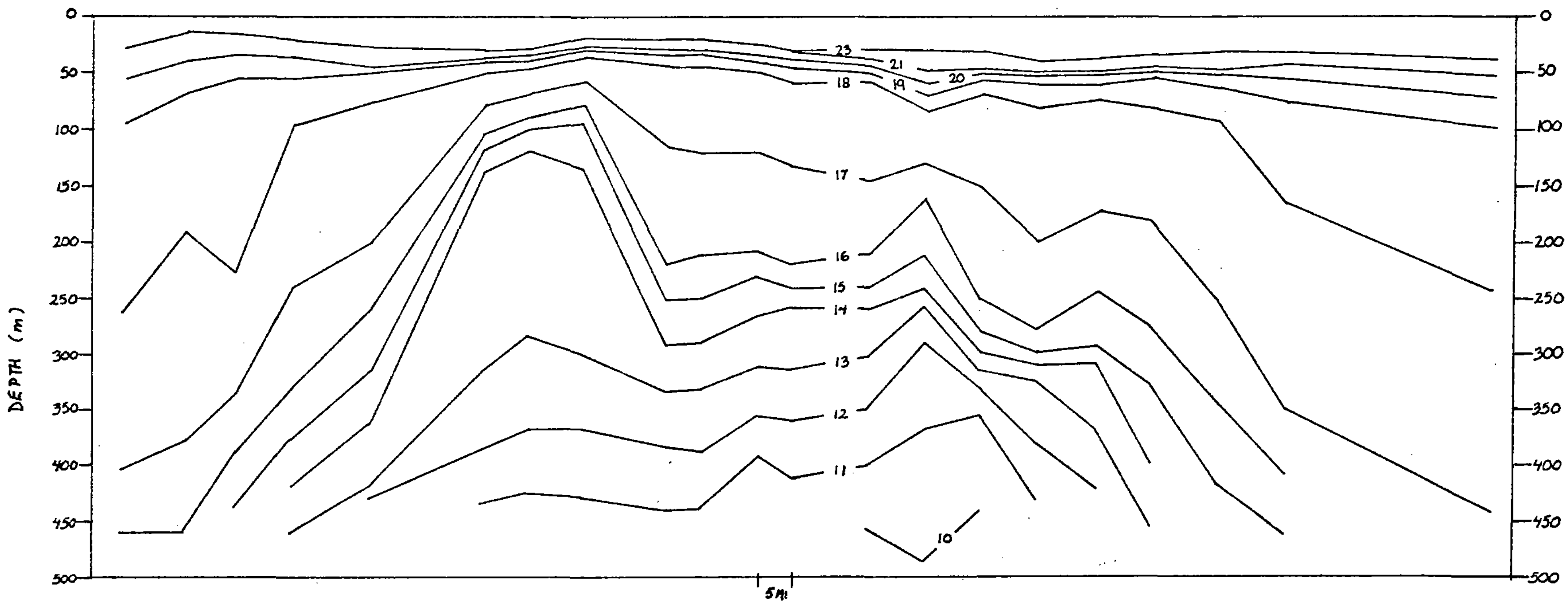


Fig. 4. Expendable bathythermograph (XBT) profile across the cold core ring shown in figure 3.

Distribution of silicates in a cold core eddy in the Sargasso Sea

Diane Biba

Abstract. The summer horizontal and vertical distributions of silicate were measured in a cold-core ring with respect to a New England Slope water control station. Hydrocasts were made along two transects across the ring at transects of 0,50,100, 200, 400 and 800 meters. Silicate concentrations in the ring above 200m and along the ring edge were similar to those found in the slope water control, with the highest concentrations at 800m for the entire transect. This may indicate a vertical mixing of the ring waters is occurring as it circulates in the Sargasso Sea and that the mixed water is sinking.

Variability of zooplankton biomass in the slope water, the Sargasso Sea and a Gulf Stream cold core ring

Jocelyn Gamble

Abstract. The imposition of a Gulf Stream cold core ring into the Sargasso Sea results in the decline of zooplankton biomass as the ring decays. This study intended to evaluate the biomass distribution of the slope water, the Sargasso Sea, and a cold core eddy with particular emphasis on depth. Both oblique and depth-specific tows were conducted. Preserved samples were measured by volume displacement and were corrected for volume of water filtered. Concurrent hydrocasts provided physical and chemical data. The biomass of the slope water was found to exceed that of both the Sargasso Sea and the cold core ring by at least two to three times (figure 5). The lack of biomass in the cold core ring can be attributed to the biological reaction to the changing physical and chemical hydrographic features which accompany ring decay.

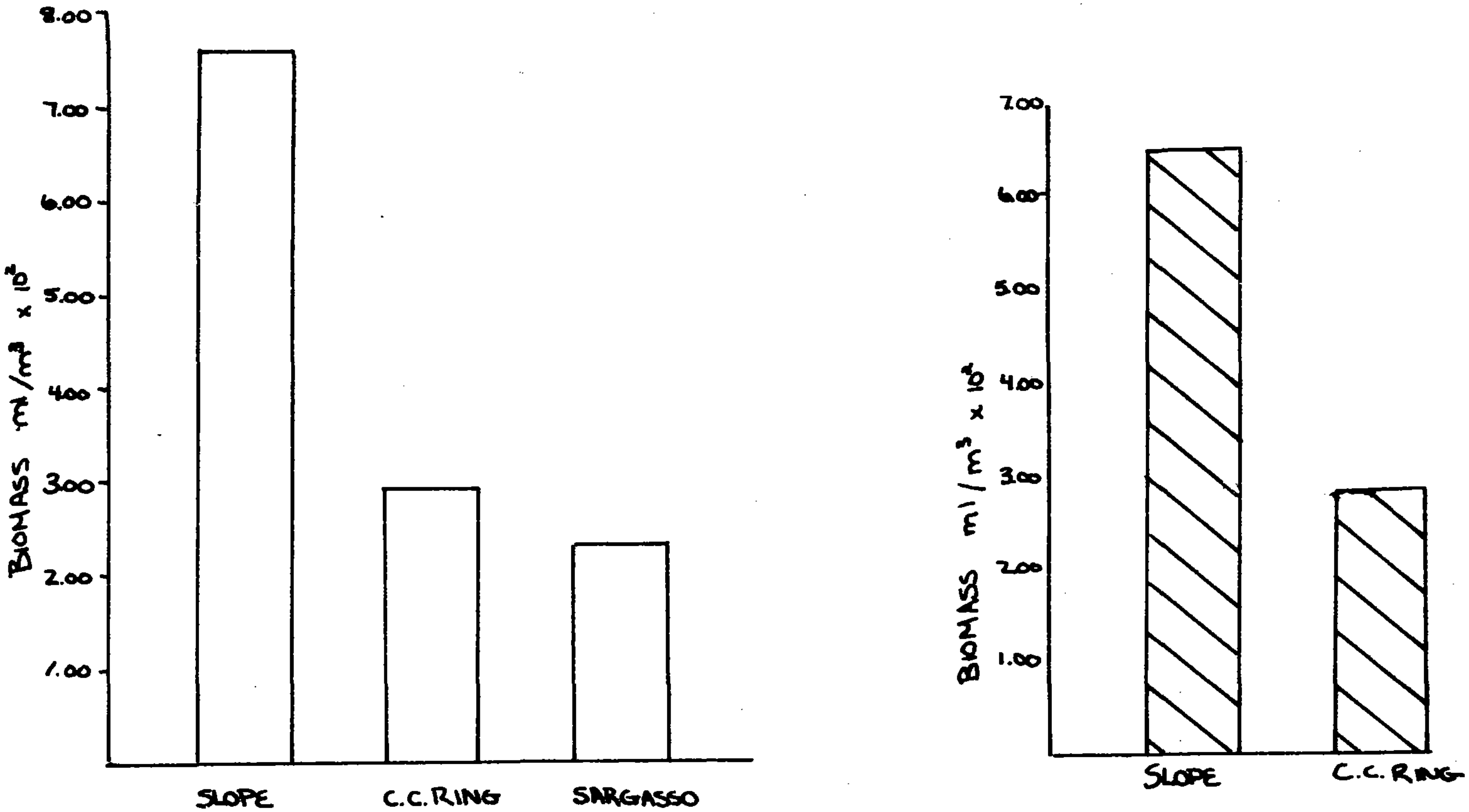


Fig. 5. Displacement volume of zooplankton from tows at 200 meters depth (left) and oblique tows to 800 meters (right) in slope water, a cold core ring, and the Sargasso Sea.

An analysis of the size structure of plankton communities in slope water, the Sargasso Sea, and a Gulf Stream cold core ring

Bradley J. Dyer

Abstract. Gulf Stream cold core rings provide an interesting study of how a biological community is altered or destroyed when presented to extreme conditions. Size fraction ratios of macrozooplankton were determined from samples taken in slope water, the Sargasso Sea, and a Gulf Stream cold core ring to provide a skeletal cross section of each area's population size structure (figure 6). Smaller zooplankton (sieve size 333 microns, 505 microns, 750 microns) size fraction ratios were greater in the Sargasso Sea than in the Slope Water, while the large zooplankton (sieve size 1650 microns) size fraction ratios were greater in the slope water than in the Sargasso Sea. In all cases the values determined for the ring were intermediate of those of the other water masses, except in the 505 micron category, where the ring had a higher ratio than the other two. How (1) degree of competition, and (2) amount of primary production as a function of nutrient concentration could change the size fraction ratios were considered. Biological decay of the standing crop as a function of the physical coherency of the cold core ring and the age of ring were also discussed.

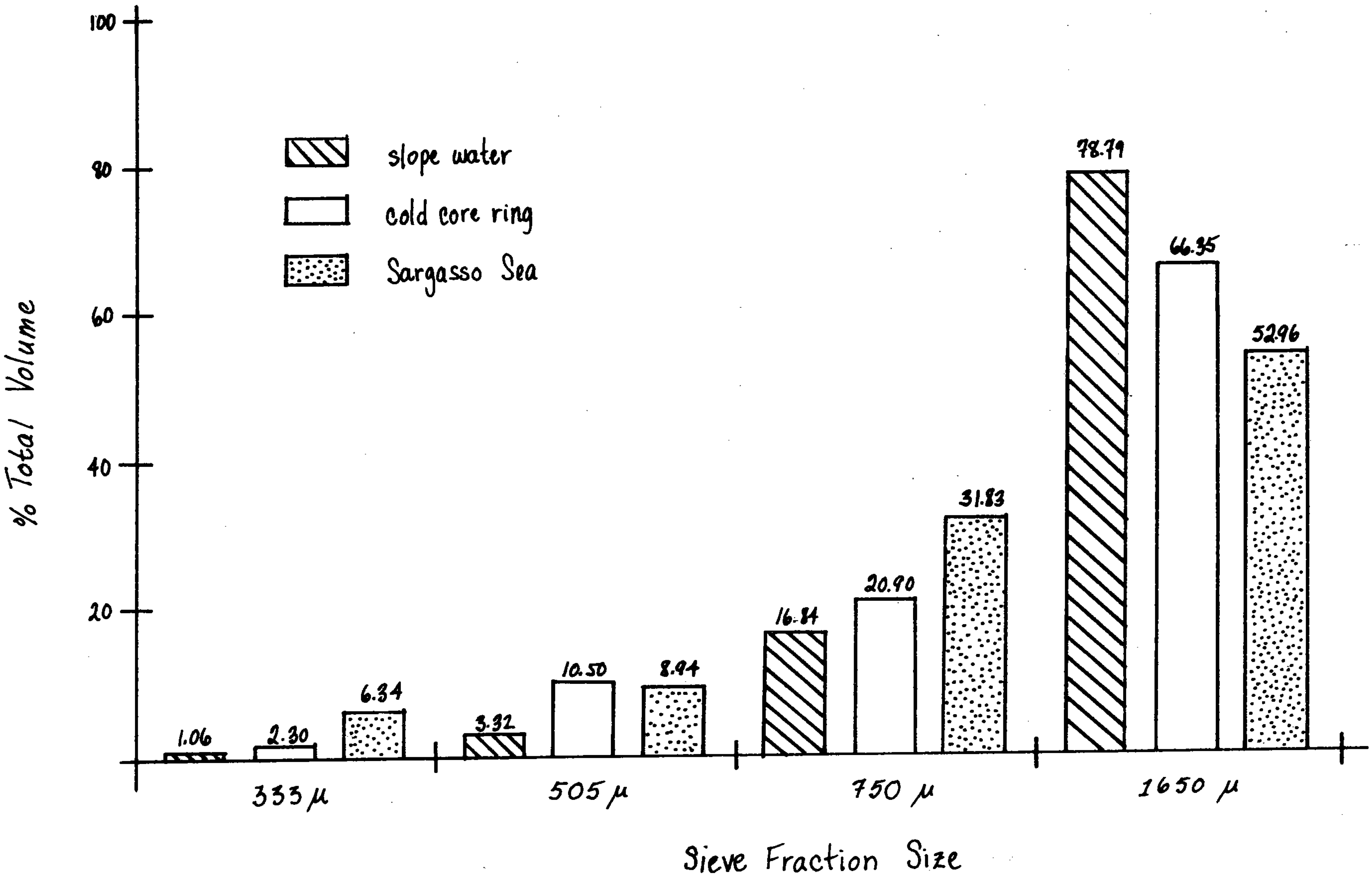


Fig. 6. Fractionation studies of zooplankton samples from the continental slope, a cold core ring, and the Sargasso Sea. Samples were sorted through sieves made of plankton netting of the sizes indicated.

A look at starvation in euphausiids of a cold core ring

Agnes Rapoli

Abstract. Euphausiids of the Northwestern Atlantic slope water are commonly transported to the Sargasso Sea via Gulf Stream cyclonic rings. The slope water in the center of these rings gradually takes on the physical and chemical properties of the surrounding water. Because the Sargasso Sea is a veritable desert, the nutrients within the ring become depleted and are not restored. This naturally leads to the extinction of the euphausiids which normally populate the slope water at the center of the ring.

The deterioration of the individuals is evidenced by a decrease in weights (mass/volume) found along a transect cutting across Continental slope water, Sargasso Sea water, and the cold core eddy. A significant difference in weights occurs between slope and ring organisms indicating that the ring euphausiids are beginning to metabolize their own food stores. Thus, evidence suggests that the euphausiids found on the cold core ring are starving and the population will eventually become extinct.

Also, evidence suggests that only one Sargasso Sea station sampled was truly Sargasso water. The euphausiids found at this particular station had a unique body mass indicating that they are probably a distinct population specifically suited to the Sargasso Sea water.

SARGASSO SEA STUDIES

Introduction and Summary

The Sargasso Sea is the center of an anticyclonic gyre in the North Atlantic, bounded by the Gulf Stream, the North Atlantic Drift, the Canary Current, and the North Equatorial Current. The Sargasso Sea is characterized by warm saline water (averaging 18°C and >36.5% throughout its volume) and low biological productivity.

One of the best known characteristics of the Sargasso Sea is the floating weed from which it is derived, *Sargassum* weed. It has been estimated that 4 - 11 tons of this weed float on the waters of the Sargasso Sea. On cruise W-46 large patches of the weed were sighted as early as 1815 on 07 June 1979, on continental shelf water north of the Gulf Stream. The weed was darker in color and otherwise appeared older than weed seen later after crossing the Gulf Stream and entering the Sargasso Sea. An invertegrate organism known to be associated with the weed, the *Sargassum* nudibranch, was the subject of a study by N. Smith, who found the organisms associated with the weed north of the Gulf Stream but not in the Sargasso Sea.

Another organism expected to be seen in the Sargasso Sea was the spiny lobster larvae, *Panulerius argus*. It was not found where expected (Ernest - discussed under Long Term Internal Programs). A possible explanation for this and other unusual findings in the Sargasso Sea was the influence of the cold core ring on the waters of our cruise track (Voytek).

The only oceanic insect, *Halobates micans*, lives on the surface of the sea as does the *Sargassum* weed. It is sometimes called "water strider" and has been known to avoid the nets that are used to catch them. Some evidence was developed on this cruise that nets towed at high speed will catch Halobates that could avoid nets towed at lower speeds (Solomon).

Distribution of the order Nudibranchae on pelagic *Sargassum*

Nora C. Smith

Abstract. Eleven stations were conducted on a transect from Woods Hole to Bermuda to collect Sargassum weed and measure the distribution of nudibranchs through three distinct water masses: slope, Gulf Stream, and Sargasso Sea (figure 7). *Sargassum* samples were collected by dipnet and neuston two; nudibranchs were removed from the weed, counted and identified. The adult nudibranch *Scyllaea pelagica* was observed on older weed in the slope water and Gulf Stream as well as unidentified nudibranch eggs. No other species were observed in the slope water and no nudibranchs were found in the Sargasso Sea. The absence of nudibranchs in the Sargasso Sea suggests a complex interaction between the seasonality of the Sargasso Sea and the life cycle of the nudibranch, though further study is necessary to quantify observations.

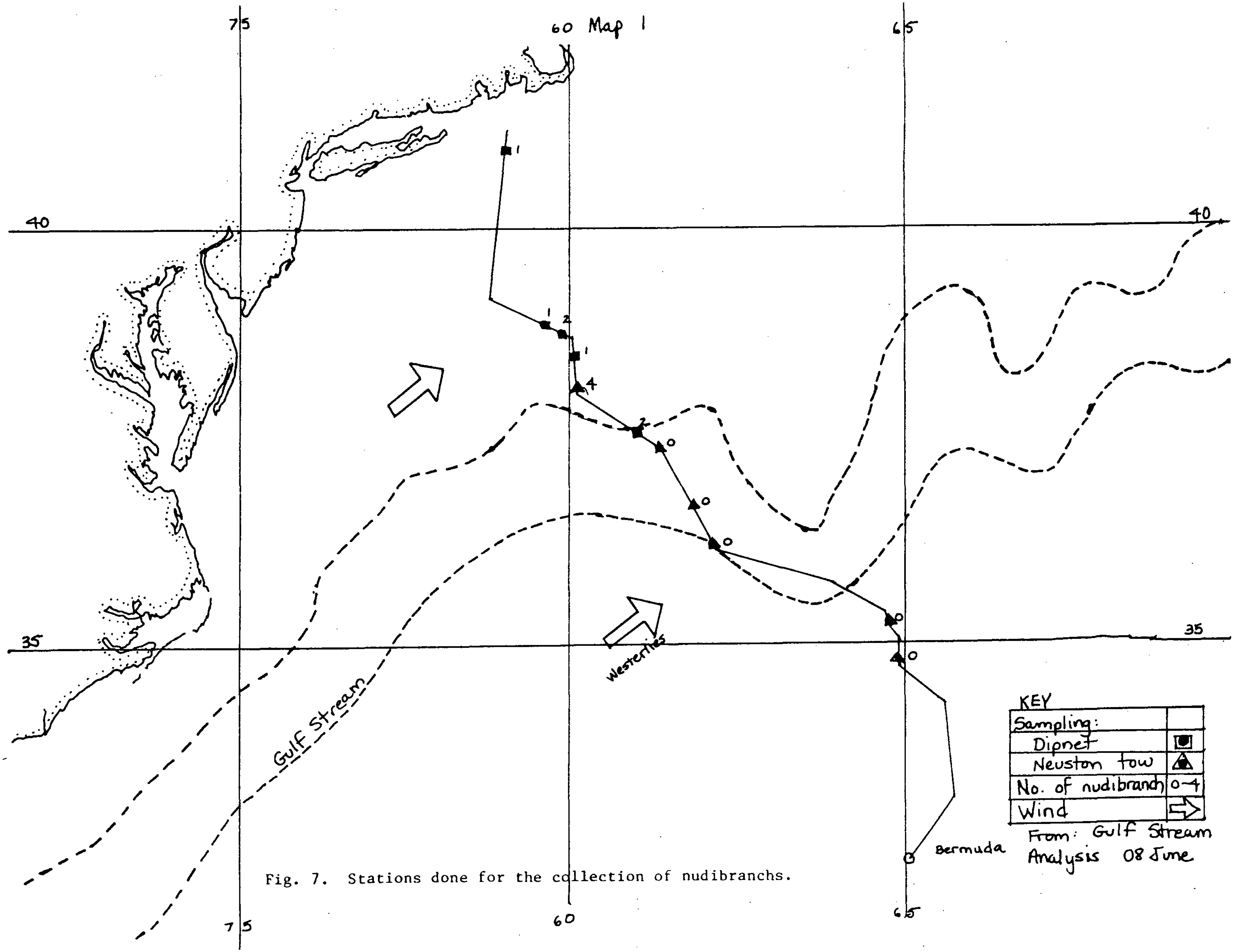


Fig. 7. Stations done for the collection of nudibranchs.

The net dodgers? A study of Halobates micans

Joel Solomon

Abstract. Halobates micans, the only species of Halobates found to date on the waters of the Atlantic Ocean are believed to be capable of avoiding surface plankton tow nets. Comparison of high and slow speed tows conducted on W-46 of the R/V Westward suggests that Halobates cannot avoid nets towed at high speeds of approximately five knots (figure8b).

Unsuccessful attempts were made to identify the instar form of the younger Halobates that were caught (there are five instar forms), and to dissect adult females for a mature egg count from their abdomens.

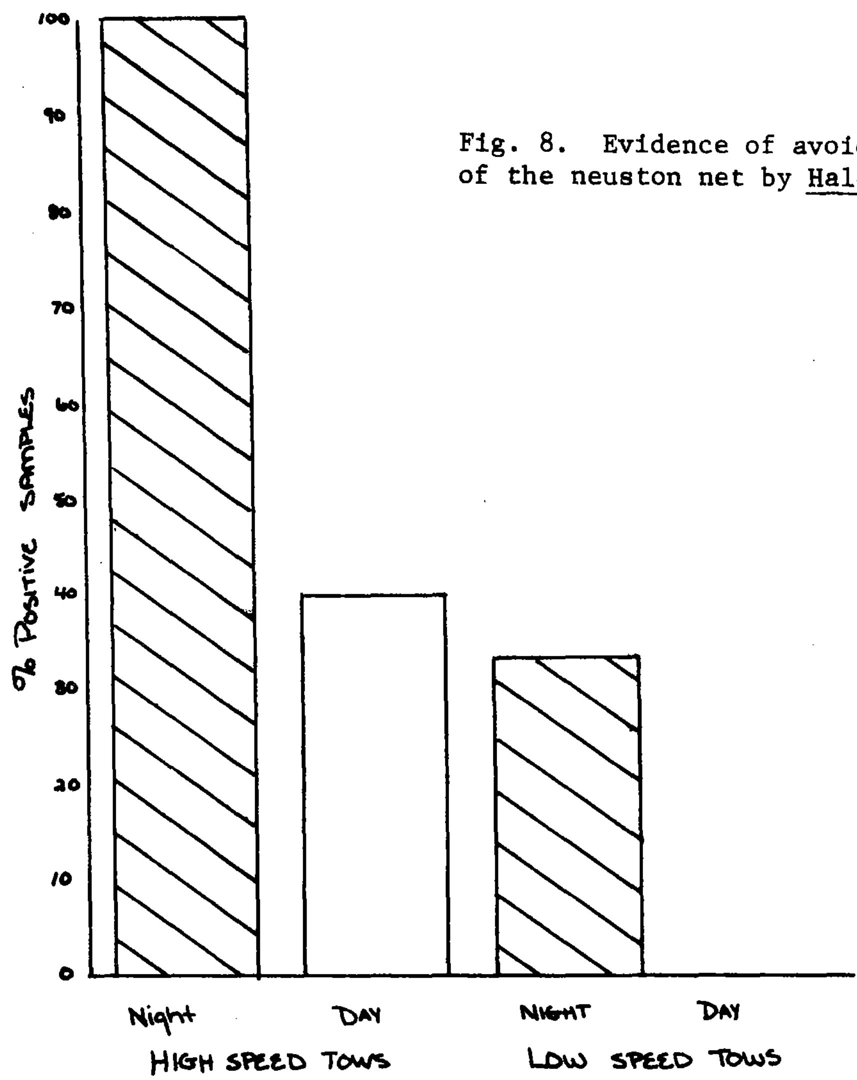


Fig. 8. Evidence of avoidance of the neuston net by Halobates.

The influence of the Gulf Stream cold core ring on the surrounding Sargasso Sea community

Mary Voytek

Abstract. The effect of the invasion of the slope water of a Gulf Stream cold core eddy on the structure and distribution of the Sargasso Sea community was examined. Zooplankton samples were collected in the Gulf Stream ring and in the surrounding Sargasso Sea. Selected species of euphausiids were assessed and the total biomass was calculated. Physical and chemical data were obtained from concurrent hydrocasts. Temperature - salinity (T.S. diagrams (figure 9) and oxygen profiles derived from these hydrocasts show the gradual decay of the ring as you move out from the center and subsequent alteration of the surrounding Sargasso Sea waters. The Sargasso Sea stations closest to the ring show lowered temperatures and salinities and high oxygen concentrations, primarily in the upper 200 m. There was also evidence of biological displacement. Many common Sargasso Sea organisms such as the spiny lobster larvae *Panulirus argus*, were absent from the zooplankton population found in these areas. On the other hand, two euphausiid species distinct to slope water were found in the community. Total biomass for the Sargasso Sea stations was higher than normal. From the evidence obtained in this study, it was concluded that the patterns of distribution and abundance of organisms follow water mass patterns determined by external physical and chemical parameters.

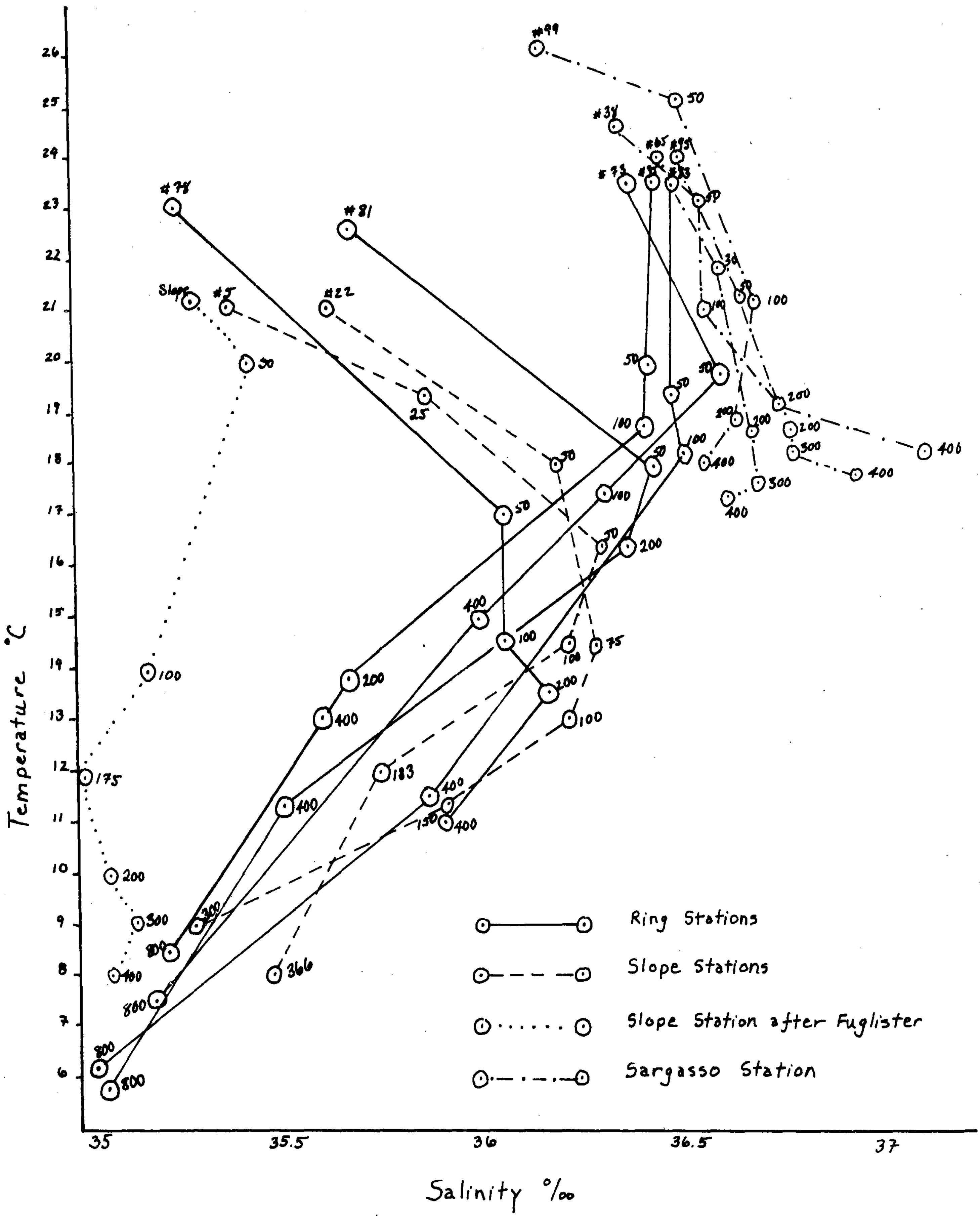


Fig. 9. Temperature-salinity diagrams for water masses studied on W-46. Numbers at the top of each line = station number. Other numbers = depth of sample.

GEORGES BANK STUDIES

Introduction and Summary

Georges Bank is a glacially formed shallow bank extending from Cape Cod toward Nova Scotia and forming part of the barrier that separates the Gulf of Maine from the Atlantic Ocean. It is a highly productive fishing ground and is currently the subject of controversy on the issue of drilling for oil.

Student projects on sediments and fish were conducted on Georges Bank. Also, visiting scientists from NOAA conducted studies on the circulation of water around the northeast corner of the bank.

Sediment studies showed a relationship between current velocity, bottom topography, and grain size (Aspinwall and Yu). Representatives of two fish families showed evidence of character displacement that resulted in differential food consumption within the families (Sobel). Current studies were done to determine whether the so-called Georges Bank gyre was actually a closed system during the summer time. Results were inconclusive (Wright and Schlitz).

Current drogue studies on the northeast end of Georges Bank

W. R. Wright and Ronald Schlitz

Summary. The objective of this program was to determine the flow pattern at the eastern end of Georges Bank by following Lagrangian drifters (drogues) with enough hydrographic measurements to keep track of the water masses involved. We hope to determine whether the so-called Georges Bank gyre is actually a closed system at the eastern end during the summer time.

The program began on 29 June 1979 by setting five drogues in a north-south line roughly along the 66°45'W longitude and at about 42° N latitude. The drogues were equipped with radios supplied by Telecommunications, Inc. of Panama City, Florida. The drogues were followed through a couple of tidal cycles before the ship left for Shelbourne.

Radio receivers were rigged in port and the ship sailed on 06 July 1979 to return to Georges Bank. Although the radio was advertised as being good for 50 to 75 miles, no signals were picked up until the ship was nearly back on location. The only drogue of the original set that was recovered was reported to us by a fishing vessel. Three new drogues were set and recovered after four days. Good bearings were not obtained and the signal was frequently lost when the ship was no more than a mile from the drogue.

We have since discovered that most of the radio problems resulted from the radios being too low on the mast of the drogue floats, so that the aluminum tubing reduced the transmission power drastically.

It was established on the Westward cruise that the drogues pretty well followed the edge of the bank, moving east, southeast, and then south, apparently moving into slightly deeper water of somewhat different characteristics. Additional observations would be necessary to accomplish the objective of determining whether the gyre is actually closed.

An analysis of the marine sediments on Georges Bank with respect to bathymetry and current velocities

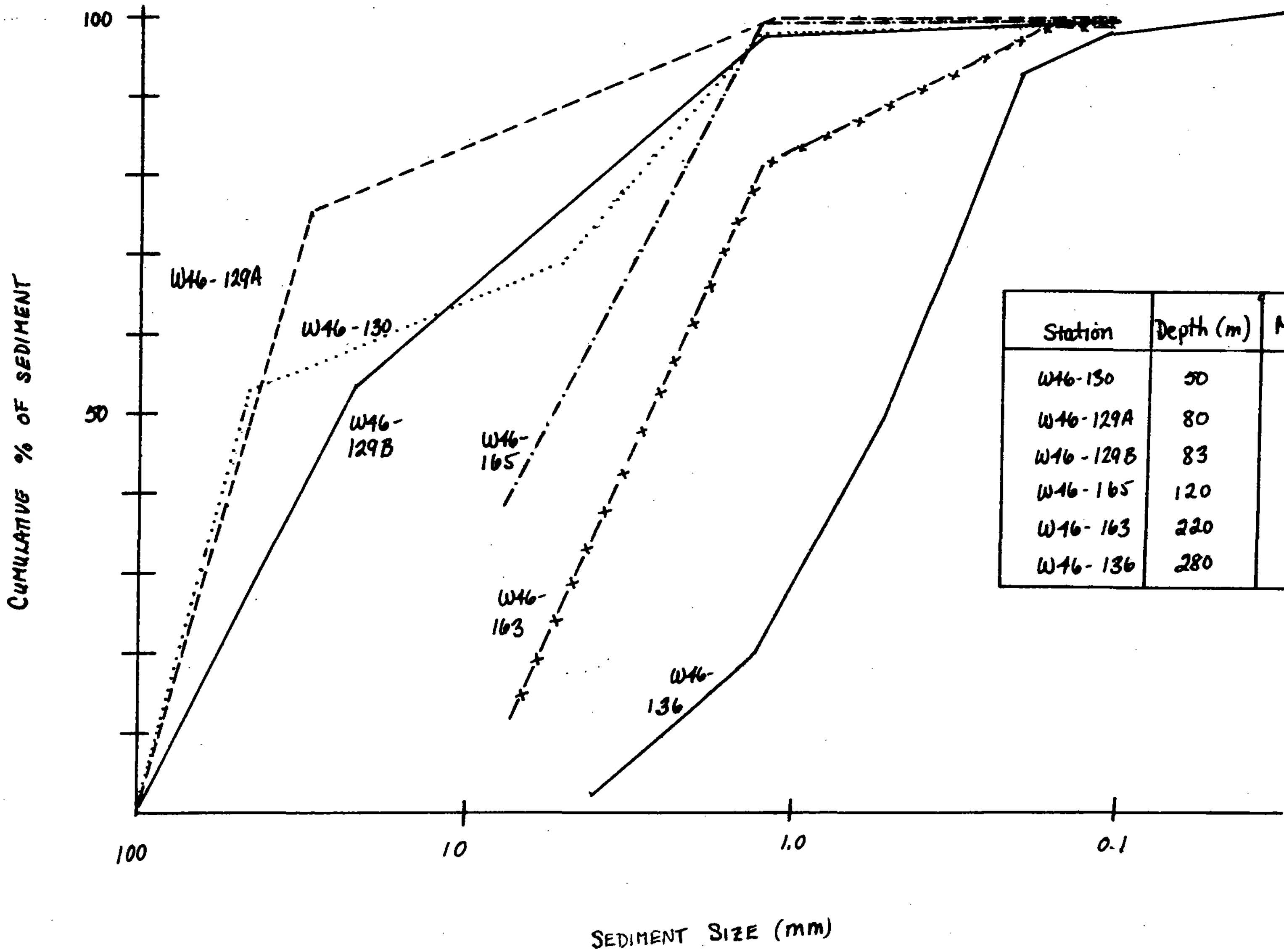
Mark Aspinwall

Abstract. According to information available on water movement on Georges Bank, there is a strong semi-diurnal tidal flow in an elliptical clockwise direction. This movement seems to be the main factor in transporting sediments around Georges Bank. In six samples taken on Georges Bank, I found that in areas where the tidal velocities are high there seem to be coarse grained sediments. Bathymetry also seems to affect, directly or indirectly, sediment coarseness. In water less than 50 fathoms, I found coarser grained material than in water over 50 fathoms (figure 10). This evidence suggests a direct relation between bathymetry, water velocity, and sediment size.

An analysis of the marine sediments on Georges Bank with respect to bathymetry and current velocities

Tso-An Yu

Abstract. Bottom sediments of the northeasternpart of Georges Bank were collected to establish a relationship between the sediment grain sizes with its respective current velocities and depths. A pattern of coarser grain sediments was found associated with relatively shallower areas where the bottom current velocities are strong. Conversely, relatively finer grain sediments were found in deeper areas where the winnowing forces of the bottom surface are relatively weak. These relationships could be sued to predict the locations of various bottom sediments.



Station	Depth (m)	Median Grain Size (mm)
W46-130	50	47
W46-129A	80	44
W46-129B	83	22.5
W46-165	120	5.4
W46-163	220	2.75
W46-136	280	0.58

Fig. 10. Sediment diagram for stations done on cruise W-46.

Character displacement with respect to food consumption between various species of the families Gadidae and Merluccidae

Jack Sobel

Abstract. Several species of groundfish from the Gadidae and Merluccidae families occur together on portions of Georges Bank and appear to occupy similar niches. It was hypothesized that character displacement has taken place between these species with respect to the parameter of food consumption. Four otter trawls were done on the Northeast corner of Georges Bank during June and July, 1979. Only young haddock, *Melannogrammus aeglifinus*, and silver hake, *Merluccius bilinearis*, were captured in sufficient numbers to study. Stomach content analysis of these two species revealed two distinctly different diets. The young haddock, *M. aeglifinus*, fed nearly exclusively on benthic organisms while the silver hake, *M. bilinearis*, were either not feeding due to spawning or feeding primarily on pelagic organisms. The difference in food consumption between these two species and a study of morphological adaptations among other members of the two families led to the conclusion that character displacement has probably resulted in differential food consumption within the two families. However, data were insufficient to actually confirm this.

LONG TERM INTERNAL PROGRAMS

Introduction and Summary

The Sea Semester program has collected data under the heading "surface phenomena" for about three years. These phenomena include sightings of marine mammals, pelagic birds, and unusual weather features such as waterspouts and the Northern Lights. Pelagic tar is also considered a surface phenomena and collections of "tarballs" are frequently made.

On W-46 several student projects entailed birds, mammals, and tarballs. Cohen and Lake found striking distribution patterns in the pelagic birds sighted. Two studies on marine mammal respiration (L. Smith and Goldberg) revealed a relationship between rate of respiration and breathing, and a study on acoustics showed possible individual patterns of clicking by the saddleback dolphin (French). Tarball distribution patterns seemed to be more closely related to wind patterns than to any other factor studied (Rappleyea and Wishinsky).

A new long-term program was initiated on Cruise W-46: the study of spiny lobster larvae. These larvae have an unusually long life before metamorphosis into adult form. They are therefore subject to long-term transport by oceanic currents, and their distribution is a puzzle. They were expected to be abundant in the Sargasso Sea. However, probably because of the influence of the cold core ring (Voytek), only ten specimens were found. This number was too small for distribution studies, so intensive morphological observations were taken instead (Ernest).

Observations of pelagic bird life

Nancy J. Cohen

Abstract. A natural history study of the birds encountered during R/V *Westward* cruise W-46 was conducted. A detailed log of daily sightings and observations was maintained throughout the first half of the cruise from Woods Hole to Bermuda to Beorges Bank. During the second half of the cruise (Georges Bank to Shelburne, Nova Scotia, to Woods Hole) data concerning population and disbribution were collected for the Manomet Bird Observatory's on-going sea-bird study.

A total of 17 species were observed throughout the cruise (table 3). The largest concentration of Gulls (mainly Herring and Great Black-backed) were observed within sight of land (Menemsha Bight, Bermuda, and Nova Scotia). This holds true for the Double-crested Cormorants, Terns, and White-tailed Tropic Birds (Bermuda) as well. Out of sight of land Wilson's and Leach's Storm Petrels were the most regularly observed species. The Greater Shearwater was the most abundant of the shearwater species seen, and the Fulmar was the most abundant species around Georges Bank.

Table 3. Species of birds seen during R/V Westward cruise W-46.

Common Name	Scientific Name
Pelagic Birds	
Leach's Storm Petrel	Oceanodrama leucorhoa leucorhoa
Wilson't Storm Petrel	Oceanites oceanicus oceanicus
Sooty Shearwater	Puffinus griseus
Greater Shearwater	P. gravis
Cory's Shearwater	P. diomedea
Fulmar	Fulmarus glacialus glacialus
White-tailed Tropic Bird	Phaethon lepturus catesbyi
Common Tern	Sterna hirundo hirundo
Pomarine Jaegar (immature)	
Shore Birds	
Herring Gull	Larus argentatus
Great Black-backed Gull	L. marinus
Double-crested Cormorant	Phalacrocorax auritus
Great Blue Heron	
Osprey	
Land Birds	
Eastern Blue Jay	
Barn Swallow	
Brown-headed Cowbird	

The distribution, abundance and feeding methods of coastal and pelagic birds

Kate Lake

Abstract. Coastal and pelagic birds were observed along R/V *Westward*'s cruise track from Woods Hole, Ma., to Bermuda to George's Bank. Attention was paid to species and number in an attempt to determine the distribution and abundance of species according to the location of coastal, slope, bank, Gulf Stream, Sargasso Sea, and cold core ring water. Results showed an expected reduction of total numbers of birds in the Sargasso Sea, cold core ring, and Gulf Stream areas (figure 11a) and a significant increase in numbers over slope and bank water (figure 11b). Coastal species disappeared with distance from the continental shelf and correspnnded to a rise in pelagic species. Distribution varied according to physical oceanographic characteristics of each water mass, suggesting such influences as high productivity and water mass interfaces on bird numbers and species.

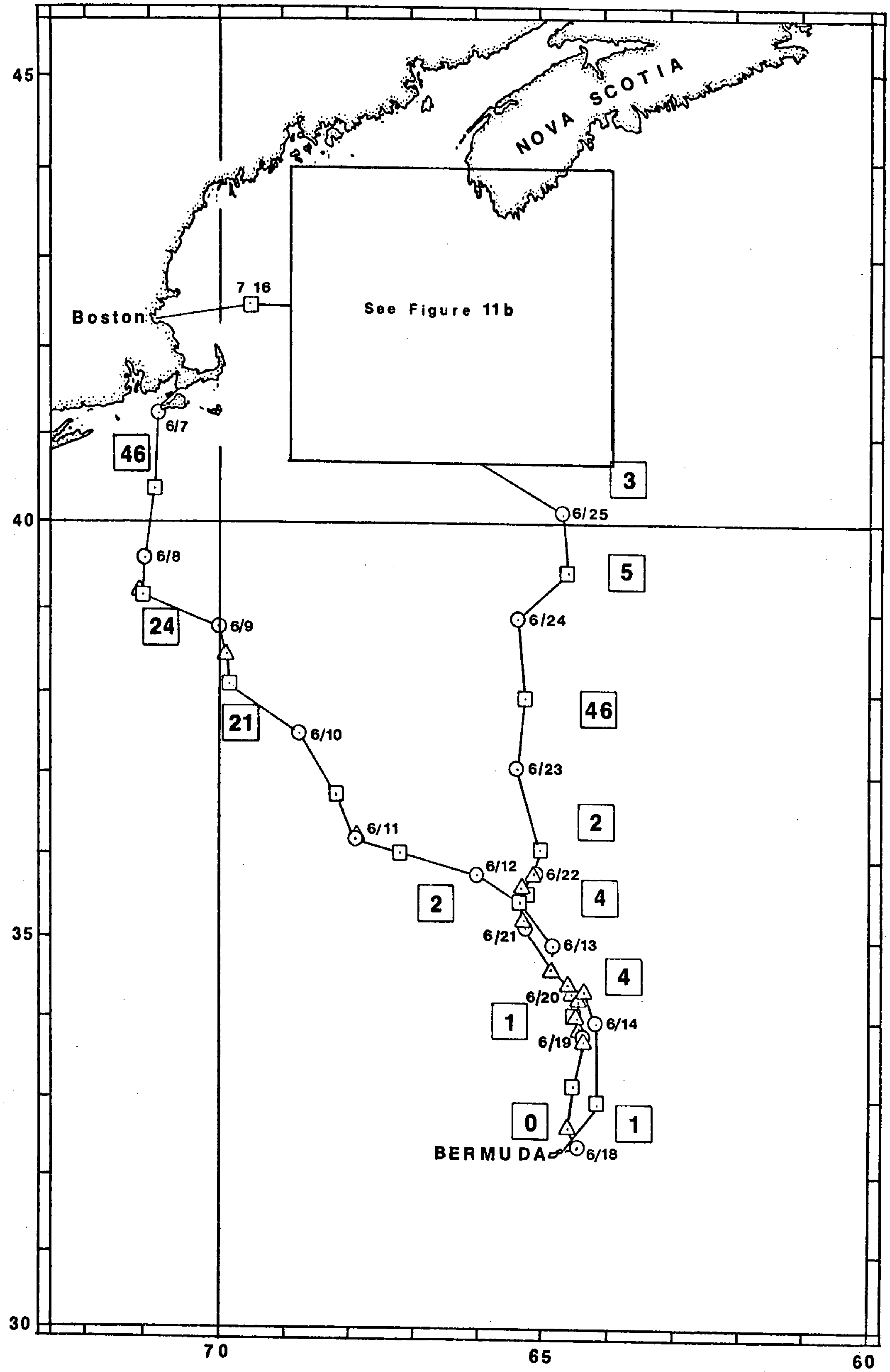


Fig. 11. A. Numbers of birds sighted along the cruise track of W-46.
B. See next page.

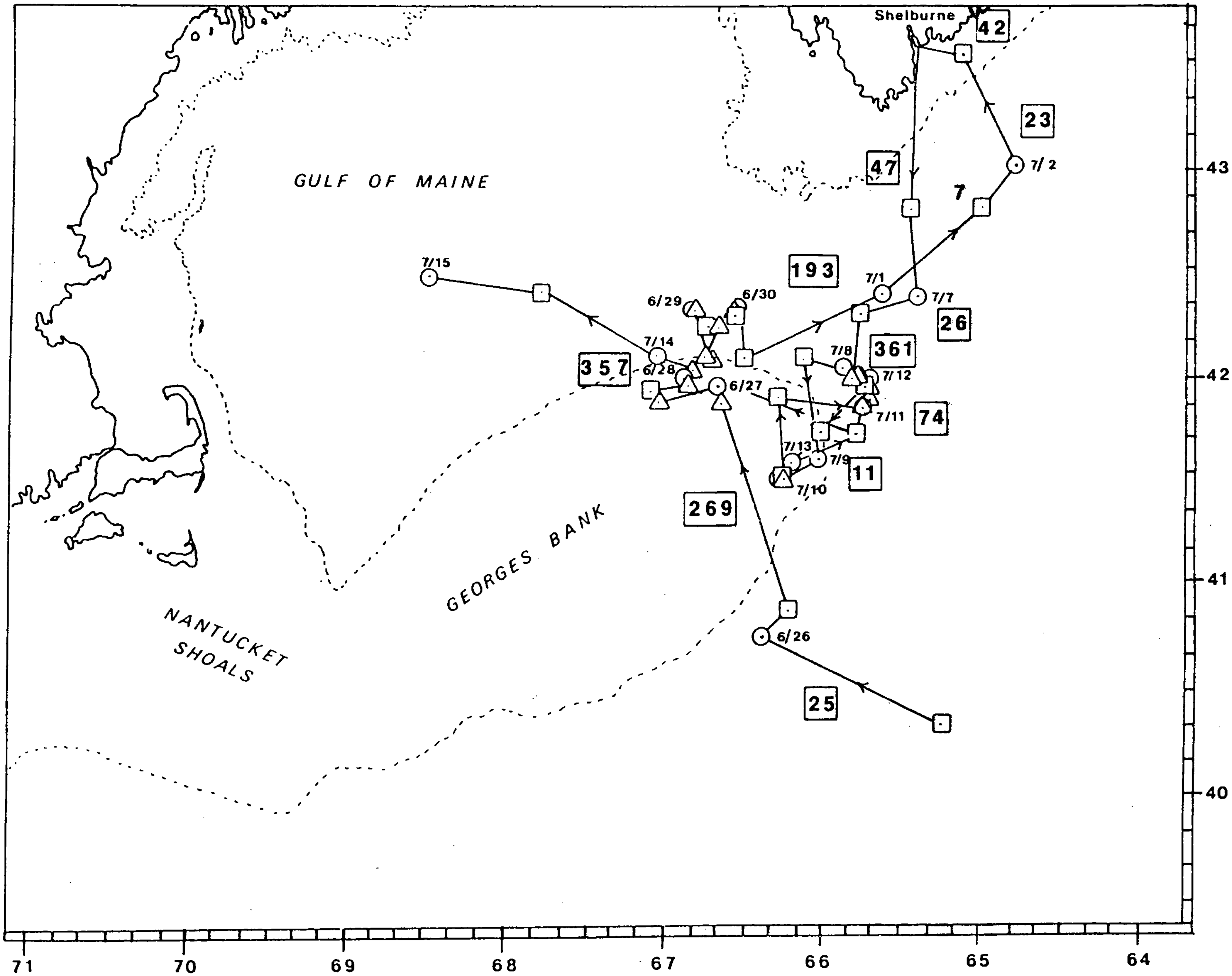


Fig. 11. B. Numbers of birds sighted along the Georges Bank section of cruise W-46.

Cetacean respiration and feeding

Loren Smith

Abstract. Mammal sightings on cruise W-46 were examined in an effort to study the respiration rates and distribution of cetaceans. The respiration rates are determined by the time between blows and the number of blows in a given time. It was expected that there would be an increase in the breathing frequency with an increase in the physical activity that is associated with feeding. Ther determination of feeding activity was to be based on the evidence of cetacean food in the area and behavioral observations. There were insufficient data for determining a correlation between feeding and respiration but a contrast between the breathing frequencies of different sized cetaceans was established(table 4). A faster breathing rate for the smaller cetaceans was observed and is possibly explained by their small size and more active swimming habits.

The greatest number of marine mammals were sighted on Georges Bank at interfaces between water masses where there was an associated increase in the number of pelagic birds.

Patterns in cetacean respiratory cycles

Bert Goldberg

Abstract. Respiratory cycles were measured in Cetacea encountered during W-46 on R/V Westward from June 6, 1979 to July 18, 1979. Surface temperatures were taken, and an attempt was made to draw a correlation between the two variables. Individuals of species: *Globiephala melaena*, *Delphinus delphis*, *Stenella plagiodon* were sighted, along with possible *Physeter catadon* and *Megaptera novaenglieae* which were timed on at least nine different occasions, along with some sightings made where timing was not possible. While no correlation between temperature and respiration could be drawn, patterns that differentiated the small and large organisms were observed, along with some interesting distributional patterns.

Table 4. Respiration rates of marine mammals seen on cruise W-46, indicated by mean time between blows

Mammals < 15 feet long	Sighting No.	Time (sec)	Mean Time(sec)
Dolphinus delphis	9	13.6	13.6
Globiephala melaena	14	13.8	
	21	13.8	13.8
Mammals > 30 feet long			
Physeter catadon	15a*	29.2	
	15b	22.1	
	15c	27.5	
	16	25.8	
Unidentified whale	17	19.2	
Unidentified whale	20	24.8	
Megaptera novaengliae	22b	16.2	

*Small letter suffixes indicate sightings at approximately the same ship's position, separated in time by at least 30 minutes. Sightings may or may not have been of the same animal.

An investigation of the individuality of cetacean sound production

Stephen French

Abstract. Cetacean sound production has been intensively studied since the end of World War II. Most of this study has concerned echolocation. Recently studies have begun to investigate the possibility of individuality of sound production. Several species, including *Tursiops truncatus*, *Stenella plagiodon*, and *Lagenorhychus acutus* have been shown to produce unique sounds.

The present study was designed to test the hypothesis that every species and every individual Cetacean produce a unique sound. Two recordings were made of saddleback dolphins, *Delphinus delphus*. Tapes were slowed down so that intervals of clicking and the rate of clicking could be measured. Group II showed a greater number of clicks with a similar rate than Group I, which seemed more diversified. (figure 12). Since recordings of other species were not obtained, no conclusions could be drawn about the uniqueness of the saddleback dolphin sounds.

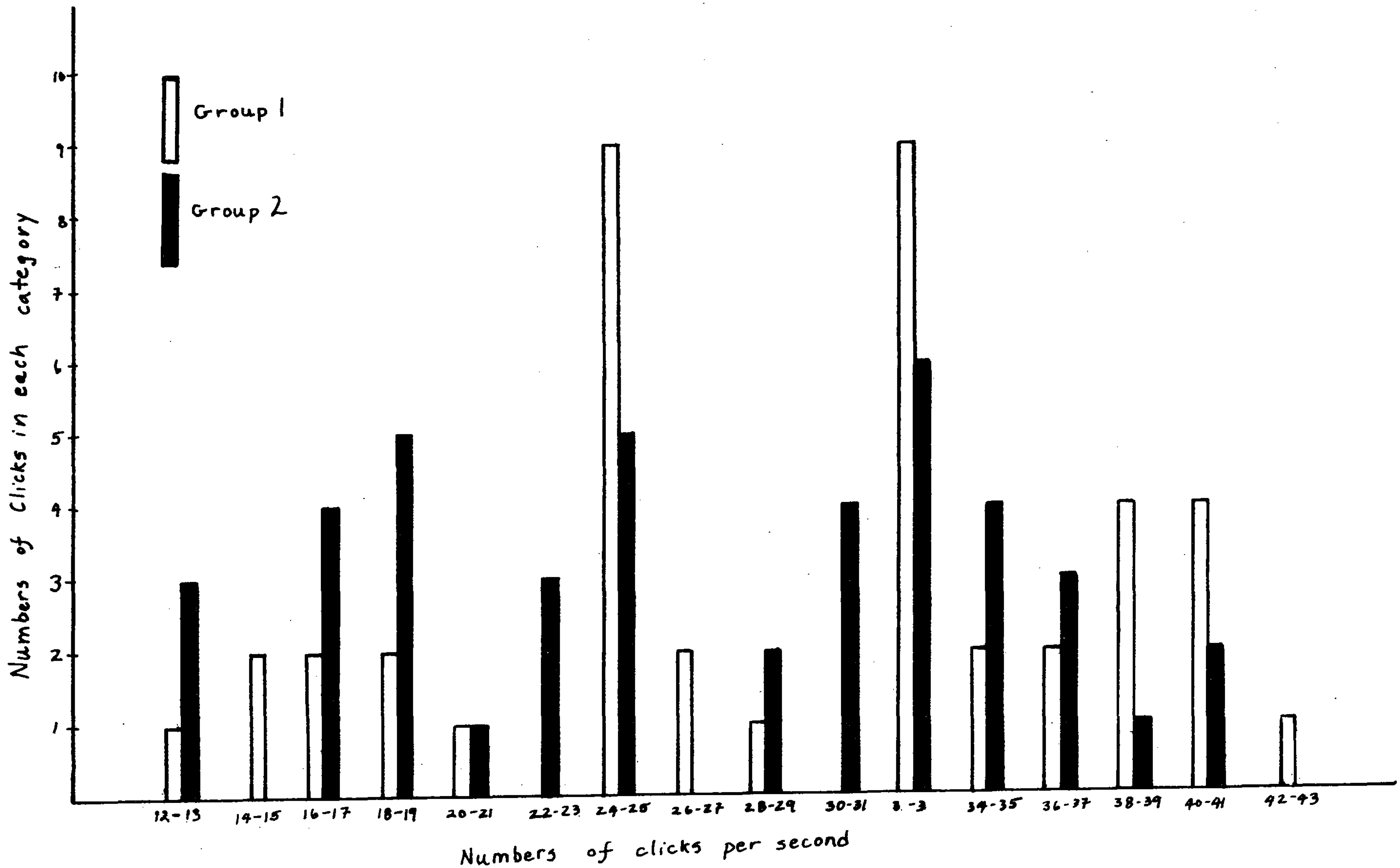


Fig. 12. Acoustical data from recordings of the saddleback dolphin, Delphinus delphus.

Distribution of pelagic tar in relation to proximity of shipping lanes with further discussion on the influence of Gulf Stream and local wind driven currents

Stacy Rappleyea and Ellen Wishinsky

Abstract. Pelagic tarballs were collected with a neuston net at twelve stations. Wet weight of samples was measured and concentration of tar (mg/m^2) calculated for each station. Concentrations were then plotted along with shipping lanes in an attempt to correlate the two. No relationship between tarball concentration and close proximity of shipping lanes was found.

Further plotting of Gulf Stream boundaries and wind direction during three hours prior to tows showed no correlation when the Gulf Stream alone was considered, but showed positive correlation when Gulf Stream and wind were considered together. Data showed tarball concentrations to be higher where Gulf Stream waters brought tar from nearby shipping lanes and winds also moved from heavily trafficked waters, or where a station was influenced only by wind and nearby shipping lanes.

A study of the spiny lobster larvae in the Sargasso Sea

Holly B. Ernest

Abstract. The original purpose of this study was to examine the horizontal distribution of spiny lobser larvae at distances from Bermuda. I set out to find whether the concentration of larvae and the number of different species changed at increasing distances from Bermuda. No conclusions about distribution could be made on this cruise because only ten larvae were collected. Several factors, including the abundance of jellyfish and chaetognaths, and the presence of a cold core ring, may have caused a reduction in spiny lobster larva numbers. The ten larvae were studied in detail morphologically (figure 13) and were keyed to species and stage.

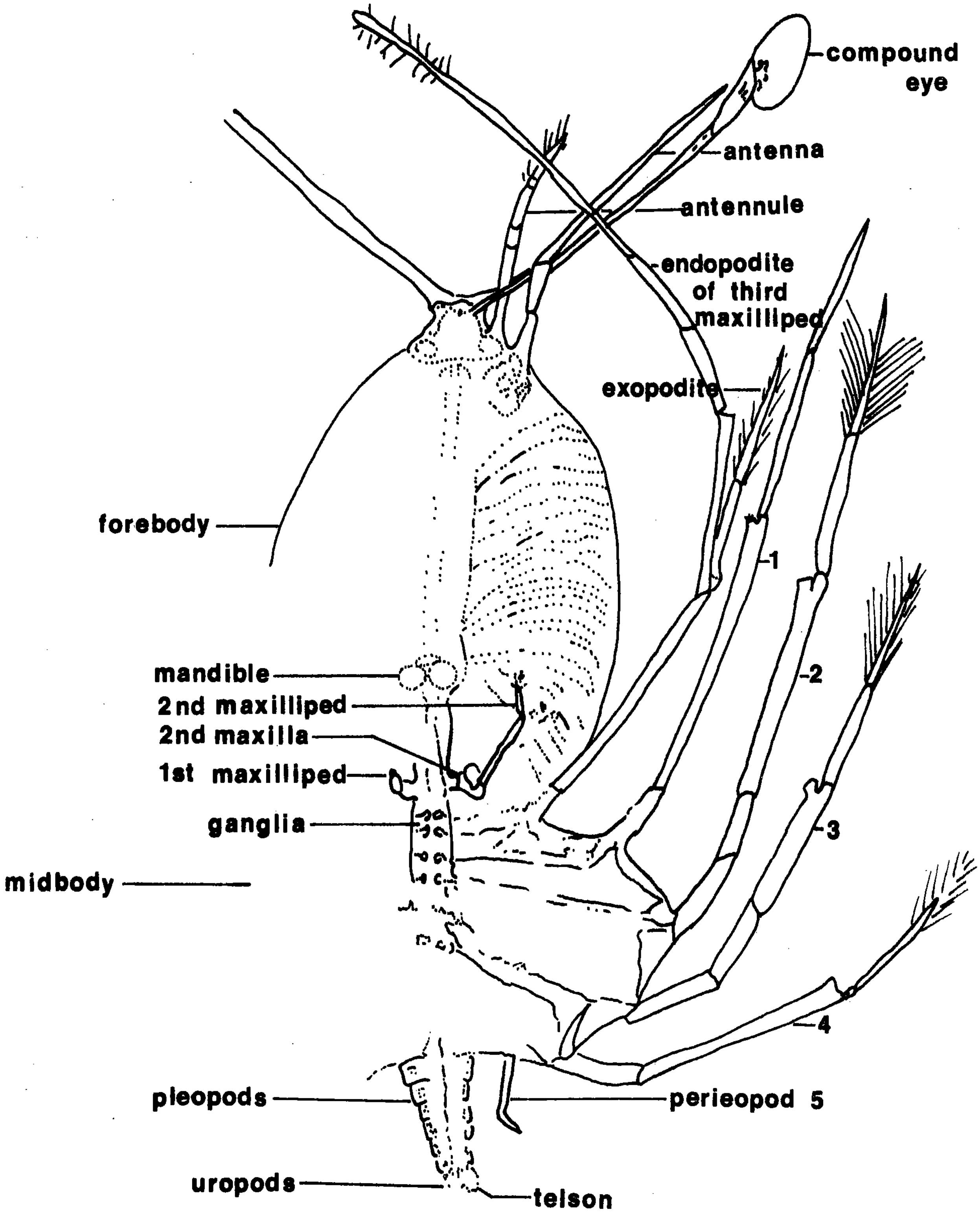


Fig. 13. A phyllosoma larva of the Family Palinuridae.

COOPERATIVE PROGRAMS

Shark Longlining/Tagging (NMFS)

The *Westward* cooperates with the National Marine Fisheries Service in a program to discover and explain the migratory habits of certain sharks in the North Atlantic. On cruise W-46 a longline of 30 hooks was set over Corsair Canyon, off the edge of Georges Bank, on 09 July 1979. Two blue sharks, one male and the other female, were tagged and released. In addition, a swordfish (*Xiphias gladius*) was caught on the line. All data were sent to the Narragansett Laboratory, NOAA, NMFS, Rhode Island.

Weather Observations (NOAA)

Weather observations were carried out twice daily. The data collected are reported in Appendix III. All original records have been sent to the National Weather Service, NOAA, AOML, Miami, Florida.

OTHER STUDIES

Introduction

Two student projects fell into none of the preceding categories. A study was done on enrichment of phytoplankton medium with molybdenum (miller) and another on various aspects of sqiud morphology (Cook). The abstracts follow.

The effects of enriching phytoplankton populations with nutrients and excess molybdenum on primary productivity

Ann R. Miller

Abstract. The intent of this study was to enrich samples of phytoplankton from three areas (Sargasso Sea, a cold core ring, and slope water) with a nutrient enrichment and the trace metal molybdenum and to then measure primary productivity. The question of nutrients and molybdenum as limiting factors was examined by incubating samples for several hours and then measuring photosynthesis via the Winkler technique. However, the sample incubation periods extended too long and bacteria growth was encountered in all of the samples. Thus, no conclusive results were obtained. Suggestions for better technique methods for future work in this area are proposed.

Squid morphology and absorption of light in squid and fish lenses

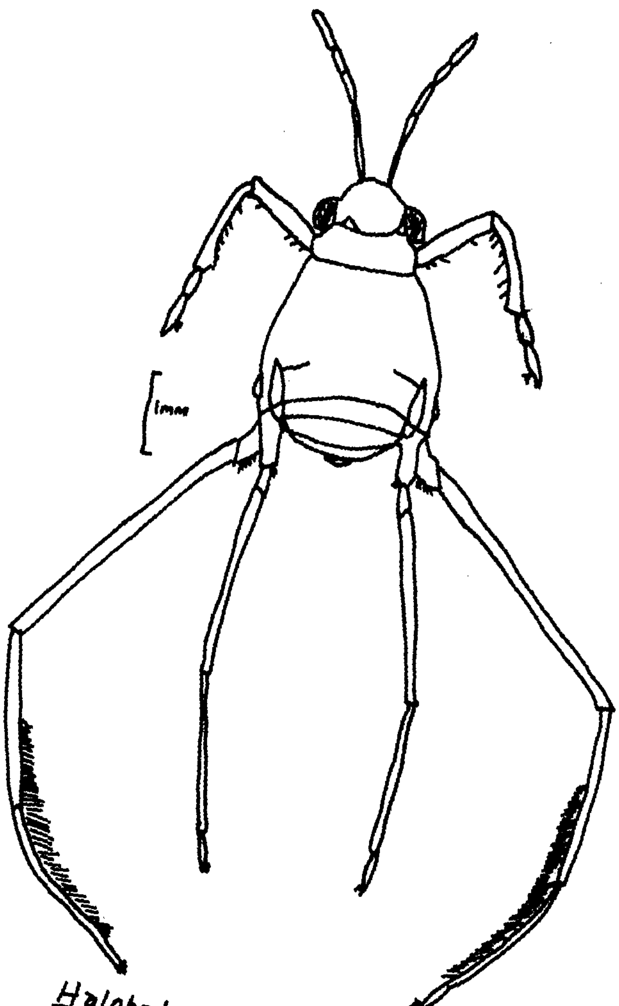
Christy Cook

Four squid representing two suborders, the Teuthoidea and the Sepioidea, were collected on cruise W-46 (table 5). The Teuthoids were found in open ocean water and the Sepioid was found in an otter trawl done on Georges Bank. A ratio between head size and eye size was calculated The Rossia and young stage had ratios of 2:1 and the Ommastrephidae had a ratio of 4:3. Spectrophotometric analysis of the Sepioid eye lens and comparison with cod and swordfish lenses suggested that the squid eye lens was adapted for a murky, bottom habitat. Lenses of the other squid were too small for spectrophotometric analysis.

Table 5. Catches of squid on cruise W-46

ORGANISM	DATE	LOCATION	TYPE OF NET	DEPTH OF TOW	TEMPERATURE	SALINITY	
Ommastrephidae (Teuthoidea)	June 11	36°16 67°55 edge of Gulf Stream/Sargasso Sea	meter net	200m	22.53	36.51	day
Young Stage (Teuthoidea)	June 18	32°45 64°37 Sargasso Sea near Bermuda	meter net	50m	21.64	36.55	day
Larva (Teuthoidea)	June 25	40°20 65°13.3 Atlantic Ocean	bongo net	800m	9.5		night
Rossia (Sepioidea)	June 28	41°13 66°34 edge of Georges Bank	otter trawl	267m	7.2	34.17	day

APPENDICES



Halobates micans

APPENDIX I

Summary Log of Stations done on Cruise W-46

Station No.	Date	Time	Lat (N)	Long (W)	Operation
W46-1	06-08-79	0912	$39^{o}43'$	$71^{o}09'$	Bathythermograph (BT)
W46-2		0951	$39^{o}41'$	$71^{o}09'$	BT
W46-3		1143	$39^{o}35'$	$71^{o}08'$	BT
W46-4		1257	$39^{o}35'$	$71^{o}07'$	BT
W46-5		1520	$39^{o}27'$	$71^{o}14'$	BT, hydrocast
W46-6		1915	(Log = 101.4)		BT
W46-7		2110	(Log = 105.6)		BT
W46-8		2300	(Log = 110.2)		BT
W46-9	06-09-79	0017	$39^{o}13'$	$71^{o}02'$	BT
W46-10		0103	(Log = 120.5)		BT
W46-11		0153	$39^{o}05'$	$70^{o}55'$	BT
W46-12		0239	(Log = 130.4)		BT
W46-13		0340	(Log = 135.6)		BT
W46-14		0430	(Log = 140.2)		BT
W46-15		0515	(Log = 146.0)		BT
W46-16		0556	(Log = 150.0)		BT
W46-17		0646	(Log = 155.3)		BT
W46-18		0825	(Log = 164.5)		BT
W46-19		1200	$38^{o}46'$	$70^{o}01'$	BT
W46-20		1513	(Log = 187.5)		BT
W46-21		1810	(Log = 196.8)		BT
W46-22		1938-	$38^{o}12'$	$69^{o}55'$	BT, hydrocast
		2342			bongo net (150 m) meter net (30m) neuston net two (0m)
W46-23	06-10-79	0236	(Log = 214.5)		BT
W46-24		0425	(Log = 224.5)		BT
W46-25		0545	(Log = 234.5)		BT
W46-26		0633	(Log = 239.2)		BT
W46-27		0724	(Log = 244.3)		BT
W46-28		0817	(Log = 250.0)		BT
W46-29		0917	(Log = 255.3)		BT
W46-30		1016	(Log = 260.8)		BT

APPENDIX I - continued

W46-31		1103	37°29.0'	68°48.9'	BT
W46-32		1200	(Log = 270.0)		BT
W46-33		1210	37°25.4'	68°44.0'	Neuston net tow
W46-33A		1340	(Log = 275.0)		BT
W46-34		1445	(Log = 280.0)		BT
W46-35		1602	(Log = 285.0)		BT
W46-36		1835	(Log = 295.3)		BT
W46-37	06-11-79	0006	36°37'	68°06'	Neuston net tow
W46-38		0715-1511	36°16'	67°55'	BT, hydrocast, phytoplankton net, bongo net (400 m), meter net (200 m), neuston net tow (0 m), light intensity
W46-39	06-12-79	1219	35°46'	66°04'	Neuston net tow
W46-40		2005	35°31.7'	65°27.4'	Expendable bathythermograph(XBT)
W46-41		2320	35°27'	65°22'	XBT
W46-42	06-13-79	0623	(Log = 399.3)		XBT
W46-43		0835	(Log = 410.2)		XBT
W46-44		1040	(Log = 420.0)		XBT
W46-45		1130	34°65'	64°55'	XBT
W46-45A		1204	(Log = 427.6)		Neuston net tow
W46-46		1235	34°51'	64°50'	XBT
W46-47		1318	34°47'	64°46'	XBT
W46-48		1430	34°42.8'	64°51.7'	XBT
W46-49		1515-1740	34°39.6'	64°55.5'	XBT, hydrocast
W46-50		1930	34°34.3'	64°53.5'	XBT
W46-51		2037	34°30.3'	64°49.1'	XBT
W46-52		2150	34°28.0'	64°43.9'	XBT
W46-53		2245-	34°26.4'	64°39.3'	XBT, hydrocast
	06-14-79	0100			
W46-54		0230	(Log = 471.2)		XBT
W46-55		0327	(Log = 476.5)		XBT
W46-56		0545-0638	34°22.2'	64°18.5'	XBT, hydrocast

APPENDIX I - continued

W46-57		0854	34°15.6'	64°17.4'	XBT
W46-58		1008	34°09.3'	64°15.4'	XBT
W46-59		1118	34°03.5'	64°13.3'	XBT
W46-60		1212	33°59.0'	64°11.9'	XBT
W46-61		1330	(Log = 506.3)		XBT
W46-62	06-14-79	1435	33°47.5'	64°08.1'	XBT
W46-63		1525	(Log = 516.5')		XBT
W46-64		1735	33°35.5'	64°14'	XBT
W46-65	06-18-79	1615-2008	32°45.8'	64°37.2'	XBT, hydrocast, phytoplankton net, bongo net (300m), meter net (50 m), neuston net tow (0 m)
W46-66		2317	33°00'	64°38'	XBT
W46-67	06-19-79	0030	(Log = 640.0)		XBT
W46-68		0135	(Log = 645.5)		XBT
W46-69		0310	(Log = 650.0)		XBT
W46-70		0608	33°30'	64°32'	XBT
W46-71		0726			XBT (failed)
W46-72		0735	(Log = 59.5)		XBT
W46-73		0858-1105	33°46'	64°23'	XBT, hydrocast
W46-74		1240	33°51'	64°22'	XBT
W46-75		1410-1608	33°59.0'	64 23.4'	XBT, hydrocast
W46-76		1710	34°03.4'	64°23.7'	XBT
W46-77		1850	33°59.8'	64°29.0'	XBT
W46-78	06-20-79	2015-0255	34°05.2'	64°29.4'	XBT, hydrocast, phytoplankton net, bongo net(400 m), meter net (200 m), neuston net tow (0m)
W46-79		0349	(Log = 689.5)		XBT
W46-80		0555	34°13.3'	64°31.0'	XBT
W46-81		0725-0945	34°16.9'	64°29.4'	XBT, hydrocast, Van Dorn water collection
W46-82		1340	34°23'	64°29.6'	XBT
W46-83		1450-1635	34°25.5'	64°31.6'	XBT, hydrocast
W46-84		1853	34°31.6'	64°30.9'	XBT
W46-85		2014	(Log = 715.7)		XBT

W46-86		2110	(Log = 720.7)		XBT
W46-87		2215	34°46.8'	64°36.8'	XBT
W46-88		2333	34°52.5'	64°40.0'	XBT
W46-89	06-21-79	0108	34°58.5'	64°43.2'	XBT
W46-90		0230	35°04.6'	64°46.7'	XBT
W46-91		0426	35°10.6'	64°50.5'	XBT
W46-92		0639	35°15.7'	64°53.6'	XBT
W46-93		0715	(Log 750.0)		BT
W46-94		1155	35°08.4'	65°09.1'	BT
W46-95		1420- 1810	35°14.1'- 35°12.6'	65°11.0' - 65°11.7'	XBT, hydrocast, light intensity, phytoplankton net, bongo net (300 m), meter net (50 m), neuston net tow (0 m)
W46-96		2228	35°23.4'	65°15.7'	XBT
W46-97		2353	35°27.5'	65°16.5'	XBT
W46-98	06-22-79	0004	(Log = 787.3)		XBT
W46-99		0246- 0800	35°39.4' 35°42.5'	65°18.9' 65°16'	XBT, hydrocast, phytoplankton net, bongo net (300 m), meter net (50 m), neuston net tow (0 m)
W46-100		1230- 1748	35°49.5'	64°57.5'	XBT, hydrocast, phytoplankton net, light intensity, bongo net (250 m), meter net (50 m), neuston net two (0 m), Van Dorn water collection
W46-101		2108	35°58.8'	65°00.2'	XBT
W46-102	06-23-79	0000	36°07.2'	65°03.8'	XBT
W46-103		0025	36°09.1'	65°06.6'	Neuston net tow
W46-104		0048	36°10.3'	65°05.7'	XBT
W46-105		0240	36°20.6'	65°09.7'	XBT
W46-106		0424	36°30.1'	65°12.6'	XBT
W46-107		0620	36°45.2'	65°19.3'	XBT
W46-108		0750	36°55.5'	65°23'	XBT
W46-109		0941	37°08.1'	65°26.1'	XBT
W46-110		1720	37°23'	65°27'	XBT
W46-111		1945	(Log = 910.0)		XBT
W46-112		2240	37°50.7'	65°17.1'	XBT
W46-113	06-24-79	0040	38°01.1'	65°17.2'	XBT
W46-114		0240	38°12.8'	65°15.7'	XBT
W46-115		0450	(Log = 940.5)		XBT
W46-116		0650	(Log = 950.2)		XBT

APPENDIX I - continued

W46-117		0928	(Log 960.5)		XBT
W46-118		1040	(Log = 965.5)		XBT
W46-119		1200	(Log = 970.2)		XBT
W46-120		1325	39°16.2'	64°46.2'	XBT
W46-121		1440	(Log = 981.5)		XBT
W46-122		1535	(Log = 985.25)		XBT
W46-123		1640	(Log = 990.1)		XBT
W46-124		2345	39°37'	64°40'	XBT
W46-125	06-25-79	0415	39°37.8'	64°30.3'	XBT
W46-126		1031	(Log = 1006.2)		XBT
W46-127		1215-1245	40°07.6' (Log = 1016.3)	64°45.9'	XBT, neuston net tow
W46-128		1750-2235	40°20.4'	65°13.2'	XBT, hydrocast, phytoplankton net, Van Dorn water collection, bongo net (Oblique tow to 800 m)
W46-129	06-27-79	1110-1515	41°52'	66°38'	Hydrocast, plankton net, light intensity, phleger core, bottom grab, otter trawl
W46-130	06-28-79	2100-0032	41°48.7'	67°02.8'	XBT, hydrocast, phleger core bottom grab, otter trawl
W46-130A		0524-0630	41°52.5'- 41°49.7'	66°51.2' 66°48.7'	Otter trawl
W46-131		1106	41°55'	66°52'	XBT, hydrocast
W46-132		1300	42°00'	66°51.5'	XBT, hydrocast
W46-133		1608	42°05'	66°45.7'	XBT, hydrocast
W46-134		1735	42°06.9'	66°41.9'	XBT
W46-135		1823	42°10.8'	66°40.4'	XBT
W46-136		2005-2255	42°13.3'- 42°12.8'	66°40.5' 66°40.8'	XBT, hydrocast phleger core, bottom grab,
W46-137	06-29-79	0000	42°12.5'	66°42.4'	XBT, drogues #29 and #6 launched.
W46-138		0545	42°04.9'	66°43.2'	XBT, drogues #11o and #11y launched.
W46-139		0955	41°52.9'	66°47.0'	XBT, drogue #39 launched.
W46-140		1221	41°54.7'	66°48.6'	XBT, alongside drogue #39
W46-141		1418	42°05.8'	66°45.6'	XBT, alongside drogue #11y
W46-142		1427	42°06.3'	66°45.0'	XBT, alongside drogue #11o

W46-143		1722	42°12.8'	66°37.8'	XBT, alongside drogue #6
W46-144		1737	42° 13.9'	66°37.2'	XBT, alongsidedrogue #29
W46-145		1940	41°13'	66°34'	Phytoplankton net tow
W46-146	06-30-79	0520			Otter trawl
W46-147		0833	42°17'	66°38'	Phytoplankton net tow
W46-148		1500			XBT, alongside drogue #11y?
W46-149		0345	42°01.5'	66°33.6'	XBT, drogue #11 relaunched
W46-150	07-07-79	0600	42°18'	65°35.5'	XBT
W46-151		0740	42°17.7'	65°37.5'	XBT
W46-152		1250- 1351	42°02'	65°24'	XBT, meter net tow (50 m)
W46-153		1644	42°08'	65°33'	XBT
W46-154		1812	42°15'	65°43.5'	XBT
W46-155		1939	42°23.0'	65°45.0'	XBT
W46-156		2035	42°25.3'	65°48.1'	XBT
W46-157		2300	42°21.2'	65°46.6'	XBT
W46-158	07-08-79	0015	42°15.7'	65°47.5'	XBT
W46-159		0152	42°05'	64°48'	XBT
W46-160		0330	41°55'	65°44'	XBT
W46-161		0515 0841	41°57.6' 42°00.6'	65°49.2' 65°53.4'	XBT, hydrocast drogue #24 launched
W46-162		0905			XBT
W46-163		1025	42°00.3'	65°52.5'	XBT, drogue #29 relaunched, bottom grab
W46-164		1500	41°58.3'	65°46.6'	XBT, drogue #24 retrieved
W46-165		1720	41°57.4'	65°59.1'	XBT, drogue #24 relaunched,
			41°59.4'	66°04.7'	drogue #21launched,
		1900- 2215	41°59.4'	66°03.3'	hydrocast, Van Dorn water collection, bottom grab
W46-166	07-10-79	1105	41°26.3'	66°16.2'	XBT, hydrocast
W46-167	07-11-79	1205	41°48.5'	65°43.0'	XBT, hydrocast, drogue #21 retrieved
W46-168	07-12-79	1020	41°55.5'	65°43'	XBT, hydrocast, drogue #22 retrieved
W46-169		1230	41°59'	65°47.5'	XBT, hydrocast, drogue #29 retrieved
W46-170		1755	41°47'	65°43'	XBT, hydrocast, drogue #24 retrieved

W46-171	07-14-79	2000	42°17.2'	67°33.8'	XBT
W46-172		2340	42°21.8'	67°47'	XBT
W46-173		2350			XBT
W46-174	07-15-79	0850	42°23'	68°10'	XBT
W46-175		1218	42°27'	68°27'	XBT
W46-176		1443	42°27'	68°37'	XBT
W46-177		1710	42°29.3'	68°53.4'	XBT
W46-178		1920	42°27.5'	69°05.5'	XBT
W46-179		2140	42°27'	69°16.6'	XBT
W46-180	07-16-79	0020	42°28.3'	69°29'	XBT
W46-181		0335	42°28.5'	69°43'	XBT
W46-182		0635	42°28.9'	69°58.4'	XBT
W46-183		0820	42°31'	70°14'	XBT
W46-184		1000	42°33'	70°23'	XBT

APPENDIX II

Summary of Hydrographic Data

Station No.	Calculated Depth (m)	Temperature (°C)	Salinity (%)	σ_t	Oxygen $(ml \cdot l^{-1})$
W46-65	0	23.91	36.406	24.76	5.51
Sargasso	30	21.71	36.591	25.53	6.08
Sea	50	19.31	36.663	26.23	5.83
	143	18.78	36.676	26.38	5.64
	245	18.36	36.642	26.46	-
	346	17.90	36.618	26.56	5.43
W46-73	0	23.64	36.678	23.99	
Cold Core	50	19.62	36.526	26.05	
Ring #1	100	17.83	36.451	26.46	
(Edge)	183	17.14	36.402	26.58	
	366	14.97	35.995	26.78	
	726	7.42	35.135	27.50	
W46-75	0	23.76	36.457	24.84	
Ring #2	50	19.04	36.327	26.05	
	100	16.74	36.057	26.42	
	156	13.84	35.623	26.73	
	312	13.14	-	-	
	623	7.90	35.124	27.41	
W46-78	0	23.78	35.200		
Ring #3	50	17.00	36.079	25.29	
	100	14.24	36.079	27.00	
	200	13.78	36.242	27.22	
	417	11.48	36.910	28.20	
	799	5.80	-	-	
W46-81	0	23.40	35.732	16.86	
Ring#4	50	18.37	36.415	26.29	
	100	17.12	36.348	26.54	
	189	16.44	36.211	26.61	
	378	11.61	35.815	27.32	
	755	6.06	35.037	27.60	
W46-83	0	23.75	36.492	24.87	

Ring #5	50	18.01	36.441	26.39	
(Edge)	100	17.17	36.407	26.58	
	196	16.52	36.326	26.67	
	391	11.53	35.461	27.06	
	787	5.82	35.069	27.65	
W46-95	0	23.85	36.446	24.81	5.23
Sargasso	50	21.28	36.686	25.73	5.70
Sea	100	18.76	36.676	26.39	5.67
	198	18.18	36.686	26.52	5.15
	295	17.76	36.558	26.54	5.06
	397	17.33	36.506	26.02	5.02
W46-99	0	26.01	36.118	23.90	5.14
Sargasso	50	25.21	36.493	24.44	5.05
Sea	100	21.34	36.695	25.71	-
	200	18.93	36.590	26.28	5.24
	300	18.27	36.563	26.42	5.27
	402	17.72	36.876	26.80	5.25
W46-100	0	23.57	-	-	5.69
Sargasso	50	20.42	34.640	24.41	5.84
Sea	100	18.94	36.563	26.26	5.64
	201	18.28	36.523	26.39	5.53
	306	17.80	36.460	26.46	5.46
	397	17.60	36.450	26.50	5.46
W46-128	0	16.74	-	-	
Slope Water	50	6.62	-	-	
	100	9.42	36.406	28.18	
	188	11.03	34.943	26.75	
	377	8.28	-	-	
	770	4.92	-	-	
W46-129	0	9.97	-	-	
Georges Bank	5	10.26	32.487	24.98	
	10	9.25	32.502	25.16	
	35	9.16	32.524	25.18	
	60	9.11	32.506	25.18	
	70	9.12	32.506	25.18	

W46-130	0	10.49	31.641	24.28
Georges Bank	11	10.48	32.425	24.89
	22	10.47	32.419	24.88
	33	10.52	32.411	24.88
	44	10.50	-	-
	55	10.51	32.479	24.93
W46-131	0	10.59	32.520	24.94
Georges Bank	5	10.32	32.499	24.98
	15	9.62	-	-
	25	9.62	32.482	25.08
	45	9.60	32.483	25.08
	65	9.62	32.518	25.11
W46-132	0	-	32.481	-
Georges Bank	5	22.92	32.449	22.08
	15	19.77	32.503	22.95
	25	9.39	32.497	25.13
	35	9.37	32.503	25.14
	55	9.34	32.500	25.14
W46-133	0	11.89	32.406	27.25
Georges Bank	15	9.60	32.484	25.08
	37	8.42	32.611	25.36
	69	7.41	32.778	25.64
W46-136	0	14.32	32.350	24.10
Drogue	15	11.80	32.533	24.74
	30	6.84	32.708	25.66
	50	5.17	33.052	26.14
	75	-	33.696	-
	100	6.99	34.163	26.79
	125	8.08	34.584	26.96
	150	8.35	34.906	27.18
	175	8.39	34.939	27.19
	200	8.39	34.964	27.21
	235	8.40	34.952	27.20
	270	8.70	34.959	27.16
W46-161	0	14.59	Remaining	
Drogue	15	-	samples to	
	25	4.35	NMFS for	
	40	7.88	analysis	

	55	-
	70	7.38
	85	7.71
	100	7.73
	108	7.72
	122	7.77
	136	7.65
	150	8.90
W46-165	0	-
	10	13.65
	20	-
	30	10.94
	40	9.84
	50	7.44
	60	6.68
	70	6.63
	80	6.66
	90	6.69
W46-167	0	15.28
	10	-
	20	-
	30	8.44
	40	-
	50	7.25

APPENDIX III

$99L_aL_aL_a$	$Q_cL_oL_oL_oL_o$	$YYGGi_w$	Nddff	VVwwW	PPPTT	$N_hC_LhC_MC_H$	D_sv_sapp	$OT_sT_sT_dT_d$	$1T_wT_wT_w{}^tT$	$3P_wP_wH_wH_w$	$d_wd_wP_wH_wH_w$
99398	70711	08123	01501	96050	25318	00900	41305	0//18	11728	30000	07501
99391	70709	09063	00601	98020	24720	00000	32007	0//20	11980	30000	10501
99388	70702	09123	01205	99010	23620	00000	32203	0//16	12258	30000	08301
99380	70698	10063	21207	99000	20220	00001	31710	0//19	12185	39900	10302
99374	70691	10123	70512	98031	19222	72400	36405	0//19	12203	30101	03102
99366	70681	11063	71402	96811	13923	73400	41707	0//21	12538	399//	22802
99360	70680	12063	71820	97188	12423	47392	21400	0//21	12478	3////	19604
99358	70663	12123	32117	98031	14924	22303	31210	0//24	12508	399//	19604
99	7	13063	82305	90812	19322	87///	400	0//23	12364	3////	99///
99352	70650	13123	71910	97808	19023	78462	31400	0//23	12348	39901	19540
99343	70643	14123	80624	96632	19922	98000	35309	0//22	12382	30401	01704
99338	70641	14183	80525	97022	21522	854//	41400	0//21	12340	30704	05704
99333	70641	15003	80522	97025	22322	88///	41206	0//20	12361	3//03	03704
99329	70642	15063	80616	96022	22022	88///	51602	0//21	12420	3//01	01504
99333	70645	19063	92212	96008	18924	960//	81705	0//24	12400	3////	/////
99336	70645	19123	22808	98021	18223	00905	81401	0//23	12336	30101	99001
99353	70645	21063	63015	90505	16823	99///	81612	0//23	12348	3////	/////
99356	70653	22063	13017	98020	19122	11400	81706	0//17	12493	30504	99///
99363	70651	22063	12715	98030	23123	18400	81102	0//16	12550	3//01	22201
99370	70654	23123	63318	99031	21823	68292	82102	0//22	12570	30304	26504
99372	70654	23183	72325	96648	20825	6856/	00505	0//22	12393	30704	23704
99390	70652	24063	32822	95131	19325	9////	75807	0//22	12550	3////	//704
99385	70654	24123	82517	97031	18425	7231/	81703	0//22	12544	30404	25404
99396	70649	25003	82430	95959	16420	872//	00705	0//20	12397	39901	27704
99395	70645	25063	92510	96018	16021	8/3//	00708	0//21	12368	399//	99///
99399	70644	25123	83206	95525	15118	7577/	11400	0//18	11781	3//01	24602
99404	70654	26063	73425	97202	22915	4869/	81220	0//12	11640	305//	02504
99405	70661	26123	33525	99011	28714	31380	71232	0//11	12030	30601	35402
99409	70661	27063	10003	99020	33114	1//00	81604	0//11	11970	3//01	34000
99419	70668	28123	21802	96020	25513	11008	30803	0//13	10983	3////	18501
99442	70667	29063	11803	97050	20514	10000	00706	0//14	11424	30000	18501
99420	70667	29123	12502	96020	20614	11370	00104	0//14	11404	30000	13502
99422	70666	30063	01101	96104	20013	00000	00400	0//14	11427	30000	///02
99428	70663	01123	81114	96505	19115	8772/	21400	0//15	11392	30201	13501
99427	70650	02063	91704	92454	13215	9////	31707	0//15	11341	3////	//501
99427	70646	02123	81402	91404	11814	8////	30503	0//15	11229	399//	14802
99425	70655	07063	12117	97000	20414	00001	61502	0//13	11270	30101	21302
99421	70659	08063	02505	98020	24814	00000	41601	0//14	11453	3//00	25500
99418	70659	09063	02310	98020	24216	00900	41400	0//14	11441	30301	00/00
99415	70658	09123	12112	97020	30219	10906	41400	0//18	11702	30101	/////
99415	70663	10063	12510	98020	22016	00001	00400	0//16	11494	30101	25301
99	7	11063	32307	98030	21915	00061	61400	0//16	11399	30001	24501
99419	70657	12063	81005	96032	15215	88220	51723	0//16	11458	30001	12501
99421	70655	12123	83005	97028	13417	868//	00706	0//17	11530	3////	13403
99416	70658	13063	82704	95424	11516	8////	51804	0//16	11572	3////	27501
99414	70659	13123	93103	91444	12315	9////	51203	0//15	11800	30101	18602
99415	70658	14063	93410	95424	11916	9////	71400	0//16	11413	30305	27302
99422	70675	15063	92502	90454	16118	9////	61400	0//19	11685	30000	///00
99424	70681	15123	91903	90454	18919	9////	61310	0//19	11752	39901	13301
99425	70696	16043	91103	90524	20819	9////	61703	0//19	11924	39901	12/01

Key: $L_aL_aL_a$= latitude in degrees and tenths; Q_c= quadrant of globe; $L_oL_oL_oL_o$=longitude in degrees and tenths; YY= day of month; GG = Greenwich Mean Time; i_w = wind indicator; N = total cloud amount; dd = wind direction ff = wind speed; VV = visibility; ww = present weather; W = past weather; PPP = sea level pressure; TT = air temp.; N_h = amount of lowest clouds; C_L = type of low cloud; h = height of lowest clouds; C_M = type of middle cloud; C_H = type of high cloud; D_s = course of ship; v_s = speed of ship; a = character of pressure change; pp = amount of pressure change; T_s = air-sea temp. difference; T_d = dew point; T_w = sea temp.; ^tT = tenths of air temp.; P_w and H_w = wind wave period and height; d_w = swell direction.