Cruise Report

W-49

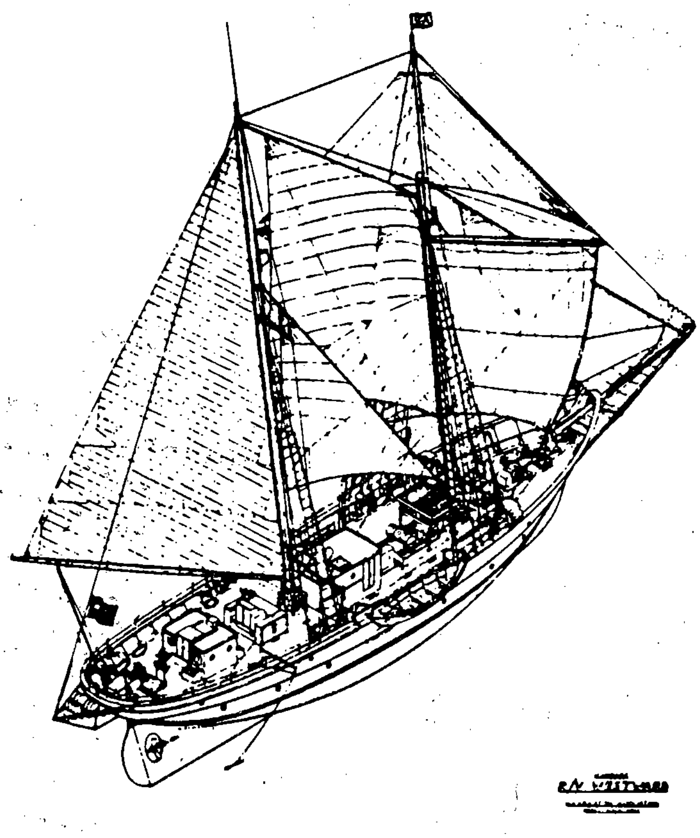
Scientific Activities

Undertaken Aboard

R/V Westward

St. Thomas - Key West

November 28, 1979 - January 9, 1980



(R. Long)

Sea Education Association - Woods Hole, Massachusetts

Cruise Report

W-49

St. Thomas - Key West

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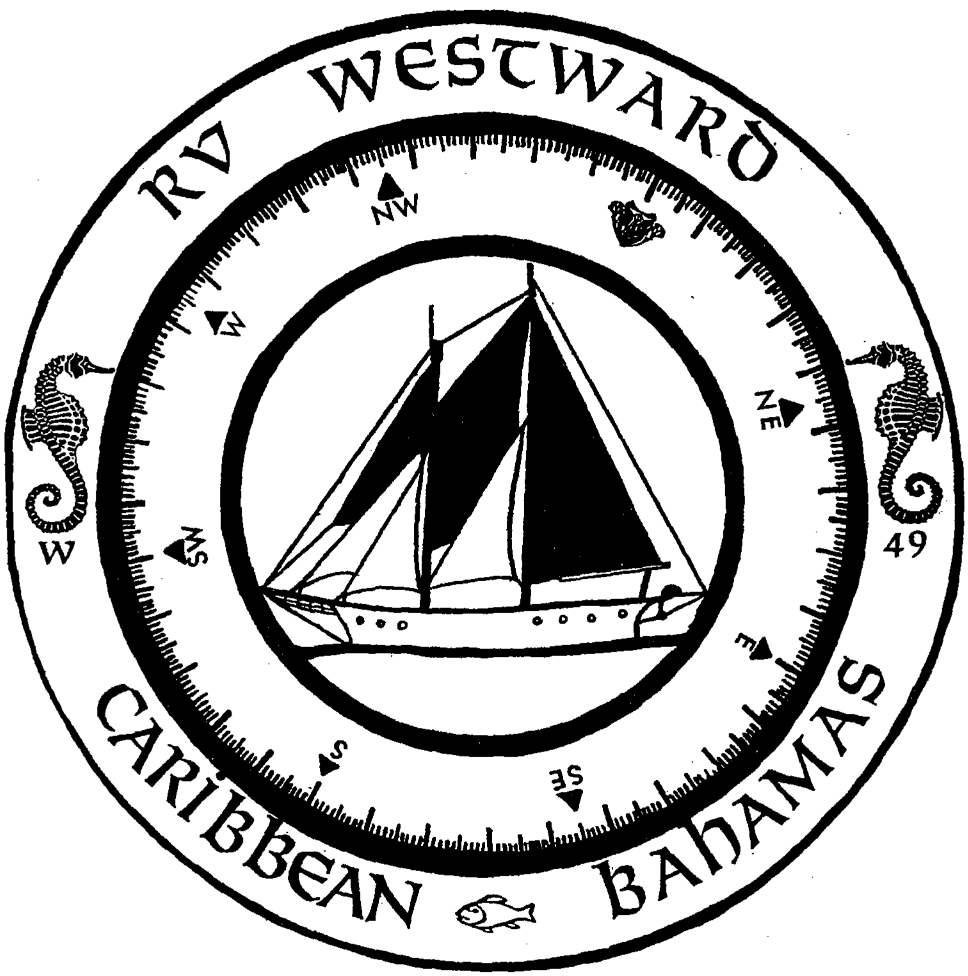
R/V Westward

Sea Education Association

Woods Hole, Massachusetts

SHIPBOARD DRAFT



PREFACE

This cruise report outlines the scientific activities for the forty-ninth cruise of the R/V Westward. These activities fall into two categories: a traditional academic program offered purely and directly for the students' scholastic benefit; and, a program of research and student projects in which the students' skill and drive and curiosity determined the scope and benefit of their participation. Emphasis was on study and investigation uniquely available aboard a sailing oceanographic research vessel. The scientific method was emphasized.

An atmosphere conducive to successful scientific activity was provided by cooperative and capable nautical and scientific staffs. Captain Sid Miller cooperated with and assisted the scientific staff in an exemplary manner above and beyond the call of duty. The mates put the ship on station and kept her there for scientific operations. They were cooperative and capable in all respects. Engineer Gary Manter kept machinery and electrical equipment in excellent order and could be counted on for emergency repairs to scientific equipment. Steward Sally Kaul kept staff and students well fed. Her scientific background provided additional assistance to the science staff.

Assistant Scientists Rob Moir and Rindy Ostermann were enthusiastic, energetic, and capable. They are to be commended for their work.

Three visiting scientists and a visiting journalist added their expertise to W-49. Mr. Will Ravenel of Florida State University studied the relatively untapped area of Caribbean Harpacticoid Copepods. Will introduced the students to the little studied area of benthic microfauna in interesting and entertaining lectures. His broad experience in oceanography was especially appreciated in the early days of W-49. Dr. Gary Faber of the College of Charleston sought information on Caribbean trace metals and the ship's effect on trace metal analysis. His lectures greatly enhanced the ship's chemistry program. Ms. Nancy Murden, a graduate student in Biology at the Citadel investigated vertical migration and brought a quest for graduate credit aboard Westward, a first for the program. Nancy's enthusiasm for every phase of the program including watch standing, dawn clean-up, and galley duty was appreciated. Mr. Ken Pierce of Time Magazine was a tireless investigator and an unparalleled student of all there was to learn aboard the R/V Westward. His curiosity, warmth, and friendliness was a privilege for participants in W-49 to experience. In addition, Ken produced an excellent, well-written report on S.E.A., Westward, and W-49 in the January 28, 1980 issue of Time Magazine.

As Chief Scientist I extend my personal thanks to the staff, visitors, and students of W-49 for their cooperation.

Donald M. Drost
Chief Scientist
Charleston, S.C.

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CHARTS AND ILLUSTRATIONS

I. INTRODUCTION

A. Cruise Summary

The session of Introduction to Marine Science offered aboard the R/V *Westward* on her forty-ninth cruise was structured about ship operations in the Eastern Caribbean and the Southwest North Atlantic. The academic program included lectures, supervised laboratory and field work (Science Watch), and individual student projects. Emphases reflect the interests of the students, opportunities inherent to the cruise track, and the expertise of the shipboard and visiting staff. Subject matter treated in the academic program encompassed physical, biological, chemical, and geological oceanography in not necessarily equal quantities.

Oceanographic stations of W-49 were scheduled to serve the data collection needs of students, staff, and visiting investigators. On Leg 1, between the U.S. Virgin Islands and Martinique, stations included hydrocasts in the Anegada Passage, bottom sampling on Saba Bank, and routine data collections which are discussed in sections III & IV of of this report. On Leg 2, between Martinique and the British Virgin Islands, work included oceanographic stations conducted around St. Lucia to study its island mass effect, simultaneous surface, mid-depth, and deep plankton net tows in the vicinity of Aves Island, an ecological survey of Aves Island, and routine work cited above. In and near the British Virgin Islands reef studies were conducted. On Leg 3, between the British Virgin Islands and Great Inagua, in addition to routine work, Navidad and Silver Banks were crossed in search of Humpback Whales and to obtain shallow water plankton data. On Leg 4, between Great Inagua and Key West, work centered on Spiny Lobster larvae studies in the Old Bahama Channel and the Gulf Stream.

B. Cruise Track

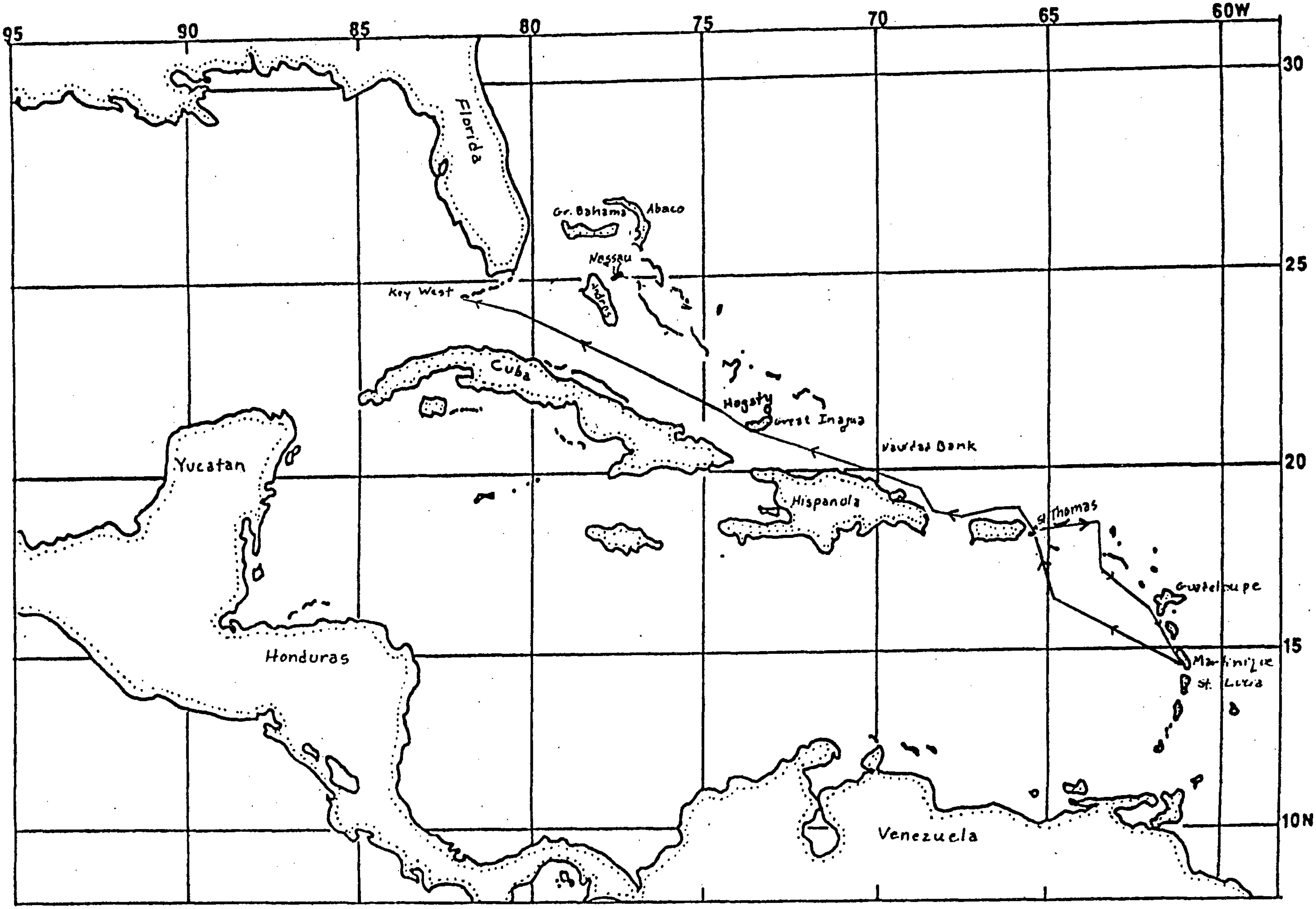
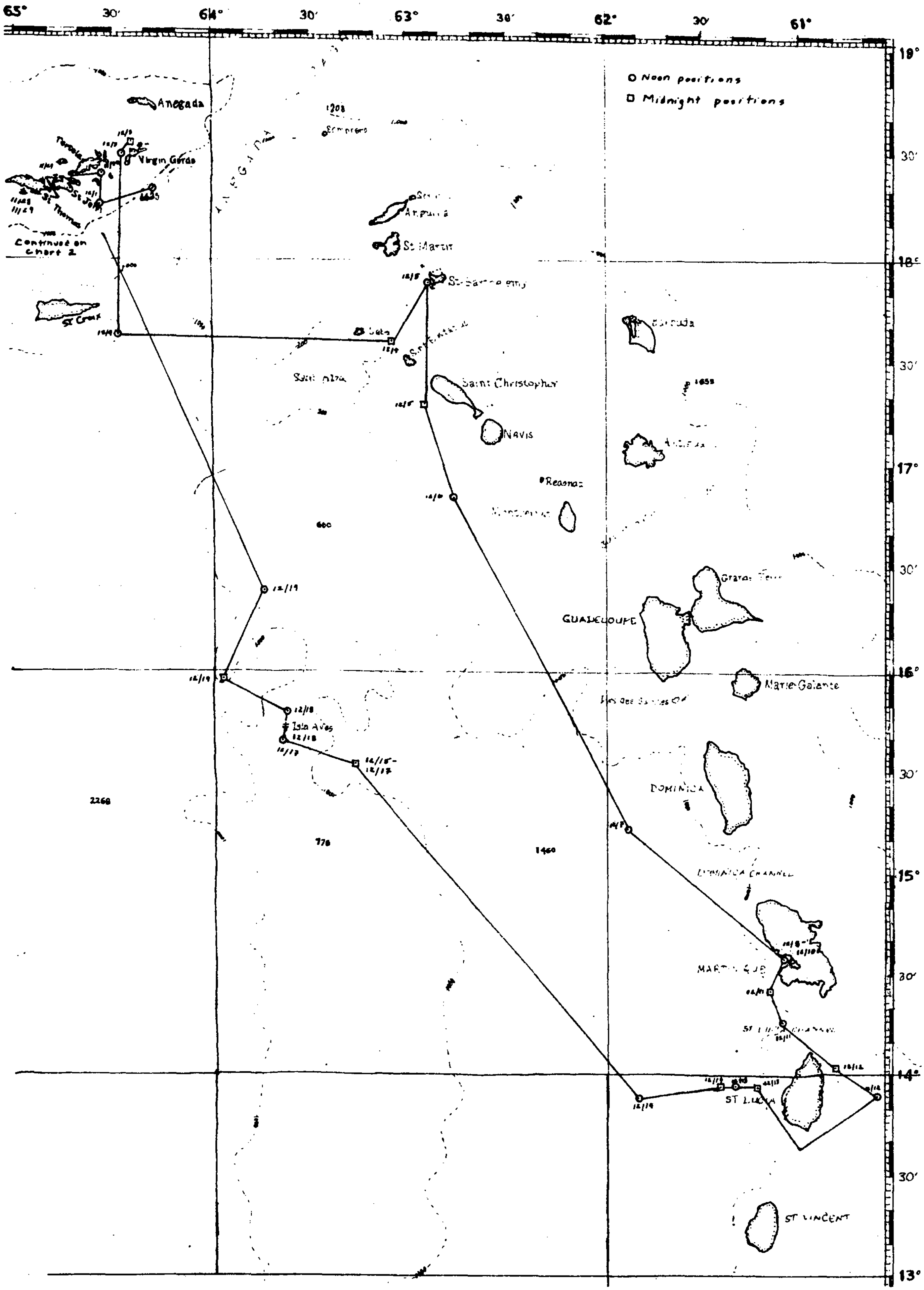


CHART 1: Cruise Track of W-49


65°
30′
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30′
62°
30′
61°
19°
30′
18°
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17°
30′
16°
30′
15°
30′
14°
30′
13°
Noon positions
Midnight positions
Anegada
Virgin Gorda
St Croix
Continued on Chart 2
Anguilla
St Martin
Saba
Saint Christopher
Navis
Redonda
GUADELOUPE
Marie Galante
DOMINICA
DOMINICA CHANNEL
MARTINIQUE
ST LUCIA
ST VINCENT
Isla Aves

CHART 2

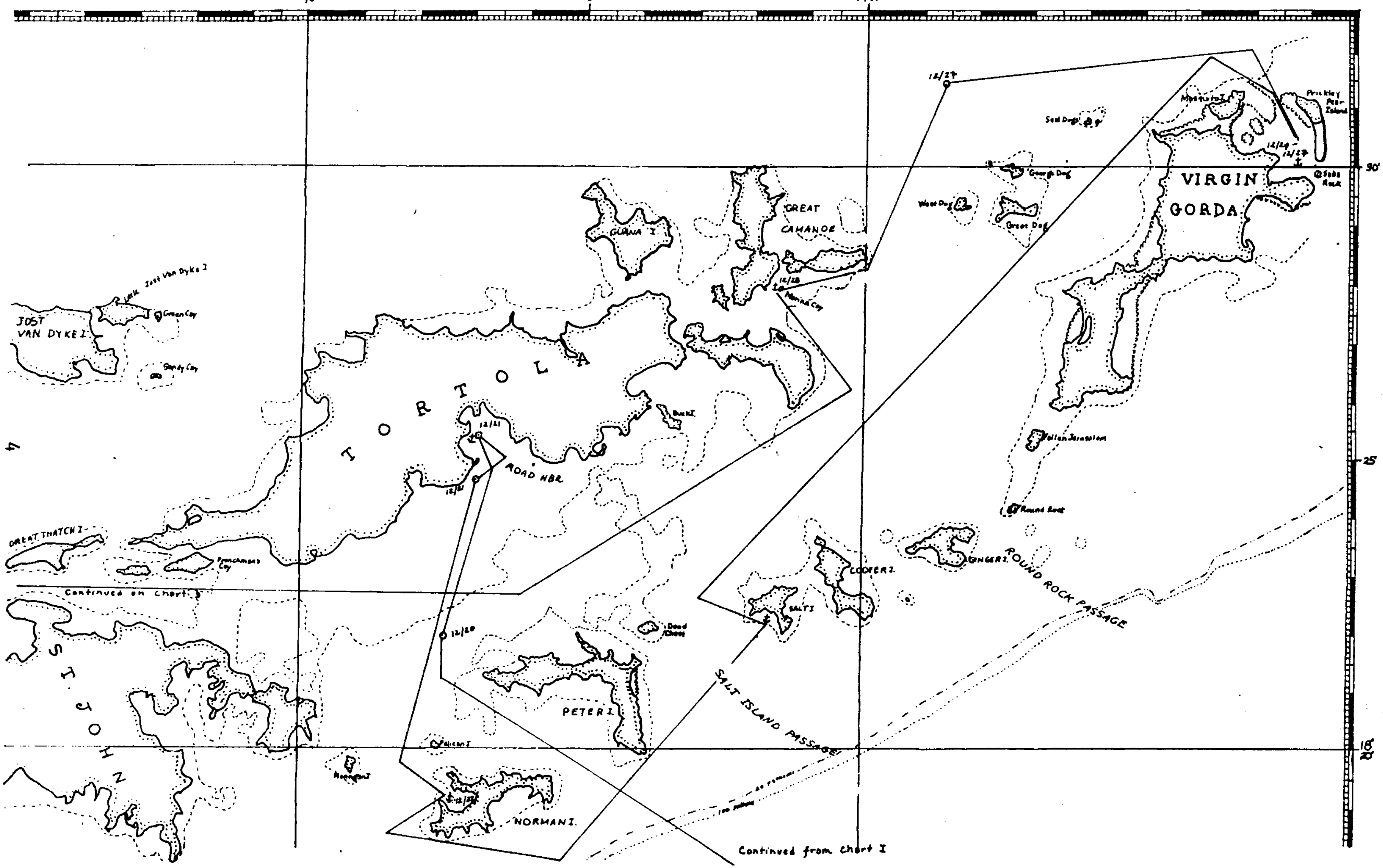

40'
35'
64°30'
30'
25'
18° 20'
VIRGIN GORDA
TORTOLA
ROAD HBR
GREAT CAMANOE
GUANA I.
JOST VAN DYKE I.
GREAT THATCH I.
ST. JOHN
PETER I.
NORMAN I.
COOPER I.
GINGER I.
SALT I.
ROUND ROCK PASSAGE
SALT ISLAND PASSAGE
Prickley Pear Island
Mosquito I.
Seal Dogs
George Dog
West Dog
Great Dog
Round Rock
Fallen Jerusalem
Dead Chest
Pelican I.
Buck I.
Marina Cay
Green Cay
Sandy Cay
Frenchmans Cay
Saba Rock
Continued on Chart 3
Continued from Chart I
12/27
12/28
12/21
12/20

CHART 3

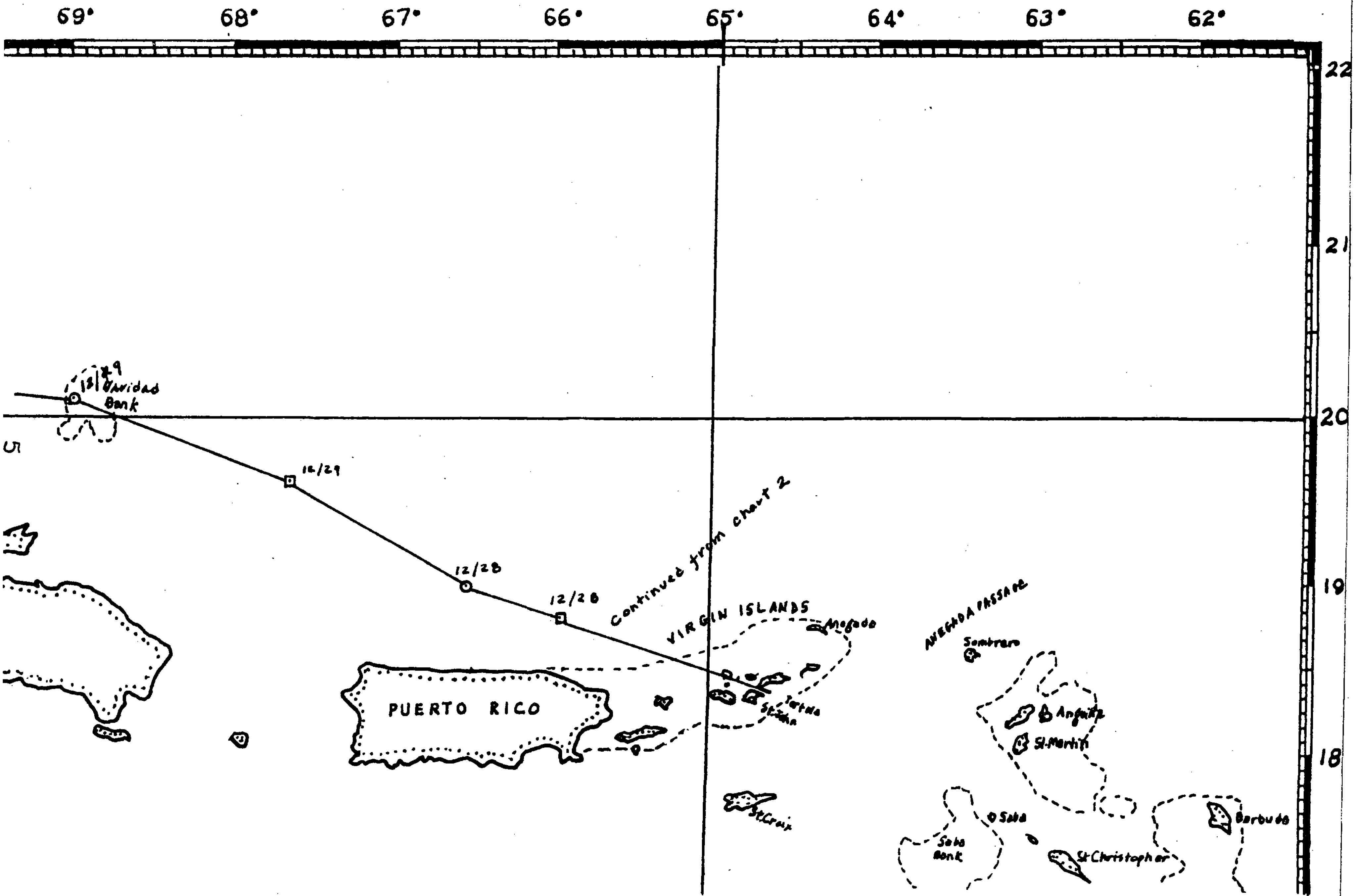
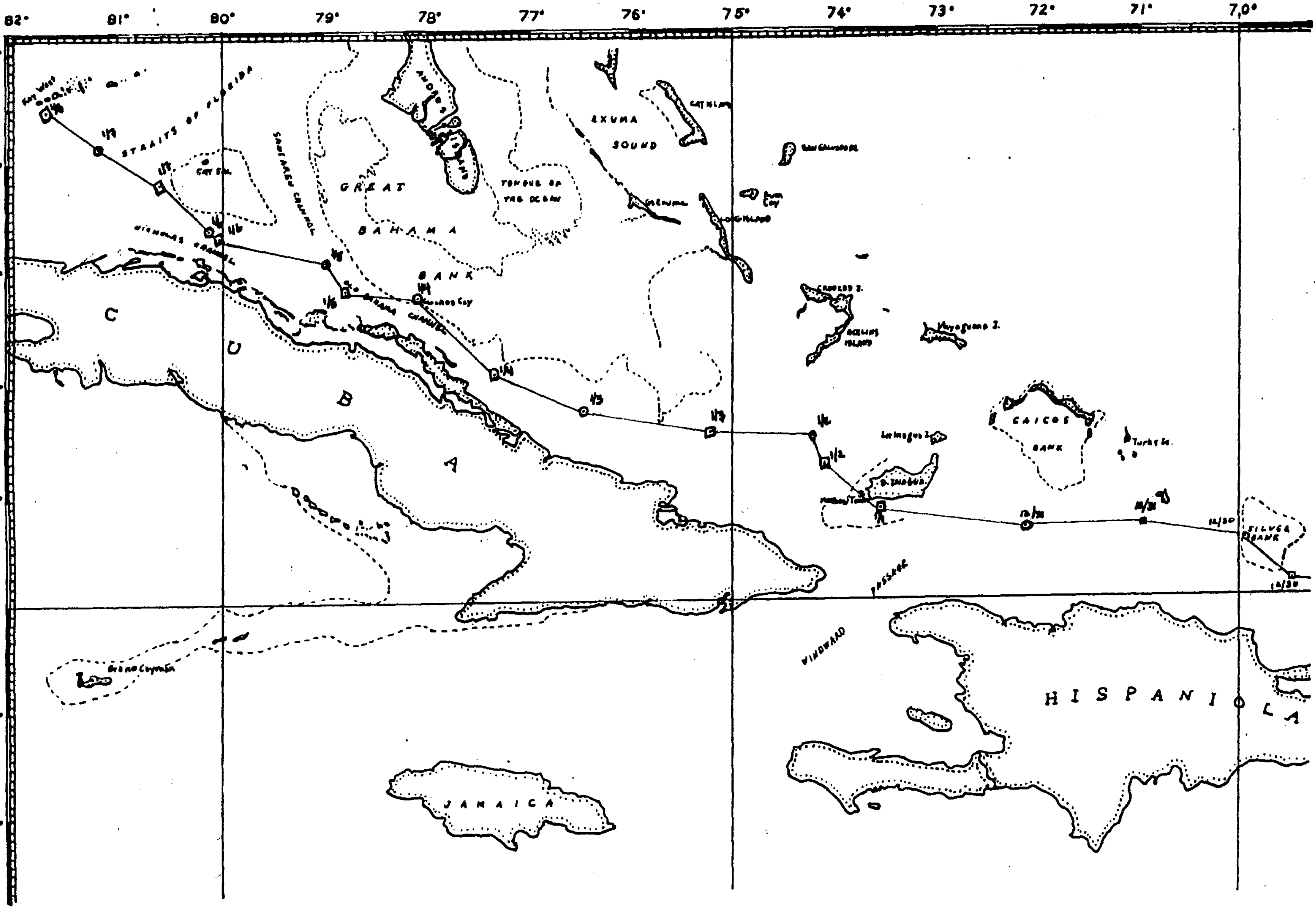

69°
68°
67°
66°
65°
64°
63°
62°
22
21
20
19
18
Navidad Bank
12/29
12/28
12/28
Continued from chart 2
VIRGIN ISLANDS
Anegada
Tortola
St. John
St. Croix
ANEGADA PASSAGE
Sombrero
Anguilla
St. Martin
Saba
Saba Bank
St. Christopher
Barbuda
PUERTO RICO

CHART 4


82°
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80°
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78°
77°
76°
75°
74°
73°
72°
71°
70°
25°
24°
23°
22°
21°
19°
18°
Key West
STRAITS OF FLORIDA
NICHOLAS CHANNEL
GREAT
BAHAMA
BANK
ANDROS ISLAND
TONGUE OF THE OCEAN
EXUMA
SOUND
CAT ISLAND
LONG ISLAND
CROOKED I.
ACKLINS ISLAND
Mayaguana I.
CAICOS
BANK
Turks Is.
SILVER BANK
C
U
B
A
WINDWARD
PASSAGE
HISPANIOLA
JAMAICA
Grand Cayman

CHART 5

C. Itinerary

Ports of Call W-49, 1979-1980

Leg	Arrive	Date	Depart	Date
1	St. Thomas, USVI	28 Nov.	St. Thomas	29 Nov.
	Caneel Bay, St. John, USVI	29 Nov.	Caneel Bay	30 Nov.
	Virgin Gorda, BWI	2 Dec.	Virgin Gorda	3 Dec.
	Gustavius Harbor, St. Barts	5 Dec.	Gustavius Harbor	5 Dec.
	Fort De France, Martinique	9 Dec.	Fort De France	11 Dec.
2	Marigot Bay	13 Dec.	Marigot Bay	13 Dec.
	Aves Island	17 Dec.	Aves Island	18 Dec.
	Roadtown, Tortola, BVI	20 Dec.	Roadtown	21 Dec.
3	Norman Island	21 Dec.	Norman Island	22 Dec.
	Wreck of the Rhone	23 Dec.	Wreck of the Rhone	23 Dec.
	Gorda Sound, Virgin Gorda & Eustatia Sound	23 Dec.	Virgin Gorda	26 Dec.
	Marina Cay, BVI	26 Dec.	Marina Cay	27 Dec.
	Great Inagua	1 Jan.	Great Inagua	1 Jan.
4	Key West, Fla.	8 Jan.		

D. Ship's Complement W-49

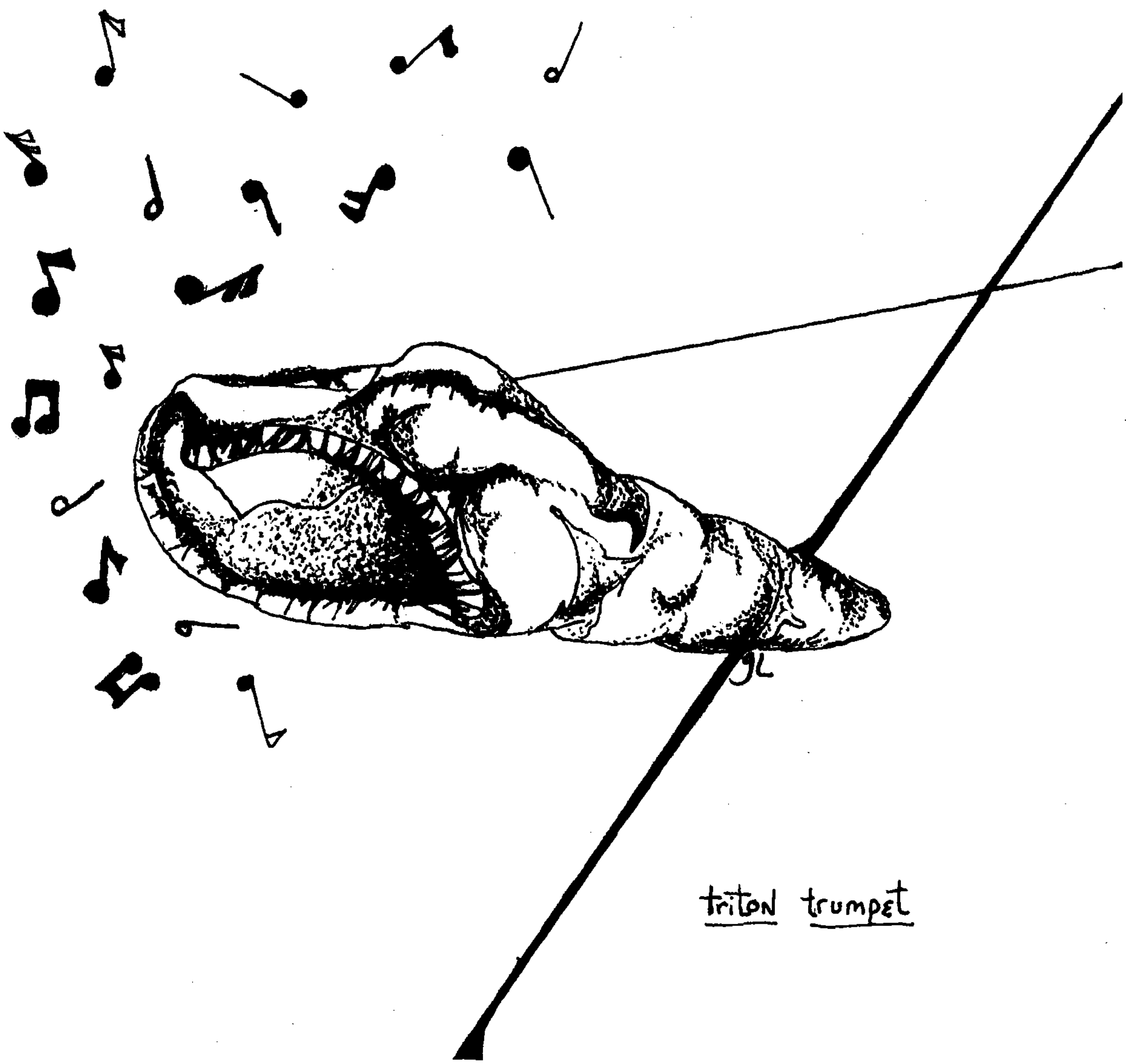
Nautical Staff
Sidney Miller, Captain
Paul DeOrsay, Chief Mate
John Wigglesworth, Mate
Phil Sacks, Mate
Sally Kaul, Steward
Gary Manter, Engineer

Science Staff
Donald Drost, Chief Scientist
Rob Moir, Assistant Scientist
Rindy Ostermann, Assistant Scientist

Visiting Staff
William Ravenel, Leg 1
Gary Faber, Leg 2
Nancy Murden, Leg 3
Ken Pierce, Leg 4

Students	College	Home
Stuart K. Allison	University of Puget Sound	Monmouth, Il.
Daniel H. Berler	Hobart College	Chevy Chase, Md.
Barbara A. Block	University of Vermont	Springfield, Ma.
Mark A. Bombelles	John Carroll University	Shaker Heights, Oh.
Arndt B. Braaten	Luther College	Decorah, Ia.
Beth S. Brodie	Bowdoin College	Duxbury, Ma.
Janet E. Collins	Catholic Univeristy	West Newton, Ma.
Ann Durbin	Wellesley College	Arlington, Va.
Robert L. Edwards	Cornell University	Reston, Va.
Paul S. Fellenbaum	University of Vermont	New Haven, Ct.
Susan L. Greenberg	Cornell University	North Merrick, NY.
Judy Henshel	Cornell University	Scarsdale, NY.
Johanna Johnson	Portland State University	Venice, Ca.
Susan M. Kennedy	University of New Hampshire	Concord, Ma.
Virginia Lermann	Boston College	Morris Plains, NJ.
Paul H. McDowell	Tulane University	New York, NY.
Debra A. Merrill	University of Vermont	Williston, Vt.
William G. Montgomery	University of Virginia	Winston-Salem, NC.

Barton C. Parrott	Tulane University	Roanoke, Va.
Leah A. Quesenberry	University of California/ Davis	Davis, Ca.
Lori M. Ragosa	Georgetown University	Washington, D.C.
Lianne Ritter	Cornell University	Mamaroneck, NY.
April E. Rivkin	Cornell University	Merrick, NY.
Susan C. Troll	Pomona College	Wichita, Ks.



II. ACADEMICS

A. Lectures

Marine Science lecture classes were conducted daily Monday through Friday, the first class being held on W-49's first day at sea, Thursday, November 29, 1979, out of St. Thomas, U.S. Virgin Islands. The classes were conducted in a traditional format, though often in a non-traditional setting. There were memorable ones, such as visiting investigator Will Ravenel's lecture on Harpacticoids conducted on deck while sailing past the majestic volcanic island of Saba. The lecture followed bottom sampling on Saba Bank to collect data on Caribbean benthic Harpacticoid Copepods. Like Will's lecture, other lectures reflected the opportunities of the R/V *Westward's* location, the expertise of her staff, and occurring investigative activities.

Of the 29 class periods available during W-49, three were used for two tests and a final exam, 25 were used for lectures which included 6 days of student paper presentations, and one class was cancelled due to weather conditions.

Student presentations were based on work abstracted in sections V through VIII. Lecture topics were largely oriented toward biological and physical oceanography with a sampling of chemistry and geology.

B. Science Watch

A scheduled 24-hour science watch consisting of a staff or visiting scientist and two or three students was maintained throughout the seagoing portions of the cruise.

Activities during watch involved execution or assistance in execution of the scientific program and maintenance of a scientific log. Time on watch provided the opportunity for personal instruction on any aspect of the cruise work and assistance in individual project work. Staff members were encouraged to conduct demonstrations or carry out exercises during watch time not otherwise committed.

A collection of demonstration organisms representing many phyla and ecological life types was assembled during watch and served as a basis for practical examination included in the final exam. Evaluation in Science Watch depended upon a subjective evaluation by the scientists on watch during the cruise and the student's record of weather observations, chemical determinations and participation in other watch responsibilities.

C. Individual Projects

Students were required to define an individual project while ashore at Woods Hole. Any topic was regarded as acceptable which (a) takes advantage of a special opportunity afforded by the *Westward* cruise; and (b) is conducted and presented in a scientific manner. The majority of projects selected are traditional problems in a natural science but occasionally an applied or engineering project is chosen.

A complete written report is required of each student prior to leaving the ship. In addition, during the last week of W-49, each student verbally presented a paper at the W-49 Science Conference conducted aboard the R/V *Westward*. Abstracts for these individual projects are presented in sections V - VIII of this cruise report.

III. COOPERATIVE PROGRAMS

A. Cooperative Ship Weather Observation Program (NOAA)

The R/V Westward is certified to gather weather observations for the U.S. National Weather Service (NOAA) in conjunction with the Organization Meteorologique Mondiale. The observations are made twice daily at 0600 and 1200 GMT and then transmitted to Coast Guard Stations ashore.

On W-49, 44 sets of observations were compiled, of which 25 were successfully transmitted. Of these, 13 were copied by NMN, Portsmouth, Va.; 10 by NMG, New Orleans; 1 by NMC, San Francisco; and 1 by NMF, Boston.

Coded weather data from W-49 is available from S.E.A. upon request.

B. Neuston Sampling (National Marine Fisheries Service)

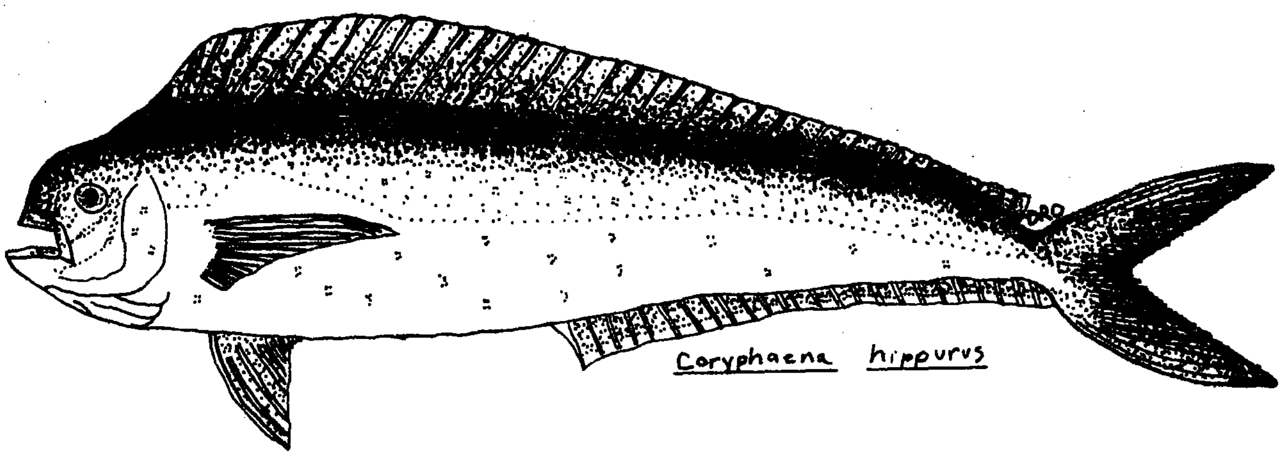
The neuston, or "surface dwellers," is a category of plankton which has received attention only for the past 15-20 years. Since the air-sea interface tends to concentrate certain pollutants the neuston has recently been regarded as a potential "early warning system" for environmental degradation. The air-sea interface also represents an environment with special properties and is of considerable interest in itself.

For more than two years Westward cruises have routinely conducted neuston sampling in a cooperative program with the National Marine Fisheries Service. On W-49, 26 neuston tows were taken and the contents studied by students and staff on Science Watch. All samples were specifically examined for *Sargassum* weed, pelagic tar balls, and the marine insect *Halobates*. For further neuston sampling information, see the Appendix of this report.

C. Shark Tagging Program (National Marine Fisheries Service)

In cooperation with the National Marine Fisheries Service, the R/V Westward continues a longlining project to catch, identify, characterize, and tag sharks. The goal of this program is to discover migration patterns of certain species of sharks in the North Atlantic.

During W-49, one longline was set on 18 December, 1979 between Aves Island and the Virgin Islands near 15°58' N, 63°39' W. The longline was retrieved on 19 December, 1979. Two sharks were caught. One blue shark, *Prionace glauca* (Linnaeus, 1758)7 feet in length was released without tagging due to difficulties with tagging equipment. Also, a white tip shark, *Carcharhinus maou* (Lesson, 1830) 5 feet in length was tagged.



IV. LONG TERM S.E.A. PROGRAMS

A. Marine Mammals

Records of marine mammal sightings have been kept on all Westward cruises for the past several years. For W-49, it was anticipated that the densest populations of whales would occur along leg 3, in the vicinity of Silver and Navidad Banks, and therefore, intensive, structured "whale watch" was limited to this leg. However, there were numerous sightings on legs 1 & 2 which were accompanied by intensive "whale watches" for varied times.

Accompanying some of the whale sightings were eight hydrophone stations. For details of the marine mammal sightings and hydrophone stations, see the Appendix.

B. Pelagic Bird Observations

Numbers and species of birds have been logged by Science Watch on R/V Westward on a continuing basis since W-33. Oceanic bird distribution is a relatively unknown field due to the low ratio of observers to square area of the ocean surface. It is hoped that continuing records will add knowledge of this little known field.

Though all watch standers participated in Bird observing and logging, Assistant Scientist Rob Moir and students Ginny Lermann and Leah Quesenberry took major responsibility for maintaining vigilance in pelagic bird observation.

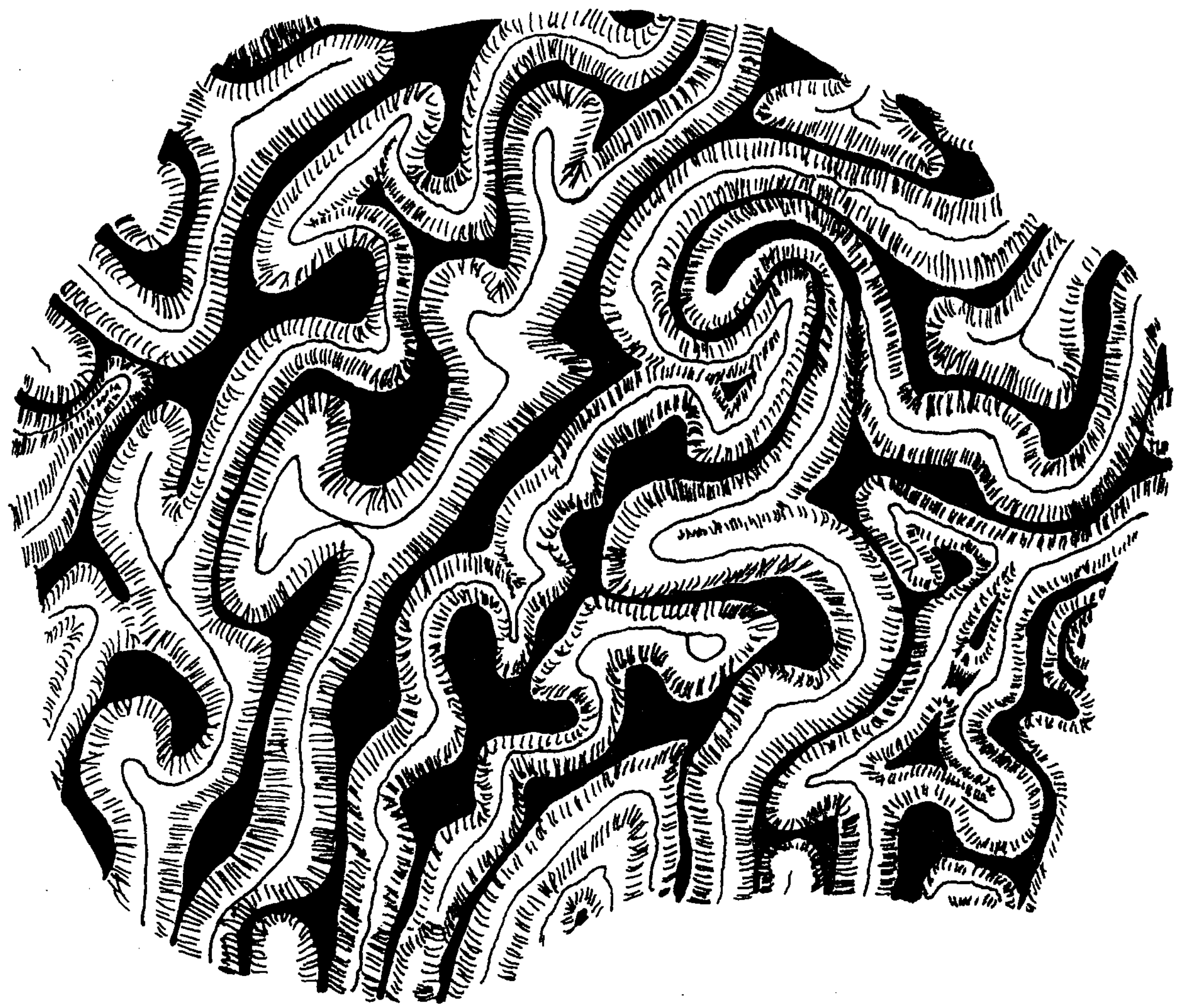
In addition to at sea studies, some land-based bird watching was conducted. The results of all observations are tabulated in the Appendix.

C. Spiny Lobster Larvae Program

The spiny lobster larvae program, under the guidance of S.E.A. Staff Scientist Mary Farmer, hopes to establish baseline information on the distribution of the larvae of the commercially important spiny lobster *Panulirus argus*.

The stations made on W-49 in the Old Bahama Channel, Nicholas Channel, and across the straights of Florida were designed to help determine (1) whether larvae are carried evenly throughout the Gulf Stream or tend to be concentrated along lines of lower velocity, and (2) whether larvae get carried away from the Gulf Stream toward the Bahama Islands.

Work on W-49 is abstracted in section VIII.L. Station locations are tabulated in the Appendix.



Diploria Labyrinthiformis

V. ISLAND MASS EFFECTS

The island mass effect is the physical, chemical, geological, and biological influence of an island on the water surrounding it. On W-49 the effect was studied in the waters surrounding St. Lucia, a relatively small conical volcanic island, in the Eastern Caribbean.

Stations were conducted at intervals of approximately 10 miles in the same latitude on the windward and leeward sides of the island as well as in the two channels separating St. Lucia from Martinique to the North and St. Vincent to the South. The stations consisted of: 1) Hydrocasts for temperature, salinity, chlorophyll, PO_4, & O_2; 2)nannoplankton; and 3) light intensity measurement at stations conducted during daylight hours. Standard methods were used to analyze the samples: $AgNO_3$ titration for salinity; Strickland and Parsons (1972) for PO_4 and chlorophylls; Winkler titrations for O_2; and counting chamber slide technique for total number of phytoplankton. Ambient and underwater light intensity were measured with a Kahl Underwater Irradiameter.

It was expected that islands by their presence would interrupt current flow, resulting in eddies, mixing and local water turbulence. The land mass should provide some nutrient input from river run-off and, where reefs are present, act as a nutrient trap, concentrating nutrients from the passing waters. The result of these effects should be an increase in productivity in nearby waters. The stations established on this cruise were designed to test these hypotheses.

The abstracts and summaries that follow present different aspects of the study.

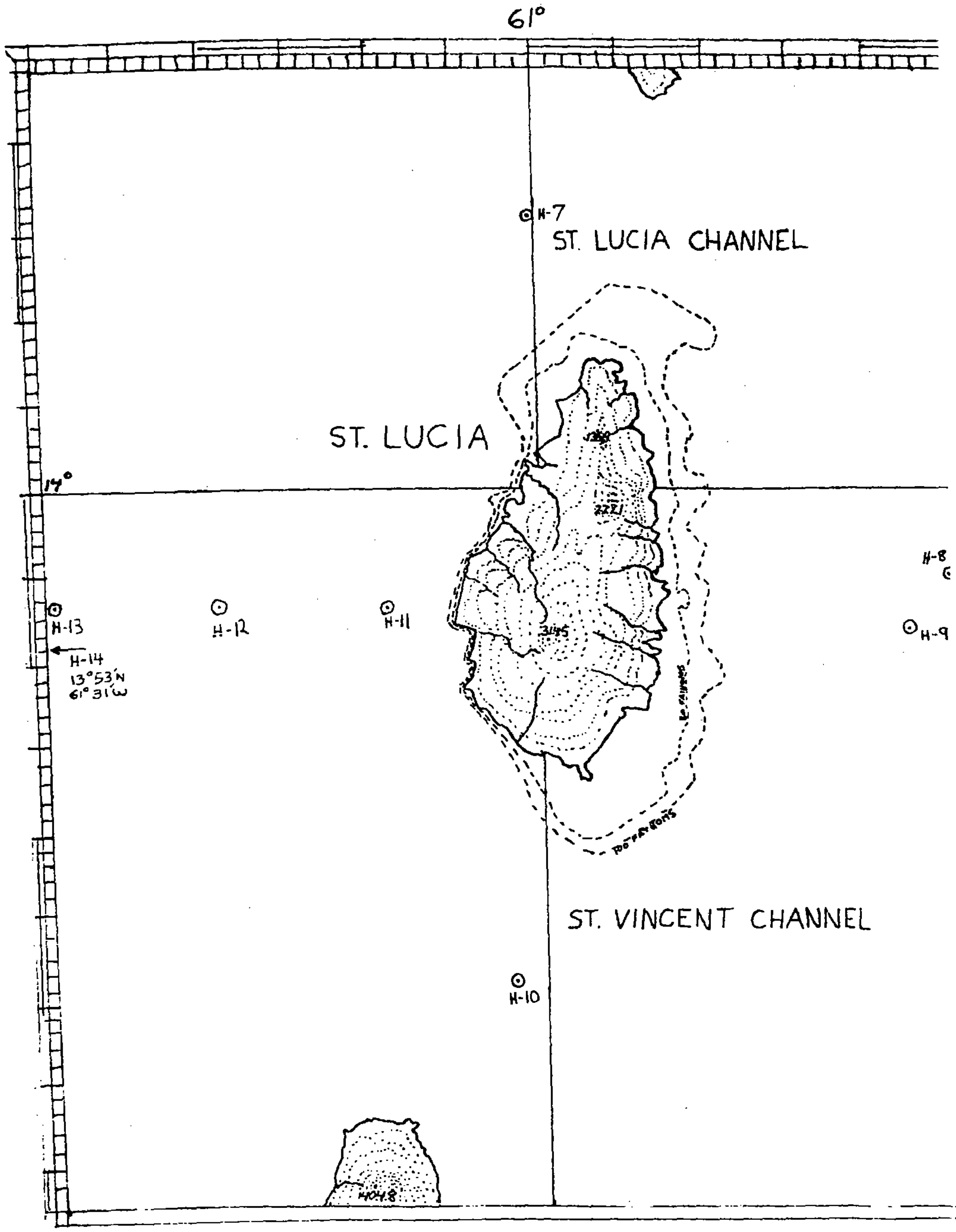


CHART 6: St. Lucia

A. The Effect of an Island Mass on Phosphate Upwelling

Mark Bombelles

Abstract

The purpose of this study was to try to determine whether or not the conical shape of an island mass causes upwelling of phosphates and therefore other nutrients. Samples were collected at various depths from eight hydrocasts situated at selected points around the island. Two were taken to windward of the island in Atlantic water, two were taken in the channels to either side of the island, and four were taken to leeward of the island (See Chart 6). Each cast consisted of six Nansen bottles spaced evenly on the wire with the last bottle being at a depth near the bottom. The results showed a definite increase in phosphate concentrations to leeward of the island mass. However, due to the small amount of data collected complete conclusions have not been drawn as to its origin.

B. Island Mass Effect: Determination of Upwelling Through Density Current Analysis

Greg Montgomery

Abstract

Studies were done near St. Lucia to determine whether the island's mass could cause upwelling on the leeward side by causing Atlantic currents to eddy there as they flow around the island.

Eight hydrocasts were done around the island; two in the Atlantic; one in either channel; and four on the leeward side (See Chart 6). Nansen bottles were used to collect water samples at various depths, and these water samples were analyzed for temperature, salinity, and density. It was hoped that data could be collected which would be accurate for computing sigma-t values which could then be used for estimating realistic geostrophic flow patterns. Due to errors in titration, the salinity data was considered invalid and therefore no concrete conclusions were made.

Temperature data, however, was considered valid and conclusions were drawn about the island mass effect through this data. It appears that colder waters are forced up from the depths as the currents collide with the island. This causes the temperatures in the 50 to 300 meter range at stations 9, 10, & 11 to be lower than the waters found in the stable water columns to the windward and far leeward sides of the island (stations 8, 12, & 14). Whether these colder waters affect the productivity of the island's ecosystem could be determined by nutrient samples.

It has been concluded that there has been some mixing present near the windward shore, above the sills and close to leeward as shown by the temperature data. Better data is necessary to draw conclusions as to whether or not this is an upwelling effect.

C. Phytoplankton Distribution and the Island Mass Effect

Susan Troll

Abstract

Phytoplankton distribution and how it is affected by the flow of water around the island was investigated on this cruise. Attention was given to eddy formation and its affect on phytoplankton. Data were collected by taking eight surface tows with a 65 μ net around the island of St. Lucia: two channel stations (H7 & H10), two stations on the windward side of the island (H8 & H9), and four stations on the leeward side of the island (H11 through H14). (See Chart 6). Phytoplankton abundance was the highest on the windward side, collecting there as the water flowing from the east piled up, and decreased through the passages. On the leeward side, three of the four stations had similar amounts of phytoplankton, but there was a significant increase in the amount of phytoplankton at station H12, indicating the convergence of some eddies. Since St. Lucia is a relatively dry island with very little runoff, it has been concluded that the flow of water, not the nutrient supply, is the determining factor in the phytoplankton distribution around the windward islands of the Caribbean Sea.

VI. VERTICAL MIGRATION STUDIES

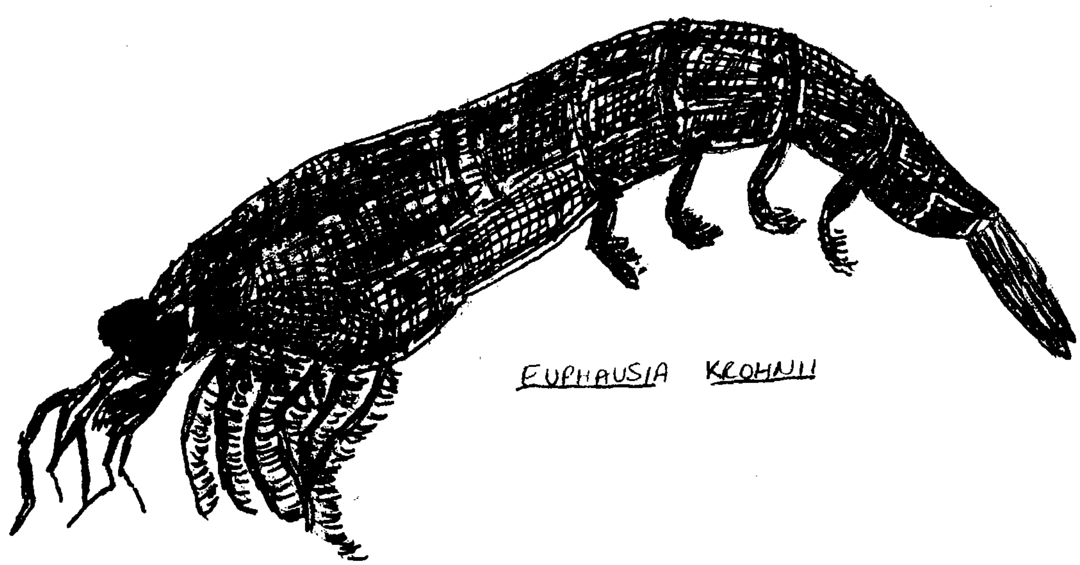
A. Vertical Migration of Euphausiids

Daniel H. Berler

Abstract

The diurnal migration of euphausiids was studied using data that was obtained at a twenty-four hour station located at 63° 14′W, 15°32′N. Tows at three different depths; 0, 150, & 300 meters, were taken approximately every six hours for a twenty-four hour period. As originally hypothesized there was a relationship between the vertical migration of euphausiids and that of their food source. Two different species of euphausiids, Euphausia krohnii and Stylocheiron abbreviatum were identified as being present in the tows. No abbreviatum were observed in any of the surface tows, and were also found in fewer numbers than the krohnii. This was due to the unproductivity of the area or the tendency of the abbreviatum to dwell in deeper waters. No conclusive statements can be drawn concerning the vertical migration of the abbreviatum due to the inadequate data collected.

The krohnii generally followed the main mass of organisms upwards towards evening, and down with the approach of noon. The results give evidence to the idea that the quest for food by euphausiids may possibly be another variable in the equation concerning the vertical migration of euphausiids.



B. Analysis of Vertical and Diurnal Variations in Zooplankton Feeding

Robert Edwards

Abstract

The diurnal vertical migration of open ocean organisms is a well documented phenomenon. The relationship between feeding and predation has been suggested as an important basis for this behavior, but the daily feeding patterns of the migrating organisms have not been adequately characterized. Previous studies have shown that most of the organisms involved are herbivorous copepods. According to theory, they should be feeding in the relatively phytoplankton rich surface waters at night and escaping predation in the lower depths during the day. It was proposed to study the feeding of these copepods by chlorophyll analysis. This was carried out at one 24 hour station in the Caribbean Sea. Results were inconclusive, but the method is considered feasible given certain improvements.

C. Diurnal Vertical Migration in Mesopelagic Bioluminescent Fish

Johanna Johnson

Abstract

Mesopelagic bioluminescent fish are well known practitioners of a diurnal vertical migration. During W-49, seventeen neuston tows, one midwater meter net trawl, and an Isaacs-Kidd midwater trawl were conducted at various times and depths to test the theory of vertical migration. Thirty specimens of bioluminescent fish were recovered in these trawls. Three major family groups were represented in the fish collected: Mytopitiae, Stomadae, and Sternoptychidae. Data collected loosely suggested the migration of these fish as they were found consistently in the upper 300 meters of the ocean at night and were rarely present there during daylight hours. However, the data could not be considered conclusive, as evidence of deep layer communities were not obtained.

VII. CORAL REEF STUDIES

A. Coral Reef Zonation

Janet E. Collins

Abstract

This study was done to determine any trends in the zonation of coral on breaking reefs.

The study was done in Eustatia Sound in the British Virgin Islands. Two transects were set up perpendicular to the direction of wave action. It was then recorded how many meters each species occupied along each transect. An average was then taken. It was found that soft coral such as Sea Fan (*Gorgonia ventalina*) and Sea Rod (*Plexaura flexuosa*) were found mainly in the backreef where the finer sediment fallout occurred. They were also found in the protected areas of the zone of breaking waves and never in the forereef. Of the brain corals, Giant Brain (*Colpophyllia natans*) was found in the rougher waters of wave action and the forereef while Grooved Brain (*Diploria labyrinthiformis*) was most abundant in the backreef. One of the most abundant coral was Elkhorn (*Acropora palmata*) and occurred more frequently at the area of breaking waves.

It was concluded that the smaller and least rigid corals occupied the backreef and protected areas of the breaking waves while almost all species were found at the breaking waves. The most abundant coral, Mountainous Star (*Montastraea annularis*) was found only in the forereef, where there was a sharp increase in depth.

B. Growth Form and Wave Intensity: A Study of Echinometra lucunter

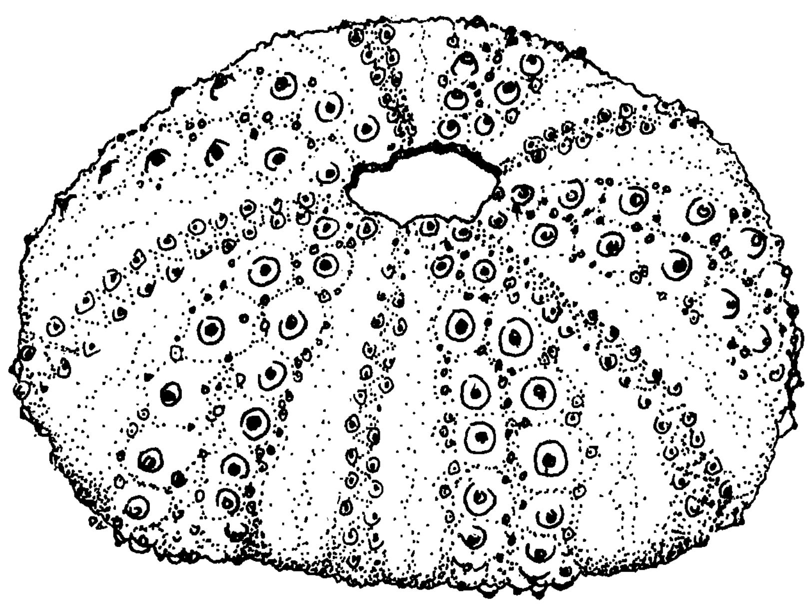
Ann Durbin

Abstract

The effect of wave intensity upon growth form in the intertidal Caribbean sea urchin Echinometra lucunter was studied with regard to three parameters: spine length, test thickness, and body flatness. Wave intensity was estimated at sites of specimen collection.

It was expected that E. lucunter found in high wave intensity areas would be characterized by shorter spines, thicker test, and flatter body shape than those from calmer areas.

Significant correlation (mean r value = .77) of spine length with wave intensity was observed. Wave intensity showed no effect upon test thickness or body flatness.



test of Echinometra lucunter

C. The Response of *Oreaster reticulantus* to Light

Susan Greenberg

Abstract

Many species of starfish have been shown to be sensitive to light. Species that live in light-exposed areas react positively to light, while those living in dark areas show a negative reaction. *Oreaster reticulatus*, a starfish that lives on the sandy bottom of Caribbean waters at a depth of ten to fifteen feet, was tested for its reaction to light. Specimens were placed in a tank and their response was recorded when a light was concentrated at one end of the tank. As *O. reticulatus* lives in areas relatively exposed to light, it was expected that the specimens would exhibit a positive response. Test results did not support this hypothesis. Rather, the starfish exhibited an approximately equal number of positive and negative responses.

D. Microscopic Organisms in Corals

Judy Henshel

Abstract

According to Humes, copepods have adapted their shapes to live in coral polyps in the Indian Ocean. In this study, an attempt to find what copepods, if any, live inside the polyps of Caribbean corals. Twenty-five samples of coral were collected from two reefs and a precipitate obtained from the coral by soaking in an alcohol solution. No copepods were found in the samples collected. Before their existence can be ruled out, a more extensive survey of Caribbean corals should be conducted.

E. Reef Fish Zonation

Susan M. Kennedy

Abstract

The purpose of this experiment was to determine the species diversity

of fish across longitudinal transects in a coral reef, Two transects across a small reef (260m x 12m) in Eustatia Sound, British Virgin Islands, were used. All data was collected by an observer snorkeling on the surface of the water column. The snorkeler swam on a compass heading of 60^{o} (NE) and stopped approximately every 9 meters counting the different fish in sight. This was done from the backreef through the breaking waves to the forereef.

Two parallel transects were done, one through the middle of the reef and one near the outer southeast edge. The number of fish species increased from the beginning of the backreef and was maximum at the breaking waves. Going from the breaking waves toward the forereef, the number of species decreased. The variation in number of fish species across the reef was a clear indication of the different zones (forereef and backreef).

Gorgonia Ventalina

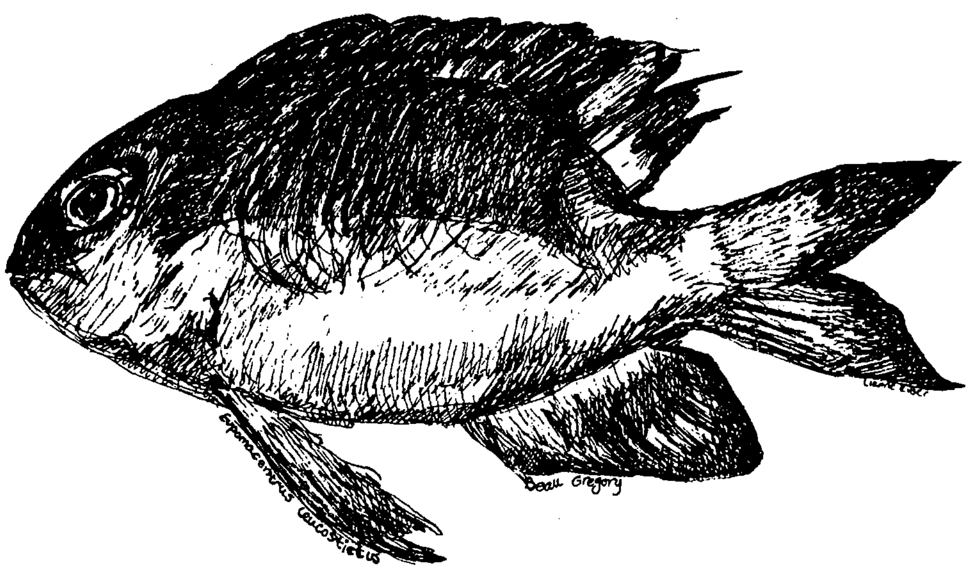
F. Reef Fish: Interspecific Agression

Lianne Ritter

Abstract

Observations were made on the territorial behavior of 5 subject *Eupomacentrus leucostictus* (Beau Gregory) and their responses to intruding crude acrylic-painted styrofoam models. The models were recombinations of colors and shapes of Scaridae, *Sparisoma chrysopterum* (redtail parrot-fish) and *Pomacentridae*, *Microspathodon chrysurus* (yellowtail damselfish), and a control (a square of unpainted block). The recombination of shapes and colors was an attempt to obtain the significance of a competitor's coloration in its elicitation of agonism.

Results were that only one subject displayed territorial behavior towards the models while the other four displayed consistently a fear response towards the intrusion of its home site. Problems with this experiment include poor control of intervening variables, difficulties with the models and an insufficient sample set.



VIII. OTHER STUDIES

A. Caribbean Distribution of Halobates Micans

Stuart Allison

Abstract

One genus, of the many insect genera, occurs in the open ocean. That genus is *Halobates* and one of its species, *Halobates micans*, occurs in the Atlantic and Caribbean Oceans. *H. micans* has not been greatly studied and only one study has been done in the Caribbean in the month of December. With their distribution and life cycle of specific interest, 245 individual specimens of *H. micans* were collected. While they were found all along the W-49 cruise track, two areas with quite large concentrations have been found. Sixty-two individuals were taken in three separate tows around Saba Bank. Ninety-seven individuals were taken in one tow 75 miles west of the St. Lucia Channel. When this project was planned, it was expected that large numbers of *H. micans* would be found in the passages between the islands where the North Equatorial Current enters the Caribbean, indicating that they occur in the North Equatorial Current itself. They have never been found in that current before though it is thought that they may have used it when crossing the Atlantic thus expanding their range. Although *H. micans* were found in the passages, they did not occur in large enough numbers to conclusively state that they are there because of the North Equatorial Current.

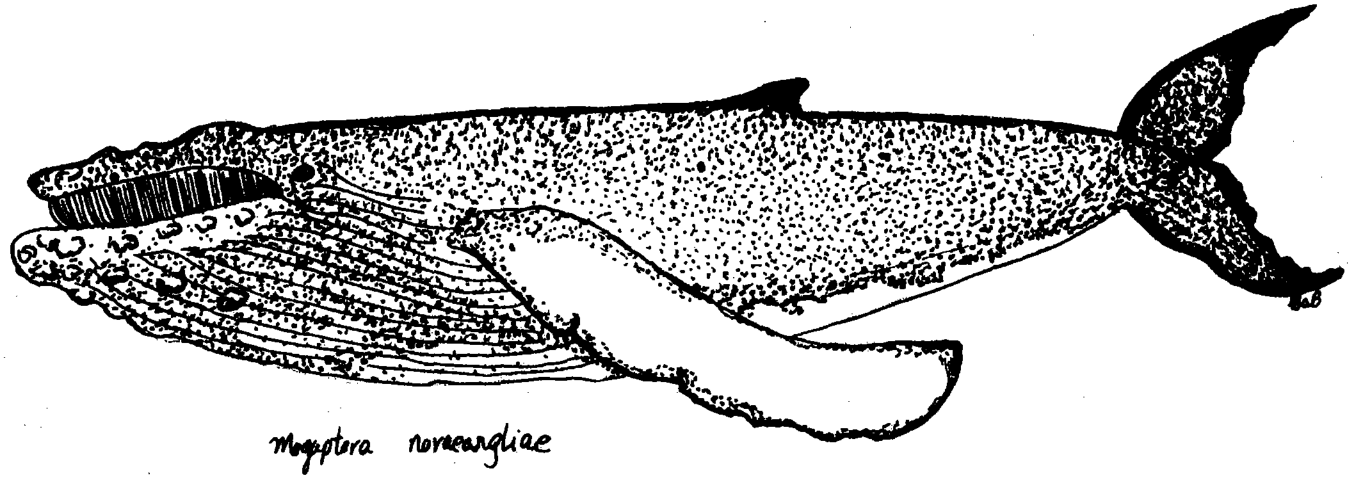
Many individuals were also measured in order to determine their stage of development, a parameter in determining the life cycle for *H. micans*.

B. <u>Marine Mammal Acoustics</u>

Barbara Block

Abstract

Underwater listening stations coinciding with cetacean observations were conducted along the cruise track of W-49. A systematic collection of vocalizations and observations was concentrated on several transects of Navidad and Silver Banks, the suggested breeding and calving grounds of the humpback whale *Megaptera novaeangliae*. The song of the humpback whale is produced only in the winter tropical calving ground but technical difficulties with the hydrophone impeded efforts to record at all of these stations. An excellent recording was obtained of vocalizations produced by the Atlantic spotted dolphin *Stenella plagiodon* while a pod of twenty individuals surrounded the vessel. *S. plagiodon* utterances from this recording are characterized by impulsive clicks at varying repetition rates, narrow band squeals and whistles, and a diverse array of complex sounds difficult to describe. Speculation as to the function of the information bearing aspect of these sounds has begun. Spectral and temporal analyses by means of a sonogram are planned in order to obtain a conclusive understanding of the communicative and echolocative aspects of *S. plagiodon* vocalizations.

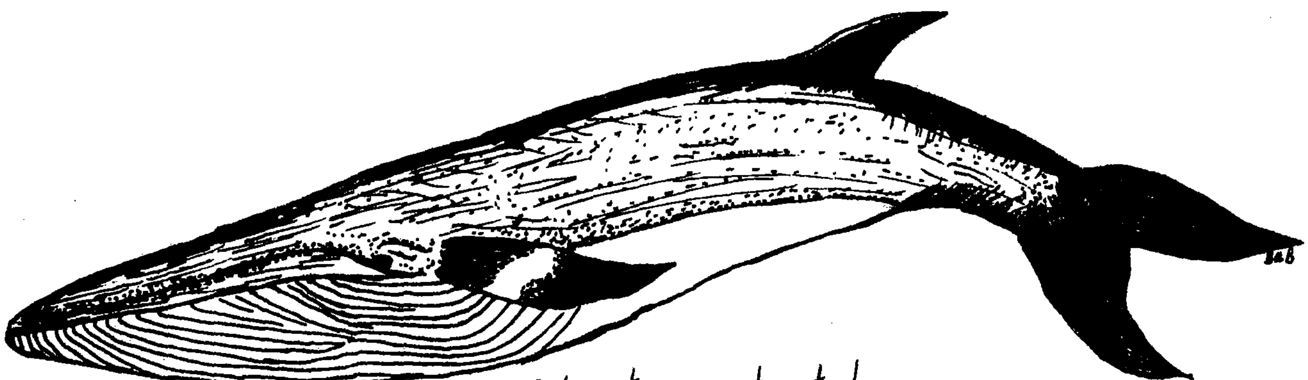


C. Identification and Distribution of Marine Mammals

April Rivkin

Abstract

An ongoing survey of marine mammals was conducted during W-49 in the North Atlantic and Caribbean as a continuation of one of Westward's long term internal programs. This included one day transects of Navidad and Silver Bank. Over 125 Cetaceans were observed, including *Stenella plagiodon*, *Tursiops truncatus*, *Physeter catadon*, *Megaptera novaengliae*, and *Balaenoptera acutorostrata*. All of the sightings on Navidad and Silver Bank were identified as Humpback whales, *M. novaengliae*, seen breaching and spouting at various distances from the ship.



Balaenoptera acutorostrata

D. Trace Concentrations of Soluble Iron off the Leeward Islands of the Lesser Antilles

Arndt Braaten

Abstract

Two aspects of trace concentrations of soluble iron were studied in the Caribbean waters off the leeward islands of the Lesser Antilles.

A concentration transect was run from 14° 07' N - 62° 03' W, a point 60 miles west of St. Lucia, on a northwestward track to Aves Island and continued on a northward track to Tortola, B.V.I. Four samples were taken south

of Aves Island after which samples were taken approximately every twenty miles to Tortola. Concentrations were measured in μ moles/liter by spectrophotometric analysis according to Strickland and Parsons (1972).

It had been hypothesized that iron concentration would vary inversely with distance from land; however, no data was collected which conclusively supported such an hypothesis. This was possibly due to a lack of information on the geology of the earth's crust along the transect.

In Tortolan waters measurements of iron diffusion off the hull of R/V Westward were made to determine its effects on subsequent trace metal analysis. Surface samples were taken at intervals of 0.0, 0.2, 0.5, 1.0, and 5.0 meters from the ship.

Another trial of the previous experiment was made off Marina Cay in which surface samples were taken at intervals of 0.0, 0.3, 0.6, and 1.0 meters from the ship. In this trial the turbulance was minimal and an inverse, linear relationship was established between concentration and distance from the ship.

Further diffusion studies are planned for Key West where more samples will be analyzed and more extensive statistical analyses made. The studies will be made in conjunction with Dr. Don Drost and Dr. Gary Faber of the College of Charleston. It is hoped that the data will suggest an efficient and accurate method for making future trace metal analyses.

E. Correlation of Wind and Barometric Pressure in the Eastern Caribbean

Beth Brodie

Abstract

High winds commonly associated with substantial changes in barometric pressure can be vital to a mariner's safety. A correlation between wind velocity and changes in barometric pressure was sought by gathering meterological data throughout the W-49 cruise. The data, collected every 6 hours, consisted of barometric pressure change, wind direction and velocity, and cloud cover

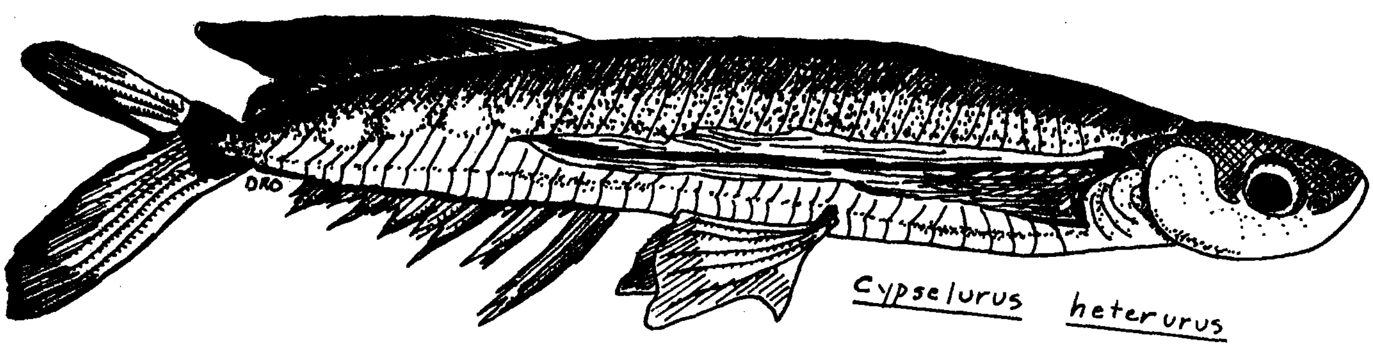
at recorded times and locations. The correlation was highly complicated by the presence of a diurnal fluctuation in barometric pressure found in the lower latitudes. Towards the end of the cruise, in more northerly latitudes, results corresponding more positively to the hypothesis were attained.

F. Aerodynamics of the Flying Fish Cypselurus heterurus

Paul Fellenbaum

Abstract

Aerodynamic features of flying organisms correspond closely to their modes of flight. With this in mind, a study of aerodynamic characteristics of the flying fish Cypselurus heterurus was undertaken. Measurements of mass, wing span, and wing area were taken from ten specimen. Aspect ratio and wing loading were then calculated. These figures, along with observations of camber, angle of attack, and modifications to the wing affecting efficiency were compared to those of various birds and bats. Results show that C. heterurus combines various features of gliding birds and high speed bats.



G. Feeding Behavior of the Magnificent Frigatebird

Ginny Lermann

Abstract

The intentions of this project were to test a hypothesis proposed by previous researchers concerning the feeding behavior of the Magnificent Frigatebird. The hypothesis states that frigates surface dive for their food in calm weather and plunder other birds, particularly boobies, in harsh weather. The investigator employed personal surveillance as well as other students' observations for data collection. The frigates were observed surface diving as well as plundering boobies, terns, and members of their own species, all in calm weather. Overall observations and conclusions, though limited due to a small number of observable feeding frigates and fairly consistent calm weather, indicate that no correlation exists between weather conditions and frigate feeding behavior. It is claimed that these birds are naturally opportunistic, taking advantage of their own maneuvering abilities to feed most effectively in the given situation.

H. Reliability of Loran C in the Eastern Caribbean

Paul McDowell

Abstract

Most of the W-49 cruise track took Westward out of areas of Loran C Ground Wave reception. From St. Thomas southward Westward relied entirely on skywaves for Loran C navigation. Skywaves are reflected back primarily off the E-layer in the middle ionosphere. As they reflect back towards the surface they are partially absorbed by the D-layer at times of high solar influx (daytime periods of high solar activity). Skywaves become particularly inaccurate for Loran C navigation at sunrise and sunset when the ionosphere is changing. Because of the nature of the Loran coverage, it was only possible to receive one line of position from the master/slave pair GRI 7980. The following data were collected: average time dif-

ference, average signal to noise ratio, weather, possible incidental interference (radio, MG sets, generators, radar), time to track, and other pertinent information. From the data it became apparent that Loran C was reliable for navigation in the evening and afternoon and unreliable for navigation during sunrise and sunset.

I. Identification of Antarctic Intermediate Water

Debra Merrill

Abstract

Measurements of salinity and temperature were obtained from five hydrographic stations in the Anegada Passage, St. Lucia Channel and Grenada Basin in order to detect the presence of Antarctic Intermediate Water. Identification of the Antarctic Intermediate Water mass was based upon temperature, depth, and a salinity minimum within the water column. The Anegada Passage represented the near northern most extent of this water mass. Due to considerable mixing with adjacent water masses during its northward flow and questionable salinity values, positive identification could not be made.

J. Low Angle Sextant Altitude Sights

Barton Parrott

Abstract

Significant atmospheric refraction occurs for low angle sextant altitude observations. This refraction varies with certain atmospheric parameters such as temperature and barometric pressure. In order to obtain information on the accuracy of low angle sun sights, a significant number of low angle sun sights were observed under varying atmospheric conditions. Standard refraction corrections available in the Nautical Almanác were used. Position lines obtained were compared with electronically obtained fixes.

K. Use of Bird Counts as Indicators of Ocean Surface Productivity

Leah Quesenberry

Abstract

Numbers and species of birds were recorded when observed during Leg I and Leg II of the W-49 cruise track. Neuston net tows were conducted at various locations during this portion of the cruise track. From the Neuston tows, the biomass of the various locations was calculated. The biomass and the numbers of birds observed at each location were examined for any possible correlation. It was observed that the results yielded no apparent correlation between the biomass of the various locations and the numbers of birds sighted in the same locations.

L. Spiny Lobster Larvae Distribution in the Straits of Florida and the Old Bahama Channel

Lori Ragosa

Abstract

Though the spiny lobster, Panulirus argus, is important commercially, very little is known about its larvae. It is believed that during the 8-11 months they live before metamorphosis, the larvae are carried by oceanic currents from breeding grounds of the adults to far distant waters and lands. It is not known whether the larvae drift passively with these currents or have some control, by a mechanism known for environmental factors such as temperature, salinity, or depth.

The purpose of this project was to establish some baseline information on the distribution of the larvae of the spiny lobster. A total of seven spiny lobster stations were conducted (See Appendix). It was assumed that larvae were concentrated at the thermocline. Meter net tows were done for 30 minutes at mid-thermocline depth. Hydrocasts of six bottles determined temperature and salinity to characterize the water column.

No spiny lobster larvae were identified at any of the seven stations in the Old Bahama Channel or the Straits of Florida.

IX. VISITING INVESTIGATOR ABSTRACTS

A. Harpacticoid Copepods Inhabiting Caribbean Coral Sands

William S. Ravenel

Abstract

Harpacticoida is an order of the subclass Copepoda containing small (.2 to 2.5 mm), predominantly benthic copepods. Harpacticoid copepods are found world-wide in the marine environment from the intertidal to the deep sea and are a major component of the meiofauna, being outnumbered only by nematodes in most sediments. Recent research has indicated that harpacticoids are an important source of food for some larval and juvenile fish and may be an important link in the food web between the benthic microfauna and macrofauna. Although studies involving harpacticoid copepods have increased in the past decade, there is much basic biogeographical and taxonomic work yet to be done. References to the harpacticoids inhabiting subtidal carbonate sands are particularly scarce. On this cruise sediment samples were collected between St. Thomas and Martinique in order to obtain qualitative information about the harpacticoid copepods associated with Caribbean coral sands.

Sediment samples were collected using an Emory and Chapman designed under-way sampler. This device is capable of collecting small samples of sediment to a depth of about 200 meters without stopping the ship and so is ideal for a qualitative, shallow-water meiofaunal survey. Unfortunately, the tripping mechanism began to malfunction after the third sample was collected, making further sampling impossible.

B. Trace Metals in the Caribbean

Gary Faber

Abstract

Trace metals in the Caribbean waters were studied in a transect along the Leg 2 cruise track between St. Lucia and the British Virgin Islands via Aves Island. In addition, measurements of soluble iron as a function of distance from the ship were made at two sites in the Caribbean. Concentrations were measured in μ moles/liter by spectrophotometric analysis according to Strickland and Parsons (1972).

Data collected on the Caribbean transect did not conclusively support any functional dependence of concentration versus distance from land, as might be expected. In the two trials for soluble iron, an inverse relationship was found between concentration and distance from the ship.

C. An Investigation of the Diurnal Vertical Migration of Euphausid and Mysid Population in Deep and Shallow Water

Nancy L. Murden

Abstract

An investigation of diurnal migration of euphausid and mysid populations in deep versus shallow water was made on Leg 3 on and off Silver and Navidad Banks. The largest planktonic sample contents were expected to be obtained in shallow water on the banks at night. This was found to be true in part; however, inadequate sampling and inability to sample in the desired areas due to international water disputes made the results inconclusive. Three samples were taken on and off Navidad Bank and just south of Silver Bank in two daytime surface plankton tows and one night tow. Few mysids and euphausids were found in the day samples, but a significant number were found in the night sample. The data show a general trend of diurnal vertical migration while not thorough enough to yield conclusive results. However, benthic Harpacticoid copepods were

positively identified in the night sample (#3). The extenuating variable in this investigation seemed to be day/night rather than deep/shallow sampling. Further investigation is warranted by the latter.

D. A Journalist at S.E.A.

Ken Pierce, Education Editor, TIME magazine

Abstract

The object of my visit to the R/V Westward was to reach the sort of appreciation and understanding of Sea Semester appropriate to a general news magazine rather than to any one specialized discipline. My research methods (a phrase likely to cause mirth among some of my journalistic colleagues, due to the implication of formality, quantitative rigor, and the use of experimental controls) were personal observation and interviewing. I found all aboard ideal objects for this sort of investigation, eager to answer questions, to think aloud about the experience, and, for the most part, to remain unaffected by such scrutiny. In particular, the courtesy, patience, companionship, and insight offered by Sid Miller and Don Drost was invaluable. Both strike me in their different ways as ideal men for the demanding and multi-faceted tasks of Sea Semester - including, on this voyage, coping with a journalist. My only regret, as so often in my line of work, is that TIME lacks the space to permit an elaborate and lengthy rendering of the diversity in students, tasks, weather, and even the all-important "comfort quotient index" aboard R/V Westward.

X. ISLANDS

The cruise track of the R/V Westward for W-49 included passages near and among the Windward Islands of the Caribbean from the Virgin Islands to St. Vincent with brief stops at some of these islands as well as Great Inagua in the southern Bahamas.

In some cases such as for Aves Island and Norman Island flora and fauna were observed, identified, and lists prepared. In other situations, general observations were made as to the suitability of the island for future Westward visits or studies. The following comments are on islands directly experienced either in some detail or superficially.

A. St. Barthélemy

The French island of St. Barts is located in the northern group of the Lesser Antilles. Like the other islands in the archipelago, it is volcanic in origin. Though nearer the high, wet islands to the south, it is lower and drier, like the farther Virgin Islands to the north across the Anegada Passages.

Westward, making an unscheduled 12 hour repair stop at St. Barts, anchored just outside the postage stamp harbor of the capital city, Gustavius. Staff and students briefly experienced St. Barts, a Caribbean island that is distinctly French with a Mediterranean flavor added by Gustavius and the villas in the surrounding hills.

In addition to shore exploration for the off watches, science watches conducted dives in the water near several large rocks at the harbor entrance.

The island of St. Barts would serve as a desirable future port stop for Westward with some opportunity for reef work both on the Caribbean and Atlantic sides.

B. Martinique

Following two weeks of mostly weather work in the northern Windward Islands, Westward anchored for two days in the harbor of Fort de France, Martinique. The contrast between the quiet of the sea and the noise of a large foreign city was immediately evident. Opinions of Fort de France were varied with some relishing its strangeness and exotic flavor and others wishing for a familiar sight or two in the city's narrow streets, small shops, cafes, and high population density.

Martinique is one of the larger, higher volcanic islands in the eastern Caribbean archipelago. The easterly trade winds against the mountains produce large quantities of rain, particularly at the higher elevations. Mt. Pélée, Martinique's most recently active volcano, is often shrouded in clouds.

Westward's staff and students toured the island on buses. Visits to rain forests, Mt. Pélée, black volcanic sand beaches, and the town of St. Pierre were included. St. Pierre, partially destroyed by an eruption of Pelee in the last century was picturesque and seemed a likely site for a future port stop for Westward.

Unlike many other Caribbean islands, Martinique has a number of coves suitable for anchoring on the windward side, sites which appear suitable for future Westward reef studies.

C. St. Lucia

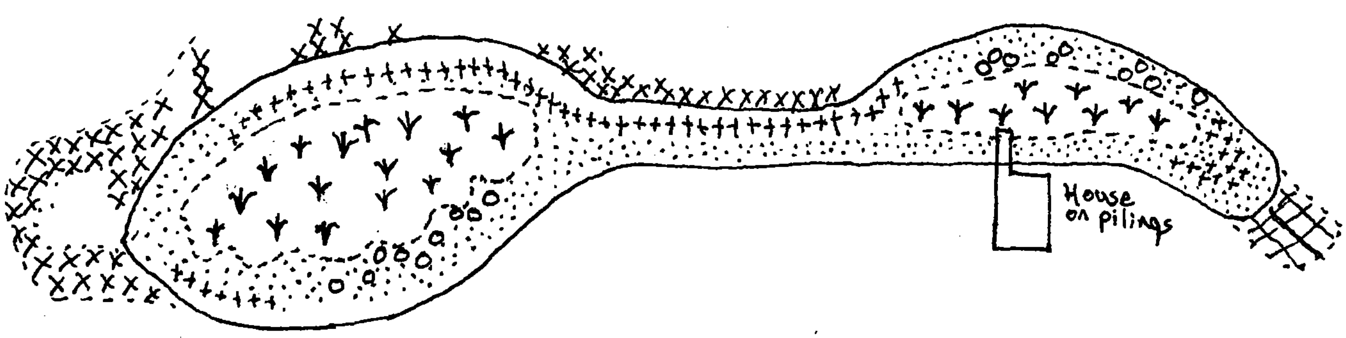
St. Lucia, lying south of Martinique, was the subject of Westward's island mass effect studies. Though a landing was not made on St. Lucia, the Westward coasted along the leeward shore of this dramatic island beneath the towering Gross and Petit Pitons to anchor briefly for soluble iron samples at the entrance to Marigot Harbor.

D. Aves Island

Between vertical migration study stations near the Aves ridge, Westward sailed near Aves Island, a speck of land the size of a large tanker, that lies in the Caribbean 150 miles west of Guadeloupe. The island has a small Venezuelan naval installation staffed by a dozen or so men. A small boat put out from the island carrying an invitation from the commandant for *Westward* to visit. Since opportunities for research vessels are non-existent in Venezuelan waters, the decision was made to accept and the *Westward* anchored just off the western side of the island.

Westward's staff and students were given a tour of the small naval installations and allowed to study the island and surrounding waters. The island is a nesting site for the green sea turtle, *Chelonia mudas* and many clutch areas were discovered. There were large numbers of sea birds nesting in the sparse grass at the southern end of the island. An organism list and a sketch chart based on the Aves Island study are included in this section.

The Venezuelan officers were entertained at dinner aboard the *Westward* and in turn a contingent of *Westward's* staff and students were treated to a Venezuelan breakfast in the officer's mess. An atmosphere of mutual friendship and good will prevailed and strengthened during *Westward's* 24 hour stay. The time was one of the high points of W-49. The ship's company gratefully acknowledge the hospitality afforded by the Venezuelan people.



AVES ISLAND   15 42'N, 63 38'W

XXX Rocky Intertidal Zone   Sea Pursland, *Sesuvium* spp.

Coral Sands   O Turtle Nest

+++ Coral and Sponge Rubble

ORGANISMS FOUND ON AVES ISLAND

Birds

ruddy turnstone	Arenaria interpres
sooty tern	Stern fuscata
noddy tern	Anous stolidus
barn swallow	Hirundo rustica

Reptiles

green sea turtle	Chelonia mudas

Fish

red hind	Epinephelus guttatus
rock hind	Epinephelus adscensionis
coney	Epinephelus fulva
graysby	Epinephelus cruentatum
grouper	Epinephelus spp.
fairy basslet	Gramma loreto
barjack	Caranx hippos
blue runner	Caranx fusus
cherub fish	Centropyge argi
bluehead	Thalassoma bifasciatum
parrot fish	Melichthys niger
yellowfin mojarra	Geres cinerus
barracuda	Sphyraena barracuda

E. Virgin Islands

The British Virgin Islands provided an ideal location for the reef studies chosen by six students on W-49. In addition, the deep water to the south allowed Westward to make night Isaacs-Kidd midwater trawls and return for daytime reef studies.

Westward's time in the Virgin Islands included entry into the country at Roadtown, Tortola; a study of Norman Island; dives on the wreck of the Rhone; and reef studies primarily at Virgin Gorda. The Christmas port stop was in Virgin Gorda Sound.

Reef studies in the Virgin Islands are abstracted in section VII of this report. The following description of Norman Island was prepared by Rob Moir.

F. Norman Island

Norman Island is a narrow island, less than ¼ mile in width and 2½ miles in length, situated southwest of Tortola. The island is marked by striking densely vegetated hills rising up 400 feet and sheer 100 foot cliffs, making it a likely setting for Robert Louis Stevenson's Treasure Island.

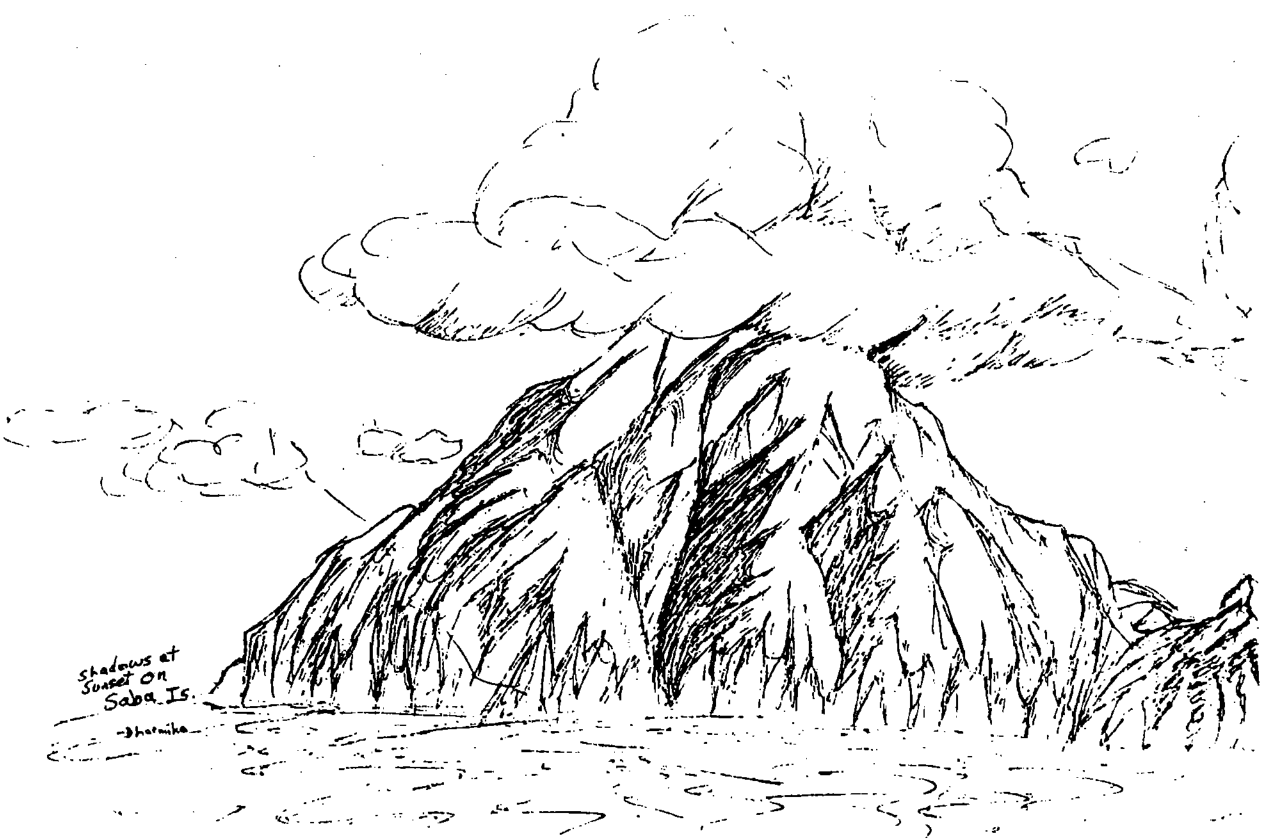
A superficial survey of flora and fauna was conducted. The survey began before dawn when a light was hung over the port rail to attract marine life. Within minutes silversides (*Atherinidae*) were schooling under the light. An animal smaller than a sooty tern and larger than a common tern flew over the fish. Two finger bones extended back through each wing giving it ridges. There were feet where a tail should have been. Identified as a bat, it appeared to have an approximate body length of 200 cm and a wing span of 250 cm.

During the morning of *Westward's* visit, a diving party visited coral reefs while a shore party explored caves and the adjacent shore. One cave was large enough for our small dory to enter and travel approximately 70 feet to its end. Inside the high squeal of bats was heard.

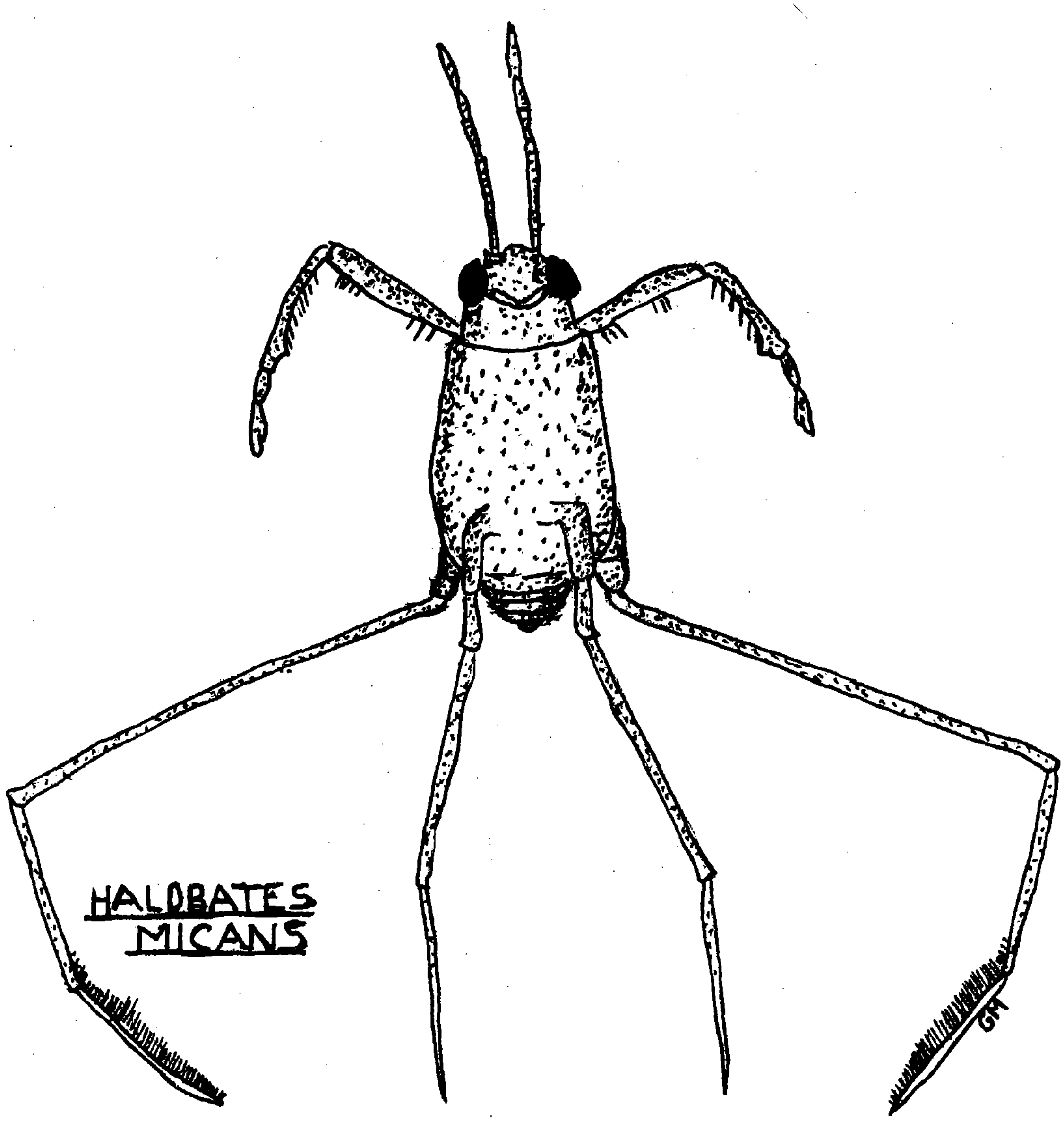
The afternoon was spent crossing the island. At the head of "The Bight" were cattle trails and dry stream beds. In the forest travel was blocked by dense vines. At higher elevations the slope became steeper. There dense thorn and other bushes as well as occasional cactus blocked travel. Stream channels were absent on steeper slopes. Over the ridge the south slope was more open at high elevations of 150 - 400 feet. Birds seen included Antillean mango, greater Antillean grackle, and red legged thrush. Two large birds were flushed from the mudpond. These were possibly green herons or shore birds.

G. Great Inagua

Westward anchored in the open roadstead of Matthew Town, Great Inagua and cleared into the Bahamas on January 1, 1980. Great Inagua is a low lying coral island with a large area of lakes in the interior. The lakes provide a natural habitat for over 30,000 flamingoes (*Phoenicopterus ruber*). A portion of the island's interior is set aside and maintained jointly by the Bahamian Government and the Audubon Society in order to preserve this valuable area. Time was not allotted on W-49 for a visit to the flamingo preserve; however, such a visit would be worthwhile for future cruises.



APPENDICES



A. Demonstration Organisms on W-49

Scientific name	Common name	Phylum
1. Copepods	Copepods	Arthropoda
2. *Trichodesmium sp.*	*Trichodesmium sp.*	Cyanophyta
3. *Cyphoma gibbosum*	Flamingo tongue	Mollusca
4. *Fregata magnificens*	Frigate bird	Chordata
5. *Cypselurus heterurus*	Flying fish	Chordata
6. *Loligo pealei*	Squid	Mollusca
7. *Porpita sp.*	*Porpita*	Cnidarian
8. *Doliolum sp.*	*Doliolum*	Chordata
9. *Halobates micans*	Water strider	Arthropoda
10. leptocephalus eel larvae	leptocephalus eel larvae	Chordata
11. *Sterna fuscata*	sooty tern	Chordata
12. *Stenella plagiodon*	spotted dolphin	Chordata
13. *Prionace glauca*	blue shark	Chordata
14. *Coenobita clypeatus*	land hermit crab	Arthropoda
15. *Acanthephyra pelagica*	scarlet praun	Arthropoda
16. *Chaetodon capistratus*	butterfly fish	Chordata
17. *Strombus gigas*	pink conch	Mollusca
18. *Coryphaena hippurus*	dolphin fish	Chordata
19. *Megaptera novaeangliae*	humpback whale	Chordata
20. *Siderastrea radians*	star coral	Cnidarian

B. Bird Sightings Reported During Cruise W-49

Date	Time	Lat(N)	Long(W)	Bird	Number	Notes
29 Nov	1610	18 17.8	64 48.3	brown booby	1	
	1700	18 21	64 49	brown booby	1	
30 Nov	630	18 21.5	64 47.0	brown booby	2	
	630	18 21.5	64 47.0	brown pelican	3	
	730	18 22.3	64 46.6	brown booby	1	immature
	730	18 22.3	64 46.6	brown booby	6	
	730	18 22.3	64 46.6	brown pelican	7	
	800	18 22.5	64 44.9	brown pelican	28	fishing & roosting, St. Johns
	840	18 23.3	64 40.5	brown pelican	75-100	fishing off a point,Tortola
	1714	18 13.9	64 37.6	brown booby	2	
2 Dec	721	18 14	64 22	cattle egret	1	
	1250	18 20	64 18	brown booby	1	immature
3 Dec	900	18 31	64 22	frigatebird	2	1 female, 1 male
	900	18 31	64 22	brown pelican	3	
	1130	18 31	64 22	frigatebird	16	6 female, 6 male, 4 immature
4 Dec	1720	17 36	63 20	brown booby	6	
	1740	17 36	63 18	brown booby	16-24	
	1805	17 36	63 14	frigatebird	1	
5 Dec		17 54	62 51	frigatebird	3	females in St. Barts Harbor
		17 54	62 51	frigatebird	1	immature
		17 54	62 51	frigatebird	2	males
		17 54	62 51	brown booby	2	

(con't.)

Date	Time	Lat(N)	Long(W)	Bird	Number	Notes
6 Dec	1600	16 13.6	62 22.8	gannet or blue footed booby	1	poor iden.
7 Dec	1220	15 14	61 51	tropicbird	3	
	1420	15 06	61 45	brown booby	100 - 200	
10 Dec	730	14 35	61 03	frigatebird	1	female, Martinique
12 Dec	650	13 58	60 43	?	4	small birds offshore
13 Dec	1250	13 58.3	61 02.3	Osprey	1	Marigot Bay, St. Lucia
14 Dec	625	13 42	61 29	brown booby	3	
	2200	14 15	62 10	gannet	1	poor iden.
15 Dec	715	14 30	62 30	brown booby	2	immature
	1045	14 58	62 51	terns	75 - 100	
	1045	14 58	62 51	frigatebirds	9 - 12	
	1750	15 20	63 06	barn swallows	6	roosting in the lab - 4 survive the night
	1750	15 20	63 06	brown booby	2	
16 Dec	1155	15 32	63 14	Wilson's petrel	1	
	1440	15 32	63 14	brown booby	40 - 60	immature and mature
17 Dec	1345	15 40	63 39	brown booby		
	1345	15 40	63 39	noddy tern	900-1100	on Aves Island
	1345	15 40	63 39	frigatebird	1	
	1345	15 40	63 39	audubon shearwater	1	
	1500	15 42	63 38	noddy tern	300 - 400	on Aves Island
	1500	15 42	63 38	sooty tern	200 - 300	on Aves Island
	1500	15 42	63 38	barn swallow	12	
	1500	15 42	63 38	ruddy turnstone	6	
18 Dec	2350	15 56	63 56	sooty tern		calls in the dark
19 Dec	945	16 14	63 48	brown booby	1	
	1115	16 20	63 45	parasitic jaeger	3	immature
	1500	16 40	63 52	parasitic jaeger	1	immature
20 Dec	1100	18 24	64 36	frigatebird	2	immature and female adult
	1100	18 24	64 36	brown pelican	1	
	1130	18 27	64 36	brown pelican	2	Road Harbor, Tortola
	1130	18 27	64 36	brown booby	2	
	1130	18 27	64 36	frigatebird	5	
	1745	18 27	64 36	tricolored (Louisiana) heron	2	
28 Dec	1645	19 13	66 54	barn swallow	3	immature
30 Dec	930	20 26	69 47	cattle egret	1	
	1610	20 36	70 30	parasitic jaeger	2	immature
1 Jan	725	20 52	73 40	royal tern	6	
	725	20 52	73 40	cattle egret	1	
	725	20 52	73 40	Audubon shearwater	2	
	1400	21 08	73 55	osprey	1	in Matthew Harbor, G.I.
4 Jan	820	22 29	77 53	frigatebird	2	female G.I.
	1040	22 40	78 04	black-legged kittiwake	1	immature
5 Jan	1210	23 05	78 55	frigatebird	1	
6 Jan	1045	23 23	80 06	brown booby	1	
7 Jan	700	23 52	80 46	laughing gull	2	second winter plumage
	855	23 54	80 50	black-legged kittiwake	3	mature
	1000	23 50	81 02	brown booby	1	
	1000	23 50	81 02	frigatebird	1	

C. Summary of Bird Sightings Reported During Cruise W-49

Number of Observations	Bird	Number of Birds
19	brown booby	350 - 460
14	frigatebird	47
7	brown pelican	91 - 115
3	cattle egret	3
3	parasitic jaeger	6
2	Audubon shearwater	3
2	osprey	2
2	ruddy turnstone	6
2	black-legged kittiwake	4
1	laughing gull	2
2	noddy tern	300 - 400
2	sooty tern	200 - 300
2	barn swallow	9
1	Wilson's pectrel	1
1	tropicbird	3
1	gannet	1
1	tricolored heron	2
Total 51	17	1030 - 1364

D. Aves Island Organism List

Fish	
blue tang	Acanthurus coeruleus
balloon fish	Diodon holocanthus
houndfish	Tylosurus crocodilus
Schooling Fish	
yellowtail snapper	Ocyurus chrysurus
wrasses	Halichoeres spp.
squirrelfish	Holocenturs spp.
peacock flounder	Bothus lunatus
black durgon	Melichthus niger
smooth trunkfish	Lactophrus triqueter
pompano	Coryohaena equisetis
Invertebrates	
sea fan	Gorgonia spp.
fire coral	Millepora spp.
star coral	Montastrea spp.
Atlantic triton	Charonis variegate
foraminefera	Homotiemia vubrum
rock urchin	Echinometra lucunter
West Indies topshell	Cittarium pica
helmet conch	Cassistuberosa
queen conch	Strombus gigas
hermit crab	Paguridae
mottled shore crab	Grapsus grapsus

E. Marine Mammal Sightings

1. Marine Mammal Sightings During Cruise W-49

	Marine Mammal	ID	No.	Size (ft.)	Date	Time	North Latitude	West Longitude	Mode	Position	Other Species
1.	*Stenella plagiodon*	1	4	4-6	12/2	1420	18°29'	64°15'	Sail	Bow	---------
2.	*Physeter catadon*	1	2	22-25	12/9	0730	14°37'	61° 9.5'	Sail	Stbd. Bow	---------
3.	*Physeter catadon*	1	1	30	12/9	0740	14°37'	61° 9.5'	Sail	Stbd. Bow	---------
4.	Unidentified dolphins	--	30-50	3	12/13	1610	13°52.5'	61° 8'	H	Stbd. Bow	---------
5.	Unidentified dolphins	--	4	3	12/15	0120	15°10'	62°50'	Sail	Bow	unidentified birds
6.	*Stenella plagiodon*	2	15-25	3-5	12/19	0730	15°58'	63°59'	H	Port Stern-Bow	2 *Sula leucogaster* 2 *Caranx bartholomaei*
7.	Unidentified dolphins	--	3	3	12/19	1430	16°34'	63°52'	Power	Stbd. Bow	----------
8.	Unidentified dolphins	--	6	---	12/20	0530	17°52.5'	64°19'	Sail	Bow	----------
9.	*Tursiops Truncatus*	2	12	3-6	12/28	1540	19°15'	66°29.5'	Power	Stbd. Bow	----------
*10.	*Megaptera novaengliae*	3	18-23	---	12/29	1025	20° 3'	68°56'	H	Bow-Stern	----------
**11.	*Megaptera novaengliae*	3	4	---	12/30	0935	20°26'	69°49'	Sail	Bow-Stern	----------
12.	*Baloenoptera acutorostrata*	2	2	20-30	12/31	1630	20°36'	72°26'	Sail	Bow-Stern	----------
13.	*Tursiops Truncatus*	1	9	6-8	1/8	0730	24°50'	81°48.5'	Power	Stbd. Bow	----------

Key: Quality of ID: 1 - Excellent, no chance of mistake; 2 - Good, high probability of correct ID.;
3 - Fair, distance or conditions somewhat marginal

* See section E-2: Marine Mammal Sightings - Navidad Bank Transect, 29 Oct. 1979

** See section E-3: Marine Mammal Sightings - Silver Bank Transect, 30 Dec. 1979

2. Marine Mammal Sightings - Navidad Bank Transect, 29 Dec. 1979

	Marine Mammal	ID	No.	Time	North Latitude	West Longitude	Position	Behavior/Other
1.	Megaptera novaengliae	1	4-6	1025	20° 5.8'	68°49.7'	Stbd. side	Breaching, showing white pectoral fins, continuously spouting
2.	Megaptera novaengliae	3	2-4	1230	20° 3.2'	68°53.8'	Stbd. side	-----
3.	Megaptera novaengliae	3	1	1305	20° 3'	68°55'	Stbd. side	Spouts sited
4.	Megaptera novaengliae	3	3-4	1310	20° 3'	68°55.5'	Stbd. bow	3-4 spouts sited
5.	Megaptera novaengliae	3	2	1316	20° 3'	68°55.8'	Stbd. bow	2 spouts sited
6.	Megaptera novaengliae	3	2	1338	20°1.5'	68°53.5'	Stbd. beam	2 spouts sited
7.	Megaptera novaengliae	3	2	1600	19°57'	68°52'	Bow	2 spouts sited
8.	Megaptera novaengliae	3	1	1610	19°57.3'	68°54.4'	Stbd. side	sited 100 yds. off stbd. side
9.	Megaptera novaengliae	3	1	1615	19°57.4'	68°56.2'	Port beam	------

3. Marine Mammal Sightings - Silver Bank Transect, 30 Dec. 1979

	Marine Mammal	ID	No.	Time	North Latitude	West Longitude	Position	Behavior/Other
1.	Megaptera novaengliae	3	1	0935	20°26'	69°47'	---------	Breaching in horizon
2.	Megaptera novaengliae	1	1	1010	20°26.8'	69°48.5'	Port beam	100 yards off
3.	Megaptera novaengliae	3	1	1020	20°27'	69°49'	Bow	---------
4.	Megaptera novaengliae	3	1	1035	20°28'	69°51'	Port bow	---------

F. Halobates Data

Neuston Tow #	Location of Tow	Time	Date	Number Caught
1	18°24.5'N 64°32.4'W	1212-1242	11/30/79	2
3	18°06'N , 64°00'W	0000-0030	12/04/79	1
4	17°39.5'N, 63°30.5'W	1215-1245	12/04/79	30
5	17°48.6'N, 63°42'W	0005-0035	12/05/79	31
6	17°45'N, 63° 54'W	0030-0100	12/06/79	1
8	16°07.5'N, 62°20'W	2310-2340	12/06/79	7
10	14°18'N, 61°02'W	0025-0055	12/12/79	11
11	13°51'N, 61°45'W	1435-1505	12/14/79	6
12	14°21'N, 62°14'W	2350-0020	12/14-12/15/79	99
13	15°05.8'N, 62°52'W	1205-1235	12/15/79	15
14	15°46.3'N, 63°39'W	1225-1255	12/18/79	3
15	16°21'N, 63°48'W	1215-1245	12/19/79	6
16	17°30.75'N, 64°06.5'W	0010-0050	12/20/79	17
17	20°06'N, 69°38'W	0405-0435	12/30/79	8
18	20°50'N, 73°20'W	0120-0150	01/01/80	5
21	21°33'N, 75°14'W	0017-0047	01/03/80	3

Note: Developmental Stage data available on request from S.E.A.

G. Hydrocast Station Data

Date	Latitude & Longitude	Hydrocast #	Depth (meters)	Salinity 0/00	$T_w C^o$	σT	O_2	Accepted Depth
30 Nov. 79	18°11'N, 64°25'W	2	surface	34.65	27.4	22.35	.79	surface
			100	37.19	25.7	24.8	.77	89
			200	36.92	20.1	26.25	.73	178
			300	36.80	18.2	26.75	.61	257
			400	36.32	16.6	26.70	.69	356
			500	35.46	14.2	26.50	.63	445
			400	36.03	---	---	.76	---
			600	36.52	---	---	.19	---
			1100	35.22	11.4	---	.13	---
			1600	35.18	04.6	28.87	.20	---
1 Dec. 79	18°25'N, 64°13'W	3	surface	35.44	21.6	---	.79	---
			400	36.398	16.5	26.70	.70	---
			800	35.06	07.2	27.45	.51	---
			1200	35.00	04.6	27.70	.76	---
			1600	35.05	04.2	27.75	.91	---
			2000	34.92	03.8	27.87	1.05	1130
11 Dec. 79	14°16'N, 61°00.5'W	7	surface	35.45	27.92	22.70	.82	surface
			400	35.28	13.64	26.50	.18	290
			800	35.04	08.04	27.29	.14	580
			1200	34.23	05.26	27.10	.65	870
			1600	35.24	04.55	27.90	.76	1160
			2000	---	04.30	---	.33	1450
12 Dec. 79	13°54.5'N, 60°37'W	8	surface	34.88	27.68	22.51	.88	surface
			400	35.24	27.67	22.51	.88	surface
			800	34.15	5.72	27.69	.55	666
			1200	---	5.39	---	.64	999
			1600	33.90	4.80	26.85	.97	1333
12 Dec. 79	13°51.5'N, 60°39.5'W	9	surface	35.81	28.20	23.10	.79	surface
			150	37.52	24.75	25.25	.69	136
			300	34.76	16.92	25.87	.55	272
			450	35.89	11.61	27.49	.50	408
			600	34.92	7.72	27.20	.47	544

Date	Latitude & Longitude	Hydrocast #	Depth (meters)	Salinity 0/00	T_w C^o	σ_T	O_2	Accepted Depth
13 Dec. 79	13°31'N, 61°02'W	10	surface	35.95	27.52	23.37	.65	Surface
			65	37.07	27.72	24.0	.78	60
			130	36.95	---	---	.49	120
			195	37.09	17.76	26.9	.56	180
			260	35.31	15.32	26.17	.53	239
			325	35.92	13.03	27.20	.49	299
13 Dec. 79	13°53'N, 61°09'W	11	surface	36.61	27.89	23.70	---	0
			200	39.93	17.91	---	---	124
			400	34.44	---	---	---	248
			600	38.09	16.60	---	---	372
			800	35.81	10.38	27.5	---	496
			1000	31.75	7.09	---	---	620
13 Dec. 79	13°53'N, 61°19'W	12	surface	36.61	27.78	23.70	---	0
			300	39.67	13.83	---	---	294
			600	37.63	7.57	---	---	588
			900	36.72	5.24	29.00	---	882
			1200	37.67	4.51	---	---	1176
			1500	35.73	4.22	28.25	---	1470
13 Dec. 79	13°52.2'N, 61°28'W	13	surface	35.60	27.72	---	---	0
			300	38.88	17.82	---	---	218.1
			600	35.12	10.61	27.00	---	436.2
			900	34.57	17.20	25.20	---	654.3
			1200	35.22	5.61	27.75	---	872.4
			1500	34.09	4.64	27.0		1091
14 Dec. 79	13°53'N, 61°31'W	14	surface	34.58	27.731	22.2	---	0
			300	---	15.69	---	---	242.7
			600	34.23	9.65	26.5		485.4
			900	34.15	6.89	26.8	---	728.1
			1200	34.05	5.26	26.9	---	971
			1500	33.93	4.42	26.9		1213.3
3 Jan. 80	21°44'N, 77°10'W	A	surface	---	25.54	---	---	0
			50	---	25.63	---	---	48
			100	---	24.63	---	---	97
			150	---	22.56	---	---	145
			200	---	20.60	---	---	194
			250	---	19.30	---	---	242.2

Date	Latitude & Longitude	Hydrocast #	Depth (meters)	Salinity 0/00	T_w C°	σT	O_2	Accepted Depth
3 Jan. 80	22°04'N, 77°10'W	B	surface	---	24.76	---	---	0
			50	---	25.31	---	---	49
			100	---	24.52	---	---	98
			150	---	22.57	---	---	147
			200	---	21.15	---	---	196
			250	---	19.10	---	---	245
5 Jan. 80	22°58'N, 79°05'W	C	surface	---	25.08	---	---	0
			100	---	25.09	---	---	93
			150	---	24.27	---	---	140
			200	---	22.07	---	---	185
			250	---	19.90	---	---	232
			300	---	18.67	---	---	278.6
6 Jan. 80	23°16'N, 79°50'W	D	surface	---	25.28	---	---	0
			130	---	25.19	---	---	100.88
			180	---	24.64	---	---	139.68
			230	---	21.58	---	---	178.48
			280	---	19.43	---	---	217.28
			330	---	17.34	---	---	256.18
6 Jan. 80	23°40'N, 80°54'W	F	surface	---	24.83	---	---	surface
			25	---	24.95	---	---	19
			75	---	24.84	---	---	57
			125	---	24.41	---	---	95
			175	---	24.43	---	---	133
			225	---	22.67	---	---	170
7 Jan. 80	24°00'N, 80°55'W	G	0	---	25.86	---	---	0
			30	---	24.70	---	---	29.61
			60	---	24.19	---	---	59.22
			90	---	23.27	---	---	88.83
			120	---	22.66	---	---	118.44
			150	---	21.84	---	---	148.08
7 Jan. 80	24° 8.1'N, 81°23.8'W	H	surface	---	23.91	---	---	0
			80	---	22.79	---	---	84
			130	---	19.75	---	---	136.5
			180	---	17.07	---	---	189
			230	---	14.90	---	---	241.5
			280	---	13.27	---	---	294.38
8 Jan. 80	24°23'N, 81°45'W	I	surface	---	22.70	---	---	0
			50	---	22.80	---	---	64.5
			75	---	19.16	---	---	96.75
			100	---	17.43	---	---	129
			125	---	16.10	---	---	161.25
			150	---	14.87	---	---	194.38

H. Neuston Net Tows

Tow #	Date	Time	Latitude and Longitude
1	30 Nov.	1212	18°24.5'N, 64°32.4'W
2	1 Dec.	1238	18°06'N, 64°28'W
3	4 Dec.	0000	18°01'N, 64°W
4	4 Dec.	1215	17°39.5'N, 63°30.5'W
5	5 Dec.	0005	17°48.6'N, 63°62'W
6	6 Dec.	0030	17°45'N, 63°54'W
7	6 Dec.	1200	16°51.1'N, 62°41.2'W
8	6 Dec.	2310	16° 7.5'N, 62°20'W
9	7 Dec.	1155	15°18.5'N, 61°56'W
10	12 Dec.	0025	14°18'N, 61°02'W
11	14 Dec.	1435	13°51'N, 61°45'W
12	14 Dec.	2350	14°21'N, 62°14'W
13	15 Dec.	1205	15°05.8'N, 62°52'W
14	18 Dec.	1225	15°46.3'N, 63°39'W
15	19 Dec.	1216	16°21'N, 63°48'W
16	20 Dec.	0010	17°30.75'N, 64° 6.5'W
17	20 Dec.	0400	20°06'N, 69°38'W
18	1 Jan.	0120	20°50'N, 73°20'W
19	2 Jan.	0007	21°18'N, 74°03'W
20	2 Jan.	1230	21°41'N, 75°41'W
21	3 Jan.	0017	21°33'N, 75°14'W
22	5 Jan.	0007	22°53'N, 78°49'W
23	5 Jan.	1245	23°05'N, 78°55'W
24	5 Jan.	2355	23°11'N, 79°30'W
25	6 Jan.	1200	23°20'N, 80°00'W
26	7 Jan.	0132	23°36'N, 80°56'W

I. Phytoplankton Net Tows

Tow #	Date	Time	Latitude and Longitude
1	4 Dec.	0955	17°41.0'N, 63°29.0'W
2	4 Dec.	1500	17°35'N, 63°21.o'W
3	11 Dec.	1355	14°19'N, 61°01'W
4	12 Dec.	1515	13°54.5'N, 60°34'W
5	12 Dec.	1725	13°51.5'N, 60°39.5'W
6	13 Dec.	0020	13°31'N, 61°02'W
7	13 Dec.	1750	13°52.5'N, 61°08.1'W
8	13 Dec.	2310	13°53'N, 61°19'W
9	14 Dec.	1133	13°53'N, 61°31'W
10	16 Dec.	1605	15°32'N, 63°14'W
11	16 Dec.	2025	15°32'N, 63°14'W
12	17 Dec.	0320	15°32'N, 63°14'W
13	17 Dec.	0758	15°32'N, 63°14'W
14	29 Dec.	1015	20°05'N, 68°53'W

J. Marine Mammal Hydrophone Stations

Date	Time	North Latitude	West Latitude	Sea State	Hydrophone Depth (m)	Visual Sighting
12/4	1230-1305	17°41'	63°29'	Force 1	7	no
12/9	1638-1738	14°36'	61°07'	Force 1	10	*Physeter catodon*
12/18	0300-0335	15°42'	63°47'	Force 1	10	bioluminescence
12/19	0745-0804	15°58'	63°59'	Force 1	5	pod of *Stenella plagiodon* 20-30
12/29	1030-1100	20°08'	68° 5'	Force 4	7	*M. novaengliae* 3
12/29	1235-1305	20°05'	68°53'	Force 4	7	*M. novaengliae* 3
12/29	1615-1645	19°57'	68°56'	Force 4	7	*M. novaengliae* 2
12/31	1620-1630	20°36'	72°26'	Force 2	2	*Balaenoptera acutorostrata*

K. Spiny Lobster Larvae Stations

Station	Latitude (N)	Longitude (W)
A	21°45'	76°31'
B	22°04'	77°10'
C	22°58'	79°05'
D	23°16	79°50'
F	23°40'	80°54'
G	23°59'	80°46'
H	24°08'	81°24'
I	24°23'	81°45'

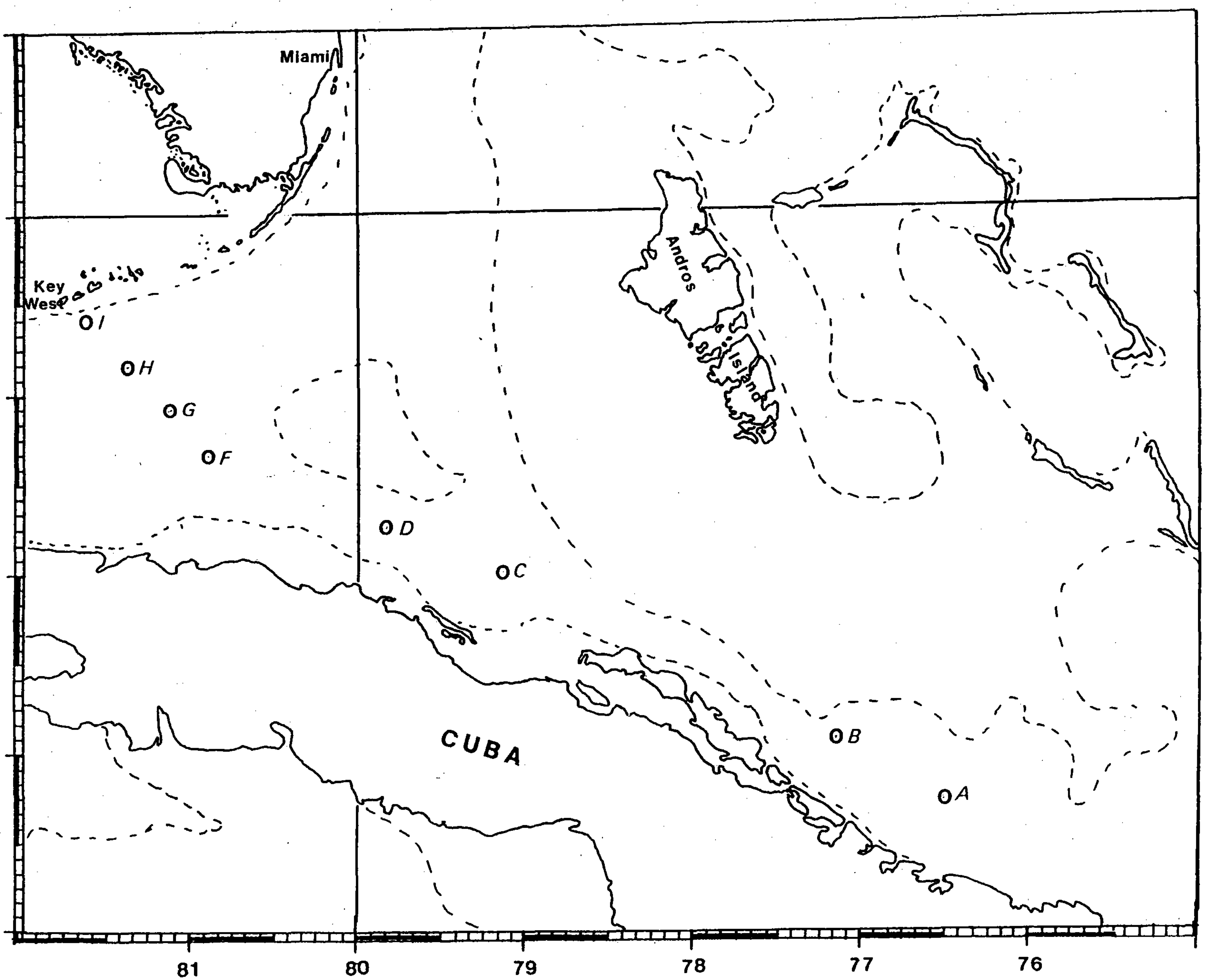


CHART 7: Approximate Positions of Spiny Lobster Larvae Stations

L. Other Data Sources

In addition to this report, other sources of W-49 data are available from S.E.A. These are: the science log, the ship's log, weather coding sheets, complete bathythermograph data with graphs, hydrocast salinity data, hydrocast oxygen data, hydrocast station logs, and student papers.

Rindy The Red Snouted Dolphin

Rindy the red snouted dolphin, Had a very shiny snout,
And if you ever saw it, You would even say it shouts.
All of the other dolphins, Used to laugh and call her names.
They never let poor Rindy, Join in any dolphin games.
Then one squally Christmas eve, Santa came to say,
"Rindy with your snout so bright, Wont you guide my boat tonight?"
Then how the dolphins loved her, As they shouted out with glee.
Rindy the red snouted dolphin, You'll go down in history!

Jack Drost & Sally Kaul