Cruise Report

W-39

Key West - Woods Hole

April 12 - May 24, 1978

R/V Westward

Sea Education Association

Woods Hole, Massachusetts

SEA DRAFT COPY

Preface

Our objective in this report is to present a record and an overview of the scientific program conducted during W-39. The annotations which accompany these abstracted results are intended to make this more than a standard oceanographic cruise report. We regard this report as an opportunity to clarify, to define and to summarize some of the research-related multidisciplinary subject matter treated in Introduction to Marine Science Laboratory, a course which inevitably draws students of diverse backgrounds.

It has been my special pleasure on this cruise to associate with an exceptional staff and a number of most stimulating visiting investigators. Miss Anne Brearley, of the Department of Chemistry, Atlantic College, Wales, was in charge of the chemistry laboratory and introduced a new level of proficiency in chemistry to Westward's program. Anne's participation also marks the initiation of the Marine Science Teacher Training Program at S.E.A.---I hope the enlarged experience she brings home with her is some repayment for what she has given us.

Mr Stephen Berkowitz of the Virginia Institute of Marine Science, directed the zooplankton program with emphasis on the neuston. My thanks and highest regards go to him as a patient shipmate, a competent scientist and a scholar whose intellect remained keen in an occasionally spartan shipboard environment.

Our Visiting Scholar for leg 1 was Mr P.W. Wilson, formerly of the American Bureau of Shipping, who does not regard himself as a scientist at all, but whose welcome participation aboard Westward marks the initiation of an expanded program to include scholars from a broader sector of the marine, nautical and maritime fields. The results of some of his observations on commercial shipping are appended to this report.

Dr Michael Carron of the Virginia Institute of Marine Sciences accompanied us during legs 2 and 3. His geological expertise and equipment and his company were valuable contributions to W-39, as they were to W-33, a year ago.

Dr Carol Reinisch, of Harvard Medical School, continued her ongoing immunology program during legs 3 and 4 with an energy and zeal that has always marked her association with S.E.A. and seems to characterize her approach to life. I thank Carol, a good friend and sailing partner, for her time, her patience and her interest in Westward.

Dr Charles McClennen, a geologist from Colgate University, accompanied us on leg 4 during which he conducted side scan sonar observations on the continental shelf. Charlie is an old colleague from graduate student days and over the years has had considerable influence on my views of undergraduate marine science education.

This report prepared at sea reflects the inevitable limitations imposed by restricted time, library facilities and reflection. On the other hand the staff and students will soon disseminate around the world and there will be no other opportunity for us to work together.

Arthur G. Gaines, Jr
Chief Scientist
May 21, 1978
$40^{\circ}49N; 70^{\circ}49W$

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Summary

This offering of Introduction to Marine Science Laboratory was structured about Westward's transects of the Gulf of Mexico and the coastal North Atlantic ocean. The course included 22 lectures, 150 contact hours of supervised field and laboratory work and an individual project for each student. The emphasis of the program reflects opportunities inherent to the ship's track and special skills of the staff but subject matter treated on W-39 was broad and encompassed biological, chemical, physical and geological aspects of oceanography.

On legs 1 and 2 in the Gulf of Mexico studies centered on the Orca Basin, a hypersaline, anoxic depression on the continental slope south of Louisiana, where water and sediments were analysed chemically and microbiologically. Nutrient and sediment studies were conducted in the Mississippi River and its plume and delta on our route to and from New Orleans, the first port. Additional work in the Gulf included an examination of water transparency and surface currents. An unusual deep sea fish in the family Gempylidae was caught on a troll line during leg 1.

Beginning on leg 3, from the Straits of Florida to Charleston, invertebrates were collected for immunological work during diving expeditions at Key West and using an otter trawl off South Carolina and later south of New York. Continental shelf sediments were examined off South Carolina and southern New England using sub-bottom profiling and side scan sonar equipment. Further progress was made on a trophic model of the Sargassum community on Leg 4 in the North Atlantic.

Thirty neuston samples collected along the cruise track were examined for Pteropod mollusks and for tar content and were preserved for further study ashore. Throughout the cruise logs were kept on sightings of marine mammals, birds, squids and notable atmospheric phenomena. Weather observations were transmitted twice daily to the National Oceanic and Atmospheric Administration.

Additional student projects were conducted on primary productivity, the toxicity of crude oil to phytoplankton and on fish behavior. During W-39 methods were refined for shipboard analysis of phosphorus, ammonia, silica and particulate organic carbon as well as for developing color slides.

The student reports, abstracted in the following pages, were written at sea and submitted prior to our arrival at Woods Hole, the terminal port for W-39.

Introduction

This offering of Introduction to Marine Science Laboratory* was structured about ship operations in the Gulf of Mexico and the Western North Atlantic Ocean. As usual, the academic program included lectures, supervised laboratory and field work ("Science Watch") and an individual project for each student. Among these areas, which receive equal emphasis, student participation, initiative, responsibility and research orientation vary from one extreme to the other.

The emphasis of a multidisciplinary course necessarily reflects the strengths of its faculty, which on W-39 centered on geochemistry and zooplankton ecology. With the participation of visiting scientists, however, we were able to treat aspects of all major subdivisions of oceanography.

Research conducted during W-39 partly represents ongoing work of individuals and agencies that have extended their assistance to our students. Material presented here should not be excerpted or cited without written permission of the Chief Scientist.

* NS CLX 225 at Boston University

Table 1. W-39 Ship's Complement

Nautical Staff

Wallace C. Stark, J.D., M.M.	Captain
Rick Farrell, B.A.	Chief Mate
David R Stuhlbarg (Licensed Mate)	2nd Mate
John R. Becker	3rd Mate
John Thompson, B.E.	Chief Engineer
Sally I. Kaul, B.S.	Steward

Scientific Staff

Anne Brearley, B.Sc. Hons., biochemistry	Scientist
Stephen P. Berkowitz, M.S., oceanography	Scientist
Arthur G. Gaines, Jr, Ph.D., oceanography	Chief Scientist

Visiting Scholars

Michael Carron, Ph.D., marine geology (legs 2 and 3). Virginia Institute of Marine Science

Charles McClennen, Ph.D., marine geology (leg 4). Colgate University

Carol Reinisch, Sc.D., pathology (legs 3 and 4). Harvard Medical School

Percival W. Wilson, shipping (leg 1). American Bureau of Shipping (ret.)

Students	College	Home
Tracy Bowman	Sarah Lawrence Westchester, NY	Seattle, WA
William Claypool	Carlton College Northfield, MN	Ft. Thomas, KY
Patricia Collins	Colby College Waterville, ME	Reading, MA
Gerald Davis	Univ. of Washington Seattle, WA	Seattle, WA
Mary Dietz	Hampshire College Amherst, MA	Evanston, IL
William (Clarke) Howard	Austin College Austin, TX	Austin, TX
Ameleia Irvin	George Washington Univ. Washington, D.C.	Pittsburgh, PA
Nancy Kiriluk	Univ. of Rhode Island Kingston, RI	Islip, NY
Nina Lian	Middlebury College Middlebury, VT	Scarsdale, NY
Marisa Mazzotta	Brown Univ. Providence, RI	Middleton, CT
Janet McMahon	Colby College Waterville, ME	Old Lyme, CT
Margaret Montaigne	Colgate Univ. Hamilton, NY	Mendenhall, PA
Jan Morris	Colby College Waterville, ME	W. Pittston, PA

Students (cont'd)	College	Home
Elisabeth Morris	Brown Univ. Providence, RI	Stamford, CT
Charles Natale	Boston College Boston, MA	Woburn, MA
Daniel Nuzzo	Boston College Boston, MA	Stamford, CT
Susan Pilling	Northern Mich. Univ. Marquette, MI (G)*	Grand Rapids, MI
George Rockwood	Colgate Univ. Hamilton, NY	Needham, MA
Judith Rosenthal	Lafayette College Easton, PA (G)	Millburn, NJ
Suzanne Sylvester	Amherst College Amherst, MA	Bradford, NH
Cynthia Schmidt	Lake Forest Lake Forest, IL	Schoumburg, IL
Priscilla Sneff	Princeton Univ. Princeton, NJ	State College, PA
Karen West	Boston Univ. Boston, MA (G)	Westfield, NJ
Sarah Wilkinson	Boston Univ. Boston, MA	Hackensack, NJ

* G= graduate

Table 2. Outlined itinerary for W-39.

Leg	Depart		Arrive	
1	Key West, FL	April 12	New Orleans, LA	April 23
2	New Orleans, LA	April 26	Key West, FL	May 3
3	Key West, FL	May 6	Charleston, SC	May 11
4	Charleston, SC	May 14	Woods Hole, MA	May 24

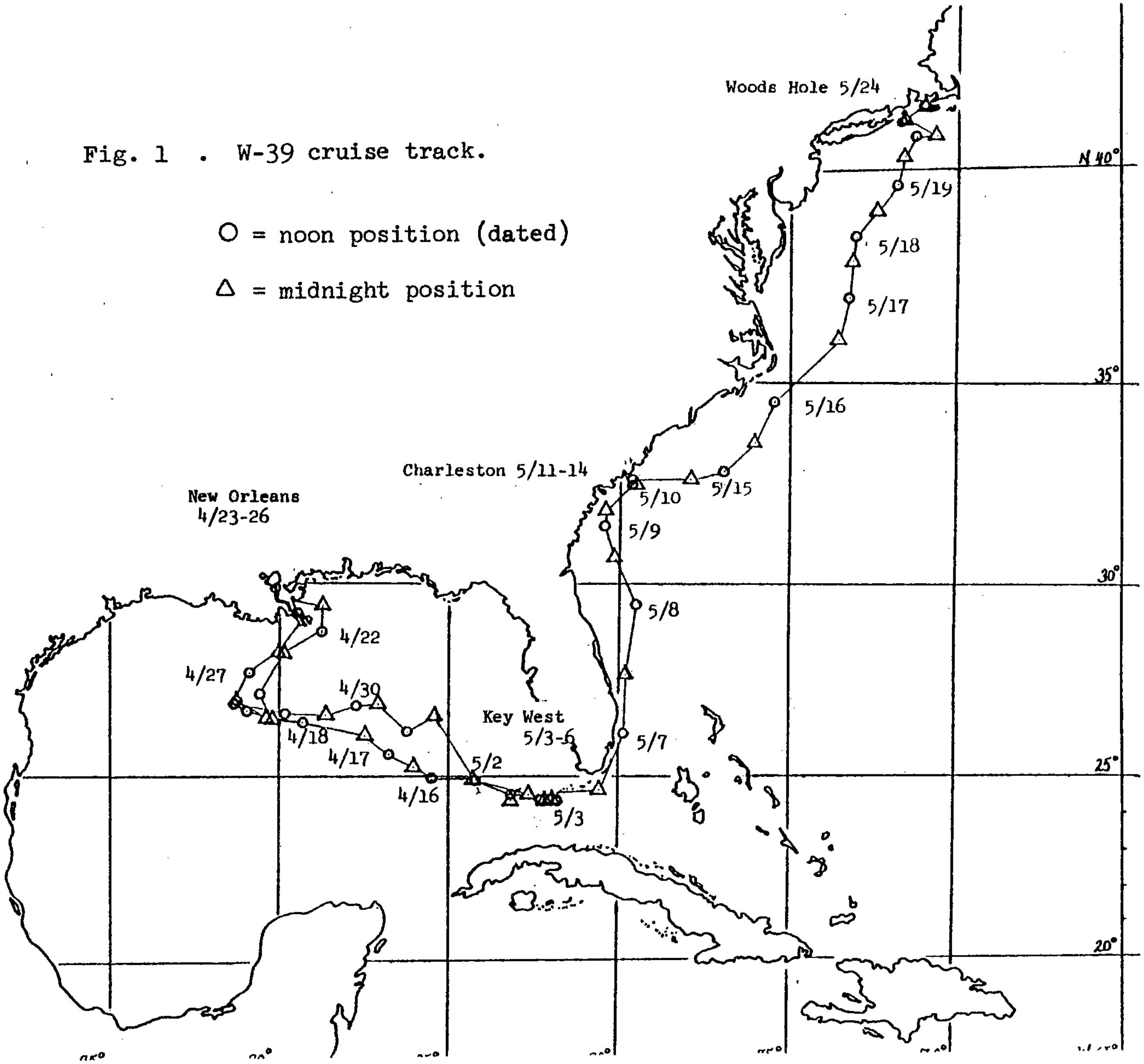


Fig. 1 . W-39 cruise track.

Academic Program

Lectures

The schedule of lectures, like the rest of the Marine Science Program, reflects the ship's location and research activities (Table 3). Lecture material formed the basis of a written final exam at the end of the cruise (Appendix 5). Lecture slots at the cruise end were filled by student seminars.

Science Watch

A scheduled 24 hour science watch consisting of a staff or visiting scientist and two to three students was maintained throughout the cruise. Activities during watch involved execution of the scientific program (Table 4) and maintenance of a complete science log. Time on watch also provided the opportunity for personal instruction discussion of oceanographic topics and individual project work. A practical examination, based upon organisms collected or observed during watch, formed a part of the final examination (Appendix 4).

Shore visits

Visits to laboratories and sites of scientific interest in port included:

The Tulane University Museum of Natural History, Belle Chasse, Louisiana.

The South Carolina Natural Resources Marine Research Laboratory, Fort Jackson, Charleston, S.C.

Table 3. Lecture schedule for W-39

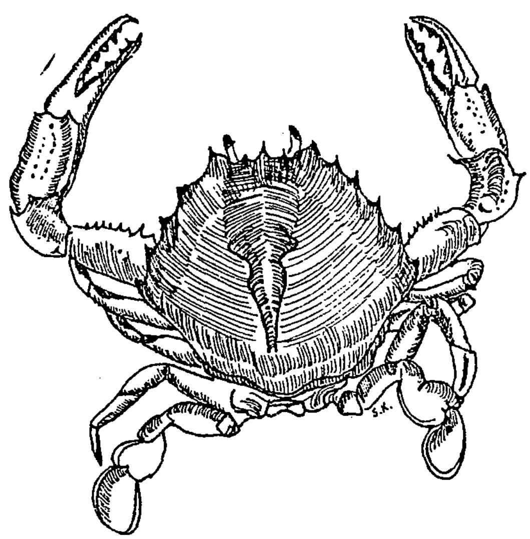
April	13	Procedures and responsibilities on science watch	Gaines
	14	The bathythermograph	Gaines
	17	Commercial shipping viewed from Westward: interpretations and implications	Wilson
	18	The zooplankton: introduction	Berkowitz
	19	Salinity determination by chlorinity: theoretical and practical	Brearley
	20	Anoxic basins	Gaines
	21	Oil drilling platforms = evolution of design	Wilson
	26	Geology of the Mississippi Delta	Carron
	27	Diel vertical migration in the zooplankton	Berkowitz
	28	Progress report: Orca Basin sampling program	Gaines
May	1	Oxygen determinationby titration: theory and practice	Brearley
	2	Geology of the Gulf of Mexico	Carron
	3	The determination of primary productivity	Gaines
	4	The zooplankton: major crustacean group	Berkowitz
	5	Defense mechanisms in invertebrates	Reinisch
	8	Geology of the eastern Atlantic coast of the U.S.	Carron
	9	Squid	Berkowitz
	14	Profiling, subbottom profiling and side scan sonar	McClennen
	15	Theory and application of spectrophotometric analysis	Brearley
	16	The sedimentary geology of the New England continental shelf	McClennen
	17	The neuston	Berkowitz
	18	Mesoscale circulation features of the Western North Atlantic	Gaines

Table 4. Scientific operations on W-39 involving general participation

Operation	Number performed
Bathythermographs	33
Zooplankton tows (Bongo net)	1
Phytoplankton tows	4
Neuston tows	30
Hydrocasts	3
Chemical determinations	
Salinity titration	279
optical	75
Dissolved oxygen	345
Reactive phosphorus	56
Oxidizable organic matter	83
Ammonia	31
Silica	11
pH	24
Secchi disk readings	18
Gravity corer	5
Reef diving trips	2
Subbottom profiling	368 km
Side scan sonar transect	368 km
Otter trawls	3
Weather observations and transmissions	56

Student Projects

Student research work aboard Westward begins with planning ashore at Woods Hole, where the facilities and staff of an international oceanographic and marine biology community are available for student consultation. The advice and assistance of our own staff continues to be available throughout the cruise, as well, but full responsibility for project work rests upon the individual student. The following pages include abstracts of this student work. Copies of the complete papers are retained at the Sea Education Association in Woods Hole.



Research, Collections and Observations

Cooperative Programs

Cooperative Ship Weather Observation Program (Mr Walter Sitarz, NOAA)

The R/V Westward is certified to gather weather observations for the U.S. National Oceanic and Atmospheric Administration in conjunction with international weather and satellite surface-truth programs. The data, collected at 0600 and 1200 GMT, are routinely transmitted to Coast Guard stations ashore.

On W-39 56 sets of observations were compiled, of which about 50% were successfully transmitted. Of these 90% were copied by NMG, New Orleans, and 10% by NMN, Portsmouth. The major problem regarding transmission on W-39 was that we were equipped only with the 4 megacycle frequency which is not monitored during daylight hours.

The W-39 weather observations (Table 5) also comprise a detailed meteorological record for the cruise.

Shark Tagging Program (Dr Jack Casey, NMFS)

Because of an unusually heavy schedule on W-39 and logistic difficulties we were not able to carry out planned work on the shark tagging program.

Neuston Sampling (Dr William Richards, NMFS; Mr Stephen Berkowitz, VIMS)

Thirty neuston samples collected on W-39 (**Table 8**) are part of an ongoing program with the Marine Resources Monitoring

Table 5 . Weather observations made during W-39, recorded in international weather code.

Weather observations follow the code: (1) $99L_aL_aL_a$, (2) $Q_cL_oL_oL_oL_o$, (3) $YYGGi_w$, (4) Nddff, (5) VVwwW, (6) PPPTT, (7) $N_hC_Lh\ C_MC_H$, (8) D_sv_sapp, (9) $0T_sT_sT_dT_d$, (10) $1T_wT_wT_w{}^tT$, (11) $3P_wP_wH_wH_w$, (12) $d_wd_wP_wH_wH_w$

99243	70824	14063	71703	97506	15325	772//	61703	00123	12485	30000	00/00
99243	70825	14123	60502	98022	15425	10724	61204	00023	12420	30000	00/00
99244	70826	15063	43604	98020	16324	2072/	62203	00023	12420	30000	00/00
99245	70830	15113	63602	98011	15024	12279	61502	00023	12400	30101	34501
99248	70847	16063	70604	97022	15625	12331	62400	05122	12550	30000	00/00
99247	70852	16123	40601	98021	14326	22570	62203	00123	12650	30000	09601
99250	70857	17053	11002	98020	14325	11300	61702	05123	12606	30101	11501
99256	70864	17123	41108	98031	13226	52402	61214	00022	12600	30101	14502
99259	70877	18063	11415	98021	13426	11600	62706	00223	12700	30101	13502
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99265	70902	21063	80904	98135	11823	3856/	12701	00318	12248	30301	31001
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99278	70902	22063	10912	98020	13922	10909	12400	00017	12255	30302	00/00
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99293	70885	23063	61302	98031	15121	65418	00807	05117	12182	30301	13504
99288	70923	26063	13317	98011	15520	00906	52205	00715	12145	30604	01504
99278	70905	27123	10206	98020	16819	10509	41213	05515	12258	30402	34703
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99268	70910	29063	01404	98000	14522	00000	31809	05217	12301	3////	13/02
99267	70903	29123	71408	97031	13923	78400	31505	00218	12255	30403	00/00
99265	70889	30063	21605	98021	11925	25420	21215	00122	12451	30401	11502
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99269	70872	01063	31710	97010	06927	33400	00400	00121	12650	30302	00000
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99253	70855	02123	31307	98030	08926	28219	32209	01125	12570	30301	00000
99243	70833	03063	11005	97050	10226	10/00	22400	00025	12600	30501	10501
99242	70827	03121	31606	98010	08825	00908	22600	00025	12589	30301	13002
99247	70806	07063	10701	98010	17927	11/00	12400	00025	12700	30501	00/00
99254	70800	07123	30906	98020	17026	33301	12210	00025	12674	30301	08504
99276	70801	08063	10902	98020	17826	1////	81705	00025	12688	3////	01///
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99325	70799	11123	21403	98020	22220	00007	00203	00017	12055	30401	/////
99324	70775	15063	60208	98022	04920	00020	22400	00115	12126	30201	25602
99326	70775	15123	12912	98001	05220	10632	11203	05817	12455	30401	26503
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99339	70756	16123	33305	98019	05321	32400	12220	0//20	12550	30501	33503
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99366	70735	17123	00000	97020	14614	00900	11324	00612	11145	30000	35501
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99381	70731	18123	02407	96001	19215	00900	81215	00715	11229	30401	16704
99390	70725	19063	70000	96051	15912	78600	11810	00412	11031	30000	00/00
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99405	70714	20123	33201	96020	14211	36200	11400	00211	10980	30101	00/00
99408	70708	21063	12415	97020	10912	00806	31734	00613	10955	30507	24/00
99409	70711	21123	82315	97022	07711	86093	72768	00510	10842	30501	26507

Assessment and Prediction Program (MARMAP) of NOAA, and the Virginia Institute of Marine Science (VIMS). They will be forwarded to VIMS (Gloucester Pt., VA) where they will be sorted into their component groups and each organism identified to species or lowest possible taxon. This suite of samples will complement others from the northwest Gulf of Mexico and the northwest Atlantic, all of which were taken in April or May.

Cellular and Humoral Defense Mechanisms in Invertebrates
(Dr Carol L. Reinisch, Sidney Farber Cancer Institute, Harvard Medical School)

The purpose of the work undertaken by four students on W-39 was to investigate both the cellular and humoral responses of several species of freshly collected echinoderms to injections of cells derived primarily from one donor species of echinoderm. Several points will be considered in the student presentations:

1. Did injections of cells from the donor species initiate a rapid cellular response as detected by a sheep erythrocyte indicator system in vitro?
2. Were hemaglutinins and hemolysins released in response to inoculation of foreign cells?
3. Could preinjection of one cell type into the recipient echinoderm interfere with the animal's response to a second, unrelated antigen?

This research was directly supervised by Dr Carol Reinisch, the Principle Investigator of this ongoing cooperative program, who participated in legs 3 and 4 of W-39.

Introduction Carol L. Reinisch

How animals distinguish their own tissue from foreign has been the subject of intensive investigation. Discriminating "self" from "non-self" was previously considered a property of the lymphoid system, first found phylogenetically in the bony fish. More work in comparative immunology has revealed that invertebrates, which have no circulating lymphocytes, but rather a predominating cell type analagous to the vertebrate macrophage, are also capable of recognizing and eliminating foreign material such as bacteria or cells from either invertebrates or vertebrates.

The vertebrate immunologic system is characterized by a specific response to a highly defined antigen, a secondary or memory response which reveals an extraordinary degree of specificity in responding to the original immunizing antigen, and a compartmentalization of functions among highly specialized subpopulations of cells. In contrast, invertebrates display little, if any, specificity in their response to a variety of antigens. Whether or not invertebrates such as starfish have an accelerated response when grafted and then regrafted with skin from other stars is still a controversial question. However, the most striking aspect of the invertebrate's ability to respond to natural pathogens such as bacteria or viruses is the fact that one cell type, the amebocyte, is primarily responsible for efficient trapping, phagocytosis and lysis of foreign material. We have previously shown that Asterias vulgaris, the northern sea star, is capable of generating an immediate, hyperacute cellular response when inoculated with cells from Arbacia punctulata, the common sea urchin.

The Cellular and Humoral Response of Sea Urchins

Cynthia Schmidt

Abstract

The effects of inoculation of cells from the sea urchin (Diadema) into similar species of sea urchins (Strongylocentrotus droehbachiensis and Arbacia punctulata) were observed. Foreign cells (sheep red blood cells) have been added to inoculated and non-inoculated sea urchins in vitro. With increased inoculations, the cellular response becomes more pronounced. The humoral responses seem to accelerate in the inoculated sea urchins.

Invertebrate Cellular Response to a Foreign Body

Sarah Wilkinson

Abstract

The cellular response of echinoderms, sea urchins and star fish in particular, to a foreign body is analyzed for signs of phagocytosis, netting, or any other defense reactions to qualify any immune responses and their ability to be manipulated. Arbacia punctulata are inoculated with Diadema coelemic fluid in an attempt to change their cellular response when exposed to sheep red blood cells in vitro. Archaster florae are inoculated with either crab blood supernatent or crab blood cells in an attempt to reduce their cellular response to SRBC in vitro. Inoculated Arbacia show signs of an amebocyte reaction to SRBC but not any more than normal Arbacia. Archaster inoculated with

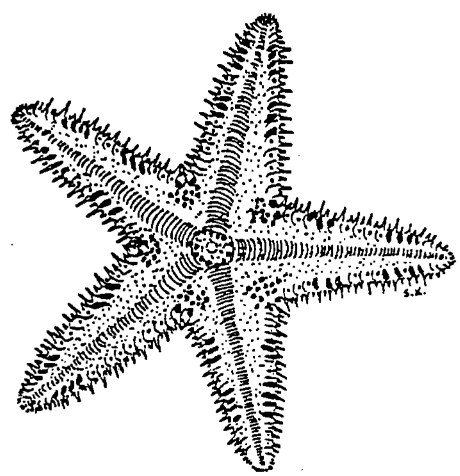
supernatent have the same kind of response while those inoculated with crab cells seem to respond mostly to the crab cell presence and somewhat less to SRBC presence.

Invertebrate Defense Systems

Daniel Nuzzo

Abstract

Inoculation of _Echinaster sponulosus_ with _Diadema antillarum_ results in increased cellular aggregation and entrapment of sheep erythrocytes _in vitro_. These results are concomittant with previous observations suggesting that inoculation of invertebrates results in increased, non-specific reactivity to foreign organisms.



Surficial Shelf Sediment Survey (Dr Charles McClennen, Colgate University)

Sediment movement on the continental shelf has important implications for the developing offshore petroleum industry. Erosion and deposition, transport, and slumping and faulting are significant factors to be considered in engineering stable platforms and pipelines. In the event of an oilspill, the mobility of sediments can influence the fate of hydrocarbons in that hydrocarbons can be expected to become physically associated with the clay fractions.

On W-39 Sidescan sonar (ORE) and 7 KHz seismic reflection subbottom profiler equipment (Raytheon) was used to examine the microtopography and near-surface sedimentary structure of continental shelf deposits. A preliminary run was made across the shelf east of Charleston past the USGS buoy which marks a current meter temperature probe, transmissometer and pressure gauge tripod. The record from this transect (Figure 2) shows clearly layered channel fill and bars in Charleston Harbor and lineations of sediment type on the mid- and outer shelf.

On the southern New England shelf the survey effort focused on 1) the midshelf portion of the "mud patch" (an anomalous region with over 20-30% silt and clay and as little as 5% sand); 2) a track around Block Island with special attention to topographic basins north of the islands and 3) a transect of submerged glacial moraine between Point Judith and the Vineyard.

Midshelf records show clear alterations of mud and sand stringers where sand was over 70% by weight and suggested an absence of these features where silt and clay made up over 30% by weight (this corresponds to depths of about 30-35 fathoms).

A preliminary examination of orientation shows that the lineations are very diverse and not just parallel to the general bathymetric contours.

Off Block Island there were stringers in water depths greater than 20 fathoms and occasional boulder fields although featureless beds predominated. Between Point Judith and the Vineyard the record shows a generally plain bed with a few stringers and bouldered areas.

No clear subbottom reflectors were noted in the entire survey of the southern New England shelf. In part this reflects limitations of the profiling equipment although better records might have been obtained at slower speeds and with greater submergence of the transducer.

Side Scan Sonar Technique

Tracy Bowman and Susan Pilling

The topography of the bottom of the continental shelf can be determined with the use of a side scan sonar. The sonar is somposed of three parts: 1) a fish towed behind the ship which sends out signals and picks them up after reflecting off the bottom, 2) a transceiver which receives these signals and converts them to usable form for the recorder (3) which records the electrical impulses on

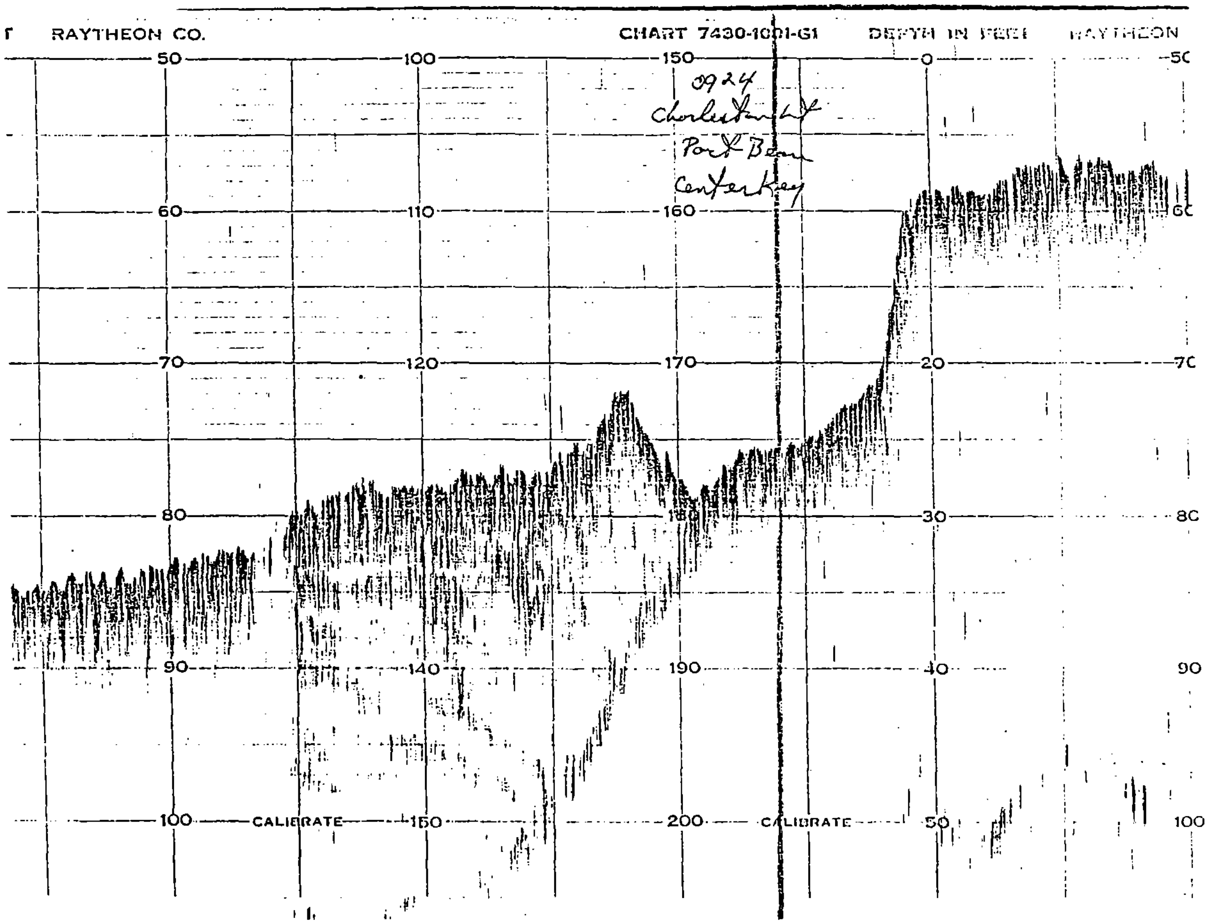


Fig 2. Sub-bottom profile showing stratified sediments in a filled channel offshore from Charleston, S.C.

paper. The recording needle builds a picture line by line as the paper moves along. The picture must then be corrected for distortion because the ship's speed, graph paper speed, and needle speed are all variable and cannot produce equivalent scales.

For purposes of illustration of the printout we chose a portion of a transect from the southern New England shelf which is very vivid (Figure 3). It was taken on the south side of Block Island at 41 08.8'N, 71 31.7'W, 0.8nm off the southeast light. This is the view of the bottom from the starboard side of the fish as it was towed through the water along a course of 195 magnetic. Below we have illustrated the record and a picture corrected for distortion (Figure 4). The dark area (A) indicates a rise. This is followed by a white "shadow" (B) which is a depression in the bottom where no signal has been returned due to the angle of incidence. The signal in area C could indicate a leveling off or slight rise in the bottom and thus a longer angle of incidence. The signal in area A is intensified slightly because of the rise and a shorter travel path for the signal. Alternatively, the signal may be darkened from coarse grain material in the sediments, or lightened if the sediment is fine grain material.

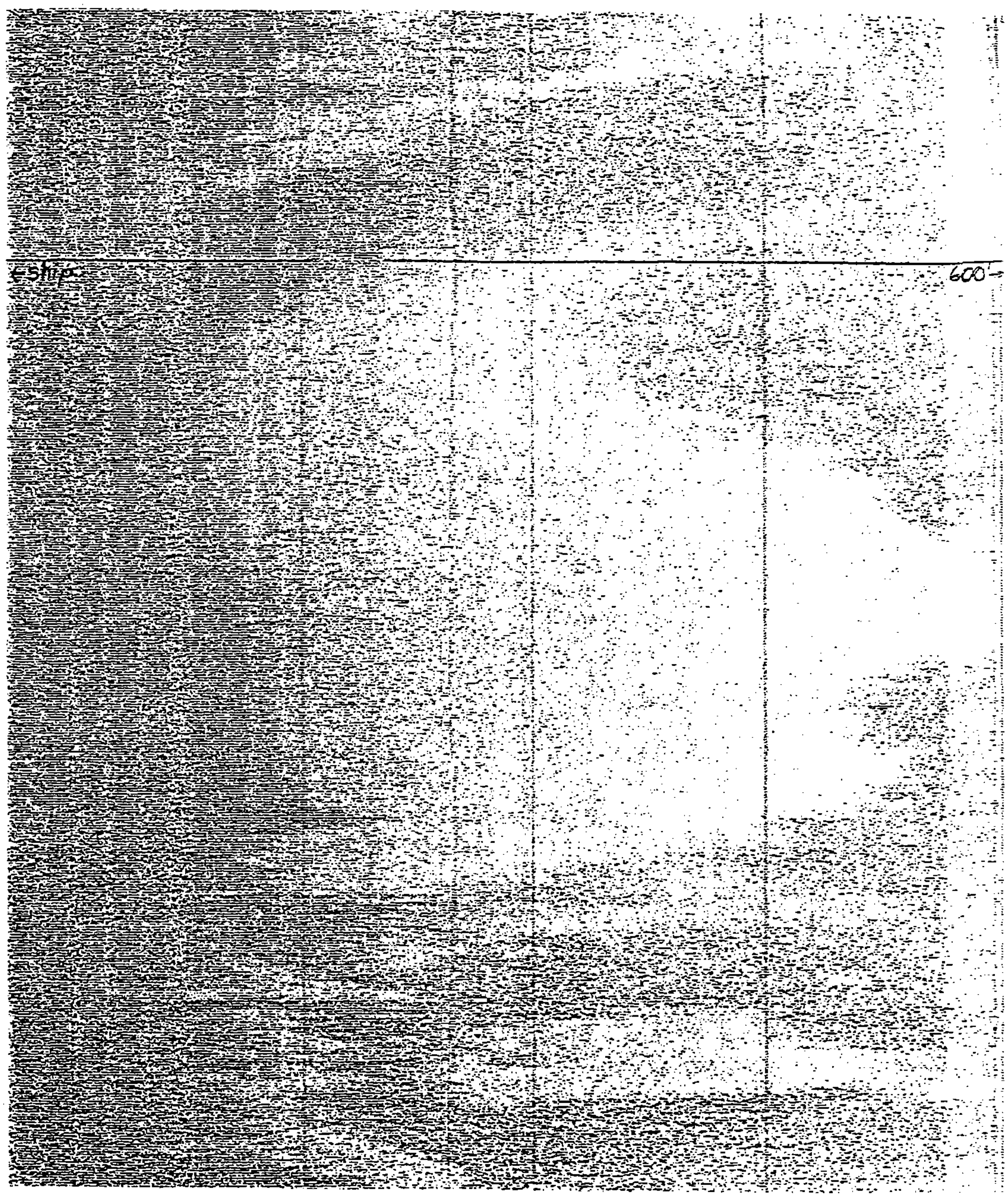


Fig 3. Side scan sonar record (starboard side only) from a transect near Block Island, R.I. (see Fig 4 and the discussion in text).

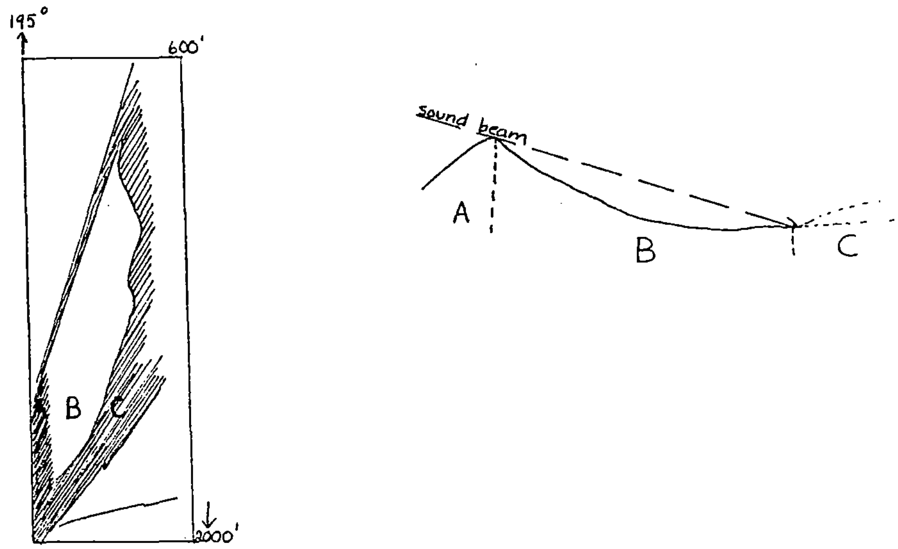


Fig. 4 . The side scan sonar record shown in Fig. 3 corrected for distortion. Schematic presentation of one interpretation of this record.

Internal Programs

<u>Surface Observations on the Ocean and Atmosphere</u>

Sun Halos Jan Morris

Optical phenomena associated with the sun and moon were observed on several occasions during W-39. Solar halos, or "sun dogs" were especially well developed on April 14 when a pattern of intersecting rings was observed. The middle ring had a measured angular diameter of about 8^{o}.

Many types of halos are possible, ranging in diameter from 8^{o} to 46^{o}, the most common of which is 22^{o}. Certain of the theoretically possible types have never been observed: the 8^{o} halo we saw from <u>Westward</u> is a rare one.

The dimension, intensity and configuration of halos are indicators of cloud temperature, the state of water, orientation, shape and size of ice crystals (which are primarily responsible for halo formation) and the conditions underwhich the crystals have formed.

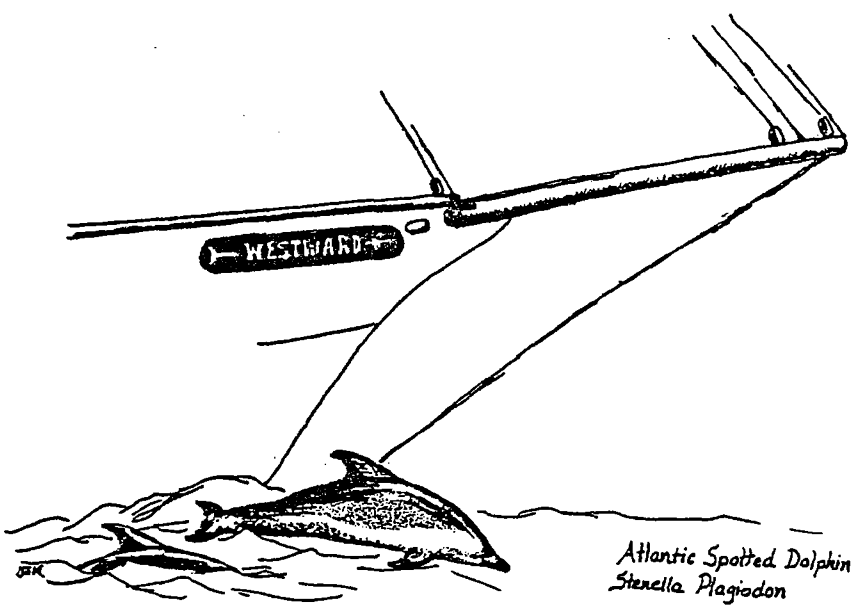
Ice crystals have a hexagonal structure and it is reflection and refraction of light through the crystal facets that accounts for the optical phenomenon. Large crystals tend to align themselves as they fall; certain sizes and crystal forms tend to spin as they fall; smaller ones orient themselves randomly. Each of these conditions can produce characteristic halo patterns.

According to Lynch (Scientific American 1978 #4) observation and documentation of sun halos remains one of the few observational areas of physics in which the non-professional can make a contribution.

Squid Program

Stephen Berkowitz and Tracy Bowman

The ship was hove to and night-lighting stations were made on several occasions, but no squid were caught on jigs. A total of ten (?Ommastrephes sp.) were seen under the lights on station over the Orca Basin. A single specimen (?Doryteuthis plei) was taken in an otter trawl made at a depth of 20m at 31°40.9'N, 80°39.2'W.



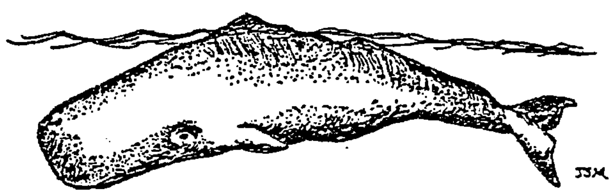
Atlantic Spotted Dolphin
Stenella Plagiodon

Marine Mammals Susan Pilling

Twenty-three sightings of marine mammals were made during W-39 (Figure 5 , Table 6) including at least 8 species and 375 individuals. These included three species of whale (Physeter catodon; Globicephala malaena; and Balaenoptera physalis) and five species of dolphin (Stenella plagiodon; Tursiops truncata; Delphinis delphis; Grampus griseus and Stenella coeruleoalba).

The abundance of whales was greatest in slope water south of New England.

These records will form part of an ongoing program of marine mammal study coordinated by Dr James Hain of the Sea Education Association.



Sperm Whale
Phyester Catodon

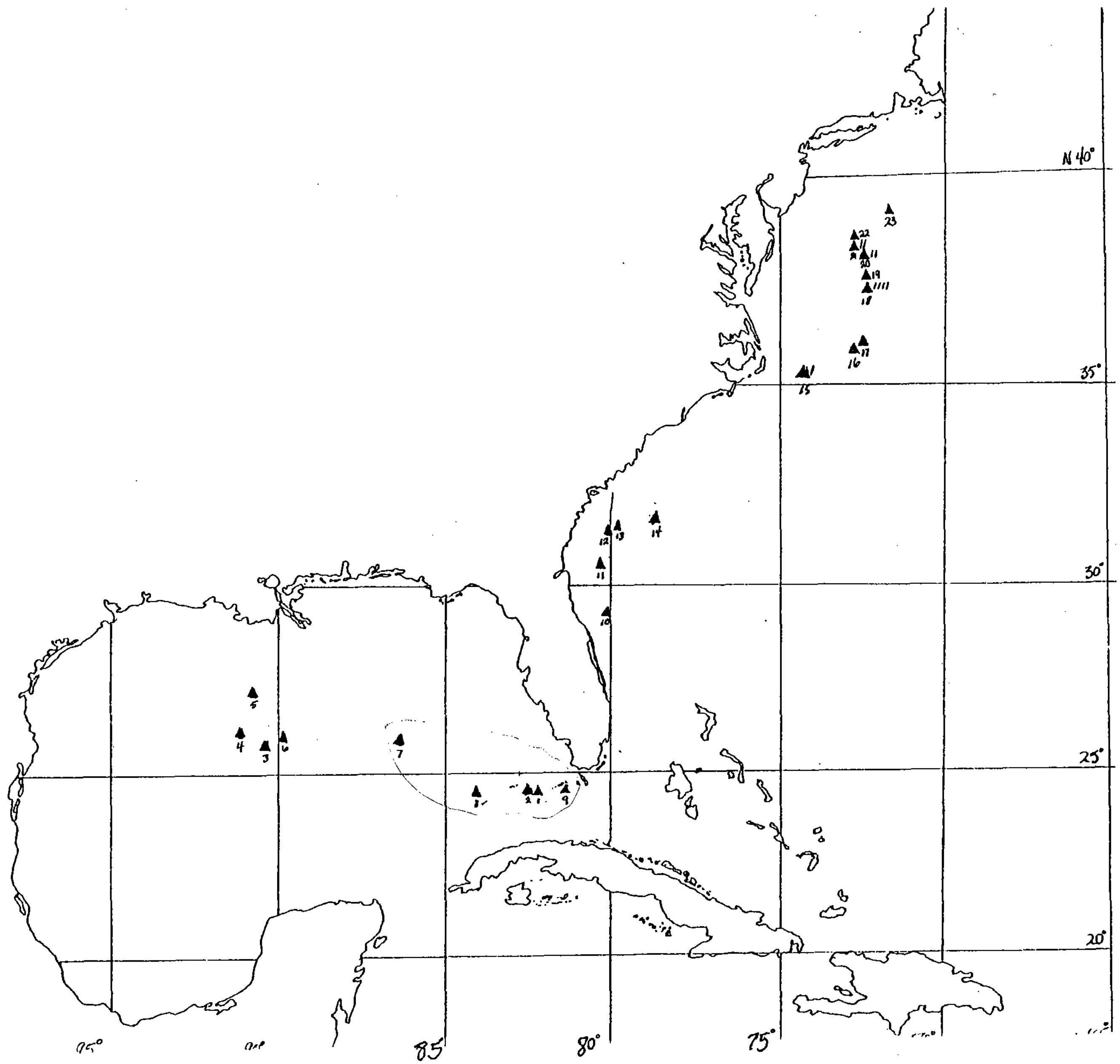


Fig. 5 . Locations of marine mammal sightings during W-39 (see also Table 6).

Table 6 . Marine mammal sightings during W-39 (see also Fig. 5)

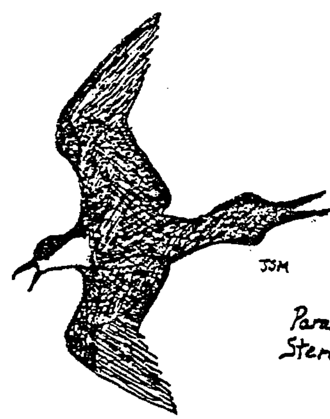
Sighting #	Marine Mammals	ID quality	#	Size (ft)	Date	Time	N. Lat.	W. Long.	Direction (PSC)	Speed (Kn)	Position
1	*Stenella plagiodon*	2	11	7	4/14	0815	24°30'	82°10'	265	7	Bow
2	*Tursiops truncatus*	2	11	7	4/14	1200	~~24°20'~~	~~82°10'~~	265	7	Bow
3	*Stenella plagiodon*	2	12-15	5-7	4/19	0930	26°50'	91°28'	250	2-4	Bow
4	*Stenella plagiodon*	2	20	5-7	4/27	1445	27°30'	91°00'	205	2	Bow
5	*Stenella plagiodon*	2	10	3-5	4/29	0640	26°30'	90°10'	105	6-7	Bow
6	*Physeter catodon*	2	2	35	4/29	1005	26°44'	89°55'	100	1	Abeam
7	*Stenella plagiodon*	2	20	3-4	5/1	0700	26°30'	86°40'	variable		Bow
8	*Globicephala malaena*	2	15	10	5/2	1630	24°35'	84°00'	variable		Abeam
9	unidentified	-	6	7-8	5/3	1420	24°40'	81°48'	variable		Abeam
10	*Tursiops truncatus*	2	5	8	5/8	0800	29°05'	80°10'	020	6	Bow
11	*Stenella plagiodon*	2	3	6	5/9	1425	31°31'	80°30'	330	3	Abeam
12	*Stenella plagiodon*	2	6	4-7	5/10	0500	32°05'	80°05'	040	6	Abeam
	Tursiops truncatus	2	12	6-9	5/10	0500	32°05'	80°05'	040	6	Abeam
13	*Stenella plagiodon*	2	4	4-7	5/10	0730	32°15	79°45'	040	6	Bow
	Tursiops truncatus	2	4	6-8	5/10	0730	32°15'	79°45'	040	6	Bow
14	*Stenella plagiodon*	3	4	4	5/14	1830	32°35'	78°37'			Abeam
	Tursiops truncatus	3	2	8	5/14	1830	32°35'	78°37'			Abeam
15	unidentified	3	-	10-12	5/16	1815	35°30'	74°20'	variable		Abeam
	Tursiops truncatus	2	8	7-8	5/16	1815	35°30'	74°20'	variable		Bow
16	*Delphinus delphis*	2	9	3-6	5/17	0630	36°35'	73°30'	020	6	Bow
17	*Delphinus delphis*	2	8	4-7	5/17	0715	36°39'	73°29'	290	15	Astern
18	*Physeter catodon*	2	1	35	5/17	1415	37°12'	73°15'	180	2	Abeam
	Grampus griseus	2	4	12	5/17	1415	37°12'	73°15'	180	2	Abeam
	Grampus griseus	3	3	6-12	5/17	1520	37°14'	73°15'	180	6	Astern
	Delphinus delphis	2	4	7	5/17	1530	37°14'	73°15'	020	4	Abeam
	unidentified	3	8-15	-	5/17	1545	37°14'	73°15'	variable		Abeam
	Delphinus delphis	2	>40	5-7	5/17	1600	37°17'	73°15'	020	8	Abeam
19	*Physeter catodon*	2	3	35-45	5/17	1715	37°22'	73°15'	200	2	Abeam
	Globicephala malaena	3	12	12	5/17	1715	37°22'	73°15'	200	2	Abeam
20	unidentified	-	6	4-7	5/18	0300	37°58'	73°05'	350	3	Bow
	Stenella coeruleoalba	2	2	6	5/18	0500	38°06'	73°05'	350	3	Bow
	Delphinus delphis	2	9	6-9	5/18	0645	38°08'	73°08'	345	3	Bow
21	*Globicephala melaena*	2	10	12	5/18	1015	38°23'	73°08'	305	10-12	Bow
	unidentified	-	25-40	-	5/18	1215	38°28'	73°03'	280	8	Bow
	Physeter catodon	3	1	40	5/18	1300	38°29'	73°03'	228	2	Astern
22	*Balaenoptera physalus*	3	1	40	5/18	1555	38°38'	73°07'	240	2	Asterm
23	*Globicephala melaena*	2	40-80	12	5/19	0530	39°18'	72°02'	variable		Abeam

Key: Quality of ID
1 = excellent, no chance of mistake
2 = good, high probability of correct ID
3 = fair, distance or conditions somewhat marginal

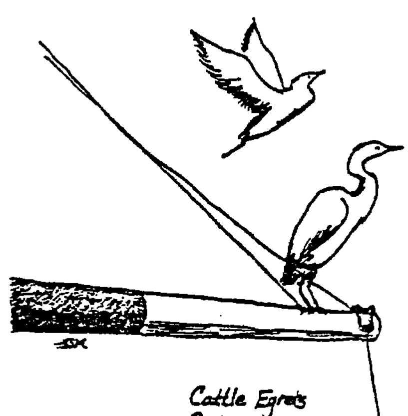
Birds

Arthur Gaines

A bird log was kept during W-39 as part of an ongoing Westward program (Figure 6). Perhaps more than any other program avifauna sightings are sensitive to the expertise of personnel involved. On W-39 we were rather weak in this area and the log must be regarded as incomplete. For example, land birds that came aboard the ship were generally spotted and identified properly while sea birds, such as shear waters, petrels and even the gulls were not spotted.



Parasitic Jaeger
Stercorarius parasiticus



Cattle Egrets
Bubulcus ibis

Bird sightings recorded for W-39

1. Bobolink
2. Catbird
3. Chuck-wills-widow
4. White winged dove
5. Cattle egret
6. Magnificent frigate bird
7. Herring gull
8. Rose-breasted grosbeak
9. Great blue heron
   Heron
10. Parasitic jaeger
11. Pomarine jaeger
12. Blue jay
13. Eastern kingbird
14. Wilson's petrel
15. American redstart
16. Sooty shearwater
17. Barn swallow
18. Cave swallow
19. Cliff swallow
20. Noddy tern
21. Turkey vulture
22. Warblers

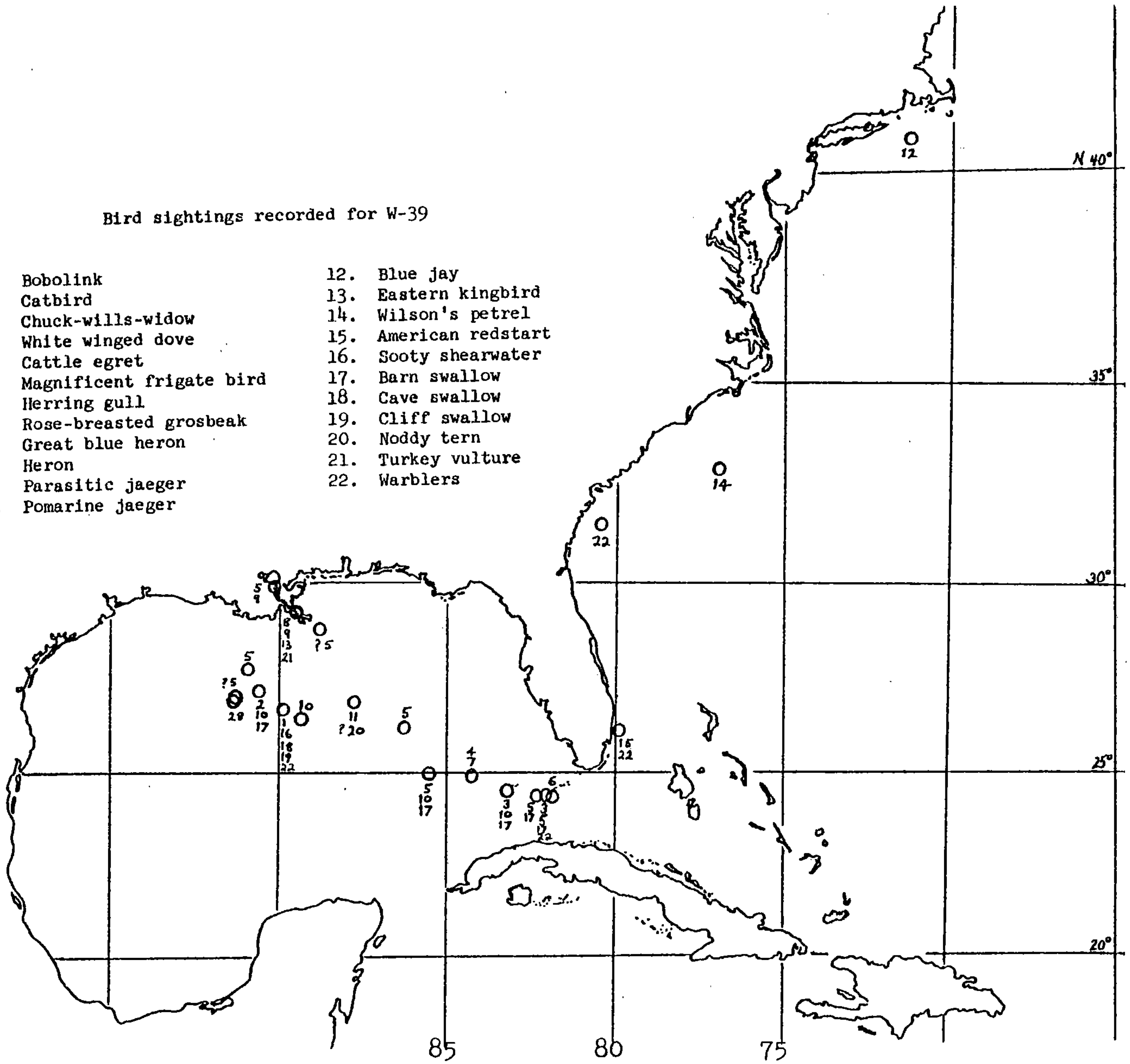


Fig. 6. Bird sightings recorded during W-39.

A Thunderstorm - May 4, 1978

David Stuhlbarg

On a quiet morning this spring, tied up at Key West, we learned. of an approaching storm expected to pass through the Florida Keys that night. It was a clear sunny morning with a gentle southerly wind. At 1100 we saw the first signs of the storm - high cirrus clouds, followed in an hour by 70% cover of cumulus clouds and higher cirrostratus. By 1400 the sky was completely covered by cumulus clouds.

The radio told us more about the storm - all the ingredients for a tornado were present and a watch was posted by the weather service. All hands kept an eye to the sky that afternoon as we proceeded with our work. The storm was moving slowly but at twilight a cumulonimbus cloud approached from the WNW - the wind aloft and the surface air began moving slowly toward the growing cloud, black and suspicious as it threateningly drew near, perhaps 30,000 feet into the sky. By dusk "Sheet lightening was dancing on the horizon to a broken tune played b y far off thunder". For hours we watched the tantalizing spectacle before the storm fell upon us with a dank first blast.

The rain reached the earth soon after. Down it came in sheets flooding Westward's decks, pouring out her scuppers, drumming a deafening tatoo on her canopies where we huddled.

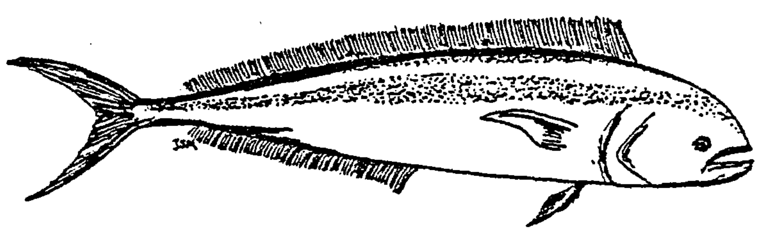
Suddenly the rain stopped but bolt upon bolt resounded on our heads. For a moment a stillness in the air and then the next storm cell was on us, its violent updrafts and turbulence, driving rain and wind obliterating everything around.

Again and again that night storm cells swept over us, again and again, as "Heavens artillery thundered in the skies". We were all very lucky to be there aboard Westward that night in Key West to observe this magnificent, powerful thunderstorm - and to wake to a tranquil, fragrant dawn.

Taffrail Fish Catch

One or more troll lines are routinely towed astern. The catch is interesting in its composition but also in its paucity. For example on W-36 nothing was caught over more than a thousand miles of ocean.

On W-39, 10 fishes were landed over the Taffrail (Table 7). The most interesting was a snake mackerel (described elsewhere), the most palatable, perhaps, the dolphin fish.



Dolphin Fish
Coryphaena hippurus

Table 7 . Fishes caught on a troll line* towed behind *Westward*, April 12 to May 24, 1978

Date	Time (local)	Species	Length (cm)	Weight (Kg)
April 15	1850	False albacore (*Euthynnus alleteratus*)	49.5	1.7
April 20	2330	Snake mackerel (Gempylid species)	112	--
April 22	0640	Spanish mackerel (*Scomberomorus maculatus*)	57.5	1.9
May 3	0840	Dolphin (*Coryphaena hippurus*)	60.9	2.0
May 6	1655	Dolphin (*Coryphaena hippurus*)	86.3	5.9
May 8	1410	Dolphin (*Coryphaena hippurus*)	62.2	1.9
	1830	Dolphin (*Coryphaena hippurus*)	70.5	2.9
May 9	1635	Cavala (*Scomberomorus cavalla*)	83.8	3.9
May 10	0930	Spanish mackerel (*Scomberomorus maculatus*)	88.9	4.5
May 18	0930	Bluefish (*Pomatomus saltatrix*)	86.4	4.5

* Pink and white, 7" rubber squid lure with feathers. $1\frac{1}{4}$" gap, barbed single hook towed *ca* 100 ft. back in wake.

The Snake Mackerel

A snake mackerel, perhaps Gempylus serpens, was caught on a troll line towed astern Westward at 2330 on April 20, 1978 in the Gulf of Mexico ($26^{\circ}32'N$; $90^{\circ}09'W$). This is a relatively little known fish species which inhabits deep water and may never have been caught at the surface before.

The overall length was 118.1cm; fork length 111.8cm. The fish corresponded in general appearance with the illustration in Breder (1948)* page 128. The first dorsal fin fitted into a groove on the dorsal surface. The ventral surface was silver; the dorsal surface a mottled red/brown and black. The fish carried two parasitic copepods laterally (family Lernaeidae ?) bearing two long egg strings. These parasites were dissected off.

The fish was caught on a 100 ft long troll line, towed in the wake, with a 7" rubber squid, pink and white in color with feathers and a single barbed $1\frac{1}{4}$" gap hook. Trolling speed was about 4 knots; sea water temperature was about $25^{\circ}C$; water depth was about 3000m.

The fish was frozen soon after capture and deposited at the Tulane University Museum of Natural History, Belle Chasse, Lousiana at the suggestion of its Director, Dr Royal Suttkus, who indicated he would identify and preserve the specimen.

* Field Book of Marine Fishes of the Atlantic Coast

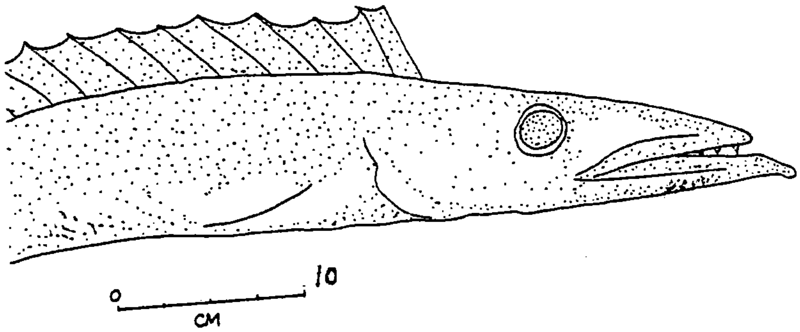
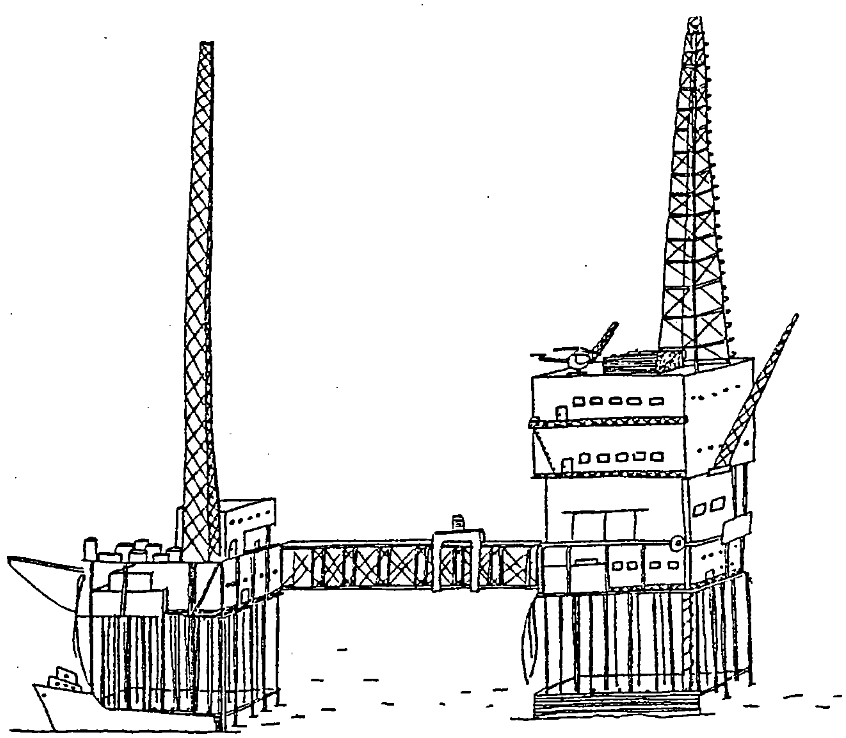


Fig. 7 . A "snake mackerel" caught aboard the Westward. Drawing from a photograph.

Other Observations - annotated excerpts from the science log

Date	Time	Observation
April 14	0735	White tip (?) shark surfaces 50m abeam of Westward.
April 14	1130	Ship passing through raft of hundreds of Physalia. the Porugese Man-o-War. Dense plankton concentration, especially salps and medusae present. Possible evidence of convergence zone.
April 15	1100	Accumulated flotsam in band estimated many miles long. Birds "working" over the area.
April 16	0750	About 20 flying fishes dart from the bow. This was the first of many observations during W-39.
April 22	0600	The color of the sea has become distinctly green as we approach the Mississippi River.
April 22	1130	The first of many fixed oil rigs is sighted off the port beam.
April 22	1225	Sighting of a sea turtle, probably a leatherback turtle.
April 22	1600	Water color becomes patchy. Green coastal water with occasional blue areas, believed to represent deeper water brought to the surface.
April 23	0415	Intense lightning display. The lightning appears to be limited to the axis of the Mississippi River
May 9	1125	Strong smell in air identified variously but possibly industrial (paper mills?). Our present position is 42 miles offshore from Savannah Georgia.
May 9	1225	Numerous insects have appeared on board the ship. Various species of flies and dragonflies are conspicuous.
May 9	1430	Several butterflies have landed on the ship.
May 14	1010	Green turtle sighted.
May 15	1450	Force 0 seas. Westward passes an unidentified Sparkling, mass ½ m diameter. Expanding and contracting, possible consisting of numerous small individuals. A dolphin fish (Coryphaena) and possibly a turtle were sighted below.

May 15	2256	St. Elmo's Fire appears on the SSB antenna just prior to a squall. Pale blue, persistent glow, gradually changing intensity over a period of minutes.
May 16	1030	Waterspout $1\frac{1}{2}$ mile astern. Visible also on radar. Cyclonic rotation is evident near the top of the funnel. Agitation of the sea surface is visible but not strong.
May 17	0920	Many surface slicks about $\frac{1}{2}$ mile apart, running E-W. Not langmuir cells.
May 17	1550	Beginning of bathythermograph section in search of a warm Gulf Stream ring reported in this vicinity. After 44 hours of profiling we had not found clear evidence in the surface 300m for the presence of this hydrographic feature.
May 18	0205	Helmsman reports dolphins "talking" (clicking, buzzing) all night.



May 18	0400	Sound of rushing water astern (force 2 conditions) Some evidence of abundant dolphins. Possibly the sound of school fish escaping predation.
May 21	1325	Montauk Light visible as normal image with inverted image on top.

Eel Program (Dr J. Hain)

The life history of the American eel (*Anguilla rostrata*)

The spawning migration of the eel is the object of an ongoing program coordinated by Dr James Hain of SEA. During W-39 we occupied one station in cooperation with this program. The station, in the Gulf of Mexico (26°58' N; 87°10' W) consisted of a hydrocast to 600 m and a stepwise bongo tow at 25m and 50m. The data will be transferred to Dr Hain for analysis.

Neuston Studies

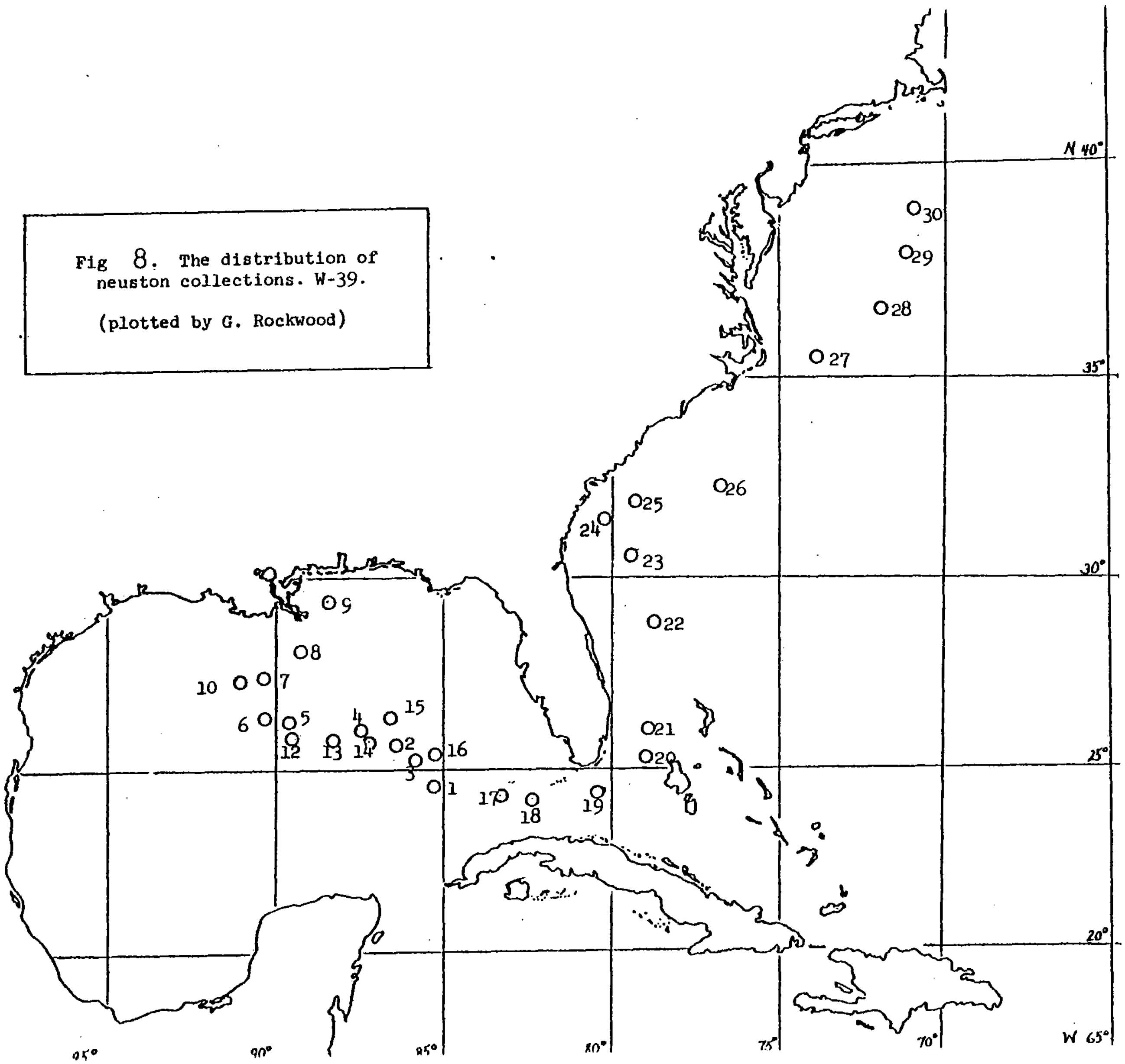
Introduction — Stephen Berkowitz

The neustonic zone has been an area of interest only for the past 15-20 years and is thus a relatively new aspect of plankton studies. Regular neuston sampling programs are now integral parts of most of the large government sponsored outer continental shelf studies. Since truly neustonic forms are always in close proximity to the many anthropogenic pollutants entering the ocean via that boundary. Thus, the neuston may be a potential "early warning system" for environmental degradation in the sea.

Thirty neuston tows were made on W-39 (Figure 8, Table 8) using a 0.5 m high by 1 m wide rectangular mouth net of 0.505 mm mesh. The net was towed at 2-3 kt for 20 minutes, and the average fishing depth was taken to be 0.25 m, or half submerged. Samples were preserved in a 4% formaldehyde-seawater solution, and specimens removed for demonstration purposes and student projects. They will be completely sorted and identified at the Virginia Institute of Marine Science.

Fig 8. The distribution of neuston collections. W-39.

(plotted by G. Rockwood)

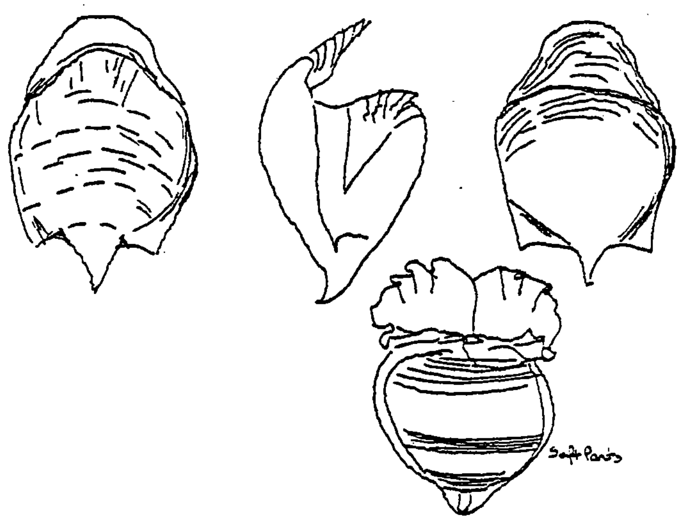


Neuston pteropods of the Gulf of Mexico and the Gulf Stream

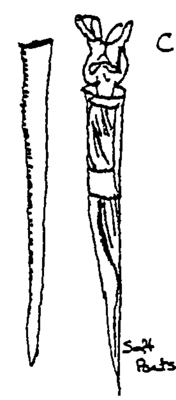
Elizabeth Morris

Abstract

A comparative analysis of pteropods found in neuston tows across a transect of the Gulf of Mexico and in an area of the axis of the Gulf Stream was undertaken. A neuston net fishing the upper ½ meter of the ocean was the method of collection. Two tows daily, one at night and one during the day showed a marked increase in diversity and biomass during the night. The only species caught consistently during the day tows was Creseis acicula. The diversity and abundance of these "sea butterflies" seemed to be very low in the Gulf of Mexico, with increasing observations as latitude increased up the coast of eastern United States in the Gulf Stream. 14 different species of pteropods were observed, the major species being Creseis acicula, second in importance being Cavolinia gibbosa.



CAVOLINIA GIBBOSA



CRESEIS ACICULA

The distribution of tar in the Gulf of Mexico and the western North Atlantic

George Rockwood

Abstract

Tar levels found in neuston tow samples along the W-39 cruise track in the Gulf of Mexico and the western North Atlantic are quantified and compared. It is found that results vary from tow to tow but that the Gulf Stream waters generally have less surface tar than do Gulf of Mexico or Atlantic waters. Regular sightings of other anthropogenic items are made in all areas. (Table 8)

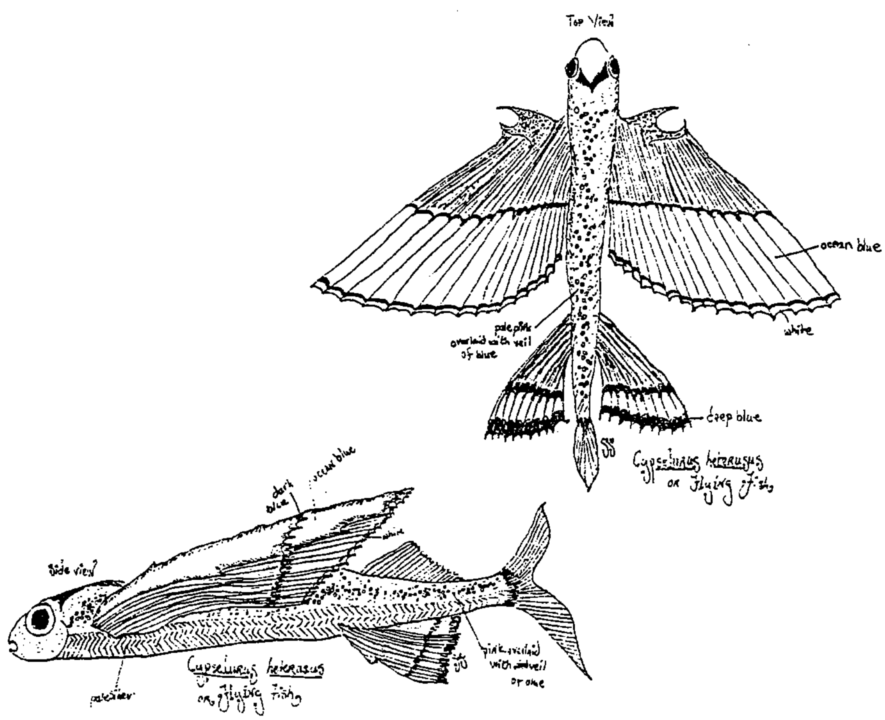


Table 8. Summarized results of neuston tows. Tar data based on a 20 min. tow at 2.5 kt for an average volume filtered of 1480 m^2.

Tow #	Date	Time-Local	Location		Tar (g/m^2)	T_s (°C)	Log
1	4/16	1200	24°54'N	85°33'W	1.08×10^{-3}	26.2	274
2	4/16	2245	25°12'N	86°00'W	1.28×10^{-3}	26.1	306
3	4/17	1145	25°35'N	86°45'W	3.38×10^{-2}	26.9	365
4	4/17	2200	25°48'N	87°25'W	4.05×10^{-4}	27.0	411
5	4/18	1130	26°20'N	89°30'W	4.12×10^{-3}	25.5	509
6	4/18	2215	26°30'N	90°20'W	2.64×10^{-3}	24.8	561
7	4/21	1145	27°12'N	90°31'W	6.28×10^{-3}	24.1	766
8	4/22	1215	28°47'N	89°10'W	6.76×10^{-4}	24.5	897
9	4/22	2300	29°25'N	88°52'W	none	21.8	925
10	4/27	1145	27°40'N	90°55'W	9.46×10^{-3}	24.0	1054
11	4/28	2315	26°50'N	90°59'W	not measured	23.2	1134
12	4/29	1245	26°34'N	89°51'W	2.03×10^{-4}	23.3	1200
13	4/29	2200	26°28'N	88°56'W	1.96×10^{-3}	24.2	1238
14	4/30	1100	26°47'N	88°01'W	2.87×10^{-3}	26.6	1282
15	4/30	2345	26°55'N	87°09'W	1.15×10^{-2}	26.5	1320
16	5/01	2300	25°30'N	85°35'W	2.70×10^{-3}	24.1	1408
17	5/02	2145	24°20'N	83°28'W	5.27×10^{-3}	25.5	1534
18	5/03	1215	24°25'N	85°55'W	2.57×10^{-3}	---	1622
19	5/06	2215	24°33'N	80°45'W	1.35×10^{-4}	25.6	1671
20	5/07	1100	26°04'N	79°52'W	1.22×10^{-3}	27.0	1734
21	5/07	2130	27°13'N	79°51'W	6.75×10^{-5}	26.8	1762
22	5/08	1130	29°24'N	79°38'W	2.03×10^{-4}	---	1830
23	5/08	2200	30°30'N	79°55'W	1.35×10^{-4}	24.5	1882
24	5/09	1130	31°24'N	80°28'W	6.75×10^{-5}	21.4	1938
25	5/10	1200	32°30'N	79°35'W	none	19.5	2018
26	5/15	1200	32°55'N	77°00'W	4.73×10^{-4}	24.0	2150
27	5/16	2145	35°52'N	74°02'W	5.41×10^{-4}	19.7	2230
28	5/17	1115	37°08'N	73°21'W	6.76×10^{-4}	16.8	2300
29	5/17	2115	37°40'N	73°12'W	none	17.0	2336
30	5/18	1200	38°26'N	73°04'W	7.97×10^{-3}	12.2	2378

Sargassum Community Studies

Introduction

The sargassum community is comprised of over a hundred species of organisms which live in close association with pelagic sargassum weed. This community has been referred to as a displaced benthic community since it resembles those associated with attached seaweeds.

For several cruises we have been working on a trophic model of the sargassum community to quantify the feeding relationships among its members and to assess the role of the weed itself as a primary producer.

Respiration Determinations of Fauna Associated with Sargassum Weed

Nancy Kiriluk

Abstract

Sargassum weed was collected from the Gulf of Mexico and from the Sargasso Sea. The Fauna found living within the Sargassum community were identified and subjected to respiration determinations. The respiration rates expressed in ml O_2/day per organism from the Gulf of Mexico are Plumularia -0.017, Lepas -0.064 , Gnescioceros -0.079, and for Anemonia -0.065. The rates calculated for the organisms from the Sargasso Sea are Plumularia -0.006, Lepas -0.058, and for Scyllaea -0.209. Comparison of the two areas of study is discussed.

Standing Crop Determinations for Certain Members of the Sargassum Community

Mary L. Dietz

Abstract

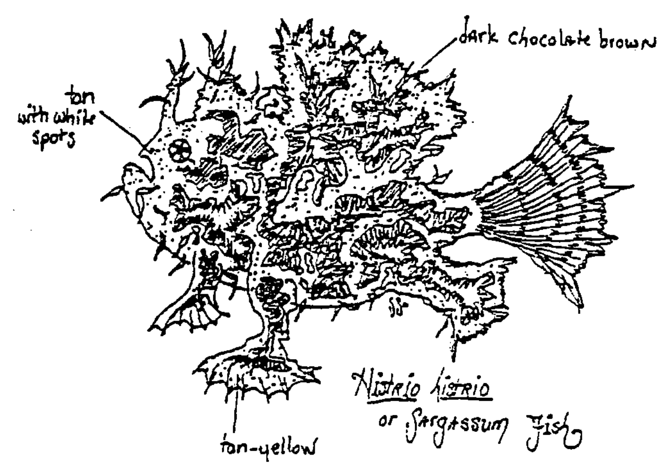
The biomass of four members of the Sargassum community standing crop is determined. The results are as follows: Lepas pectanata, 2.77 mgC/organism; Plumularia sp, 0.323 mgC/organism; Anemonia sargassensis, 3.30 mgC/organism; Scyllaea pelagica, 7.07 mgC/organism. These values define the biomass of these organisms within a specific size range.

A Comparison of Sargassum Weed Communities in the Gulf of Mexico and the Sargasso Sea

Janet McMahon

Abstract

The Sargassum community is well adapted to life in the Sargasso Sea. Physical conditions there are relatively constant. Permanent currents are weak and the water temperature and salinity vary little throughout the year. Species diversity is high, nearly all the common macroscopic species that have been keyed in privious studies were found in a relatively small number of samples. Sargassum weed is also found in the Gulf of Mexico. In a band of water north and west of the Florida keys, patches of sargassum are almost as abundant as in the Sargasso Sea. Although the number of species present varies little between the Sargasso Sea and Gulf of Mexico communities, species richness differs significantly. The two dominant species in the Gulf of Mexico sargassum, an anemone Anemonia, and the gooseneck barnacle - Lepas pectinata, were uncommon in the Sargasso Sea community. The type of sargassum also varied.



Special Programs for W-39

Studies in the Gulf of Mexico

Introduction Michael Carron

The Gulf of Mexico can be divided into two physiographic provinces: 1) a terrigenous province consisting of the Mississippi Delta and Cone, the north, west and south continental teraces of the Gulf, and the abyssal Gulf; and 2) a carbonate province consisting of the Western Florida shelf and the Compeche Bank.

The Delta and Cone are the seaward end of a sedimentary apron that was initiated early in the cenozoic and has prograded nearly 1000 Km to the edge of the continental plateau. During the past 6000 years seven deltas have developed.

Salt diapirs (di'·a·peers) or salt domes are abundant in the Delta and Cone region and in some cases act as traps for oil and gas. The Orca Basin, which was the object of considerable research on this cruise, appears to be associated with one of these diapirs.

The shelf off western Florida consists of a thick section of late Jurassic-Cenozoic carbonate and evaporite deposits resting on Paleozoic and Triassic Rocks. There are indications that reefs were formed in the Key region as early as 100.000 years B.P. during a higher stand of sea level. Today, the Keys are represented by relic and active carbonate deposits and carbonate sands.

Surface Currents in the Gulf of Mexico

Karen A. West

Abstract

Ship's drift calculations are used to estimate surface currents in the Gulf of Mexico. The results compare favorably, with one exception, to the published prevailing current patterns for the area. The exception, a southwesterly current between 86° West, 26° North, and the Dry Tortugas, is possibly a small gyre created by the strong southeasterly current from the Mississippi Delta area, relative to the northeasterly current from the Yukatan Channel. This anticyclonic system, generated as a meander, is encountered as well as the expected merging of the two easterly systems.

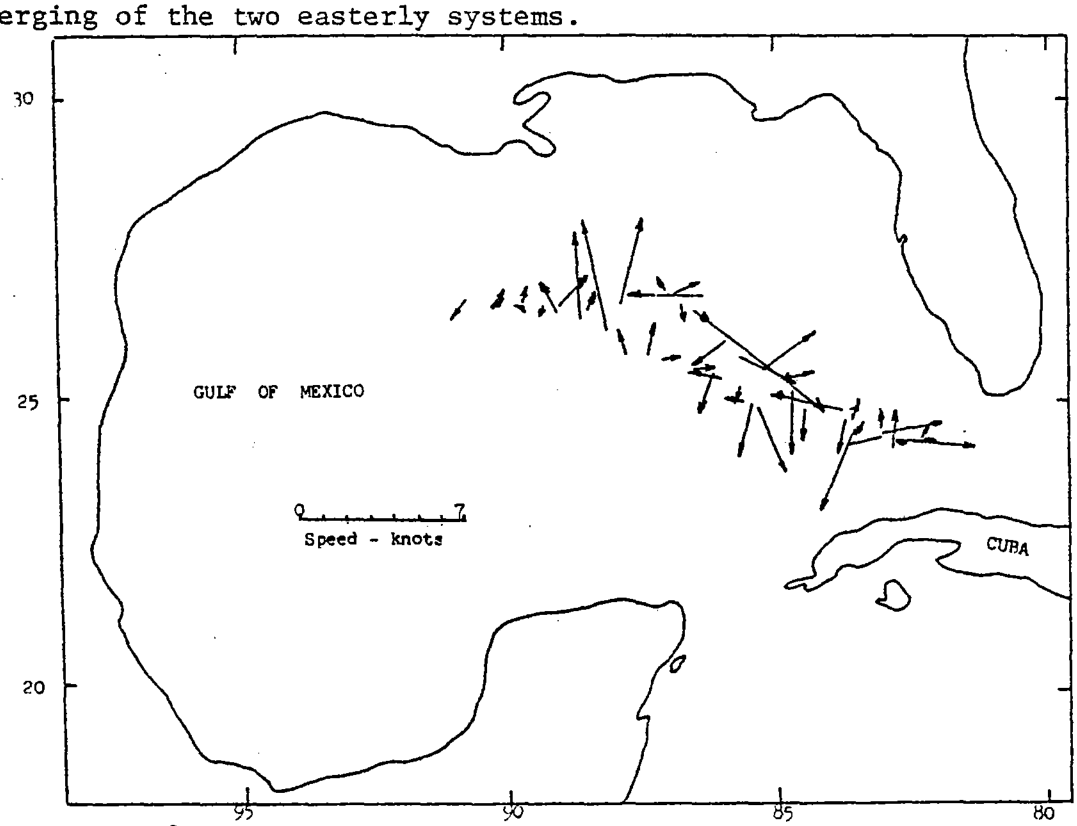


Figure 9. Surface currents encountered during legs 1 and 2, W-39; calculated from ship's drift.

The Mississippi River Plume - Salinity and Turbidity Measurements

Abstract

Marisa Mazzotta

The areal extent of the Mississippi River plume is studied, using measurements of salinity and turbidity taken along a transect through the Gulf of Mexico to the river delta. It is observed that both salinity and turbidity are fairly constant in the Gulf waters at distances greater than around sixty miles from Pass a Loutre. At distances less than this, salinity begins to decrease and turbidity begins to increase as the delta is approached. A correlation between salinity and light transmittance confirms the inverse salinity/turbidity relationship in this area

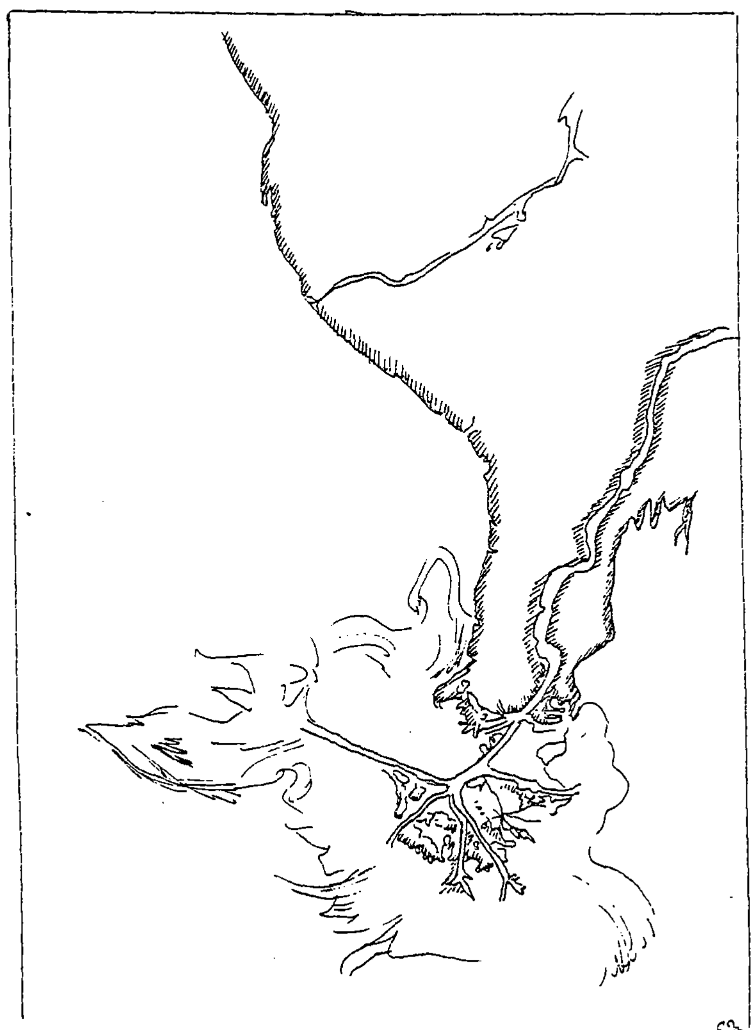


Fig 10. Tracing of an aerial photo of the Mississippi River Delta and plume.

Mississippi Delta Studies

Introduction — Michael Carron

The Mississippi Delta complex is one of the largest of the world's major delta systems. Its subaerial surface extends from the mouth of the Mississippi River aluvial valley to a base of 360 kilometers along the coast. Underlying this plain and the adjacent continental shelf and slope is a huge mass of quaternary rive-mouth deposits consisting of a thick onlapping sequence grading upward from basal fluvial and strand-plain sands and gravels to deltaic and marine silts and clays. This sequence is overlaid by a thinner series of offlapping deltaic sands, silts and clays.

The onlapping sequence records the rise of the sea from its last low stand and the offlapping sequence represents progradation since the sea reached near its present level. At that time, 3500 to 4000 years ago, the Gulf of Mexico shore coincided approximately with the present Pleistocene-Holocene contact and subsequently has advanced far seaward by construction of the Deltaic Plain. In building this plain the Mississippi River has occupied several courses and deltas.

Sediments are supplied to the delta through the main Mississippi River Course and its principal distributary, the Atchalafaya River, which enters the Gulf of Mexico 270 kilometers west of the main mouth. Together, these rivers carry to the Fulf of Mexico each day an average of more than 1 million tons of sediment which consists of more than 75 per cent silt and clay and less than 25 per cent fine sand.

Four basic factors control and influence delta formation[2]: (1) river regime, quality and quantity of material supplied by the river to the delta and the hydraulic regime of the river; (2) coastal processes, influence of waves, tides and currents on the delta's seaward margins; (3) structural behavior, the relationship of sea level to the depositional site, ie. the change in relative sea level and (4) climatic factors, which control deltaic vegetation.

The Mississippi Delta is characterized by rapid subsidence and minor modification by coastal processes. It has a relatively large sediment load and dense deltaic-plain vegetation.

The Transport of Particulate Organic Matter by the Mississippi River

Patricia Collins

Abstract

Analyses of particulate organic matter and certain nutrients in Mississippi River water were performed in an attempt to determine the river's contribution of organic matter to the Gulf of Mexico, and its significance in the net productivity of the river plume. Seven surface samples were taken, from New Orleans seaward out to 100 miles from the mouth of the distributary.

From the results it is calculated that particulate carbon input amounts to less than 10% of the net productivity of the plume area. On the other hand, the input of phosphorus is sufficient to support a productivity equal to the average reported for coastal Gulf waters.

Dissolved silica dropped abruptly from an average of 223 u M/L in the river to levels below 40 u M/L in adjacent water. This is believed to result from a combination of dilution and biological extraction processes.

Observations on the suspended - and Bed load Sediments in the Lower Mississippi River

Jan Morris

Abstract

Sediment samples from the South Pass of the Mississippi River Delta were collected using an underway bottom sampling device (Fig11). Analysis shows organic carbon content to increase slightly downstream. The carbonate content is comparable to that found in the open ocean near the delta. Quartz is the most abundant constituent with small quantities of feldspar and organic matter present. Particle size tends to decrease downstream.

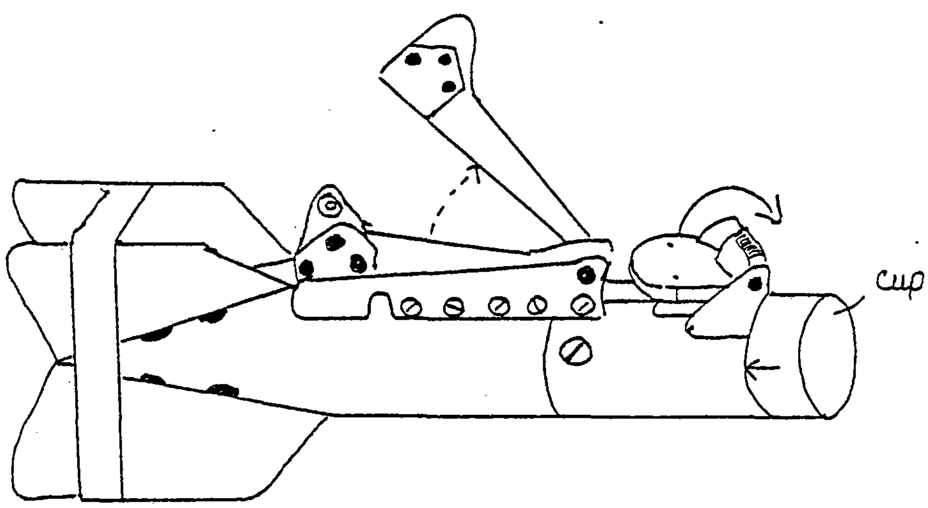


Fig. 11. Sediment sampler designed for taking small samples from a moving vessel. Impact with the bottom triggers a closing device.

The Orca Basin

Introduction

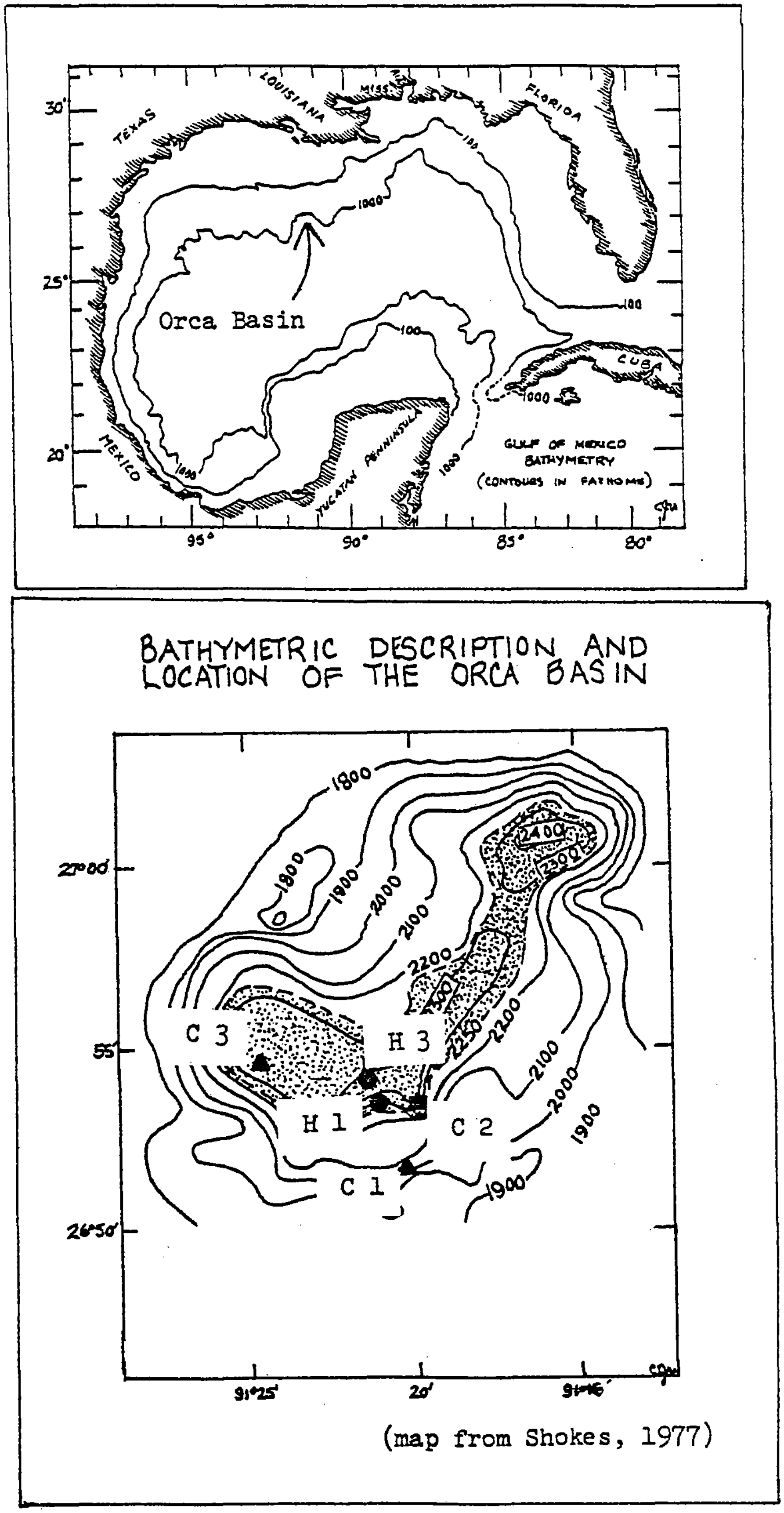
Anne Brearley

In 1977 a 400 Km^2 depression in the continental slope of the Northern Gulf of Mexico was reported to contain anoxic, hypersaline water in the bottom 200 meters (Shokes _et al_, Science 196: 1443-1446).

The basin is a 25 Km. long, elbow-shaped depression which can be represented by a closed contour at 2000 m.(Fig 12). The depression is believed to result from solution of a near surface salt diapir with subsequent slumping and collapse. The brine is believed to be cascading into the depression from a salt outcrop on the basin wall.

Westward shipboard analysis has confirmed a sharp salinity interface between approximately 2312 and 2330 meters depth where salinity increased from 62% to 264%, determined by optical refractometry.

The objective of our studies at the Orca Basin was to examine the effects of this ultra stable hydrographic condition on the chemistry of the water column, on the Basin sediments and on the occurrence of microorganisms.



▲ = Cores ● = Hydrocasts

Fig. 12. Core and hydrocast stations in the Orca Basin. The stippled area contains anoxic bottom water.

Chemical Profiles of the Orca Basin

Abstract

Gerald Davis

Profiles of chlorinity, oxygen, ammonia, silica, phosphorus and pH are given for bottom water in the Orca Basin (Table 9). Samples from deeper than about 2250 meters were effervescent with an unknown gas. The ammonia concentration of anoxic water, which has not been reported before, reached a level of 433 u M which is two to three orders of magnitude higher than normal sea water values. The pH of anoxic water, which also had not been reported previously, reached a low level of 6.86 compared with 8.2 for surface water.

Salient aspects of the results include a thermal conversion of more than $1^{o}C$ which may result from geothermal heating. Salinities determined on an optical refractometer were lower than those determined from chlorinities presumably because of compositional departures in the hypersaline brine from ordinary sea water.

Other chemical determinations confirm previously published results (Shokes et al, 1977). Hydrogen sulfide could not be detected by smell and therefore is either extremely low in concentration or is absent, which makes this anoxic environment distinctly different from the Black Sea, the Cariaco Trench or others in which H_2S is accumulated.

Table 9. Chemical Profiles for Bottom Water in the Orca Basin

Accepted depth (m)	Hydrocast #W-39	[1] Temp °C	Salinity (optical) o/oo	Chlorinity o/oo	[2] Salinity (Knudson) o/oo	O_2 mlL^{-1}	P uM	NH_3 uM	$Si(OH)_4$ uM	pH
2132	1	4.23	-	19.13	34.56	-	1.33	-	-	-
2181	1	5.48 ?	-	19.24	34.76	-	1.45	-	-	-
2231	1	4.22	35.9	20.33	36.72	-	1.38	-	-	-
2262	3	4.35	39.8	23.05	41.64	3.37	1.80	[3] nd	121	7.75
2280	1	4.60	45.4	27.11	48.88	-	2.10	-	-	-
2287	3	4.61	51.4	30.90	55.82	0.16	4.04	1.99	243	7.69
2312	3	4.79	61.9	38.96	70.38	0.11	10.24	62.4	284	7.75
2330	1	5.30	264.1	165.36	-	-	49.1	331	193 ?	-
2337	3	5.55	272	170.49	-	0.00	56.5	327	303	6.91
2362	3	5.64	272	171.6	-	0.00	63.5	433	344	6.86
2379	1	5.62	272	170.7	-	-	74.3	308	-	-

1/ Hydrocast 1 was taken April 20, 1978
Hydrocast 3 was taken April 28, 1978

2/ Salinity calculated from chlorinity using the relationship S=1.8065 (Cl).
This is not regarded as valid for brine samples.

3/ Not detectable

Buffering reactions in Orca Basin water

In ordinary seawater buffering of acid (a property related to what oceanographers term "alkalinity"*) results primarily from equilibria involving the bicarbonate, carbonate and borate ions. Seawater normally displays approximately 2.4 mEq/L of buffering between pH 8.2 and pH 4.5. Expressed as specific buffering, that is, buffering relative to chlorinity, ordinary seawater displays approximately 0.123 mEq/L/o/oo.

Preliminary measurements of this property aboard Westward on Orca Basin water suggest that the deepest samples have greater buffer capacity that ordinary seawater (Fig. 14). If the buffer capacity to pH 4.5 is calculated from the empirical curves shown in Fig one arrives at a value of 2.2 mEq/L for surface water and 3.5 mEq/L for samples from deeper than 2312. The specific buffering values, however, are 0.108 and 0.021 mEq/L, respectively, which confirms our suspician that the buffers present in ordinary sea water are not proportionally represented in the hypersaline brine. Sources of buffering in this water could include contributions from the addition of NH_3, PO_4 (Table 9) and perhaps solution of carbonates.

It should be emphasized that a treatment of the chemistry of this water is by no means straight forward because of its high ionic strength, which appears to be in excess of 4 (versus 0.7 for seawater).

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* The functional definition of alkalinity given by Strickland and Parsons (1972) is synonymous with buffering or buffer capacity.

One immediate difficulty is that the Debye-Huckel relationship for calculating activity coeffecients breaks down.

Thus determination of alkalinity or buffering for Orca Basin water is even more complex than for seawater; the method of Strickland and Parsons is inapplicable without further experimental and theoretical work.

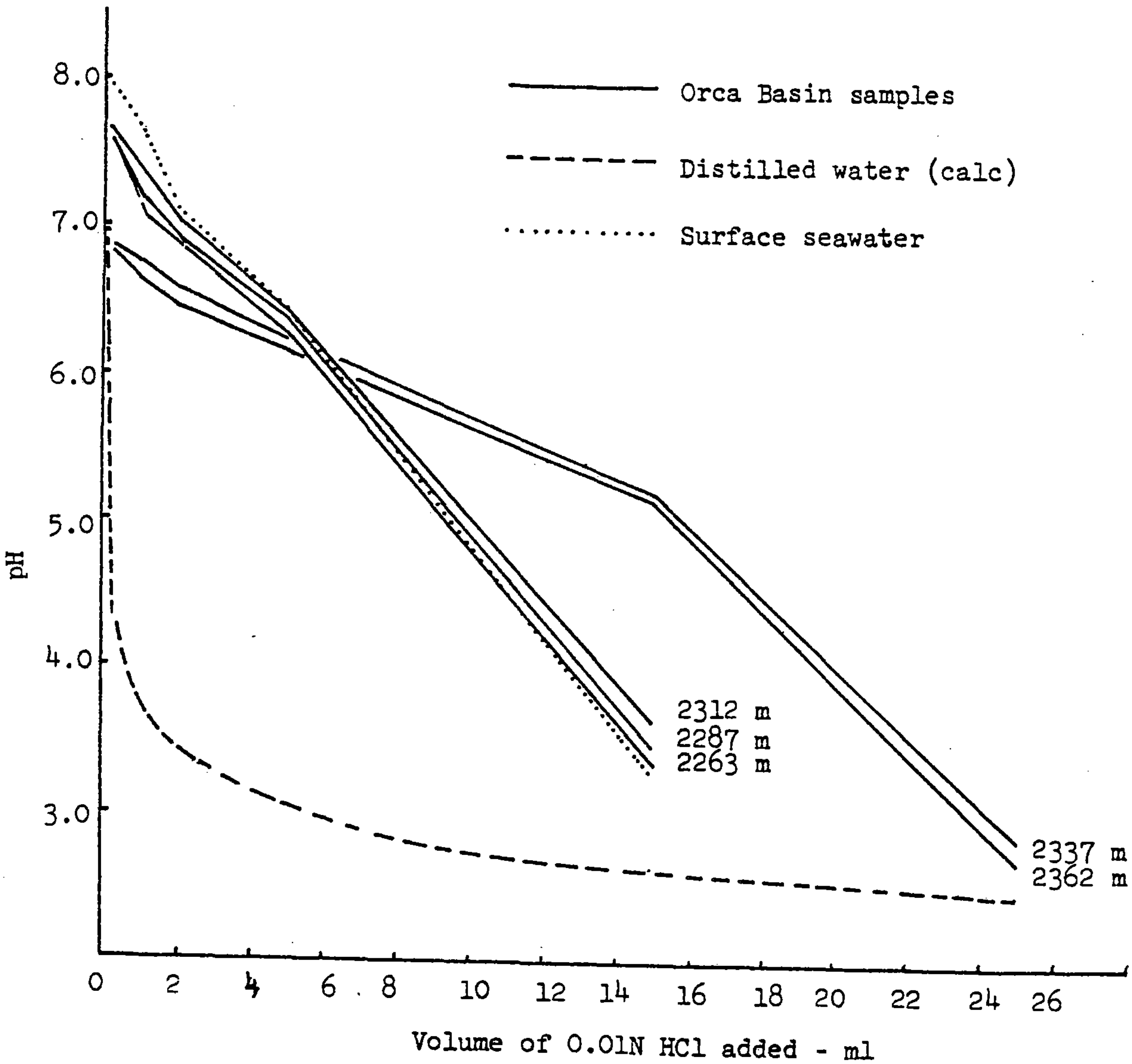


Fig 14. The pH response of 50ml samples to stepwise additions of acid.

Chemical Analyses of Orca Basin Sediements

Abstract Margaret Montaigne

The purpose of comparing two sediment samples - one taken in the anoxic hypersaline waters of the Orca Basin and the other taken outside the basin - is to further characterize the unique qualities associated with anoxic sediments. Orca Basin sediments contained an average of twice as much organic matter as the aerobic sediment. Carbonate was slightly higher in the aerobic sediment. Acidification of the Orca Basin sediments resulted in a strong smell of sulfide suggesting the presence of sulfide minerals and, indirectly, activity of sulfate reducing bacteria.

Microfossils in Aerobic and Anoxic Sediments from the Orca Basin Area

Abstract William Clarke Howard

Microfossil distribution is studied in anoxic and aerobic cores taken from the area of Orca Basin, an anoxic, hypersaline basin in the Gulf of Mexico. The most abundant microfossils, all pelagic species, are spatially homogenous in each core, and the assemblages of foraminifera are consistent with published data. Delicate and diversified tests in the anoxic Orca Basin sediment are absent in the aerobic core. Several species of pteropods are found exclusively in the anoxic basin sediment. The significance of these differences is discussed.

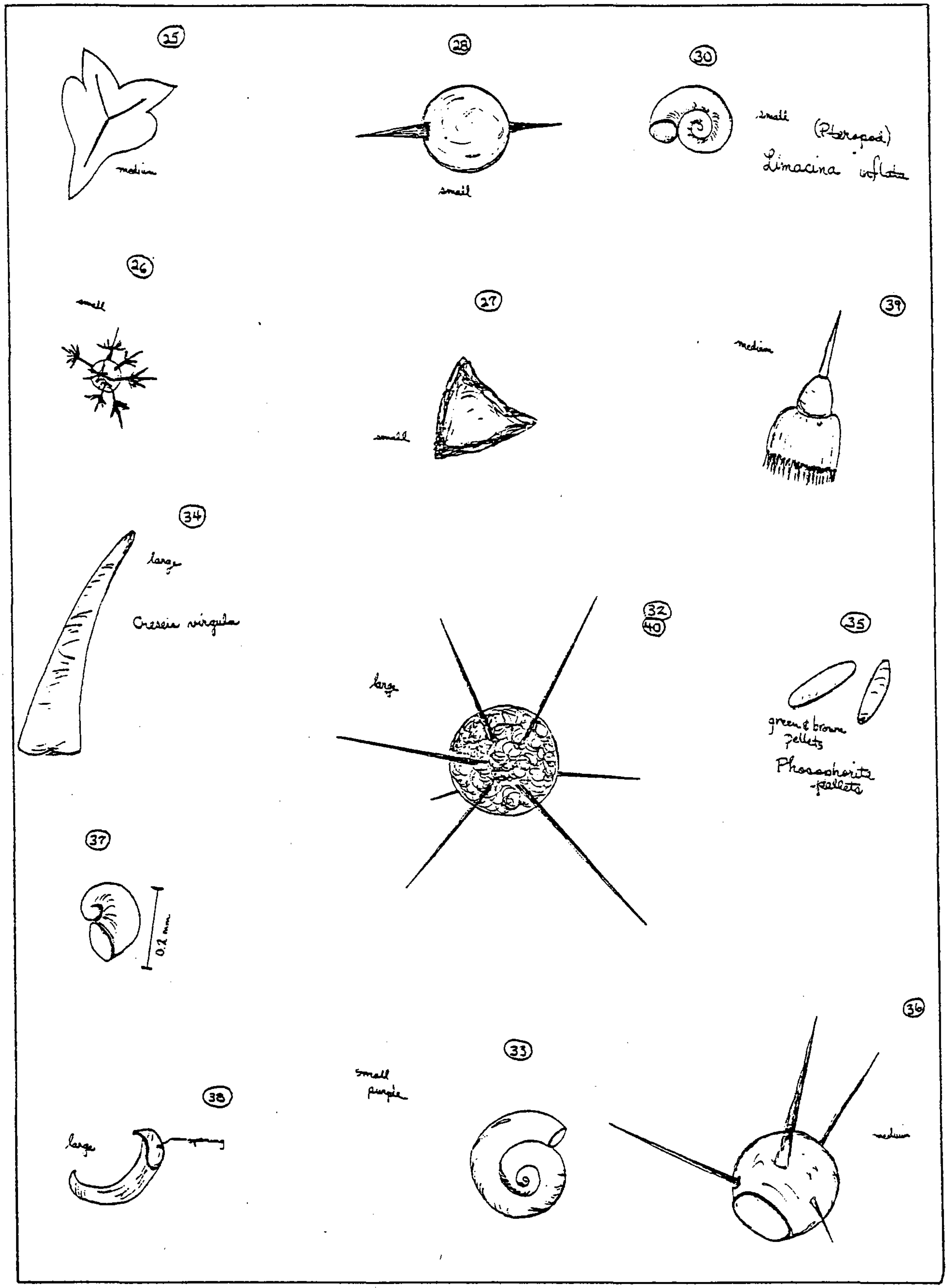


Fig 15. Microfossils from anoxic sediments (surface), Orca Basin

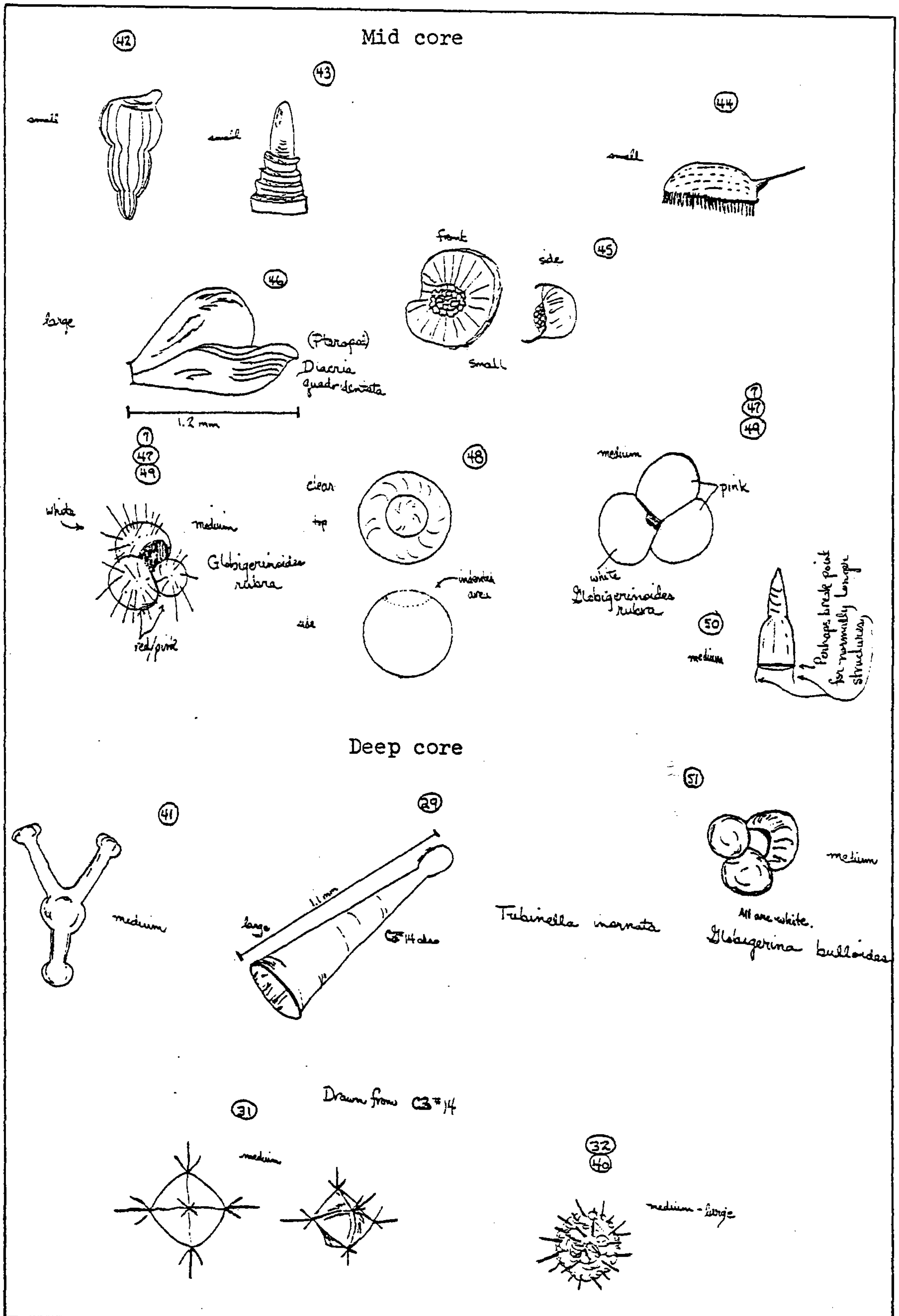


Fig. 16 . Microfossils from anoxic sediments (mid- and deep), Orca Basin.

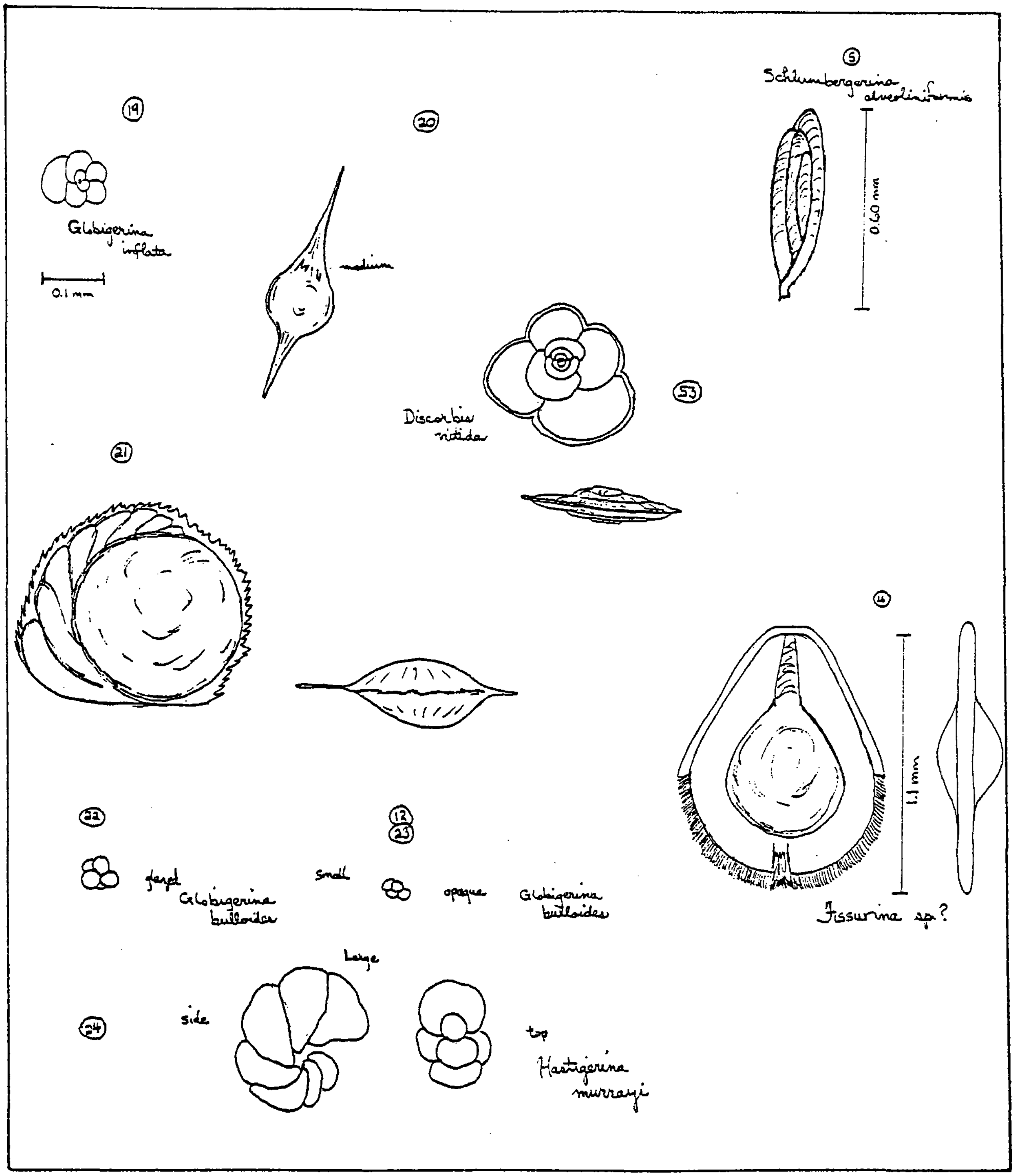


Fig. 17 . Microfossils from aerobic sediments(deep core) near Orca Basin.

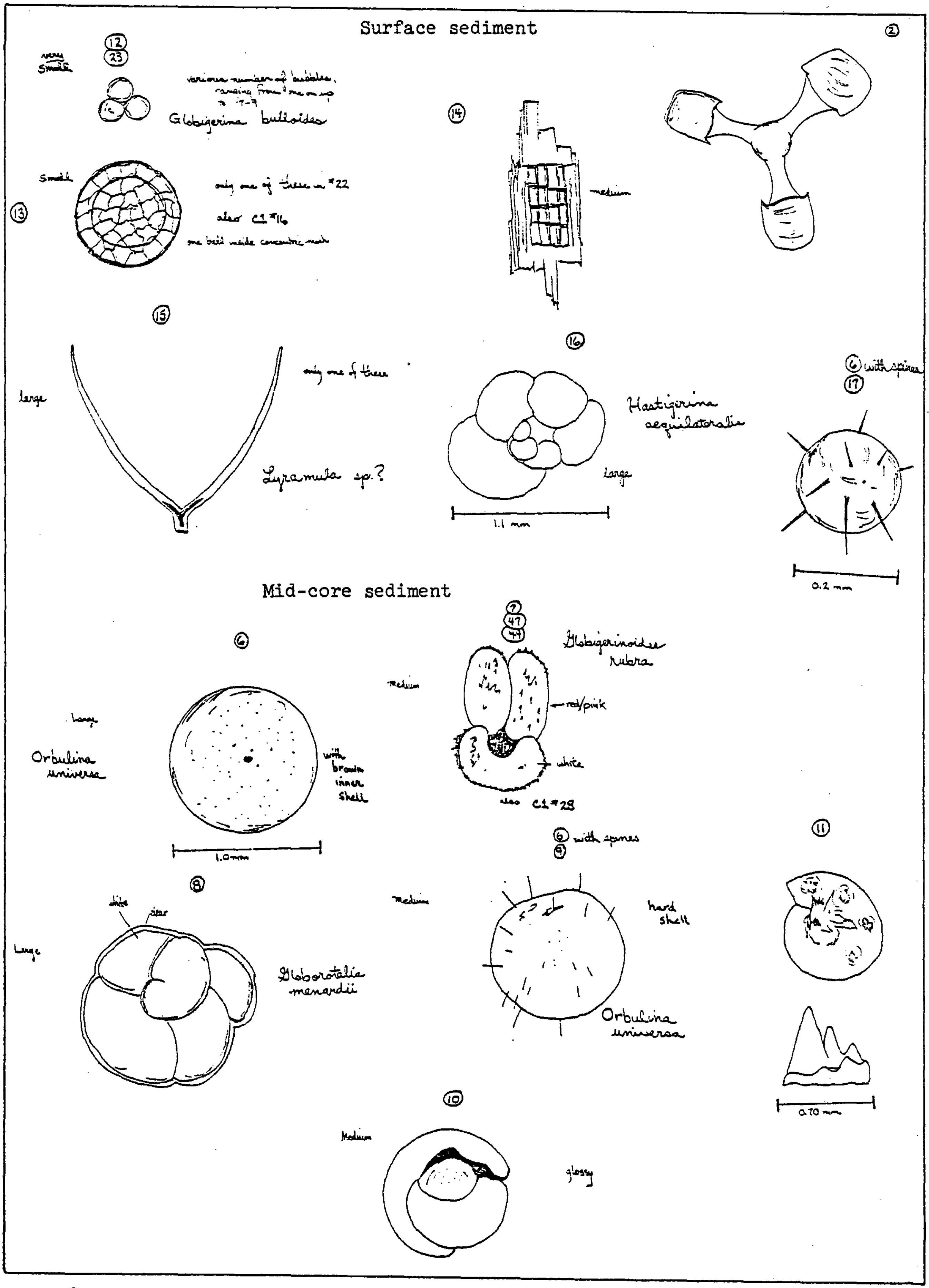


Fig. 18 . Microfossils from aerobic sediment (surface), near Orca Basin.

A syringe sampler for aseptic sampling of deep water.

Charles Natale

Abstract

An inexpensive sampler incorporating a 50 ml disposable plastic syringe was designed and constructed for use in microbiological studies. The sampler (Fig. 19) can be mounted on a Nansen bottle, in which case reversing of the bottle triggers the syringe, or it can be mounted on a vertical shaft for microgradient sampling in conjunction with a gravity corer (Fig. 20) in which case the falling corer triggers the syringes.

Our experience on W-39 indicates that for use with Nansen bottles the triggering mechanism requires improvement. The microgradient sampler/ gravity corer arrangement worked satisfactorily.

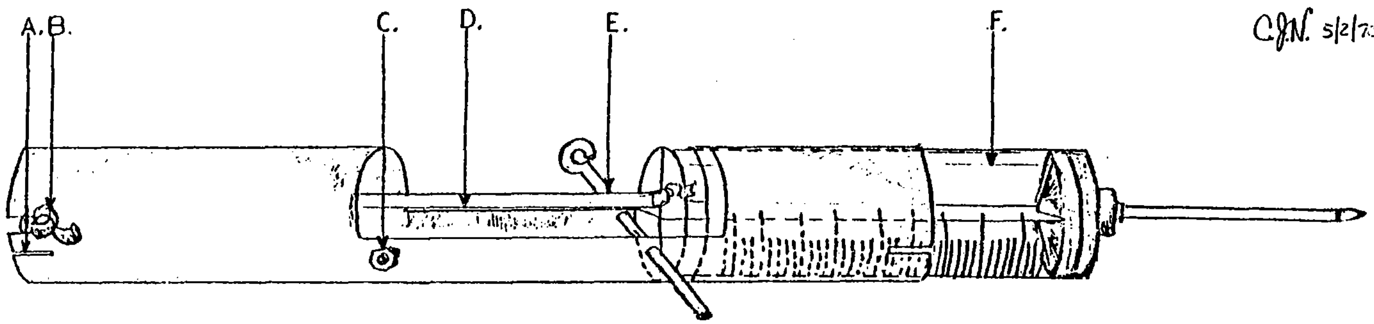


Fig 19 . The W-39 syringe sampler. A= slot for attaching sampler to Nansen bottle with hose clamp; B= knot in surgical tube to establish tension; C= limit screw for syringe barrel; D= surgical tubing to fill syringe; E= trigger pin; F= disposable plastic sterile syringe.

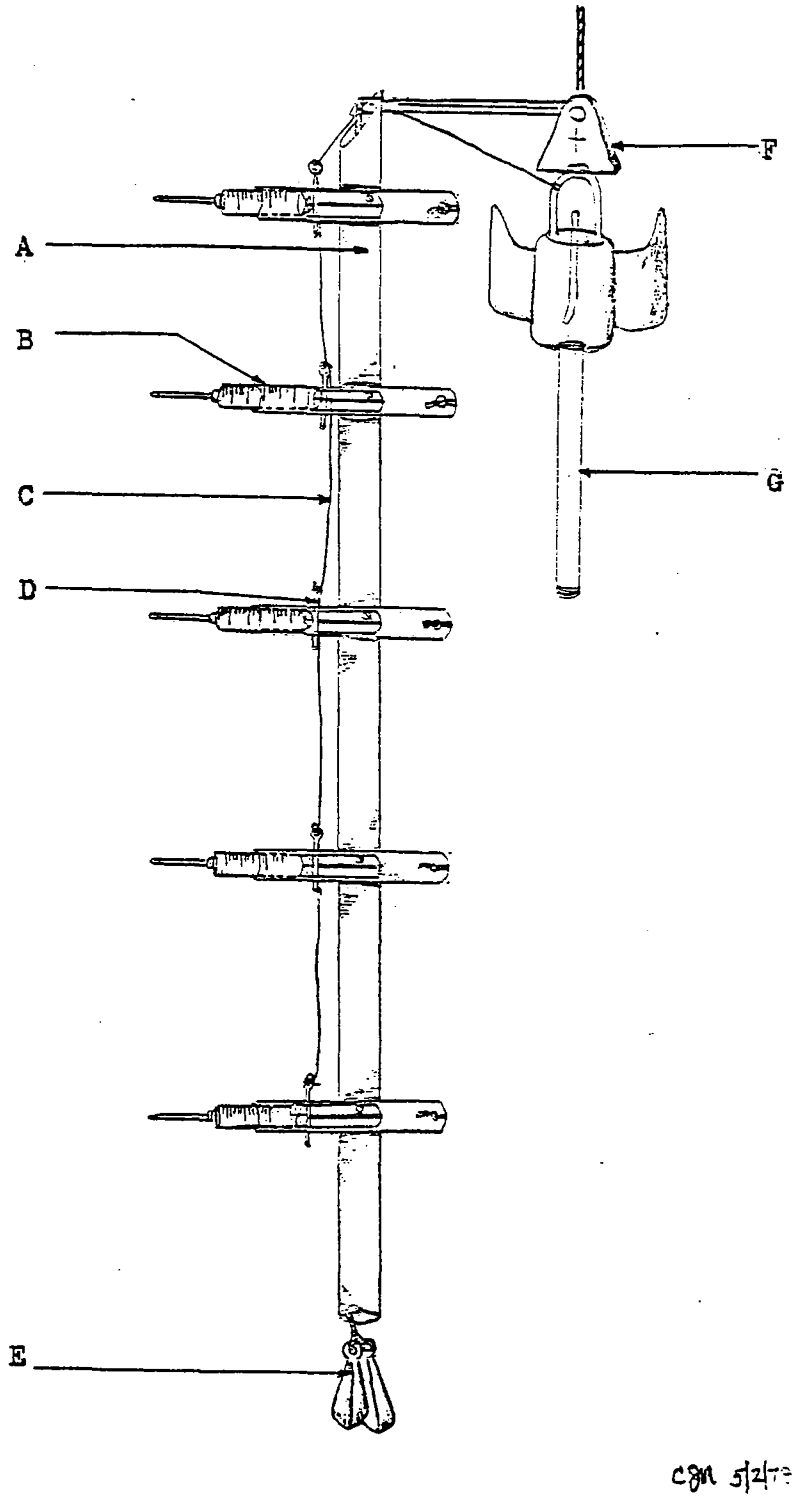


Fig 20 . The W-39 syringe sampler deployed in conjunction with a gravity corer for micro gradient sampling purposes. A= vertical support; B= syringe sampler; C= trip line; D= trip pin of syringe sampler; E= depressor weights; F= gravity corer trigger mechanism; G= gravity corer.

Bacteriological investigations in the Orca Basin, an anoxic basin.

Nina Lian

Abstract

Water and sediment samples from the Orca Basin were enriched with peptone and yeast extract and incubated under aerobic and anaerobic conditions in broth and agar stabs. Evidence of growth in aerobic broths suggests facultative aerobes inhabiting the brine but the possibility of contamination has not been eliminated. Anaerobic growth was observed only in agar stabs of sediment samples.

Chemical data suggesting the presence of sulfide minerals in the sediments could be construed as indirect evidence of bacterial activity. Sulfide was absent in the water column.

Residence Time in the Orca Basin

Abstract William E. Claypool

The residence time of the hypersaline water in the Orca Basin is estimated through two different methods. The silica and heat budgets provide residence times of 0.427 and 1700 years respectively. Variability is discussed.

The effect of varying crude oil concentrations on the growth response of open ocean phytoplankton

Judith Rosenthal

Abstract.

The present investigation is concerned with determining whether crude oil affects the growth response of open ocean phytoplankton. A preliminary study is performed to establish optimal growth conditions. An inoculum is prepared from a culture tube showing a high growth response. Culture tubes are divided into 3 grou ps. Group 1 serves as a control; no crude oil is added. One drop of oil is added to tubes in group 2; 10 drops are added to tubes in group 3. Growth response is significantly depressed in group 3 (90% confidence level). Furthermore, it is found that growth response varies inversely with light intensity over the range of light used here. Resul ts are anomalous in that Phaeodactylum tricornutum predominate in the inoculum whereas in the oil study, Detonula cystifera are the predominant species in all 3 groups.

Primary productivity in ocean waters

Amelia Irvin

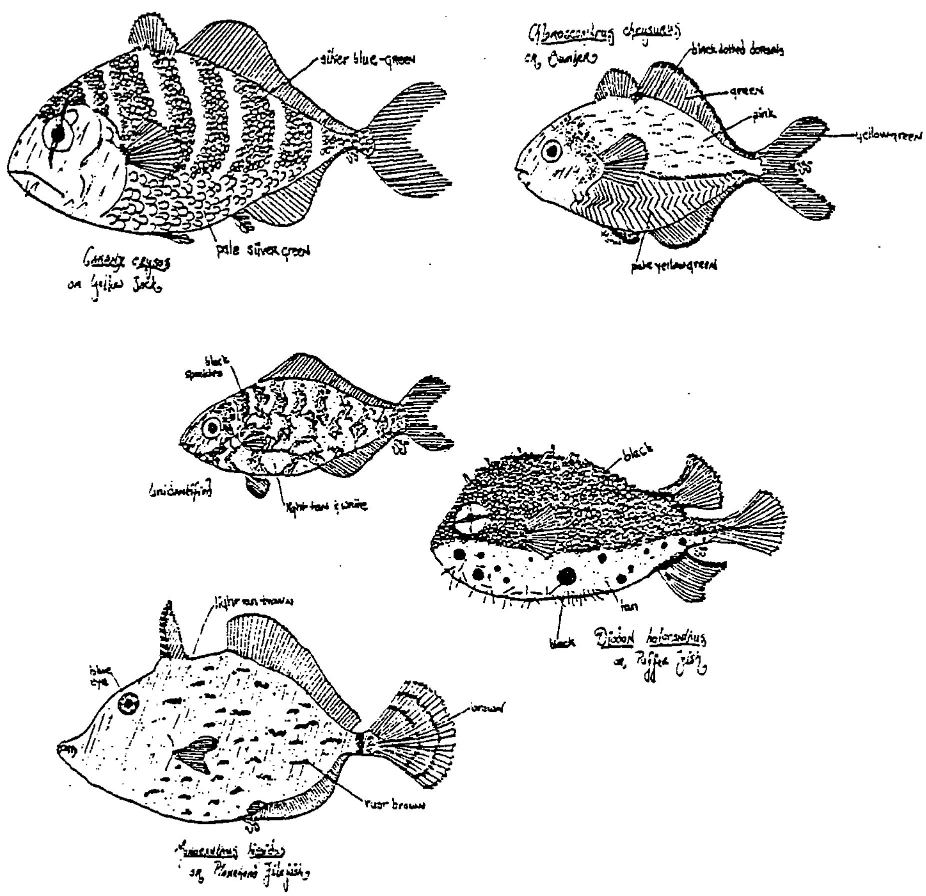
Primary productivity is determined by light-dark bottle, oxygen change method for open ocean, shelf and coastal waters. Some of the results are inconclusive due to the apparent production of oxygen in dark bottles which cannot be accounted for in conventional terms. The results of successful determinations for coastal and open ocean waters are discussed.

The Behavioral Responses of some Pelagic Fishes to Substratum Color

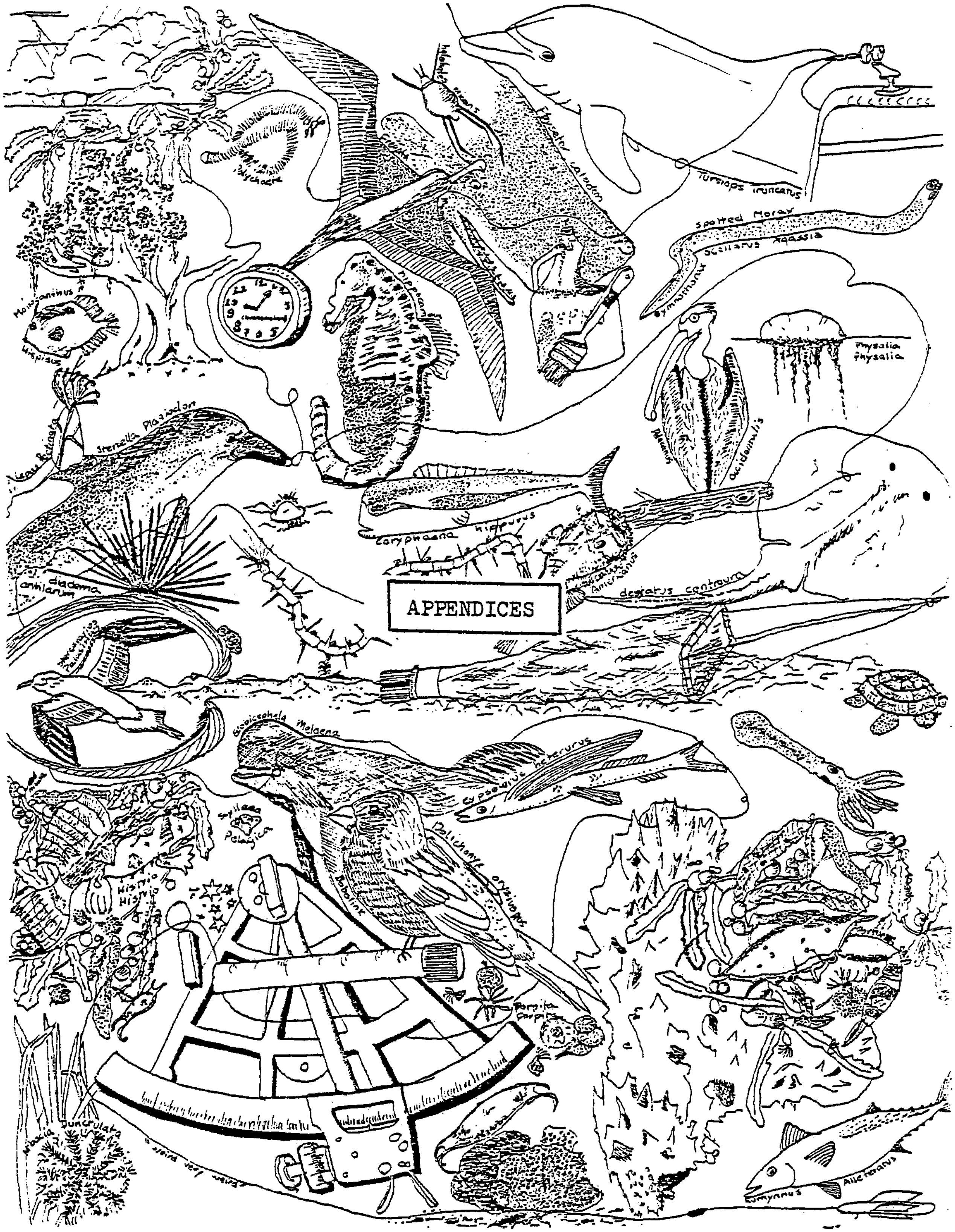
Suzanne Sylvester

Abstract:Pelagic Fishes collected from the Gulf of Mexico and the Gulf Stream off the east coast of Florida were studied in an aquarium on board.The fish were studied for any color changes and preferences to substratum.

Thirteen fishes were observed individually in an environment divided in two equal sections of black and white.Of the thirteen fishes studied four remained predominately in the black half of the aquarium,three remained predominately in the white half, and six exhibited no preference for either side.Four of the thirteen exhibited color changes and physical responses to external stimuli.Possible reasons for this are discussed.



APPENDICES


Polychaete
Tursiops truncatus
Spotted Moray
Physalia physalia
Stenella Plagiodon
Coryphaena hippurus
diadema antillarum
Bobolink
Porpita porpita
Alletteratus

Appendix 1

Offshore oil production and related services

Percival W. Wilson

Prior to reaching the off-shore oil production area of Louisiana a preparitory lecture was presented in order that the students would be in a better position to understand this vast and complex engineering system in their study of the various uses of the ocean.

Historically, drilling for oil was land based but as oil finds moved closer to the coast and approached the swampy areas, new methods had to be devised. The land type drilling derricks were put on barges, floated to the swampy locations, with the aid of dredging at times, sunk to rest on the bottom and thus form a steady drilling platform. Later, beyond the swamps drill platforms were built on pilings driven into the sea bottom. The next logical step was to build a drill rig that could float yet be able to lower its legs to the sea bottom and then self-elevate its drilling platform above the surface waves. This also provided the great advantage of the drilling unit to be lowered, the legs lifted, and then towed to a new position. If oil had been found a permanent production platform would be placed over the hole for pumping and piping the oil ashore.

As distance from shore increased another design was needed. It was floatable, supported by large vertical columns that provided buoyancy and with a drill platform work deck at the top. By flooding the column legs the structure could sink to the bottom in shallow water or by partial flooding remain semi-submerged in deep water and still provide a stable drilling platform either anchored or positioned by various new position sensing devices that are working with great success.

A study of the charts of the area crossed by Westward during W-39 indicated the number of production rigs in operation, the network of underwater pipeline systems, for both oil and gas, and also provided an opportunity to study the relatively new energy source below the sea. The first off shore oil well was drilled in this area in 1947.

In addition to the drilling and oil production operations the related service systems were discussed. To transport men and materials to off-shore facilities has created a new industry that is estimated toexceed, or at least equal, that of the rigs themselves. Supply boats, now 200 footers, carry drill and casing pipe, drilling mud, cement, food and other items. Men are transported by fast "crew boats" or by helicopter. As distances increase the helicopter is preferred. Re-fueling platforms are provided for dawn to dusk safety in addition to electronic navigation beacons in the vast oil rig area that now extends beyond 100 miles from shore.

The newer supply boats with high power, 10,000 HP total twin screw now act as towboats for drill rigs and also do the anchor positioning and handling for semi-submersibles in deep water.

The off shore industry provides a great future for students interested in the use of the oceans. SEA is to be complimented on bringing the Westward and her students to this area.

Appendix 2

Ocean Transportation

Percival W. Wilson

Tn the study of the use of the ocean. past and present, it is well to include one of its first uses, that of transportation, in the light of today.

A sampling of a small portion of the ocean highway, or trade route, was made during W-39 of the R/V Westward departing from Key West Florida, bound for New Orleans via the Orca Basin station. Transit of the Florida Passage provided a rather heavy concentration of ships of many types and trades. During the daylight hours of 13 to 15 April 1978 a total of 35 ships were sighted and type identified as follows:

Oil rig supply ship	1	(appeared rigged for research)
Ship in tow	1	(ship possibly damaged)
Gas carrier	1	
Tankers	9	
Bulk carriers	9	
Cargo freighter	6	
Tug and barge	2	
Container ship	2	
Barge carrier ship	4	

It is of interest to note that the majority of the ships sighted were of modern design and recent build (less than 10 years). This presented an added problem in ship identification for the newer ships tend to look alike from a distance: with the machinery and quarters located at the extreme after end. In past years it was relatively easy to spot a tanker with its machinery aft and bridge amidships, and the freighter equally distinctive with its machinery and bridge midships plus its array of masts and cargo booms.

Identification of the ships with the "modern look" required a closer look to determine details of the deck arrangements. The tanker with its single set of kingposts and hose handling booms about midships could be tererated from the freighter with numerous masts or kingposts and booms at each hatch. The bulk carrier looked somewhat similar when fitted with booms or cranes at each hatch; others were bare on deck exept for hatch coamings and no means of unloading. This indicates the increasing trend to build ships to specific trade and trade route that provides loading and unloading facilities at terminal ports.

The common freighter has gone througha radical change in design and appearance with the introduction of containers. Port facilities provided loading and unloading arrangements and the ships became bare of lifting devices. Standardization of containers permitted world wide transfer to rail or truck on land forming a "total transportation system" which could span continents as in the case of Europe to Japan via a Canadian "land bridge" between the Atlantic and Pacific. A second land bridge spans Siberia to link Japan with all of Europe.

As a further step box-like barges are carried by another very special type of ship that can load or unload its barges over the stern and thus link up existing river or canal systems on both ends of an ocean voyage.

Many of these specialized ships were in port at New Orleans for the duration of Westward's stay. In all, 146 ships were in port and for the two day period of our visit 27 arrivals were noted. During the same time there were a total of 33 departures, of which 20 were bound for foreign ports, 11 for U.S. ports and 2 for "unknown" destinations, according to the Marine Log in the newspaper.

To understand the evolution of ship design requires an equal understanding of trade, commerce, economics and international political attitudes. Energy transportation alone can be a vast and interesting subject for detailed study.

Appendix 3

Bathythermograph stations for w-39

BT #	Date	Local time	N. Latitude °	'	W. Longitude °	'	Log	T_s (°C)
1	4/14	15:45	24	18	82	30	73	27.3
2	17	12:15	25	35	86	25	366	26.9
3	18	12:15	26	24	89	21	510	25.5
4	20	12:00	26	56	91	21	554	24.0
5	21	15:30	27	23	90	27	778	24.3
6	22	06:00	28	25	89	25	871	24.0
7	22	12:45	28	47	89	10	899	24.5
8	22	18:30	29	09	88	54	926	22.5
9	-	-	-		-		-	-
10	30	23:30	26	58	87	10	1319	26.5
11	5/17	14:00	37	07	73	16	2304	17.3
12	17	16:00	37	16	73	15	2310	17.0
13	17	18:00	37	24	73	14	2322	16.7
14	17	20:00	37	32	73	12	2333	16.7
15	17	22:00	37	40	73	11	2338	12.6
16	18	00:15	37	48	73	10	2341	13.7
17	18	02:00	37	54	73	09	2345	15.7
18	18	04:00	38	01	73	10	2352	12.2
19	18	06:00	38	05	73	11	2358	12.2
20	18	08:00	38	11	73	10	2363	11.5
21	18	10:00	38	19	73	08	2373	10.9
22	18	12:00	38	26	73	06	2378	12.0
23	18	14:15	38	34	73	06	2386	12.5
24	18	16:45	38	42	73	00	2398	11.1
25	18	18:15	38	45	72	55	2404	10.3
26	18	20:00	38	50	72	48	2413	12.7
27	18	22:45	38	56	72	37	2420	10.6
28	19	00:45	39	01	72	28	2423	10.3
29	19	02:15	39	04	72	23	2431	11.0
30	19	04:00	39	06	72	16	2440	11.7
31	19	06:00	39	07	72	06	2450	11.7
32	19	08:00	39	15	72	00	2462	12.5
33	19	12:00	39	40	71	53	2480	11.4

Appendix 4. Demonstration organisms on W-39 (feature creatures)

Stephen Berkowitz

Histrio histrio -Sargassum fish
Often found in clumps of Sargassum, usually not moving and holding on to the weed with it's fins. They are superbly camouflaged for their environment, as far as color, and their fins are tattered and irregular looking to match the appearance of the weed. They are carnivores and prowl through the jungle of fronds looking for shrimp copepods and other organisms commonly associated with floating Sargassum.

Physalia physalia - Portugese man-of-war
Seen floating on the surface, blue in color. Float may reach 30 cm in length, tentacles several meters. Each one is a colony! The float is a gas filled individual which supports the entire colony. The gonozooids are reproductive individuals. Each gastrozooid has one long tentacle, equipped with stinging cells for paraltzing prey. The fertilized egg gives rise to a larval float, and then budding zones produce the other individuals. Even though it is a colony, Physalia functions as a unit because of digestive and nervous connections between the members.

Tursiops truncatus - Bottlenose dolphin
Yes -"Flipper" was one of these. This is a warm blooded, air-breathing mammal which bears and suckles live young. They have returned to the sea only relatively recently, evolving from terrestrial ancestors - for instance, that's why their tails move up and down, and not sideways, like a fish. They can grow to 8-12 feet long, and usually travel in groups. They feed on fish and squid, which they can locate using echo-location. They have an 11 month gestation period, and may live to be 25 years old. They are social and intelligent and show some complex behavior including homosexuality.

Euthynnus alleteratus - Bonito, little tunny
Countershaded steel blue above and glistening white on lower sides and belly, dark wavy bands above the lateral line. Average growth to about 2½ feet. Tropical oceanic fish related to the tuna. Fins fold into special grooves in the body for stream lining when swimming fast.

Stercorarius parasiticus - Parasitic Jaeger
We have seen many of these oceanic birds flying around the ship, as well as landing on the water. They are powerful fliers, and seldom come ashore except to nest. One of the key identifying features is the elongated central tail feather. They are often seen robbing other sea birds of fish. They are generally silent. Immatures lack the long tail feathers. The parasitic is the most common Jaeger. They range up and down both sides of the North American continent.

Lepas pectinata -Sargassum gooseneck barnacle
These are the common barnacles on Sargassum, reaching 20 mm in "shell" length. Barnacles, believe it or not, are crustaceans, like copepods,crabs,shrimp,lobster,etc. They have pelagic larvae, which are members of the zooplankton, and which must find a suitable attachment site before they can settle out. They then spend the rest of their days "sitting on their heads" and straining water with their "feet" or cirri. They are filter feeders.

Halobates micans- marine water strider
These are the only insects living on the surface of the open ocean. They are in the same family (Gerridae) as the freshwater striders. They spend their entire lives living above the surface film. The eggs are attached to floating objects,such as feathers,wood,and the floats of dead siphonophores(jellyfish such as the Physalia). It is believed that they feed on these same siphonophores puncturing them with their elongated mouthparts, which are similar to those of mosquitoes.

Scyllaea pelagica - Common Sargassum nudibranch
This is the large brownish one in the aquarium with the two pairs of straplike processes on it's back and one pair on its head. It is responsible for the yellow-tan egg string laid in the unusual pattern on the front glass of the aquarium. Its length may reach 40mm. It probably browses on the feathery hydroids and othee epifaunal organisms growing on the Sargassum. Nudibranchs are mollusks you can think of them as snails without shells. They often carry their gills on their backs,as is the case with the other nudibranchs in the aquarium.

Cambarus virilus -Crayfish
This crustacean(phylum Arthropoda) is a fresh water form which closely resembles the marine lobster. There are about 75 species in the U.S. They inhabit ponds,lakes, rivers,streams and marshes.One species is blind and lives in cave waters. They feed on insect larvae,worms,other crustaceans,snails,fish,tadpoles,and some dead animal matter. Their enemies include certain fishes,turtles, water snakes,herons,and other aquatic birds and some aquatic mammals. They can walk forward,sideways,obliquely or backward and can quickly dart backward by sudden flexion of the abdomen.

Velella velella - Sailor-by-the-wind
This jellyfish(phylum Coelenterata,order Siphonophore) is in the same group as Physalia and Porpita.It is a colonial organism,with a central gastrozooid mouth (on the ventral side of the disk),gonozooids(reproductive individuals) and stinging cells. It has the charcteristic blue color of the neustonic organisms. The sail on the top of the float enables Velella to tack along with the

wind. It is fed upon by Janthina a purple snail, and Halobates ,the marine water strider.

Stenella plagiodon - Atlantic spotted dolphin
This marine mammal can be distinguished from the bottle-nose dolphin by its smaller (2.3 -2.4m) size and more slender profile,as well as by the greyish-white spots. The lips and top of the snout are often white. They feed primarily on squid,but may also take fish. They occur commonly in the continental waters of the tropical and warm temperate waters of the western north Atlantic, usually more than five miles offshore.

Coryphaena hippurus -Common dolphin (fish)
This is one of the most beautiful of open ocean fishes- its sides are mostly brilliant blue when it is alive, and the tail mostly yellow. The colors fade rapidly after death. The maximum length is about 2 meters, and they are fine sports fish. The flavor is excellent,whether eaten raw or cooked. They feed largely on flying fish. Often ,if one is hooked the rest of the school stops near the ship and may all be caught one by one. They are fast swimmers and are often taken on jigs trolled behind fast moving ships.

Cypselurus heterurus -Common Atlantic flying fish
These fish don't really fly,but glide on their highly developed pectoral fins,most probably as a means of escaping predators. A large one(30cm) may glide for more than 100 meters in favorable conditions. They feed on zooplankton, and are themselves eaten by many fish, including dolphin and billfish,and some squids. They show the blue and silver countershading characteristic of animals living at or near the surface of blue oceanic waters.

Arbacia punctulata -common Atlantic sea urchin
This member of the class Echinoidea (phylum Echinodermata) is often abundant on shallow bottoms. They are radially symmetrical and the skeletal ossicles are fused into a solid case(the test). Locomotion is by means of many small tube feet- part of the water -vascular system. The spines which are movable due to a ball and socket joint can also be used for locomotion,but are primarily defensive in nature. They may feed on all types of organic material plant or animal, living or dead which is chewed up by the five teeth found on the oral(bottom)surface. The larvae are planktonic.

Fregata magnificens - magnificent frigate bird
We saw these large tropical sea birds circling overhead almost constantly in Key West. They have long wings and long forked tails and very short legs-characteristic of

birds that spend very little time on the land. They spend much of their time floating on the air with little apparent effort,plunging to the sea surface to pick up some floating object.They also often pursue other sea birds to make them dispose of their catch. Frigates breed in colonies on tropical islands - in trees,bushes,or sometimes on rocks. A single egg is the rule.

Chiton (common name)
The large,flat,brown creature on the glass in the left rear of the upper aquarium is a chiton. They are mollusks (phylum) in the class Amphineura, subclass Polyplacophora (many plates). They are considered to be the most primitive of existing groups of mollusks. They are highly adapted for adhereing to rocks and other hard surfaces. The eight overlapping transverse plates are articulated and enable the chiton to roll up in a ball, and also to adhere to a sharply curved surface.They are very sluggish and may remain immobile for weeks. They are herbivorous and feed on algae that they scrape forom the surface of rocks and shells.

Dasyatis centroura -Sting ray
The large(57" across) specimen in the otter trawl was probably this species. It is the largest sting ray of the western north Atlantic. The tail spine(brought into action as the tail is lashed back and forth) is a dangerous weapon and its wounds cause excruciating pain. The young are born alive. Skates and rays,along with sharks,are in the class Chondrichthyes- these are cartilaginous fishes with no bones. Rays and skates are bottom dwellers, with a few exceptions,and feed on a variety of benthic fauna, including bivalves,crab,and shrimps,etc.

Hippocampus hudsonius -sea horse
This unlikely looking fish has no ventral or caudal fins, and must swim by rapid vibrations of the dorsal fin, because the body is too stiff for normal swimming movements The tail is prehensile and is used for clinging to plants. The female deposits her eggs in the male's brood pouch, where they grow and hatch;the young emerge when the yolk sac is absorbed. They feed on small crustaceans and other creatures,which they suck in by expanding their cheek pouches.

Pelecanus occidentalis -Brown pelican
This large aquatic fish-eating bird is a locally common breeder on both coasts. It can have a wingspan of 2.5 meters (7.5 feet) It is rarely found in fresh water. They are excellent fliers,with a powerful stroking flight alternating with short glides,which often carry the bird only inches above the water. It flies with the head drawn back into the shoulder and dives into the water from heights of 30' for small fish. All 4 toes are webbed-for swimming and diving. They lay 3-5 eggs at a time. Semi-tame birds often beg.

Ovalipes guadulpensis -Crab
This was the crab that was so abundant in our third otter trawl. It is a decapod crustacean in the family Portunidae (swimming crabs). They inhabit sandy bottoms down to at least 1 00 meters from Cape Hatteras, N.C. to Ardusas, Texas, as well as Guadeloupe and Brazil. The fifth pair of legs are modified into flattened paddles - this instantly identifies the family, which also includes the famous and commercially important blue crab of the Chesapeake Bay and surrounding areas.

Appendix 5

Final examination essay questions
Introduction to Marine Sciences Laboratory
($1\frac{1}{2}$ hours; answer one from A and two from B)

A1. " The ocean is opaque to electromagnetic radiation but transparent to sound". Discuss this statement in light of the uses man and other animals have made of sound in the sea.

A2. Several methods are available to estimate salinity. Discuss three or more of these, indicating what property is actually measured, its relationship to salinity and the most serious problems associated with the method.

A3. Although the media tend to leave us with the impression that the Aqua-Lung has been a major tool in oceanography, the spectrophotometer has been responsible for a greater scientific contribution. Discuss.

A4. You are located east of the Gulf Stream off the coast of South Carolina. The wind is force 5 southerly. You are about to engage in a project to characterize the neuston. Discuss the factors which might contribute to variability on successive tows.

B1. Contrast the continental shelf south of Louisiana with that off southern New England.

B2. You have been awarded a $1,000,000 grant for three years to investigate the ontogeny (development) of the immune system, starting with invertebrates and ending with man. Describe how you would attack this problem on a stepwise basis, giving rationale for each major sub-project you would like to investigate. Place particular emphasis on how working with invertebrates might provide a key to our understanding of diseases associated with man, for example, cancer and auto immune disease.

B3. Imagine that you are a small zooplankter living in the open sea. Name and discuss at least three modes of existence that you might choose as a lifestyle, and all the implications that each one entails. For example, what depths would you frequent and when, the effects of physical factors upon your existence, etc. Mention at least three other creatures you might encounter and something about their modes of existence.

B4. The liberation of chemical energy through respiration processes is fundamental to life and is ubiquitous in the oceans. Discuss the nature of energy-releasing biochemical reactions, their spacial distribution in the ocean and some of the consequences to the composition of the sea water in which they occur.

Appendix 6

Methodology Aboard R/V Westward

Microscopy on the Westward

Mary Farmer (CUNY)

Use of a high-power binocular microscope is not usually feasible on oceanographic vessels because the vibrations from the ship's engine affect any small organism within a drop of water. The vibrations are magnified in a high-power field so that identification of organisms is impossible. A high-power microscope can be used in the R.V. Westward, however, as long as she is under sail even under fairly heavy seas. The sloshing back and forth of a sample with the roll of the ship is not a serious impediment to identification the way vibrations are. This facility for microscopy opens an area of research on the Westward that is closed on most other modern research vessels.

The advantages of doing microscopy on the ship are several. (1) Planktonic organisms can be examined while they are still alive. This is the only way to identify some species, especially worm-like forms, which retract or disintegrate under even the most careful preservation techniques (Gosner 1971). (2) Examination for organisms that help identify water masses can be done on the spot. The results can then be used to plan immediate further sampling or course changes as required. (3) Samples can be processed immediately to compare with other biological, chemical, and physical data on the cruise so the data can be included in the cruise report. This last example is particularly important for educational cruises where data not worked up on the cruise itself is unlikely to reach students after the cruise is over. Also, it means an entire field of study is available for student projects that is not available on most other ships.

Unicolor Chemistry E-6 Developing for Ektachrome film

Color developing aboard Westward was succesful using Photo System's Unicolor Chemistry kit. All chemicals were mixed with distilled water according to concentrations given in the instructions.

To maintain the chemicals at the required 92 - 102 F temperatures, a container was constructed to be filled with water and heated by an aquarium heater (see diagram). Several hours were required to heat the water from faucet temperatures (approx. 78) to 100 F. To speed up the process an immersion heater worked very quickly.

Transferral of film into the developing tank was done in the dry stores compartment of the freezer flat. A note was placed in the main head on the sight tube to warn people against doing a boat check and allowing the darkness to leak out.

We followed the step-by-step instructions for developing. Chemicals were measured in a graduated cylinder (250 ml), which was rinsed with fresh water, then distilled water after each use. Chemicals can be used for two rolls of 35 mm, 36 exposure film before discarding.

The major difficulty while developing was keeping the chemicals at a constant temperature. We overheated them at first, expecting them to cool by the time they were needed. We would suggest making sure the chemical temperature has reached an equilibrium before beginning developing.

We found timing was not as critical as stated in the instructions. As much as 3 minutes delay between steps occured with no apparent affect on the slides.

Results were better than expected. The color quality and clarity of the slides was very good. A few dried with water spots. We suggest using Photo Flo to alleviate this.

Susan Pilling
Tracy Bowman
SEA

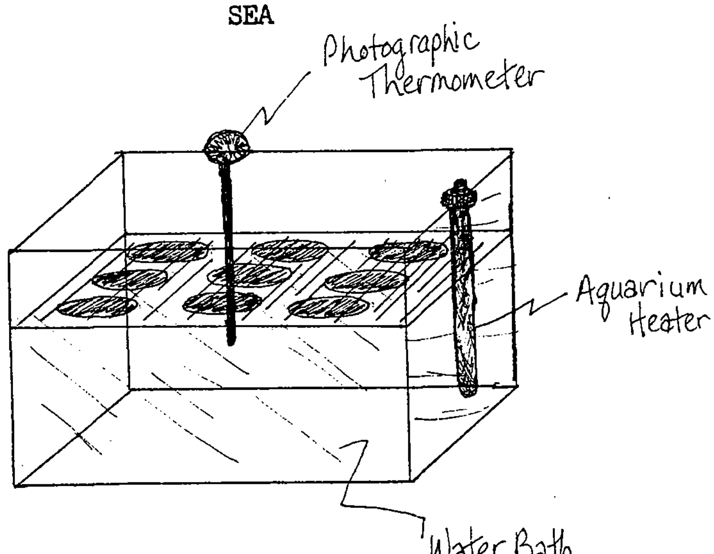


Diagram of Water Bath used to keep chemicals at a constant temperature

Comments on Rigging Sidescan Sonar and High Resolution Seismic Profiling Systems on R/V Westward during W-39

The transcievers (2) and recorders (2) were all set up in the dog house simultaneously with stacking of the units and the addition of a six outlet grounded (3 prong plug) 6 foot long extension cord to use the available 115 volt AC current. The power supply was sufficient for 8 hours of continuous use without recharging by the generator. The cables to the transducers lead out through the dog house hatch which would be a problem while operating in wet weather because of exposure of the transcievers and recorders. The continual traffic through the companion way also was an inconvenience to both those annotating the records and conducting the ship navigation. The Sidescan fish was easily strung off the BT winch davit with a snatch block, which allowed cable length adjustments by hand. The 7 kHz Raytheon transducer was mounted on a pole from the boomkin and bobstay with a 6' horizontal, a 6' vertical pipe (connected with a "T" fitting), and a 10' 2"x4" extension lashed to the vertical so as to extend it up to the deck level. The cables were used to the limit of their length so measurements are recommended for subsequent repetitions for this set up. Also, given typical sea states and ship pitching the transducer was displaced vertically through 4'-6' excursions which degraded the record. Furthermore, the record was entirely eliminated at times by bubble streams and lifting the transducer out of the water. A longer vertical shaft, so as to enable deeper submersion (4' below still water level was used) would solve these latter sources of record discontinuity. A forward leading guy rope was set between the transducer and the base of the bob stay at the hull. The safety line leading from the transducer forward to the deck was never tested, since our mounting never failed.

Charles McClennen
Colgate University

Microscopy aboard Westward (Stephen Berkowitz, VIMS)

The three microscopes saw heavy use during W-39. Examining whole plankton samples under the dissecting scopes was difficult under most conditions due to ship movement, although individual specimens could be examined satisfactorily in small dishes. When the engine was running, vibration made any microscopy extremely difficult, even with slide mounted specimens.

Chemical analyses (Anne Brearley, Atlantic College, Wales)

These fall into three categories:

Volumetric (titration)	Spectrophotometric	Optical refractometry
Chlorinity (& salinity) Dissolved oxygen	reactive phosphate ammonia particulate organic carbon reactive silicate	salinity

Volumetric methods

a) Chlorinity and salinity. The precipitatable halide halogens in a 5 ml volume of seawater sample were determined by titration with a silver nitrate solution using a dichlorofluorescin endpoint, and dextrin stabilizer. The silver nitrate was standardized against 5 ml of a seawater standard of known chlorinity (Eau de Mer Normale). Salinity was then calculated from chlorinity.

b) Dissolved oxygen. This is a modification of the Winkler dissolved oxygen method by the Chesapeake Bay Institute. Samples in 300 ml B.O.D. bottles were fixed within 5 minutes by addition of manganous chloride and alkaline iodide, followed by sulfuric acid. 50 ml of treated sample was then titrated with sodium thiosulfate using starch as an indicator. Potassium iodate was used to standardize the thiosulfate solution.

c) Comment. Titration methods proved that they could be handled with speed and accuracy even by complete novices, provided that they were reasonably conscientious. The following table gives data on the precision of these methods:

	Oxygen	Salinity
No. of determinations	106	62
No. of operators	19	19
Modal range	0.014 ml/L	0.04 o/oo
Mean range	0.04 ml/L	0.11 o/oo

The ranges given above represent the range of values among triplicate titrations of the same sample by the same individual. These data do not include values from a single, conspicuously inept individual whose range for six oxygen titrations was 0.48 ml/l

Spectrophotometric Methods

All of these methods were from Strickland and Parsons (1972). The procedures proved suitable for Westward's laboratory from the point of view of being reasonably rapid once the initial reagents were made up and of being mastered by relatively inexperienced workers.

The spectrophotometer (a Bausch & Lombe Spectronic 100) turned out to be highly satisfactory within its design objectives. It was most stable despite the variations in voltage aboard ship and its digital readout was unaffected by ship movement.

As is the case on any ship, it was necessary to take special precautions against spillage of reagents, and to remind inexperienced workers to wear suitable protection for their clothing.