

woods Hole
oceanographer

MPOM

**Marine Policy
& Ocean Management**

**Woods Hole
Oceanographic Institution
Woods Hole, MA 02543**

Marine Policy and Ocean Management Program

The Marine Policy and Ocean Management Program of the Woods Hole Oceanographic Institution provides an opportunity for individuals to conduct research regarding the ocean and the problems generated by our increasing use of it. Evaluating and establishing appropriate policies and management strategies to deal with these problems is a complex task, often requiring the data and skills of both marine and social scientists. The three main objectives of the Marine Policy Program are:

- 1) to provide experience to Research Fellows interested in marine policy issues;
- 2) to provide opportunities for interdisciplinary application of natural science, technology and social science to marine policy problems;
- 3) to research, evaluate and convey the information necessary for development of sound local, national and international ocean policy.

A staff of Policy Associates and Research Fellows, with appointments of one to two years, conducts research on a wide range of policy issues. In addition, the Program sponsors lectures, conferences, seminars and workshops involving senior policy makers and academicians.

Research

Present research activities in the Marine Policy and Ocean Management Program fall into four general thematic areas: 1) Coastal Management and Marine Pollution, 2) Fisheries Management, 3) Marine Mining, 4) Cooperative International Marine Policy.

Coastal Management and Marine Pollution

Research in this area includes the social and economic ramifications of management schemes for sewage sludge and industrial waste disposal in the New York Bight region, as well as work considering the implementation of health and environmental regulations in the marine environment. Several other studies focus on Georges Bank and the resource conflicts arising from recent OCS oil and gas activities.

Fisheries Management

This area considers the problems of managing ocean fisheries, and includes analysis of the variability of fish stocks, the fishery and the fishing industry, in the context of international, national, regional and local governmental policies.

Research is directed toward developing techniques for the integration of social, economic and biological information in fisheries management planning, and toward analyzing the effectiveness of fisheries management policies.



The coastal zone: a major concern in marine policy.

Marine Mining

Research in this area examines the domestic and international marine policy problems of mining metals contained in sea-floor nodules and, potentially, polymetallic sulfide ore deposits.

Projects will consider the question of whether or not deep-sea mining will proceed under present international guidelines, under legislation recently passed by the U.S. Congress, or under some future national or international arrangement.

Cooperative International Marine Policy

This Program considers the transfer of marine science and technology to developing countries for the purpose of marine resource management. Research will involve the design of a mechanism for identifying countries interested in this kind of assistance and implementation of training modules in the form of mini-courses and workshops. If successful, this project could serve as a model for other U.S. programs of technology transfer and cooperative scientific efforts.

Other Research

Additional research projects include work in maritime archaeology, and a comparative study of national inter-sectoral marine policy which

examines the problems faced by national governments in managing offshore uses by competing industrial sectors.

Fellowships

The Marine Policy and Ocean Management Program offers Research Fellowships to professionals in social sciences, law or natural sciences, to use their training on problems that involve the use of the ocean. In addition to their research efforts, Fellows are encouraged to participate in Woods Hole seminars and study groups and to develop collaborative research with other members of the scientific and technical staff. Applicants to the program must have completed a doctoral level degree or possess equivalent professional qualifications through career experience. Thus far, over 70 Fellows, trained in such fields as law, economics, anthropology, political science, engineering, marine science, mathematics and geography, have taken part in the Program.



Crowell House: home of the MPOM Program.

Facilities

The Marine Policy and Ocean Management Program is part of the Woods Hole Oceanographic Institution, one of the largest and most prestigious marine research institutions in the world. The Institution has departments in Biology, Geology & Geophysics, Chemistry, Physical Oceanography, and Ocean Engineering. Because of its location in Woods Hole, participants in the Policy Program have an excellent opportunity to interact with other laboratories including the Marine Biological Laboratory, the U.S. Geological Survey, and the National Marine Fisheries Service.

Staff 1981-1982

ROBERT E. BOWEN, Marine Policy Fellow, 1981-82; Ph.D. in International Relations, University of Southern California. Research interests: Marine policy analysis, bargaining theory, quantitative policy analysis, evaluation research.

JAMES M. BROADUS, Marine Policy Fellow, 1981-82; Ph.D. in Economics, Yale University. Research interests: Marine resource economics, organization and regulation of marine industries, energy and environmental economics, international cartels.

MYRON B. FIERING, Visiting Investigator, 1981-82, Senior Fellow, 1980-81, also Gordon McKay Professor of Engineering and Applied Mathematics at Harvard University. Research interests: Operations research applied to models for water resource management (particularly in environmental systems), sanitary engineering and waste management, public policy analysis through the use of mathematical models, robust estimating techniques.

DANIEL P. FINN, Marine Policy Fellow, 1980-81; J.D. in Law, University of Hawaii Law School. Research interests: Regulation of ocean dumping (especially radioactive wastes and toxic substances), transportation of oil and hazardous substances, coastal zone management and wetlands protection, oil transportation through Southeast Asia and the Western Pacific.

PAUL M. FYE, Special Consultant in Marine Policy, President, Woods Hole Oceanographic Institution; Ph.D. in Physical Chemistry, Columbia University. Research interests: Law of the Sea issues.

MICHAEL C. HEALEY, Research Fellow, 1982-83, also Research Scientist, Pacific Biological Station, Nanaimo, B.C.; Ph.D. in Natural History, University of Aberdeen, Scotland. Research interests: Population ecology, habitat protection, fisheries management.

MERRIE G. KLAPP, Marine Policy Fellow, 1981-82; Ph.D. in City and Regional Planning, University of California, Berkeley. Research interests: Conflicts in OCS petroleum development, fishery management in Norway, Britain, Indonesia and Malaysia.

ROBERT W. KNECHT, Senior Fellow, 1981-82; MMA in Marine Affairs, University of Rhode Island. Research interests: Ocean policy, coastal zone management in the United States, deep seabed mining, ocean management on the U.S. continental shelf, nuclear waste disposal.

THOMAS M. LESCHINE, Policy Associate, 1978-present; Ph.D. in Mathematics, University of Pittsburg. Research interests: Coastal zone management and the use of mathematical models in research and management.

PETER V. McAVOY, Marine Policy Fellow, 1981-82; J.D. Law, Marquette University. Research interests: Evaluation of changes in U.S. policy in international marine resource issues.

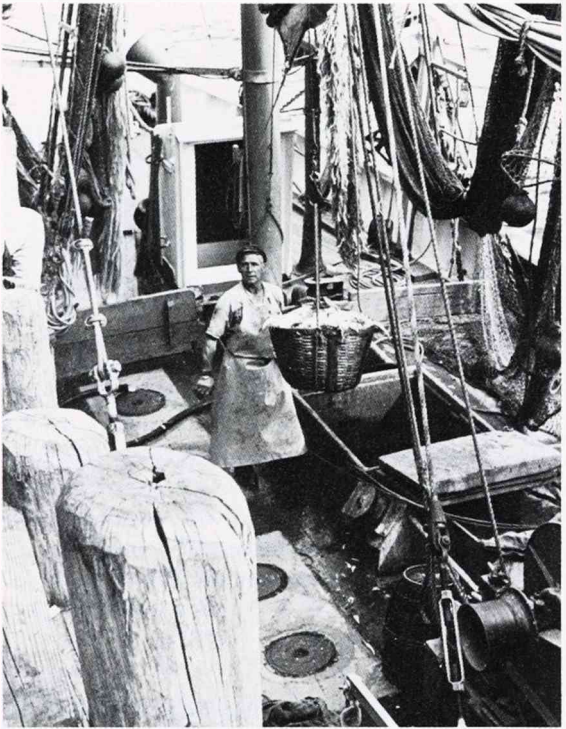
ROBERT W. MORSE, Special Consultant in Marine Policy, also Senior Scientist, Department of Ocean Engineering, 1973-present (on leave), previously Director, Marine Policy and Ocean Management Program, 1973-80; Ph.D. in Physics, Brown University. Research interests: Research and development management, science and technology policy.

SUSAN PETERSON, Policy Associate, 1978-present; Ph.D. in Anthropology, University of Hawaii. Research interests: International fisheries agreements, coastal communities, fisheries management and pollution.

RICHARD L. PRICE, Policy Associate, 1982; Ph.D. Geography, University of Oregon. Research interests: Public policy regarding settlement and land use for tourism and recreation in the coastal zones of the United States and Europe, particularly England, France, Italy.

DAVID A. ROSS, Director, Marine Policy and Ocean Management Program, 1980-present; Senior Scientist, Department of Geology and Geophysics, Sea Grant Coordinator; Ph.D. in Oceanography, Scripps Institution of Oceanography. Research interests: Policy problems associated with marine research and energy and mineral activities, marine science in the Middle East.

KURT M. SHUSTERICH, Marine Policy Fellow, 1981-82; Ph.D. in Political Science, University of California, Santa Barbara. Research interests: Deep seabed mining, Law of the Sea, Antarctica, international policy implications of strategic mineral development.



New England fisheries: a primary focus of MPOM research.



MPOM Fellows address many ocean resource issues.

Staff (continued)

MAYNARD SILVA, Marine Policy Fellow, 1981-82; Ph.D. in Political Science, University of California, Santa Barbara. Research interests: Impacts of competing and conflicting multiple uses of ocean resource, environmental ethics.

LEAH J. SMITH, Policy Associate, 1978-present (on leave of absence); Ph.D. in Economics, The Johns Hopkins University. Research interests: Fisheries management, aquaculture, marine resource economics, regulation of marine industries.

DAVID R. WATTERS, Marine Policy Fellow, 1980-82; Ph.D. in Anthropology, University of Pittsburgh. Research interests: Oceanography and prehistoric archaeology, marine adaptations in insular areas, Antillean archaeology.

Administrative Staff 1981-1982

ANN GOODWIN, Staff Assistant

KALEROY L. HATZIKON, Executive Assistant

ROSAMUND C. LADNER, Research Assistant

WILLIAM LAHEY, Research Assistant

ETHEL Le FAVE, Secretary

CHARLENE R. LEWIS, Marine Policy Administrator

KATHARINE F. WELLMAN, Research Assistant



For More Information Contact:

Marine Policy Administrator

Marine Policy and Ocean Management Program

Woods Hole Oceanographic Institution

Woods Hole, Massachusetts 02543

Phone (617) 548-1400 ext. 2867

Woods Hole Oceanographic Institution

Woods Hole, MA 02543

Phone: (617) 548-1400

Telex: 951679



September 1, 1981

Mrs. Elizabeth Mann Borghese
c/o Permanent Mission of Austria
to the United Nations
rue Varembe 9-11
Geneva, Switzerland

Dear Ms. Borghese:

Here are two Red Sea core slides that may
be of use to you. I don't seem to find anything
on the nodules.

I hope these will help.

Sincerely,

A handwritten signature in red ink that reads "Vicky Cullen". The signature is fluid and cursive.

Vicky Cullen
Publications and
Information Manager

Woods Hole Oceanographic Institution

Woods Hole, MA 02543

Phone: (617) 548-1400

Telex: 951679



July 28, 1981

Mrs. Elizabeth Mann Borghese
c/o Permanent Mission of Austria
to the United Nations
rue Varembe 9-11
Geneva
SWITZERLAND

Dear Mrs. Borghese:

I believe the enclosed slides will provide what you need. Caption material can be found in the enclosed clipped article from National Geographic magazine.

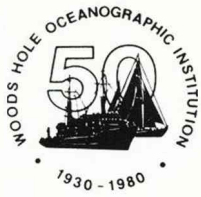
Please let me know if we can be of any further help to you.

Sincerely,

A handwritten signature in cursive script that reads "Vicky Cullen".

Vicky Cullen
Publications and
Information Manager

P.S. I haven't located any Red Sea core photos but will keep trying. The picture of the Atlantis II in the Black Sea can be used so long as credit is given to the National Geographic Society.



WOODS HOLE OCEANOGRAPHIC INSTITUTION

Woods Hole, Massachusetts 02543

Phone (617) 548-1400

EDUCATION OFFICE

23 February 1981

Dear Elisabeth:

This letter was attached to the back of your reference for Baidy Diene, which we received today. I hope you didn't go "out of your mind" looking for it. I know how frustrating that can be with paper! I'm sorry we stamped this letter before we realized it was not intended for us.

Sincerely yours,

A handwritten signature in red ink that reads 'Abbie'.

Abbie Alvin
Secretary

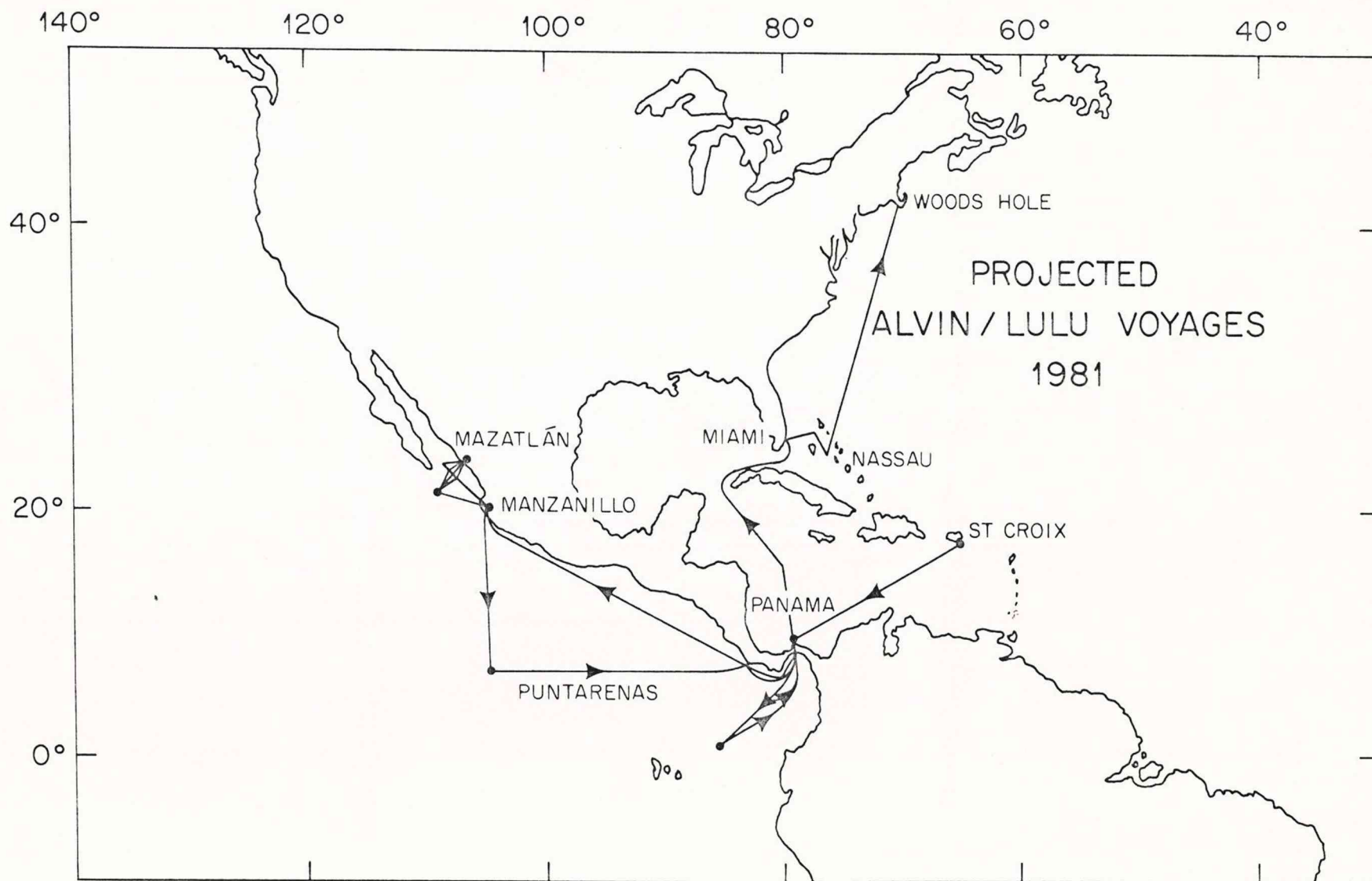
/aa
Enclosure

WOODS HOLE

SECTION 4

ALVIN/LULU Schedule For 1981

<u>Dates</u>	<u>Area of Operation and Objectives</u>	<u>Chief Scientist</u>	<u>Funding Agent</u>	<u>Port of Call</u>
1-15 Feb 81	Tamayo Transform Fault - Geology	P.J. Fox SUNY Albany	NSF	Manzanillo Mazatlan
19 Feb-6 Mar	EPR 21°N Geology/Geochem.	R.D. Ballard W.H.O.I.	NSF	Mazatlan
21 Mar-5 Apr	EPR 21°N Volcanology Biology	P. Lonsdale/SIO A.Alldredge/UCSB	ONR NSF	Mazatlan - "
9 Apr-22 Apr	EPR 21°N Biology	K. Smith SIO	NSF	Mazatlan
26 Apr-9 May	EPR 21°N Biology	K. Smith SIO	NSF	Manzanillo
13 May-2 Jun	MANOP M SITE MANOP Lander Volcanology	G. Heath/OSU P.Lonsdale/SIO	NSF ONR	Puntarenas, C.R.
8 Jul-27 Jul	Galapagos Rift Geology	M. Bender U.R.I.	NSF	Panama
1 Aug-21 Aug	Galapagos Rift Geology/Geochem.	R. Ballard W.H.O.I.	NSF	Panama
26 Aug-15 Sep	Galapagos Rift Geology	A. Malahoff NOAA	NOAA	Panama
3 Oct-12 Oct	Blake Outer Ridge Geology	R. Flood Lamont	ONR	Savannah
1 Nov-30 Nov	Florida/Bahamas	TO BE ASSIGNED		



1980



WOODS HOLE OCEANOGRAPHIC INSTITUTION

SHIP SCHEDULE

1980

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC			
Atlantis II	PUNTA ARENAS 10 GORDON	PUNTA ARENAS 17 NOWLIN	PUNTA ARENAS 31 5 DICK	CAPTOWN 7 12 THOMPSON/ SHILLING	RIO 16 22 HOGG/BISCAYE	RIO 20 25 JOHNSON	MAR DEL PLATA 24 29 GEORGI	PUNTA ARENAS 30 4 MCCARTNEY	PUNTA ARENAS 6 9 21 HOGG	RECIFE 24 18 LOHMANN	WOODS HOLE MAINTENANCE & CREW VACATION				
Knorr	MAINT. & LAYUP		BERMUDA 24 20 SCLATER/ VON HERZEN	WOODS HOLE 24 20 PURDY	WOODS HOLE 25 4 WILLIAMS/ HOLLISTER	BERMUDA 19 17 23 BRYAN/ THOMPSON	PUNTA DELGADA 19 24 FOX	WOODS HOLE 19 24 EWING (J.D.I.)	WOODS HOLE 17 23 12 WALSH (BRUCKHAGEN)	WOODS HOLE 20 8 HOLLISTER/ WILLIAMS (HEGGBLE)	WOODS HOLE 14 8 BREWER (T.T.O.)	WOODS HOLE 13 4 BRISCOE/ FOFONOFF			
Oceanus	← PORT CALLS: Woods Hole UNLESS OTHERWISE NOTED →														
	BARBADOS 18 BACON	BELEM 8 12 WALDEN	RECIFE 21 7 KATZ	PUNTA DELGADA 10 4 STOMMEL	Maint. 10 26 MCCARTNEY GEORGI	1 10 11 19 23 BRISCOE JANNASCH BUTMAN	16 28 MADIN	1 13 MURPHY/ GULLARD	21 28 2 11 JANNASCH BRISCOE	15 BERMUDA 14 BACON/ FARRINGTON/ SAYLES	22 17 SCHMITZ	31 23 BUTMAN	6 19 HAYS/ SPINDEL	24 3 BUTMAN	MAINT. & CREW VACATION
Alvin / Lulu	PANAMA 5 MALAHOFF	PANAMA 21 26 TRANSIT	MIAMI 2 6 14 WOODS HOLE - OVERHAUL			BERMUDA 20 15 26 BRYAN/ THOMPSON	PUNTA DELGADA 20 25 FOX	BERMUDA 19 24 GRASSLE TURNER JANNASCH WILLIAMS	WOODS HOLE 8 14 23 27 COOPER BUTMAN	WOODS HOLE MAINT	NORFOLK 30 13 17 2 BENNETT DILLON	NASSAU 5 14 18 23 GILL HECKER GRASSLE TURNER	ST. CROIX 20 30 5 16 GRASSLE TURNER JANNASCH	ST. CROIX STAND DOWN	
DATE 28 MAY 1980													APPROVED <i>Arthur E. Howell</i>		
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC			



Woods Hole Oceanographic Institution

Woods Hole, MA 02543

Phone: (617) 548-1400

TWX: 710-346-6601



June 23, 1980

Elisabeth Mann Borgese
Professor
Dept. of Political Sciences
Dalhousie University
Halifax, N.S. B3H 4H6
Canada

Dear Elisabeth,

Each year ALVIN makes about 100 dives. Each of those dives are awarded to a particular scientist who has total control over the selection of the two observers participating in any one dive. Enclosed you will find the 1980 dive schedule for ALVIN which lists the various Chief Scientists in charge of the various diving programs. As far as my particular diving programs are concerned, the 1981-1983 diving efforts have already been submitted to the National Science Foundation for funding, and the dives have also been committed to an agreed upon list of scientists who are part of my research team. Such advanced planning is necessitated by the high costs associated with each ALVIN dive (at the present time, each dive costs about \$10,000 to \$15,000). After many years of diving, I am making only a limited number of dives, averaging about two a year.

I am sorry to bear such poor news, but perhaps you may be more successful by contacting the other Chief Scientists listed on the enclosed diving schedule.

Sincerely,

Robert D. Ballard

RDB/ajs
Enclosure

WOODS HOLE OCEANOGRAPHIC INSTITUTION

WOODS HOLE, MASSACHUSETTS 02543

Department of Geology and Geophysics

Phone (617) 548-1400
TWX 710-346-6601

June 23, 1980

Elisabeth Mann Borgese
Department of Political Science
Dalhousie University
Halifax, N.S.
Canada B3H 4H6

Dear Elisabeth:

I will be in the Woods Hole area the week of July 7th. My best times are:

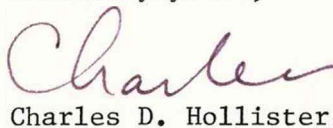
July 7 from 10 a.m. until noon

July 8 from 2 p.m. until 5 p.m.

July 11

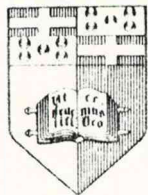
Let me know which time you prefer in order that my research secretary, Cindy, can make reservations for you.

Sincerely yours,

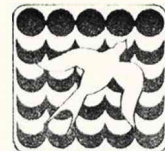

Charles D. Hollister

ccb-s

International Ocean Institute



Old University
Msida - Malta (TEL. 36450)



Pacem in Maribus

→ WOODS HOLE

September 24, 1980.

Dr. A. Alldredge
University of California
at Santa Barbara
Santa Barbara, California

Dear Dr. Alldredge:

Bob Ballard sent me the ALVIN/LULU schedule for 1981 and suggested that I should get in touch with you directly, concerning the trip of March 21-5April, for which you are chief scientist.

As I explained to Dr. Ballard, I am presently writing a book on seabed mining which will be published by Elsevier International in the Spring of 1982, and it would be of quite enormous importance to me to be able to get on a diving expedition.

I will participate in the Valdivia cruise through the Red Sea during the second half of February, on invitation by the Red Sea Commission, and am much looking forward to this experience. But a dive is something else again.

I am aware of course that there is a tremendous demand for participation in your expeditions, but I thought, it never hurts to try: Perhaps you have a cancellation and can put me in.

I am writing also to Dr. Lonsdale in this sense.

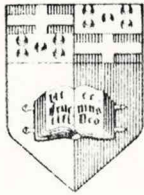
With all good wishes,

Sincerely yours,

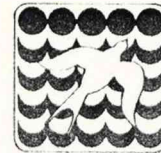
Elisabeth Mann Borgese
Department of Polit. Science
Dalhousie University
Halifax, N.S. B3H 4H6
Canada

Permanent address:

International Ocean Institute



Old University
Msida – Malta (TEL. 36450)



Pacem in Maribus

September 24, 1980

→ Dr. Crassle
Woods Hole Oceanographic Institution
Woods Hole, Mass. 02543
USA.

Dear Dr. Crassle:

Bob Ballard sent me the ALVIN/LULU schedule for 1980 and suggested that I should get in touch with you directly, concerning the trip to St Croix of December 5-16, for which you are chief scientist.

As I explained to Dr. Ballard, I am presently writing a book on seabed mining, which will be published by Elsevier International in the Spring of 1982, and it would be of quite enormous importance to me to be able to get on a diving expedition.

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I am also writing to Dr. Turner and Dr. Jannasch in this sense.

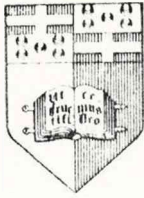
With all good wishes,

Sincerely yours,

Elisabeth Mann Borgese
Dept. of Political Science
Dalhousie University
Halifax, N.S. B3H 4H6
Canada

Permanent address:

International Ocean Institute



Old University
Msida – Malta (TEL. 36450)



September 24, 1980.

Dr. P. Lonsdale
SIO
→ Woods Hole Oceanographic Institution
Woods Hole, Mass. 02543
USA

Dear Dr. Lonsdale:

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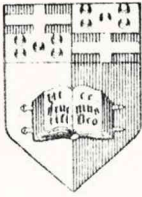
With all good wishes,

Sincerely yours,

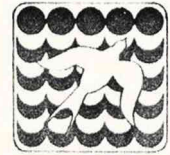
Elisabeth Mann Borgese
Department of Polit. Science
Dalhousie University
Halifax, N.S. B3H 4H6
Canada

Permanent address:

International Ocean Institute



Old University
Msida – Malta (TEL. 36450)



Pacem in Maribus

September 24, 1980.

→
Dr. Turner
Woods Hole Oceanographic Institution
Woods Hole, Mass. 02543
USA

Dear Dr. Turner:

Bob Ballard sent me the ALVIN/LULU schedule for 1980 and suggested that I should get in touch with you directly, concerning the trip to St. Croix of December 5-16, for which you are chief scientist.

As I explained to Dr. Ballard, I am presently writing a book on seabed mining, which will be published by Elsevier International in the Spring of 1982, and it would be of quite enormous importance to me to be able to get on a diving expedition.

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I am also writing to Dr. Crassle and Dr. Jannasch in this sense.

With all good wishes,

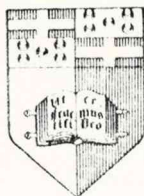
Sincerely yours,

Elisabeth Mann Borgese

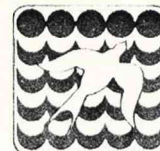
Elisabeth Mann Borgese
Dept. of Political Science
Dalhousie University
Halifax, N.S. B3H 4H6
Canada

Permanent address:

International Ocean Institute



Old University
Msida – Malta (TEL. 36450)



Pacem in Maribus

September 24, 1980.

Dr. Janasch
→ Woods Hole Oceanographic Institution
Woods Hole, Mass. 02543
USA.

Dear Dr. Janasch:

Bob Ballard sent me the ALVIN/LULU schedule for 1980 and suggested that I should get in touch with you directly, concerning the trip to St. Croix of December 5-16, for which you are chief scientist.

As I explained to Dr. Ballard, I am presently writing a book on seabed mining, which will be published by Elsevier International in the Spring of 1982, and it would be of quite enormous importance to me to be able to get on a diving expedition.

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I am also writing to Dr. Crassle and Dr. Turner in this sense.

With all good wishes,

Sincerely yours,

Elisabeth Mann Borgese

Elisabeth Mann Borgese
Dept. of Political Science
Dalhousie University
Halifax, N.S. B3H 4H6
Canada

Permanent address:

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASSACHUSETTS 02543

OFFICE OF THE PRESIDENT

August 23, 1977

Miss Elizabeth Mann Borgese
Sanatorium Bühlerhöhe
Schwarzwaldhochstrasse
7580 Bühl/Baden 13
Germany, Federal Republic

Dear Elizabeth:

I have only scanned the first Chapter of your Book and read sections of it. It is most intriguing. I want to read it in detail but that must wait a bit and I don't wish to delay writing you. I like the approach and especially the anecdotes interwoven through the text. I would like to meet Farmer Jamandre. I am sure he could teach us a great deal.

I am enclosing an article by John Ryther on Fish Farming. As you will see, he suggests that aquaculture could produce significantly more food fish if only 10% of the brackish water ponds were utilized.

Forgive this short note. I am in the midst of moving a house, an office, and two young Fye's into new quarters.

I will look forward to seeing move of your manuscript and hope I am less harrassed.

Best of everything,



Paul M. Fye

PMF/jpz

Zurich, July 26, 1977.

Dr. Paul Fye
Woods Hole Oceanographic Institution
Woods Hole, Mass.

Dear Paul:

I have been thinking about your IFIAS aquaculture study, and it seems to me that your approach is immensely useful and interesting. I think it will provide a great deal of inspiration for the final chapter of my new book and I would be grateful if you keep me posted on the progress of this work.

I am enclosing today a first draft of the first chapter of my new book. It is nothing more than a conceptual framework, with some illustrations in words and images. the images (pictures) are absolutely marvelous. But obviously, the real work is in the two following parts of the book. I am now deep in seaweeds. I would be very grateful, however, for your reactions/^{to}and criticism of this introductory chapter.

My address, for the next four weeks, will be

Sanatorium Bühlerhöhe
Schwarzwaldhochstrasse
7580 Bühl/Baden 13
Germany, Federal Republic
Telephone: 07226/216. Telex 0 781237.

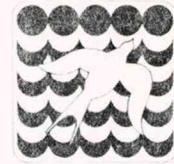
I keep my fingers crossed until August 2, when the Board of the Clark Foundation will decide on our grant....

Thanks again for everything.

Love,


Elisabeth Mann Borgese

Call him
Call Revelle



Pacem in Maribus

Box 4716

Santa Barbara, California 93103

July 13, 1977.

Dr. Paul Fye
Director
Woods Hole Oceanographic Institution
Woods Hole, Mass.

Dear Paul:

Thank you so very much for having arranged the appointment with Mr. Coleman. I have a feeling that it went very well indeed, and that it is very likely that we will get the \$30,000 for each of three years (1977, 78, and 79). This will be of absolutely enormous help to us. It means stability for the Yearbook for this initial phase. It means we can concentrate on its quality, and don't have to scrounge around for money: such a wasteful activity, as you know.

The Trustees meet on August 2. The grant for the Yearbook would fall under the 10% of the grants which the Trustees have decided to dedicate to projects outside the scope of their regular activities. Considering the interest of the brothers Clark in marine sciences, Mr. Coleman thinks it is extremely likely that they will indeed make a favorable decision.

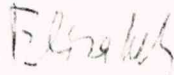
He thinks it would be extremely helpful to have a letter from you, somewhat to this effect: Data and information on the diverse uses of the oceans are, at present dispersed and often not easily accessible to the public. The Ocean Yearbook will be the first attempt to put them together comprehensively, in their interaction and in an easily accessible manner, updated every year. Considering the enormous and rapidly growing importance of the oceans in the economy of all nations and in international affairs, you think that it is the right moment to start such a Yearbook and that it will be an important, even an indispensable working tool for people dealing with ocean affairs everywhere, but especially in Third World Countries where decisions-makers do not have these data readily available, and they need them.

I am getting statements from Roger Revelle, and from Frank Njenga of Kenya and Jorge Castaneda of Mexico -- and that

should do it. It is really great.

Thanks again.

Yours as ever,



Elisabeth Mann Borgese
Chairman, Planning Council.

P.S. Mr. Coleman's address:

Mr. John R. Coleman
President
The Edna McConnell Clark Foundation
250 Park Avenue
New York, N.Y. 10017.

P.P.S. I am leaving for Santa Barbara on Friday, July 15,
for Europe on July 21. Will be gone until October. Can
always be reached through my Santa Barbara office.

Press Information from

Hollister
Woods Hole Oceanographic Institution

Woods Hole, Mass. 02543

February 10, 1977

OCEANUS MAGAZINE EXAMINES RESEARCH
ON SEABED DISPOSAL OF NUCLEAR WASTES

Woods Hole, Mass. -- After three years of initial research, investigators working at the Woods Hole Oceanographic Institution and elsewhere have not identified scientific reasons why high-level nuclear wastes could not be buried in remote areas of the seabed in ways which would isolate these deadly materials from the ocean and from all forms of life for more than a million years.

Instead, they say, the major difficulties in a "seabed option" might prove to be more of political than technological origin, despite the fact that there are existing national and international organizations that could administer a sub-seabed program.

Oceanus, the illustrated magazine of marine science published by the Woods Hole Oceanographic Institution, has devoted its entire winter issue to examining the scientific research done to date on this increasingly serious international disposal problem. The issue also focuses on the ocean policy implications that would be involved in any adoption of a seabed option by the U.S. government.

The lead article by Robert A. Frosch, Associate Director for Applied Oceanography at the Woods Hole Oceanographic Institution and Chairman of the Committee on Radioactive Waste Management of the National Academy of Sciences/National Research Council, states that under some circumstances sub-seabed sites might prove "superior to land sites".

The United States government is currently examining a number of potential land sites for the disposal of low-level, medium-level, and high-level wastes created in both the commercial and military nuclear fuel cycles. The sub-seabed

(more)

is regarded as a possible alternative to terrestrial isolation.

The articles in Oceanus, which cover geological, chemical, biological, and engineering studies on sub-seabed disposal, stress that much more research needs to be done before there could be adoption of such a program.

In addition to Dr. Frosch, the authors are Dr. Charles D. Hollister and David A. Deese, Woods Hole Oceanographic Institution; Drs. G. Ross Heath and Armand J. Silva, University of Rhode Island; Dr. Robert R. Hessler, Scripps Institution of Oceanography; and Dr. Peter A. Jumars, University of Washington.

The issue will be published February 15.

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WOODS HOLE NOTES

PUBLISHED FOR THE ASSOCIATES OF THE WOODS HOLE OCEANOGRAPHIC INSTITUTION

VOLUME 9 NUMBER 1

APRIL 1977

OIL and WATER

Oil in the marine environment has been much in the public mind recently, and this issue of Woods Hole Notes is largely devoted to an overview of work at the Institution related to that subject.

RECENT events have kept ocean oil spills much in the public mind, although there have no doubt been spills and leakage into the marine environment from man's activities since oil was discovered more than a century ago. The first studies of hydrocarbons, the major constituents of petroleum, in deep ocean surface sediments were not undertaken until 1971. In that year, Institution Associate Scientist John Farrington began following up nearshore studies underway for some years with analysis of samples taken on *Knorr* Voyage 19 from the abyssal plains of the North Atlantic and in the Hudson Canyon.

The western north Atlantic was chosen as a starting place because work there could build on studies of hydrocarbons in the organisms of the pelagic community by Senior Scientist Max Blumer and also by Senior Scientist John Teal and Joint Program Graduate Kathryn Burns.

Over the past five years, Farrington has examined sediments from some twenty-six western north Atlantic stations in the deep sea, on the continental shelf and slope, and in the New York Bight. High concentrations of hydrocarbons were found in and near the New York Bight where sewage sludge and harbor dredge dumping sites are the logical sources. There is evidence of some transport of the dumping material in the Hudson Channel midway to the edge of the continental shelf. Lesser amounts of hydrocarbons found farther out in the abyssal plain samples also document transport of some land-derived organic matter to the deep ocean.

"Oil pollution in the marine environment is a very difficult research problem," Farrington says. "Petroleum and petroleum products such as fuel oils are very complex mixtures of chemicals. When introduced by a variety of man's activities into the equally complex chemical soup of seawater, the petroleum pollutant is subject to a variety of



Aerial photograph of still-intact *ARGO MERCHANT* wreck leaking oil was taken by NASA aircraft December 19. Two days later the ship broke up and spilled remainder of cargo into the Atlantic.

interacting physical, chemical, biological, and geological processes. A thorough understanding of how the majority of these processes affects the distribution of oil pollutants in the sea is needed if we are to understand the potential long-term chronic effects of oil pollution in the marine environment."

In a paper presented to the American Association for the Advancement of Science annual meeting in Boston last year, Farrington listed three research areas that he feels must be pursued in order to understand ocean oil pollution:

- sources of oil in the ocean;
- the processes controlling the flux of the oil through the marine environment;
- the real and potential effects of oil pollution on marine organisms.

Chronic inputs of oil to the ocean are beginning to be understood. The report, *Petroleum in the Marine Environment**, published in December 1975 by the

*Available from the Printing and Publishing Office of the National Academy of Sciences, 2101 Constitution Avenue N.W., Washington, DC 20418, \$6.50.

National Academy of Sciences offers an extensive discussion of this subject. Senior Scientist John Hunt of the Institution Chemistry Department was vice chairman of the study group for the National Academy report, which was compiled with the advice of some sixty scientists from the United States and abroad. In a report to the U.S. Senate National Ocean Policy Study Committee last year, Hunt listed transportation as the largest regular source of oil input to the oceans (2.13 million metric tons per year) and urban runoff as the second major input (1.9 million). Coastal refinery operations, municipal and industrial waste, offshore drilling and oil production, atmospheric fallout, and natural seeps contribute the remainder of the 6.11 million metric tons of petroleum hydrocarbons the study group estimated is added to the oceans each year. Large-scale spills, such as the *Torrey Canyon* and the recent *Argo Merchant* spill off Nantucket are in addition to the chronic input estimates, so scientists are interested both in the effects of continuous low-level oil pollution as well as in the effects of large input to a small area.

The cliché "out of sight out of mind" does not apply to oil discharged into the sea, according to Farrington. "Oil pollutants in the marine environment are affected by a variety of alteration processes including evaporation; solubility; adsorption onto particulate matter, rocks, and beaches; deposition to sediments; direct incorporation into sediments and marine life; and formation into tarballs," he observes. "The ultimate fate of oil inputs is either burial into sediments, evaporation into the atmosphere, or chemical and biochemical degradation. The absence of a visible slick in a given area does not preclude oil contamination of living resources. The longevity of oil inputs in the marine environment is not well documented for more than a few cases. We do know from the study of a 1969 fuel oil spill in West Falmouth near the Institution

(see page 5) that oil can persist for as long as seven years in surface muds. This exposes the bottom dwelling organisms and hence the entire marine ecosystem to some degree of oil pollution for long periods of time."

Farrington's work on hydrocarbons in marine sediments is done in close collaboration with colleagues at several other institutions. Seventeen investigators from W.H.O.I., the University of Rhode Island, the Skidaway Institute of Oceanography, the Lamont-Doherty Geological Observatory, the State University of New York, and the University of Maryland base some of their work at the Marine Ecosystems Research Laboratory (MERL) organized in 1975 at the University of Rhode Island. At MERL, experimental work on the environmental stresses related to development of energy resources in or near the sea is underway in a dozen six-by-twenty-foot tanks where representative water column communities of zooplankton and phytoplankton are established along with benthic communities. The stresses that could be expected to accompany such energy resource development include contamination by petroleum, heavy metals, and toxic chemicals; entrainment in power plant effluents; and eutrophication of waters.

In one section of the work, low-level concentrations of Number Two fuel oil are introduced and the response and uptake by the organisms monitored. One objective is to determine the pathways chemicals take as they move through the ecosystem. If the pathways can be established in these controlled systems, this knowledge can serve as a guideline for designing research on the larger natural systems and eventually for ecosystem management decisions. Farrington's work with MERL concentrates on the aromatic hydrocarbons (those having a chemical structure characterized in early chemical studies by an aroma), which are among the more toxic components of oil. Recent advances in the use of two analytical instruments, the gas chromatograph and the mass spectrometer, have provided improved techniques for detecting low concentrations of aromatic hydrocarbons in marine samples and help chemists in tracing the pathways of hydrocarbons through an ecosystem.

Institution Associate Scientist Fred Grassle is also engaged in research at MERL. He and Dr. Judith Grassle (his wife) of the Marine Biological Laboratory in Woods Hole are studying the benthic community structure in the contained ecosystems and the effects of petroleum hydrocarbons on it. Their objectives include determination of rates of extinction and immigration of bottom species in the ecosystems and determination of the effects of petroleum on

bottom populations and on community diversity. One approach they use includes comparison of population growth and mortality of the common species in control ecosystems with those in tanks where oil has been introduced. Most of the work at MERL is supported by the Environmental Protection Agency (EPA).

Another EPA sponsored program in which Farrington is involved and which involves investigators from many institutions is the Mussel Watch Program of the Global Environmental Monitoring System (GEMS), one of four components of the United Nations-sponsored Earthwatch. (The other components are evaluation, research, and the exchange of information.) The purpose of GEMS is to provide early warning of impending natural or man-induced environmental changes or trends that threaten harm to human well-being.

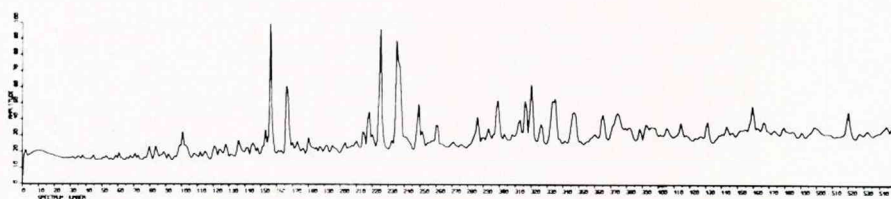
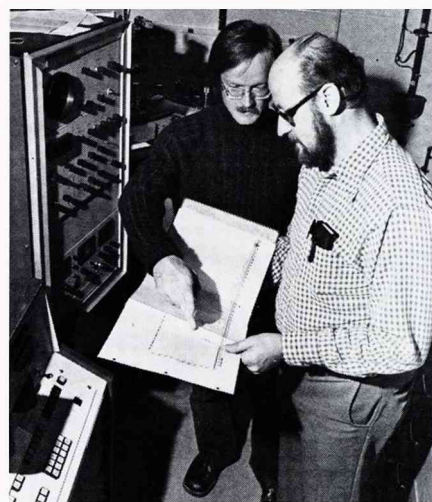
As it is impractical to attempt to monitor all possible components of the marine system, the Mussel Watch Program is intended to provide annual selective monitoring of the cosmopolitan mussels (or oysters, in some locations) in designated coastal areas. Both the soft and hard parts of the mussels accumulate some pollutants in their tissues and can, therefore, serve as sentinels of coastal contamination. Measurements include contaminant levels of metals (lead, cadmium, mercury, selenium, zinc, and copper), plutonium, americium, the halogenated hydrocarbons (such man-made substances as polychlorinated biphenyls), and petro-

leum hydrocarbons. It is in measurements of the latter that Farrington participates—samples come to him from some fifty U.S. coastal collection locations for analysis in his Woods Hole laboratory. One possibility for eventual application of this work would be the use of mussels as a pollution early-warning system. For example, bags of mussels might be hung on buoys in areas that need monitoring and checked regularly to see what changes in their composition have taken place.

"Measurements of oil pollutants in the water, sediment, and organisms of the United States coastal zone are limited in number," Farrington observes. "Only a few locations have been sampled more than once. In addition to lack of data, it is difficult to compare one area with another because of the differences in methods of analysis and criteria for distinguishing oil pollutant hydrocarbons from hydrocarbons present from natural processes. It is essential that further research be conducted on the transfer of oil pollutants into marine organisms, partitioning of the pollutants within the organisms, metabolism within the organisms, and release or discharge of oil pollutants from organisms no longer exposed to a polluted habitat. This information is basic to understanding the effects of oil pollution on marine organisms, to understanding the pathways of transfer and fate of oil pollutants in the marine environment, and to understanding if, when, and how oil pollutants accumulate in seafood."

Gas Chromatography – Mass Spectrometry

Farrington consults with Nelson Frew, who operates the gas chromatograph-mass spectrometer (GC-MS) facility for chemists at the Institution. The GC-MS provides a detailed analysis of the fuel oil composition after the oil has been extracted from seawater and chemically separated into aliphatic and aromatic fractions. Each fraction is further separated into individual components in the GC by gas-liquid phase partitioning. These components are then bombarded with electrons in the MS to produce fragmentation patterns characteristic of the components' molecular structures. The partial chromatogram below is the signature of the aromatic fraction of the number six fuel oil carried by the *Argo Merchant*. This profile is almost identical to that of number two fuel oil, which has, until now, been thought more toxic than the heavier oil.



Students Assess Impact Statement for Offshore Drilling

A group of biology students in the W.H.O.I./M.I.T. Joint Program met government and its decision-making process head-on recently. Each semester the students of biological oceanography organize a seminar exploring some aspect of life in the oceans. Subjects considered over the past several years have ranged from ecological theory to the biology of the southern ocean.

Last fall the group, which included five Joint Program students and five more from the Boston University Marine Program based in Woods Hole, decided to focus on the biological communities of Georges Bank and their interaction with the proposed development of oil resources there. They summarized their studies in a review of the Draft Environmental Statement prepared by the Department of the Interior's Bureau of Land Management for outer continental shelf lease sale number forty-two. W.H.O.I. students Mike Connor and Bob Howarth edited the written report of the seminar and also presented the views of the group in December at hearings held on the statement in Boston. Their appearance and the hearings were the subject of a *Boston Globe* column which is reprinted below.

Senior Scientist John Teal and Associate Scientists Fred Grassle and John Farrington guided the course along with guest lecturers from the Institution, the Marine Biological Laboratory, the National Marine Fisheries Service, and Martingale, Inc.

Among the summary conclusions of the report are these: "In the view of the draft environmental statement, a community either dies or it is unaffected. This is naive. We believe that chronic oil pollution associated with oil exploitation on Georges Bank may affect benthic communities in more subtle ways, changing the relative composition of the species in a given community, for example. This has important ramifications for the fisheries, for most of the commercially important fish of Georges Bank are bottom feeders, and a change in the bottom community structure may well change the abundances of the different species of fish . . . We also believe that the Bureau of Land Management's analysis of the time needed for recovery—weeks or months— following a spill is excessively optimistic. Apparently, the Bureau considers recovery to coincide with any repopulation by organisms. A better definition of recovery is a return to the same sort of biological community as existed prior



Joint Program student members of biology seminar locate Georges Bank fishing grounds on charts of area. Left to right, they are Bob Howarth, Larry Brand, Russell Cuhel, Joy Geiselman, and Mike Connor.

to the oil spill—the same sort of organisms in similar numbers and ages interacting with one another in the same way, with processes occurring at similar rates. A forest clearly has not recovered from a fire when the first few blades of grass colonize a few weeks after the fire . . . After a careful study of the

environmental statement for outer continental shelf sale number forty-two, we are unconvinced that the oil of Georges Bank can be exploited without serious risk to the commercial fisheries and to this environment. Is it worth risking one of the world's richest fisheries for a few weeks' or months' supply of oil?"

Grave doubts raised about offshore drilling by Ian Menzies, Boston Globe

The following column appeared in the Boston Globe December 13, 1976, after Columnist Ian Menzies had attended hearings on the environmental impact of possible oil drilling off the New England coast. It is reprinted here courtesy of the Boston Globe.

They were numbers 33 and 34 on the witness list.

When their names were called they walked up to the table just vacated by witness 32, sat down, shuffled some papers, adjusted the two separate microphones and looked up toward the members of the Federal hearing panel seated on the stage in front and above them.

They were young, in their mid-20's, casually dressed. One wore a thick white fisherman's-type sweater.

They identified themselves as Michael S. Connor and Robert W. Howarth of the Woods Hole Oceanographic Institution-MIT Joint Graduate Program in Biological Oceanography.

They explained that they, along with eight other graduate students, some from Boston University, had spent all fall studying and researching the possible environmental effects of drilling for offshore oil on Georges Bank.

Connor and Howarth, like others, had come to Boston's Howard Johnson Hotel last week to comment on the draft environmental impact statement drawn up by the Department of the Interior's Bureau of Land Management.

This 2000-page document, which has been analyzed by concerned groups in recent weeks, is one of the final steps, and the last public one, in the process scheduled, in this case, to lead to the sale of oil leases on Georges Bank around June of next year.

All comments and criticisms concerning the draft environmental impact statement have to be taken into consideration by Interior in drawing up the final statement, but the final statement, although available to the public, is not given a public hearing.

It is on the basis of the final statement (due May 1977) that the decision is made whether or not to hold a lease sale, whether to delete particular tracts or place restrictions on specific tracts.

And the person who makes that decision—go or no-go—is the Secretary of the Interior who, interestingly, won't be the same one currently holding office.

(Continued, next page)

What took place at last week's public hearing was therefore of added significance because a new Interior team would feel obliged to proceed with considerable care.

And it was something of a surprise at last week's hearing to find almost all Massachusetts's leading public officials, both state and Federal, advising extreme caution, modification and even delay.

Gov. Dukakis reiterated his support of offshore oil development but called for "stringent environmental controls."

Secretary of the Environment Evelyn Murphy criticized the impact statement as "less than excellent" and urged that one first be done on the exploration phase and then a second on development while, on the same note, Atty. Gen. Francis Bellotti charged that the process all but prohibits intelligent and informed action by the state.

All three pointed out that strict environmental enforcement would not only protect the state's brittle ecological balance but also provide jobs, lots of them, something underemphasized heretofore.

Industry, as expected, advocated "getting on with it," criticized the slowness of the process, spoke of the national

need for oil and de-emphasized the environmental risks.

But it was left to Connor and Howarth to really nail the Bureau's impact statement on the basis of its depth and credibility. With carefully documented and referenced statements, they gently tore it apart as "weak, inadequate and contradictory," and with making assumptions based on questionable and insufficient data.

They pointed out, for instance, something that had even escaped the notice of some state officials—that oil, if found, would not be piped ashore, the safest method, but tankered to New Jersey which would increase the chance of spills.

Further, they brought out that the impact statement, in speaking of the risk of spills, used pipeline data (safer), while at the same time indicating the oil would be tankered (riskier).

They presented field evidence that oil spills do not dissipate as quickly as the Bureau's statement claims; that it sinks into the sediment where New England's bottom-feeding fish would encounter it.

But their emphasis was that Georges Bank is a breeding ground; that fish eggs

and larvae float for months on the surface and can easily be wiped out by an oil spill which could destroy an entire age-class of fish.

And they pointed out that, around a fishing ground, accumulating small oil spills, which might never be publicized, could cause as much damage as a Torrey Canyon disaster.

They also questioned the impact statement's claim that oil spills could be contained on Georges Bank because the weather is not all that severe. Interior, they said, had grossly underestimated weather severity.

They also pointed out that, based on present estimates, the oil that lies beneath Georges Bank could only supply New England's total energy needs for three months and the nation's for 35 days.

What Connor and Howarth said deserves wide public exposure, not as an argument to kill oil development on Georges Bank, but to illustrate the risks we take clashing with a biological system without adequate knowledge.

Georges Bank is not just another part of the ocean; it is one of the world's great food reserves. ■



Farrington, left, Hampson, and Sanders at main lab meeting on cruise "weather window" before OCEANUS departed December 20 under threatening skies for sampling near ARGO MERCHANT.

Oceanus Participated in Argo Merchant Sampling

OCEANUS made two cruises to the areas expected to be affected by the *Argo Merchant* spill off Nantucket in late December. As ships are scheduled six months to a year in advance, it was only by chance the ship was available at all. A one-week cruise for biological studies in Sargasso Sea and continental slope waters returned to Woods Hole a day early to board the research party for the oil spill work. Associate Scientist John Milliman of the Geology and Geophysics Department was Chief Scientist for both cruises, and some eighteen staff members and students were involved nearly full-time for many days in active and advisory spill response capacities.

As it happened, though the tanker had been leaking oil for nearly a week,

the cruise left Woods Hole December 20, the afternoon before the ship broke up and spilled the rest of its seven and a half million gallon cargo of thick number six fuel oil. Worsening weather sent the ship back to port the next day with a total of nineteen samples from three locations. The spill itself was avoided in favor of sampling for background data north and west of the wreck in the expected path of the spill. Later sampling in the area crossed by the oil would then allow evaluation of the environmental impact of the spill.

A second cruise went out December 28 in terrible weather to take more baseline samples, to deploy current meters for the United States Geological Survey, and to take samples from an area already

traversed by the spill. *Oceanus*' sister ship *Endeavour* of the University of Rhode Island has made several sampling cruises as have National Oceanic and Atmospheric Administration (NOAA) and Coast Guard ships.

Institution scientists commit their time to projects months or even years in advance when they apply for and receive research grants. Therefore, the amount of effort they can devote to quick-response situations is limited. Most of the follow-up analysis of samples from the *Argo Merchant* cruises is being done elsewhere, though the early biological samples are being processed and stored in Howard Sanders' laboratory. Sanders was aboard the first *Oceanus* cruise and also led a team that did extensive sampling in the intertidal region on Nantucket against the possibility, fortunately unrealized, that the oil might wash ashore. Initial screening of chemical sediment samples was done at the Coast Guard Research and Development Center in Groton, Connecticut. Those showing substantial quantities of oil will undergo further analysis at the NOAA Environmental Research Laboratories located in Seattle in anticipation of dealing with the environmental impact of shipping Alaskan slope oil. Institution Associate Scientist John Farrington is one of a six-member review committee charged with oversight of the work and final publication of results. ■

1969 Cape Cod Spill Has Provided Nearby Field Laboratory for Extended Study



Mud-dwelling creatures were forced to the surface where they died of immediate toxic effects of oil spilled in Wild Harbor in 1969.



Howard Sanders collects samples in intertidal area of Wild Harbor on one of repeated sampling trips during extended study of 1969 oil spill.

A small oil spill—about 175,000 gallons—occurred when a barge grounded off West Falmouth, Massachusetts, on September 16, 1969. This spill inadvertently created an easily accessible field laboratory for scientists at the Woods Hole Oceanographic Institution. They took their first samples on September 19, establishing stations in the Wild Harbor River, Wild Harbor, and adjacent marshes. Control stations were also established in nearby Sippewissett marsh, which was not contaminated by the oil, and offshore where effects of the oil were not expected to reach. Contrary to predictions based on conventional studies of oil spills, however, the oil contamination expanded steadily with time, as wind, waves, and bottom sediments interacted to spread the oil. Within three weeks, contamination had spread to the nearest offshore station, and another was established twice as far away. Three months later that, too, was polluted.

By noon the day after the grounding a few piles of dead lobsters were to be seen on the shore not far from the barge. Falmouth Shellfish Warden George Souza told *New Yorker* magazine writer William Wertenbaker about a walk he took the evening following the spill. "I followed the stuff up the river, in the estuaries. After a while, you could see things coming out of the mud, looking for a place to go. You could actually see clams dying, suffocating. Their necks were sticking way out, and they were just laying over on their sides. The next tide toppled them all over."

During the next week or so, the marine animal population of the spill area declined from about 200,000 animals per square meter to about two animals per square meter. Bottom animals are the specialty of Senior Scientist Howard Sanders, and they are of great importance in pollution studies because they don't move. As Sanders told Wertenbaker, "They can't get up and go away

when things don't suit them any more. A fish can do that, and most of the oil pollution studies since the Torrey Canyon have relied on fish counts. That's why few of them mean anything at all. The fact that commercial fishermen are catching fish within a certain time after an oil spill tells you nothing about what oil does to fish, because there's no way for you to know how long the fish have been there. But with clams and crabs and worms you have a chance of seeing what happens and how long it takes. By October, we were looking at a biological desert in the intertidal area. It was a strange autumn. You could go down to the marsh and there wouldn't even be a gnat. We took samples in which there was nothing alive at all. That was our lowest ebb. We weren't at all prepared for it—you can go anywhere in Buzzards Bay and find lots of animals."

For the analyses, bottom samples were carefully taken from the marshes and from the offshore areas. The mud was then washed through sieves to recover living or dead organisms, which were preserved, identified, and counted. Results of counts from the polluted areas were compared with those from control areas not polluted by the spill.

Early in October, the first worm was found. It was *Capitella capitata*, which Sanders describes as "an extreme opportunist with unbelievable physical resistance." Soon they were everywhere, in the sand, mud, peat, salt marsh, and in shallow areas offshore. A series of opportunistic species bloomed and then crashed after a few months as time and tide began to cleanse the polluted areas and growing conditions for less opportunistic species returned. This pattern was to repeat itself in various areas over the next months as water motion moved the still-toxic oil around.

"It's pretty clear what happened," Sanders told Wertenbaker. "After everything died, there was no longer anything

to hold the mud and the banks together, and they began to erode. The peat in the marsh had sopped up the oil like so much sponge, and when the grass died, the peat began to slide down into the creeks. Below the tide line, the mud is held together with thousands of little worm tubes. When the worms died, all that binding network went. After a while there were deltas of sand where there had been nice thick mud. The sediment was certainly moving, and it had certainly been full of oil right after the spill."

Some of the stations would have shown no oil or dead animals for months and then suddenly there would be a fresh kill, and chemical samples would show characteristic traces of the oil from the West Falmouth spill.

Chemical analysis of the water, sediments, and organisms were carried out by Senior Scientist Max Blumer (see tribute to Blumer on page 8) using a gas chromatograph. He described the instrument to Wertenbaker as "about the size and shape of a single file cabinet and very disappointing to look at. It heats and evaporates a sample and measures how much evaporates at different temperatures, producing a profile of its components. For the West Falmouth oil, the profile looks like a mound with many sharp peaks sticking up—like a porcupine."

No oil was ever visible in West Falmouth Harbor, where the town of Falmouth had a heavy population of seed scallops that were to be ready for harvest in October the following year. Shellfish Warden Souza said, "When I got there the morning of the wreck, they were all acting kind of peculiar. The ones that were swimming seemed kind of sluggish, instead of darting around, the way they do usually, and it appeared to me their equilibrium was off. The whole seedbed was opening and closing in rhythm, pulsating, as if it were looking for a place to go." The shellfishing beds

were closed throughout the area and many remain closed, largely because no standard has been arrived at to allow for their opening.

Yearling scallops which had been young at the time of the spill were stunted in the spring and contained as much oil as the mature scallops of the fall. Shellfish areas that had not been polluted in the fall showed the West Falmouth fuel oil profile in the spring.

The polluted areas expanded tenfold between mid-autumn and mid-spring until some 5,000 acres offshore and 500 acres of tidal river and marshes were affected. The areas initially affected were still nearly lifeless the following May except for the *Capitella* and a few hardy blue mussels and ribbed mussels that survived the spill and the winter but turned out to be sterile and then died the next summer. It appears that all the mussels' energy went into body maintenance with none left over for gonad development, so they could not breed. No marsh grass grew the next season, and wave after wave of larvae and eggs washed into the polluted area and died as creatures in neighboring areas spawned. By autumn, a year after the spill, a few young representatives of most species were occupying the sediments in all but the most polluted spots,

but there were still no birds because there was nothing for them to eat. It was during the second year that something approaching normal growth began to appear.

Today the animal population is essentially back to normal, but the peat or marshy areas are still soaked with oil. Footprints made in the peat still show an oil film as they fill with water. The oil soaked in as much as a meter and once below the surface in an oxygen-free environment there is nothing to degrade it. So each tide still leaches small amounts from the marshes.

Responses of two marsh animals to the oil spilled at Wild Harbor were studied in detail by Joint Program graduate Kathryn Burns for her doctoral dissertation with Senior Scientist John Teal as advisor. Burns found that the marsh minnow was able to adapt to the pollutant oil by inducing enzymes which could degrade the oil, reducing the amount it had absorbed to tolerable levels. The fiddler crab, on the other hand, could not. Crabs, like many other crustacea, are sensitive to pollution and cannot adjust, even over periods of several years. Although there were crabs found in the oiled marsh throughout the study, they were adult males that migrated into the unusual

environment, absorbed oil, and eventually died. Their body systems for ridding themselves of oil could not have reduced their body burden of oil to zero in less than their maximum lifespan under good conditions.

Teal has studied salt marshes for many years. "Since the fiddler crab lives by burrowing into and feeding on the mud," he says, "they could not escape being poisoned by the oil. Mobile animals characteristically expand their population by migration into surrounding regions. They normally do not expand into areas unsuitable to them, but fiddler crabs do not seem to recognize the presence of oil as a factor which can make an otherwise suitable marsh poisonous." The same behavior and fatal results have been found by Sanders for small, shrimp-like amphipods, important as fish food, which live on the bay bottom in the Wild Harbor area.

Work on the spill in West Falmouth convinced the scientists involved that oil spills in the marine environment do have long-range effects. This has not been a popular view, particularly with the oil industry. Blumer and Sanders, particularly, suffered attacks on their characters as well as their conclusions when their findings were first published. A heavily promoted study of the area affected by the Santa Barbara blowout reported increased catches of fish and extensive damage only to birds and to one species of barnacle. It is not well known that there has been an out-of-court settlement with Santa Barbara fishermen who sued the oil developers for reduced catch and ecological damages. Many scientists questioned the methods of the Santa Barbara study, and Blumer observed, "It is unfortunate that the research that has been done on oil spills and pollution has been dominated so strongly by subjective, visual observations. The difficulty of measuring the total impact of oil on marine life has led many to doubt the seriousness of the Santa Barbara study. Our findings were based on objective chemical analyses and quantitative biological measurements, rather than on subjective visual observations, and they indict oil as a pollutant with severe biological effects." Some other studies have recently supported the idea that oil spills have long-term effects.

The definitive publication on the extended biological study of the West Falmouth oil spill is yet to be published. Sanders says he has three hundred pages now and is not yet finished. In the meantime, spills from three barges within a three-mile area of Buzzards Bay—September 1969, October 1974, and January 1977—have provided several new opportunities to study oil in the nearby marine environment. ■

Policy Fellows Study Spill, Drilling Impacts

AS we move from ocean exploration into an era of ocean exploitation, questions of management become more and more important in marine affairs. The creation of the Marine Policy and Ocean Management Program at the Institution in 1970 responded to this progression. It provides research and study fellowships for young professionals who wish to direct their careers toward problems involving the uses of the oceans.

Program Fellow Peter Fricke, a sociologist, has been following the progress of the response to the *Argo Merchant* spill very closely, not only for the Institution but also for the wider scientific and government agency community. He is cataloging and archiving press reports on the spill for the National Oceanic and Atmospheric Administration as a base for a report on the sociology of the communications and information transfer among the government agencies, the press, and the scientific community. Fricke is also studying the movement of oil by tanker and barge through New England waters and will soon begin a study of sea traffic management systems, focusing particularly on the Georges Bank area.

Should there be exploration for and production of oil on Georges Bank, some of the greatest impact will fall on

the New England fishing industry which depends on the rich harvest of the area for its livelihood. A study conducted by several Marine Policy and Ocean Management Fellows on "Effects on Commercial Fishing of Petroleum Development off the Northeastern United States" was published last summer. It discusses the nature and character of interactions to be anticipated between the two industries, identifies specific areas of conflict and cooperation, and makes recommendations for minimizing conflict and maximizing cooperation. The general conclusion of the report is that oil development on the outer continental shelf off the northeastern United States is not likely to have a major overall impact on the commercial fishing industry. However, an effect which is small with respect to the whole industry may be very important to an individual fisherman or to a given fishing port, and the report attempts to identify the conflicts likely to arise between the two industries and suggests ways for minimizing them.

The report explains in detail the character and technology of both offshore fishing and petroleum development and describes the physical environment of the coastal area and the legal and regulatory framework for planning and resolution of conflicts. ■

Response of Organisms to Oil Is Under Study

THE first experimental studies of contamination of marine organisms exposed for long periods to low levels of petroleum hydrocarbons were undertaken at the Institution in 1971 by Associate Scientist John Stegeman and Senior Scientist John Teal. They exposed oysters (*Crasostrea virginica*) to #2 fuel oil for up to seven weeks and then removed them to clean water. Their analysis showed that the amount of hydrocarbons accumulated in the tissues of oysters living in contaminated water came to equilibrium with the amount in the water, and that an organism's lipid (fat) content strongly influenced this process. When the animals were moved to uncontaminated water, they expelled about ninety percent of the accumulated hydrocarbons fairly rapidly, within one to two weeks, and the remainder was released slowly over a longer period of time. Studies elsewhere have shown similar results, and now biologists generally accept these phenomena as typical for marine animals, with allowances for level and duration of exposure, rates of hydrocarbon metabolism, and other physical differences between organisms.

Following the oyster studies, Stegeman, along with Assistant Scientist Dennis Sabo, began to look at the effects of petroleum on metabolic processes in fish tissues. The aim of this Sea Grant supported project is to provide an index of effects of hydrocarbons in fish, to serve in a diagnostic and predictive capacity. This work initially focused on lipid and carbohydrate metabolism in killifish (*Fundulus heteroclitus*) and scup (*Stenotomus versicolor*) and involved incubating living tissue samples with an acetate or glucose compound containing carbon-14 to provide a tracer for various metabolic activities. Comparison of tissues from contaminated and uncontaminated fish showed that normal lipid metabolism was altered in certain contaminated individuals, including some *Fundulus* samples from the areas affected by the West Falmouth oil spill.

Stegeman's current work along this line, being conducted in cooperation with Sabo and also scientists from Kiel, Germany, and the University of Rhode Island, is with winter flounder (*Pseudopleuronectes americanus*), which are being exposed to different concentrations of petroleum for varied periods. Animals are then examined for hydrocarbon content and various physiological and metabolic parameters, including aspects of lipid metabolism, energy metabolism, and the activity of hydrocarbon metabolizing enzymes in the liver. Tissues are also being examined microscopically for

cellular structure, and blood samples taken from the fish are clinically analyzed for substances present and for enzyme activities which may be diagnostically important. Special attention is being paid to effects on males and females at spawning time, and eggs from these fish, fertilized in the laboratory, are monitored for developmental abnormalities and metabolic function. This is the first coordinated study of effects of petroleum hydrocarbons on fish.

A factor important in altering the half-life, hence the effect, of hydrocarbons in fish is the rate of hydrocarbon metabolism (degradation) carried out by an enzyme system which may be involved in many functions of the fish's body but is not very well understood in fish. With Sea Grant support, Stegeman has been using several species to characterize this system in fish and describe functional differences under different conditions. One aspect of particular interest is the nature of the products of

hydrocarbon metabolism in fish. Metabolic conversion of certain hydrocarbons by mammals may yield several products, some of which may be more toxic than the parent compound, possessing mutagenic or carcinogenic activity. Stegeman recently has determined that certain fish are very active in converting some aromatic hydrocarbons to highly mutagenic (carcinogenic?) products.

The activity of the hydrocarbon metabolizing enzymes in fish may change after exposure to oil. In a recently initiated study, supported by the National Science Foundation, Stegeman will be further investigating the feasibility of developing a bioassay system employing this enzyme activity. This work seeks to provide information concerning sources of variability in rates of hydrocarbon metabolism, aspects of which are basic to understanding the physiology of marine fish and their interactions with the external chemical environment. ■



Associates' Activities

PHOTOGRAPHS above and below show some of the more than 200 Associates and guests who attended last fall's Annual Associates' Day of Science in Woods Hole. Day's activities included morning lectures on several areas of research and an afternoon of open house visits to several areas of the village and the Quissett Campus. Associates' dinners in Woods Hole, Boston, and New York this month feature Director Paul M. Fye discussing the law of the sea negotiations and their effect on marine science.

PHOTOS BY FRANK MEDEIROS



Ships Need Encyclopedias

EACH year the Institution's research vessels leave home port at Woods Hole for cruises which may last from one month to two years. Libraries aboard each of the larger vessels, *Atlantis II*, *Knorr*, and *Oceanus*, serve as both the social and intellectual center of shipboard life. Scientists and ships' crew members use the recreational reading material to while away off-duty hours, to escape the constrictions of close quarters, and to develop skills in their individual hobbies. The music tapes provide individual and group entertainment. The scientific section of the library provides the scientists a reference library and the students a study collection. Special favorites of both scientific and regular crew members are the encyclopedias. From their contents controversies are settled, private research projects pursued, and self-education undertaken. Unfortunately, the *Encyclopaedia Britannica* editions now housed in the ships' libraries are so out of date they can no longer adequately serve these purposes. (*Atlantis II* has the 1951 edition, *Knorr* the 1966 edition, and *Oceanus* the 1961 edition.)

If a ship's library is given a recent set of the new version of the *Encyclopaedia Britannica* or the purchase price (\$579.00 each) of the 1977 edition, a special bookplate will be placed in each volume identifying the donor. Such a gift is, of course, tax deductible. The donor can be assured that he or she has enriched shipboard life for many years to come. Anyone wishing additional information on this or other needs of ships' libraries may contact Librarian Carolyn Winn at the Institution.

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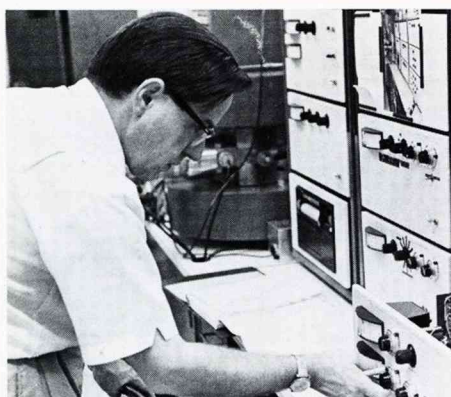
WOODS HOLE NOTES

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MAX BLUMER

SENIOR Scientist Max Blumer died February 11 at the age of 54 following a long illness. A native of Switzerland, he joined the chemistry staff of the Institution in 1959. For biographical notes accompanying an article entitled "Polycyclic Aromatic Compounds in Nature" in *Scientific American* last year, he wrote, "I have been fortunate in finding an environment where I could remain intimately involved with the experiment. Nature is too complex and my anticipation of the unexpected is too limited to allow me to delegate most observations. This attitude has been rewarded many times when I have suddenly found a consistent explanation for seemingly independent observations, often separated by many years." He was the author of 99 publications in geochemistry and analytical chemistry and five publications in electronics as well as co-author of two patents.

Following completion of his Ph.D. at the University of Basel and postdoctoral research years at the University of Minnesota and the Scripps Institution of Oceanography, Blumer worked for several years in European Shell oil company laboratories where he began work with hydrocarbons that would continue through his career. He did extensive analysis of water, sediment, and organism samples from the area polluted by the West Falmouth oil spill in 1969. (Falmouth Shellfish Warden George Souza refers to him as "my good friend"—Blumer stepped in to analyze samples for Souza when state laboratory equipment failed.) It was on the basis of this work that he told the NATO Committee on Challenges to Modern Society meeting in Belgium in 1970, "Oil and oil products must be recognized as poisons that damage the marine ecology and that are dangerous to man." He went on to call for worldwide assessment of



Dr. Blumer at mass spectrometer.

the influx of petroleum to the ocean, extreme caution in the use and transportation of petroleum, and research into the impact of oil pollution on marine organisms, persistence of hydrocarbon pollution in seawater and in marine organisms, and the tolerance of the marine environment for oil pollution.

In a tribute to Blumer, Chemistry Department Chairman Derek Spencer and another friend and colleague, Senior Scientist Vaughan Bowen, wrote: "Max Blumer has had a distinguished career marked with major contributions to organic geochemistry. Although there have been many individual highlights in his work, it is the dedication to new knowledge and his constant drive to press analytical techniques to their ultimate resolution that have given the touch of greatness to his endeavors. In 1950 Max published his first report of 'fossil pigments' in Swiss carbonate rocks of marine origin; in 1961 he published his first report of the concentrations of carcinogenic hydrocarbons in soils. His research ever since has been animated by two themes: first, the chemical diversity to be observed in nature and its significance in organic chemistry; second, questions posed by the distri-

bution of toxic and carcinogenic organic compounds throughout the environment, often from man's activities. But an even longer-standing interest in the niceties of quantitative analytical chemistry can be seen to have pervaded each step of his work. It has never been enough to Max to know that petroleum hydrocarbons were released or that pigments were present; so long as an analytical procedure existed that could show which specific compounds, and their relative abundance, he pursued this knowledge ruthlessly and often with the result of improving by several quantum jumps the sensitivity or precision of his chosen techniques. His stimulation, example, and leadership will continue to be vital factors in the development of environmental chemistry."

THE PRESIDENT'S LETTER

Dear Associates:

If I were asked what sort of a research scientist could best advance this institution and the ocean sciences, I can think of no better example than Max Blumer, whose untimely demise is reported on this page.

His integration of a broad respect for the complexities of the natural environment, a keen perception of new applications of analytical chemistry and an appreciation of the support his work received from other branches of science set a criterion that his followers will find hard to match. Certainly none can outdo his quiet modesty and subtle good cheer. All of you who knew him, however slightly, will understand how very much he will be missed.

Sincerely yours,

Townsend Hornor
President of the Associates