

DEEP-SEA NEWSLETTER



No. 25, December 1996

8TH DEEP-SEA BIOLOGY SYMPOSIUM
MONTEREY BAY AQUARIUM MONTEREY, CALIFORNIA

Monday Sep. 22-Friday Sep. 26, 1997

SECOND ANNOUNCEMENT

Theme: Biology and Ecology of the Deep-Sea

Symposium office:

Annette Gough/Ginger Hopkins
8th Deep-Sea Biology Symposium
Monterey Bay Aquarium Research Institute
Box 628
Moss Landing California 95039-0628

Tele: 408 775 1701

Fax: 408 775 1645

e-mail: goan@mbari.org

web site: <http://www@mbari.org>

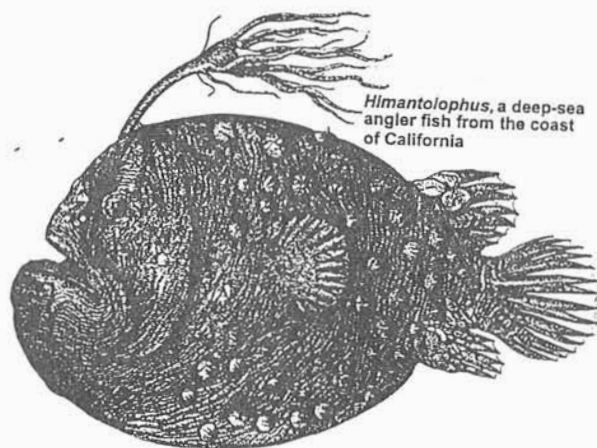
Organizing committee:

Dr. James Barry
Dr. Bruce Robison
Monterey Bay Aquarium Research Institute

Dr. Chris Harrold
Dr. Randy Kochevar
Monterey Bay Aquarium

Language:

The Symposium will be in English



Himantolophus, a deep-sea angler fish from the coast of California

Symposium Fee:

Before June 15, 1997

\$140.00 (USD), students \$75.00 (USD)

After June 15, 1997

\$200.00 (USD), students \$90.00 (USD)

Symposium Information

The goal of the Organizing Committee is to bring together all members of the international deep-sea research community. The Symposium is open to scientists from all countries. Young scientists and students are encouraged to participate and present their work. Following the first announcement, **85 scientists** from **11 countries** have already expressed interest in participating in the Symposium. To date, topics of presentations include deep-sea biota, community structure, hydrothermal vents, cold seeps, seamounts, microbiology, fluxes, food chains and studies carried out with remotely operated vehicles. The organizing committee hopes that many more will register and take advantage of the weather and scenery that makes Monterey such a popular resort destination at this time of the year.

Canada

Andrew Grant McArthur

Denmark

Jørgen B. Kirkegaard
Torben Wolff

France

Gaill Francoise

Germany

L.A. Beck
Hartmut Bluhm
Antje Boeti
Angelica Brandt
Dieter Fiege
Norbert Huelsmann
Gerd Schriever
Thomas Soltwedel
Hjalmar Thiel
H.J. Wagner
Horst Weikert

Japan

Yoshihisa Shirayama
James Hunt

Mexico

Elva G. Escobar Briones

Norway

Jon-Arne Sneli

Portugal

Manuel Biscoito
Luiz Saldanha

Russia

Andrey Azovsky
Andrey V. Gebruk
Vadim Mokievsky
Alexander L. Vereshchaka
Dmitry G. Zhadan

UK

Simon Creasey
John Gordon
P. Graham
Julian C. Partridge
I.G. (Monty) Priede
Alex Rogers
H.J. Wagner

USA

Allen Andrews
Pamela Arnofsky
Amy Baco
Joan Bernhard
Ewann Agenbroad Berntson

USA, continued

James A. Blake
Laura Brink
Erica Burton
Robert S. Carney
Pierre Chevaldonne
Jody W. Deming
Kevin Eckelbarger
Donald D. Flescher
Tamara Frank
James W. Hagadorn
Marcia Gowing
Prof. Greene
Gordon Hendler
Holger W. Jannasch
Wally Jarman
Kristen Brynie Kaplan
Michael Latz
Lisa Levin
Baldo Marinovic
Charles G. Messing
John Norenburg
Shannon Parratt
Virginia Rich
Richard Rosenblatt
Amelie H. Scheltema
Rudolf S. Scheltema
Carol T. Stuart
David Thistle

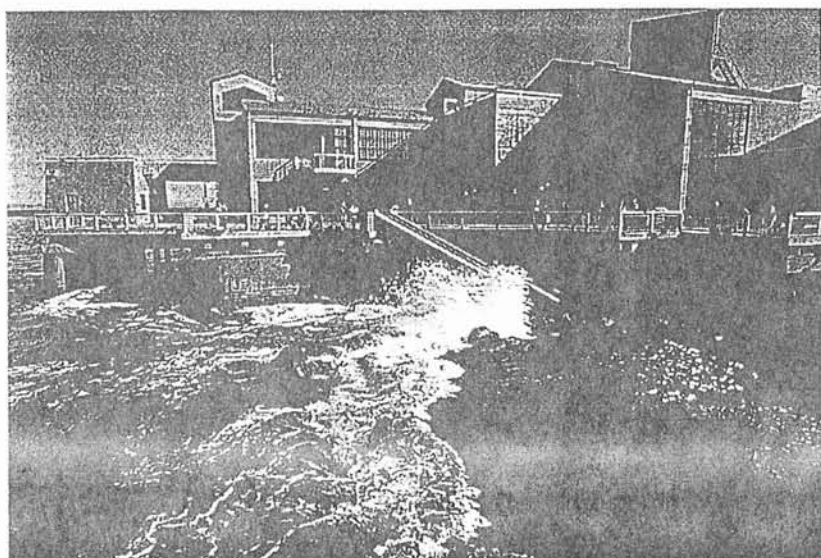
Passports and Visas:

Visitors entering the US should have a valid passport. Depending upon nationality, some foreign visitors may require a visa. Please inquire at your local US Embassy or Consulate.



Monterey

Monterey is a scenic city perched on the edge of Monterey Bay and is renowned for its deep cultural roots and history. The Monterey Bay Aquarium, site of the Symposium, is situated in the heart of Cannery Row, immortalized by John Steinbeck in the heyday of the sardine fishery. Currently, Monterey and Cannery Row are more often thought of as tourist destinations. Other local attractions include Carmel, miles of beaches and rocky seashore, wineries, golf courses, motorsport venues and redwood forests. Monterey is also the site of many festivals including the Monterey Jazz Festival, which this year falls on the weekend prior to the Symposium. The Aquarium is convenient to many fine accommodations, restaurants and shopping and is only 10 km from the airport.



How To Get To Monterey

By Air:

Monterey can be reached via air from either San Francisco or Los Angeles International Airports. Several airlines (United, Delta, USAir, American) operate numerous connecting flights daily to Monterey from these airports. Once at the Monterey Airport it is only a short taxi ride (approx. 12USD) to any of the accommodations. The Embassy Suites (see below) offers a shuttle from the airport, upon advance request.

By Car:

Monterey is approximately 2-3 hours south of San Francisco and 5 -6 hours north of Los Angeles. Once in Monterey there are numerous signs for the Aquarium.

Accommodations

There are three sets of hotels that have agreed to provide rooms for your stay in Monterey from Sep. 21-27, 1997. This time of the year is particularly busy and most hotels expect to have no vacancies so you are encouraged to reserve accommodations at the earliest date. The Saturday evening prior to the symposium is the date of the Monterey Jazz Festival and is always sold out in advance. To reserve a room at one of the hotels listed on the following page, you must make a reservation prior to July 21, 1997, to ensure availability and price. Hotels may require a deposit for the first night, however, some may take a credit card number as a guarantee. All prices quoted are per room and are in USD and do not include tax. **Participants are responsible for**

procuring their own accommodations and are encouraged to contact the hotels directly for additional information.

Cannery Row

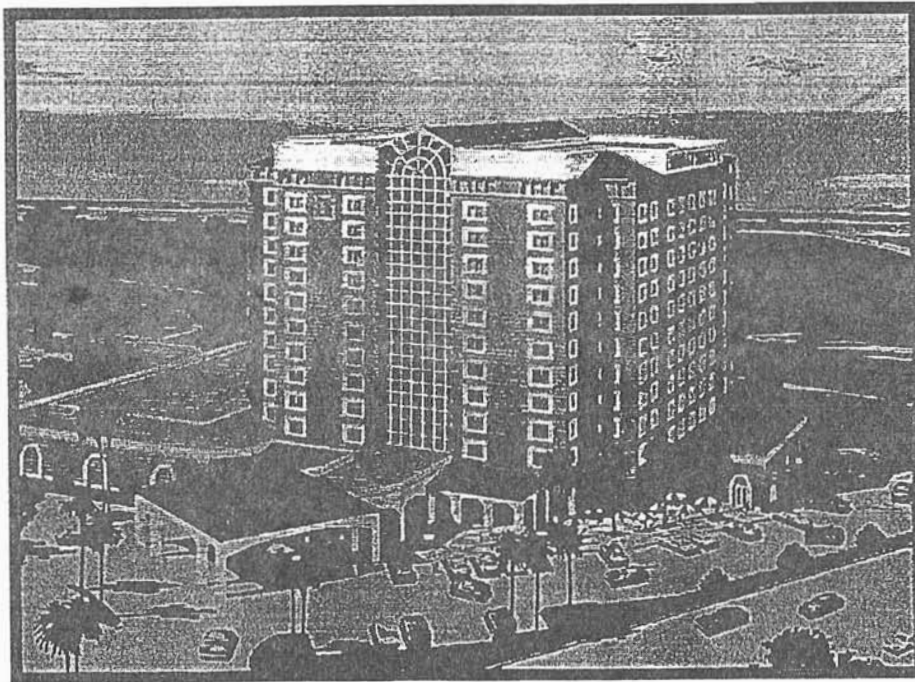
\$109 Sunday-Thursday, \$159 for Friday and Saturday. In room coffee and pastry, free parking, some rooms with fireplaces. For reservations call 408 649 8580 and ask for Mary Ann Cannery Row Inn- 200 Foam Street, Monterey, 5 blocks from the Aquarium Otter Inn- 571 Wave Street, Monterey, 3 blocks from the Aquarium

Asilomar Beach

\$75 and up. Located in Asilomar approximately 4 miles from the Aquarium a variety of Inns operated by the Larchwood Properties offer deluxe standard rooms, most with fireplaces and with a complimentary continental breakfast and free parking. Free shuttle to and from the Aquarium. Tel. 408 373 1114, Fax 408 655 5048.

Seaside

\$125. Embassy Suites on Monterey Bay, Seaside. 4 miles from the Aquarium, 2 room suites, cooked to order breakfast, nightly 2 hour hosted Manager's reception, free parking and shuttle service to Airport (upon prior arrangement), free shuttle service to and from the Aquarium.



Presentation Information

Oral Presentations:

The scientific program will include oral presentations, posters and informal video sessions.

Instructions for Authors of Papers and Posters:

Papers and posters may concern any aspect of deep-sea biology and ecology. Depending on the number of oral presentations submitted we may have to ask some contributors to present their research as a poster. Posters will be displayed throughout the Symposium. Abstracts, due 15 June 1997, should not exceed one full page in length (approximately 22x16cm) and should include the title of the presentation or poster, the authors' names and addresses, and text. With computer prepared abstracts please send a hard copy of the abstract as well as a floppy disc (3.5"). A volume with the abstracts will be available at the Symposium. The proceedings will not be published.

Instructions for Posters:

Posters should be prepared beforehand and brought in person by participants. Do not send your poster by mail. The poster may be up to 1.2 x 1.2 m. Use lettering that can be read at a distance of 1-2m. You may wish to include a photo of yourself. Materials for assembling posters will be provided (i.e. thumbtacks, tape, etc.).

Projection Facilities:

The auditorium where the oral presentations will be held is equipped with slide, overhead, LCD (for projection directly from a computer), and video capabilities. Slides should be numbered in the upper right hand corner as seen when they are placed in the projector. Please try to minimize the number of the words, and maximize the size of the lettering on slides and overhead transparencies.

Video Film Sessions:

Scientific videos will be presented in the breaks between sessions in the area where the posters are set up. MBARI will show some of the deep-sea video material collected over the last 8 years, and will be feeding in a live link from our ROV. Others who wish to present video material should specify the format in advance. These persons should plan to be present when the video is running.

Provisional Program

Sunday, Sept. 21, 1997	Registration
Monday Sept. 22, 1997	Registration, Morning and Afternoon Scientific Sessions, Evening Mixer
Tuesday Sept. 23, 1997	Morning and Afternoon Scientific Sessions, Evening Poster Session
Wednesday Sept. 24, 1997	Morning and Afternoon Scientific Sessions, Symposium Dinner
Thursday Sept. 25, 1997	Excursions, MBARI Reception
Friday Sept. 26, 1997	Morning and Afternoon Scientific Sessions

Social Events

Mixer-Monday, September 22nd

Evening hosted reception at the Aquarium.

Symposium Dinner-Wednesday, September 24th

Symposium dinner will be held in the Aquarium in the area immediately outside the 16m wide window of the Outer Bay Waters tank. The tank holds 1 million gallons and is the home of pelagic organisms such as tuna, mola-mola and shark. This is a dinner not to be missed.

Excursions-Thursday, September 25th-Three separate excursions are offered as follows:

Wine Country Tour- Monterey and surrounding regions are home to some of the best vineyards in California. This excursion will offer the opportunity to sample several of the best. Box lunch included.

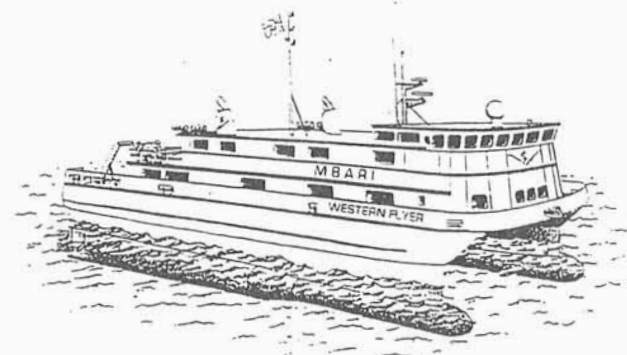
17 Mile Drive and Pt Lobos Nature Walk- 17 Mile Drive presents some of the most breathtaking scenery in the world and is a definite must-see for first time visitors to the area. Pt Lobos State Park offers spectacular rocky intertidal and kelp forest scenery replete with marine mammals such as otter, sea lion, harbor seal and cetaceans as well as birds. Box lunch included.

Western Flyer Excursions. A limited number (32 total) of participants (on a first-come, first-served basis) will be offered the opportunity to partake in a short excursion from Moss Landing to the deep waters of Monterey Canyon aboard our new SWATH design research vessel the *Western Flyer*. We anticipate being able to deploy our new ROV, *Tiburon*. We plan to run two short (3 hour) trips, one in the morning and another in the afternoon. An optional side trip up Elkhorn Slough for spectacular bird viewing will also be offered. At the end of the day it is the pleasure of MBARI to host a reception at our Moss Landing Facility.

Registration and Payment

The Application and Registration Form (see next pages) must be completed and returned with payment not later than **June 15, 1997**, in order to avoid late fees. All payments can be made by check drawn on USD or by credit card and, sent to:

Annette Gough/Ginger Hopkins
8th Deep-Sea Biology Symposium
Monterey Bay Aquarium Research Institute
Box 628
Moss Landing, California 95039-0628, USA



Please make checks payable to: **Monterey Bay Aquarium**. Any bank charges will be borne by the remitter.

The Symposium fee covers: attendance at all scientific sessions, morning and afternoon coffee breaks, one copy of the Abstracts, the evening mixer, Symposium Dinner, MBARI Reception, T-shirt and group photo.

We can accomodate guests of Symposium participants at the social events for an additional fee.

June 15, 1997: Application & Registration form and abstract must be completed and returned. Participants choosing to register after June 15, 1997 will have to pay the late registration fee.

July 15, 1997: Authors will be notified of any rejections.

August 15, 1997: Registration cancellation: Upon written request received no later than August 15, 1997, 50% of the registration fee will be refunded after the Symposium. After August 15, 1997 no refund will be made.

8th Deep-Sea Biology Symposium September 22-26, 1997 Monterey California Pre-Doctoral and Student Eligibility Form

Name:	
Institution:	
I certify that the above-named fellow/student is currently enrolled at this institution	
Name:	(Dept. Head or Major Professor)
Signed:	

POSTER

8TH SYMPOSIUM ON DEEP-SEA BIOLOGY

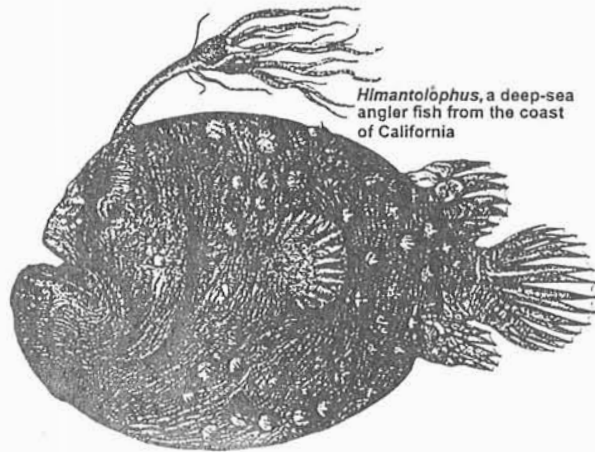
September 22 - 26, 1997

Theme: Biology and Ecology
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Organizers:

Dr. James P. Barry &
Dr. Bruce Robison
Monterey Bay Aquarium
Research Institute

Dr. Chris Harrold &
Dr. Randy Kochevar
Monterey Bay Aquarium



Himantolophus, a deep-sea
angler fish from the coast
of California

For details please contact:

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8th Deep-Sea Biology Symposium
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Moss Landing, California 95039-0628

Telephone: 408 775 1701

Fax: 408 775-1645

e-mail: goan@mbari.org

web site: <http://www@mbari.org>

Registration & Application for The 8th Deep-Sea Biology Symposium

Deadline for receipt of pre-registration is June 15, 1997

Name:		
Institution:		
Address:		
e-mail:	Telephone:	Fax:

<input type="checkbox"/> Oral Presentation	<input type="checkbox"/> Poster
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Video Format: VHS	<input type="checkbox"/> PAL	<input type="checkbox"/> SESAM	<input type="checkbox"/> NTSC	<input type="checkbox"/> Other (specify): _____
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Fees:

<input type="checkbox"/> Non-student registration:	\$140.00 USD
<input type="checkbox"/> Student registration:	\$ 75.00 USD

Excursions:

<input type="checkbox"/> Wine country tour w/box lunch \$40.00(USD)	<input type="checkbox"/> 17 mile Drive & Pt. Lobos w/box lunch \$40.00(USD)
<input type="checkbox"/> MBARI/Western Flyer tour No charge	<input type="checkbox"/> Elkhorn Slough (MBARI) bird watching \$22.50(USD)

Guest Social Event Attendance:

<input type="checkbox"/> Mixer \$20.00(USD)	<input type="checkbox"/> Symposium Dinner \$40.00(USD)	<input type="checkbox"/> MBARI Reception \$35.00(USD)
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Note: Excursion and Guest event fees are due on or before June 15, 1997

Total Amount Enclosed: (USD)

Payment may be made by check drawn on US funds.	Make check payable to : Monterey Bay Aquarium
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Or you may pay by credit card:

<input type="checkbox"/> Visa	<input type="checkbox"/> Mastercard	<input type="checkbox"/> American Express
Card Number:		Expiration date:
Name as it appears on the card:		
Signature:		

BENGAL GETS OFF TO A FLYING START

The first cruise within the BENGAL programme, on RRS *Discovery*, took place between 29 August and 24 September 1996.

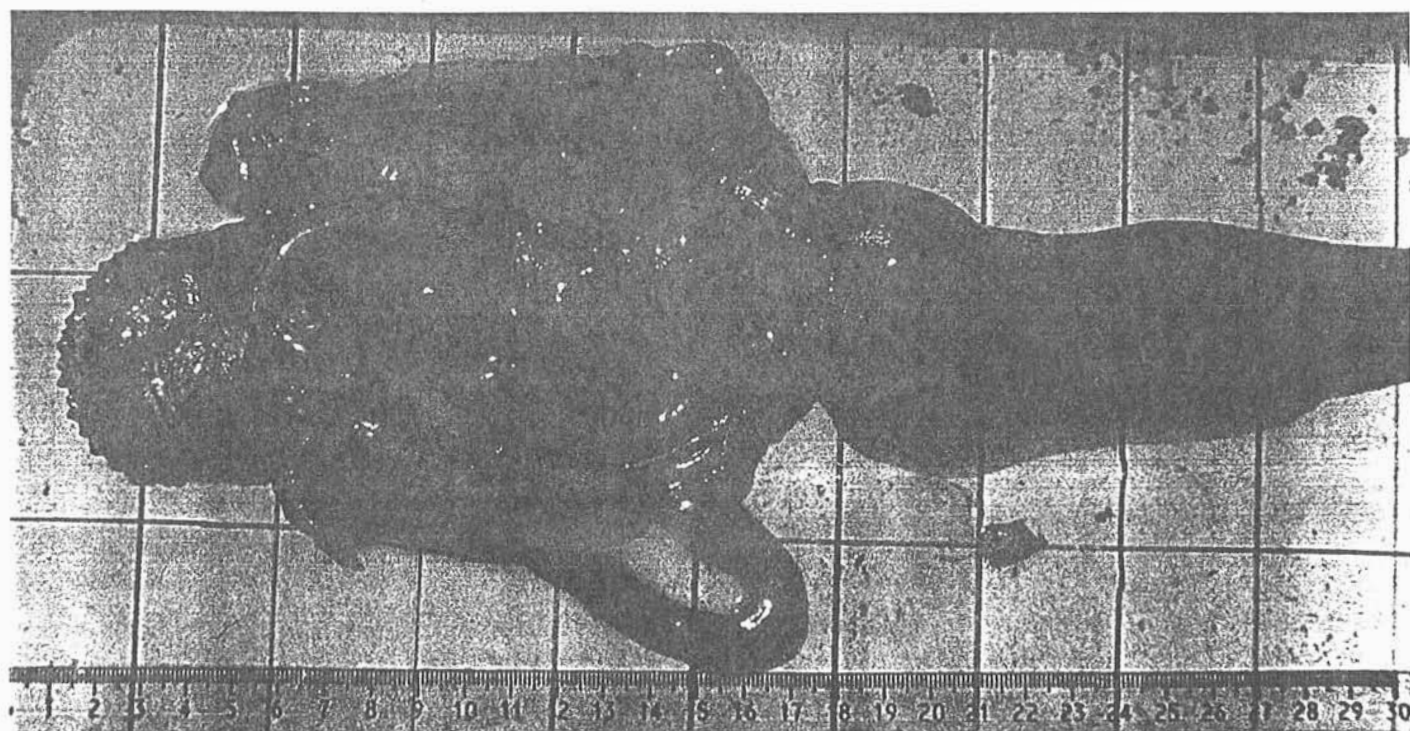
BENGAL, D-SN readers may remember, is an EU MAST III funded contract which caused all the problems with the timing and venue for the Eighth Deep-Sea Marine Biology Symposium, now to be held at Monterey in September 1997.

The BENGAL contract a "High resolution temporal and spatial study of the benthic biology and geochemistry of a north-eastern Atlantic abyssal locality" has the overall objective of understanding how the physics, chemistry and biology of the abyssal benthic boundary layer respond to, and modify, the incoming chemical signal from the overlying surface layers and thus affect the palaeoceanographic records of the underlying sediment. The chosen study site, on the Porcupine Abyssal Plain in the NE Atlantic, has already been studied for some years and is known to be subjected to a regular seasonal input of aggregated phytodetritus. The idea of the contract is to study this phenomenon, and the benthic response to it, intensively during a series of 4 visits to the site within a single 12 month period from March 1997 to March 1998. It was because these closely spaced cruises were expected to interfere seriously with the ability of Galway (a BENGAL partner) to organise a Deep-Sea Symposium that year, and the ability of the other 16 BENGAL partners to attend, that the Symposium venue was ultimately changed to Monterey.

In addition to the intensive series of cruises, we planned a preliminary cruise to obtain further baseline data, to set up long-term moorings to run throughout the study period and hopefully to help solve some of the many logistic problems we anticipate in 1997-98. It was this cruise that has just been completed.

Ten of the 17 BENGAL partners were represented on the cruise, with samples and/or data being collected for several of the "missing" ones. We had a total of 21.5 work days at the study site, losing only 44 hours to inclement weather, almost unheard of in the North Atlantic in September.

In addition to obtaining a good series of multiple corer, box corer, otter trawl and water bottle samples and mid-water and benthic photographs, we were able to service (retrieve and redeploy) a sediment trap mooring and a long-term Bathysnap mooring, and to deploy the IFREMER MAC (Module Autonome de Colonisation) to accompany their MAP (Module Autonome Pluridisciplinaire) which Annick Vangriesheim had deployed on the preceding *Discovery* cruise (part of Monty Priede's ALIPOR contract). We were also able to deploy and recover a series of short-term moorings including two short deployments of an NIOZ near-bottom sediment trap and a



A *Psychropotes longicauda* with what appears to be the coils of a "preformed faecal cast" in the hind gut.

trial experiment (BIOFEED) in which multiple core samples are incubated *in situ* on the sea floor without organic enrichment. These all worked rather well, as did four deployments of the NIOZ lander which among other things measures the oxygen uptake across the sediment-water interface. Unfortunately, this complex and normally very efficient lander failed to return from its fifth deployment, rising only about 1000 m from the bottom before it adopted the role of the most expensive neutrally buoyant float ever deployed! The only other significant loss was of the IFREMER beam trawl which inexplicably dropped off the end of the trawl wire during recovery from its first (and only) deployment.

Inevitably, the data from the analysis of the various samples obtained, shared between the BENGAL partners, will take many weeks or months to appear. But even during the cruise itself we made some interesting, and surprising, discoveries. For instance, the trawl-caught megafauna samples, which were internally very consistent within this cruise, were significantly different from those collected from the same locality over several years during the late 1980s and early 1990s, particularly in the relative proportions of the holothurian species which dominate the fauna both numerically and in biomass. How and why has this change occurred?

We also think we made an intriguing discovery about sea cucumber faecal casts. These little piles of excrement are characteristic and abundant features of all deep-sea photographs, occurring in complex spiral, curled or beaded patterns that seem to be specific. Apart from the interest of holothurian defaecation with respect to organic matter turnover rates, many deep-sea benthic biologists must have puzzled over how each species produces its particular brand of cast. We still don't know, but at least one species, *Psychropotes longicauda*, seems to preform its cast before evacuation rather than acting like a simple cake icing bag. Isn't it amazing what some grown men and women can get excited about?

But the main lesson from the cruise was the demonstration, as if we needed confirmation, that a wide range of European scientists with very diverse interests can work together efficiently, intensively and amicably in a relatively small ship. It bodes well for the rest of BENGAL; we will let you know if these early indications were justified - possibly at Monterey!

Tony Rice
Southampton Oceanography Centre

THEORY OF ANIMAL ABUNDANCE IN THE DEEP SEA REVERSED

During an expedition with RV *Polarstern* to the East Greenland continental shelf at 75°N in 1994, epibenthic-sledge samples were taken in order to analyse the peracarid composition on a vertical transect from about 200 to almost 2700 m depth. The analysis of the samples revealed an interesting result: The abundances of all peracarids was highest at about 1500 m with 23,280 specimens (/1000 m) and still quite high at the deepest station at about 2700 m depth with 13,557 peracarids. On the contrary, at the shallower stations the numbers were much lower, e.g., 5312 individuals at about 200 m and 2425 individuals at about 450 m depth, respectively. The species richness, however, did not change markedly at the different depth levels, though a slight decrease in species number with depth was recorded from 76 species at 200 m depth and 82 species at about 300 m, to 70 species at 1500 m and 50 species at 2800 m depth. Nutrient composition and hydrographical conditions were quite similar at all stations, and even in the deep sea enough food was available for the animals. Interestingly, the presence of predatory polychaetes feeding on epibenthos at the shallower stations might have reduced the success of the peracarid taxa at shallower sites, whereas they might have thrived more easily at the deeper stations, where infaunal polychaetes feeding on infaunal benthos dominated (Klaus Schnack, pers. comm). These results and more detailed information are in press in *Polar Biology* and will probably be printed early in 1997.

Angelika Brandt
Zoological Institute and Zoological Museum,
Martin-Luther-King-Platz 3, D-20146 Hamburg



DEEP-SEA DECOMMISSIONING

A large splash sloshed over Britain, Germany and other European countries in connection with the events around *Brent Spar* some 18 months ago, throwing up emotional breakers, partly with uncontrolled overreactions, and the swell abated over the Earth.

The story is still in progress, and the monster oil storage platform is still alive and well, resting in the Norwegian Erfjord. No decision has been made about its fate, but many ideas have been put forward: between deep-sea dumping, recycling and the re-use of its parts.

The community has been enriched by this experience. Industry, and we believe not only oil- and gas producers, has learnt tremendously. Some of their expressions show a significant insight into societal feelings and environmental demands; others document their affrontery in claiming a key role as forerunners with responsibility for the environment.

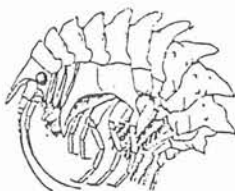
We participated recently in a one-day meeting in Germany with representatives from governmental administrations, consultants and academia, invited by industry. The discussions did not aim at coping with the past but at contributing to solving problems for the future. World wide, about 6500 oil- and gas installations are planted into the sea. There are more than 400 in the North Sea alone. All their top structures will be removed for re-use or recycling on land, and most installations, all those in depths less than 75 m will be removed. About a quarter of them remain, and for many of these a case by case decision must be arrived at by evaluating the environmental impacts, the effects on human health, the safety of the decommissioners, the technical feasibility, the economic balance, including the energetic aspects, and last but not least, the public concerns. This discussion group had nothing to decide. The meeting resulted in interprofessional dissemination of knowledge and the insight that the multi-faceted decisions must be based on multiprofessional expertise.

Since deep-sea dumping is one of the options for decommissioning some of these tremendous structures, discussions on these problems will occur in many countries. As background for such occasions we wish to introduce to you a report by a group of British scientists and engineers with participation from other European countries.

This document covers many aspects of the decommissioning of large structures. It is a broad and well balanced review of knowledge, perspectives and ideas. It is well worth reading, and it may help to minimize apparent disagreements in scientists' views. This, in turn, would help industry to accept scientific recommendations.

Below you find the "Summary" and "The Group's Conclusions and Recommendations" reprinted (with permission). If you wish to receive the total report, contact Anthony L. Rice at the Southampton Oceanographic Centre or one of us. Although the publication is termed "First Report" we would like to mention that no further report has so far been commissioned.

Hjalmar Thiel and Gerd Schriever



SCIENTIFIC GROUP ON DECOMMISSIONING OFFSHORE STRUCTURES FIRST REPORT, APRIL 1996

A REPORT BY THE NATURAL ENVIRONMENT RESEARCH COUNCIL FOR THE DEPARTMENT OF TRADE AND INDUSTRY

Summary

S1. The Scientific Group on Decommissioning was set up by the Natural Environment Research Council at the request of Mr T Eggar, the Energy Minister at the Department of Trade and Industry following the controversy surrounding the attempt to dispose of the *Brent Spar* in the deep Atlantic in summer 1995. The Group, chaired by Professor John Shepherd, Director of the Southampton Oceanography Centre, is made up of scientists and engineers with specific professional expertise in deep ocean biology, physical oceanography, environmental toxicology, chemistry and geology, and engineering.

S2. The task of the Group is to "examine the scientific evidence in relation to the potential envi-

ronmental impacts of the disposal of large off-shore structures, using the Brent Spar as an example". This corresponds with Term of Reference (i) but Terms of Reference (ii) and (iii) are addressed too. The Membership and Terms of Reference are set out in Appendix 1.

S3. The environmental impact of the disposal of wastes is a crucial factor which must be taken into account in reaching decisions about disposal options. However other factors, including social, ethical, aesthetic, legal and economic factors, must also be considered in addition to the scientific evidence.

S4. The deep ocean environment, typified by abyssal waters at depths of around 4000m, is quite distinct from that of the shallow seas found on the continental shelves close to land (with water depths less than a few hundred metres). Temperature is low, light is completely absent, and water motions (currents and turbulence) are relatively weak compared to those in surface waters. Biological productivity and standing stocks are relatively low, and physical and biological transport processes from the sea bed to shallow waters are weak. There is as yet little or no fishing activity. Recent studies have however shown that biodiversity can be unexpectedly high, for reasons which are not yet understood. The deep ocean is an active system, where conditions are maintained by a complex interaction of physical, chemical, biological and geological processes. The rates of these processes may be relatively slow, but they result in a state of dynamic balance. The ecosystem they support may be damaged by man, but is also resilient to considerable perturbations, both natural and man-made.

S5. The areas proposed for deep-sea disposal of the Brent Spar were in about 2300 metres of water on the continental margin to the west of Scotland, in depths more than ten times greater than in the North Sea, but considerably shallower than the abyssal depths of the Atlantic which exceed 4000 metres. Within these areas the mean current speeds in the deep water are low, but benthic storms, associated with the sea floor, are frequent. Benthic storms are periods when currents accelerate to more than 25 cm/sec, and sediment is stirred up and transported elsewhere. Most of the sediment in this area has been deposited as drifts from currents flowing along seafloor topography. Biological communities on the bottom in this area have been studied for many years, but are complex enough still to be poorly understood. Biodiversity is high here compared with areas of similar depth elsewhere, and biomass whilst low, is somewhat higher than usual. Fish populations have been well studied, and deep sea fishing for species such as the orange roughly have already begun in the general area.

S6. The properties of an optimum site for waste disposal depend on the nature of the materials involved, and especially on whether fast dispersal or slow dispersal of contaminants is preferable. Since a typical structure will contain chemical components with different dispersal requirements, no single choice of site can be ideal. Once wastes have been released into seawater, their dispersal is inevitable.

S7. Dispersal occurs primarily through water movements, since biological transport processes, other than vertically downwards, are weak, unless there is a direct link into a food chain. In the short term (hours), any materials released will disperse by turbulent mixing. Contaminants are immediately diluted by a factor of about 100 when this happens. Modelling of dispersion of material from the ocean bottom in this area shows that it is possible for contaminants to be mixed across the entire ocean basin within about a hundred years. Some at least would arrive at the ocean surface, mainly at the outcrops of deep water masses, though only after enormous dilution, so that the level of contaminants at any one place would be extremely small. The modelling also shows that there is no benefit in disposing of waste in minor depressions on the ocean floor; as material is dispersed from such local deeps as fast as from adjacent flat sea floor.

S8. The site chosen in 1995 for the disposal of the Brent Spar is unusual in several ways. The currents are relatively high and variable, and scour around the adjacent seamount of Rosemary Bank has removed soft sediments from the area. The resulting pebbly sea floor supports a rather unusual biological community. The presence of the seamount will enhance local vertical mixing of water and hence transport of contaminants towards the surface. Whilst it is not therefore unsuitable for waste disposal, it is unlikely that the site is the best possible which could be found within the criteria used.

S9. Scientific knowledge of deep sea environments is considerably less comprehensive than that of shallow seas, and it is correspondingly more difficult to make quantitative predictions of the effects of waste disposal in deep waters. There are however a number of natural and man-made analogues which can be used to assist in estimating the effects. Different analogues are appropriate for different components of a structure. Natural analogues include deep sea hydrothermal vents, cold hydrocarbon seeps and large dead animals, while man-made analogues include shipwrecks, sewage sludge dumps and oil spills. Of these, shipwrecks are the closest parallel, since the Brent Spar is equivalent in size to an oil tanker of 30,000 to 50,000 tonnes with its tanks pumped out. Tens of millions of tonnes of shipwrecks already lie on the deep ocean floor, but no effect has yet been detected from them on the global deep ocean environment. Debris from a wreck may be scattered over several square kilometres of the ocean floor and may affect the local

environment in that area, but no detailed studies have yet been made of the nature and intensity of that impact.

S10. Other analogues, such as natural oil seeps, show that waste petroleum arriving on the ocean floor will be colonised by bacteria that consume it to derive energy for life, and may support a community of other animals. Natural disturbance of the ocean floor by deep sea storms and landslides is frequent, and more intense than would be produced by the impact of the Brent Spar on the bottom. Deep sea biological communities have evolved to survive such events.

S11. All of the components of the Brent Spar already reach the deep ocean floor from other sources. Metals come from the land through rivers and the wind, and from hot springs on the ocean floor. Some metals are toxic to marine life at low concentrations, and in some areas already inhibit normal biological communities. Oil is also toxic to normal communities, but specialist communities can thrive even in environments with high metal or petroleum concentrations. PCBs are not readily degraded and reach the deep oceans from the continental shelf, and will continue to do so even though PCB production has stopped.

S12. Analysis of the stresses imposed on the Brent Spar at the time of disposal suggests strongly that it would break into fragments either at the surface, if the explosive charges do not perforate the hull uniformly, or as it accelerates during its plunge towards the sea floor, through the drag imposed on the overhanging superstructure. Terminal velocity is expected to be very high, between 15 and 20 metres per second, and any part of the structure still intact is likely to collapse on impact with the ocean floor. If the structure breaks up during disposal, it will release a mass of warm, oily water as it sinks, which will rise in the water column, either to reach the surface or to disperse at or below the thermocline.

S13. Analysis of dispersal of each of the components of the Brent Spar shows that though there may be local effects over areas of up to several square kilometres, there would be no detectable effects in the water at greater distances, even if dissolution were relatively rapid. Local effects on the sediments and the animals living in it may be larger, and could be estimated from studies of existing shipwrecks.

The Group's Conclusions and Recommendations are :

General

C1. The UK strategy for dealing with wastes is that they should wherever possible be reduced, re-used or recycled before they are disposed of. Recycling of decommissioned off-shore structures implies disposal on land. Provision for removal of new offshore structures will be required from 1998. **The Group endorses recommendation 4.9 of the House of Lords Select Committee that "companies should indicate at the design and emplacement phase what their entire decommissioning plan is, including plans for disposal as well as removal" (See Section 7.1)**

C2. Wastes released to the water will be dispersed, and are unlikely to be confined to the waters of a single nation. **The effects of any contamination should be considered in an international context (See Section 7.1).**

C3. The optimum site for waste disposal may prove to be anywhere in the ocean, including abyssal depths outside UK jurisdiction, whilst acceptable sites may also be found in shallower waters. **Sites outside areas under national jurisdiction should be considered if necessary (See Section 2.4)**

Procedures

C4. The processes by which the preferred disposal options for decommissioned offshore structures are established and approved in the UK do not necessarily mobilise as much of the available scientific expertise as would be desirable to ensure public confidence that all relevant aspects have been examined and assessed. **We recommend that a mechanism which provides for the critical evaluation of the evidence by a wider scientific community should be established (See Section 7.2).**

C5. It is essential that this mechanism ensures :

- verification that any survey or assessment work is commissioned, conducted and evaluated by an organisation with appropriate expertise
- openness of the process in relation both to consultation and to the availability of relevant documentation
- adequate attention to any possible international aspects and appropriate consultation

- clear separation of responsibilities between the operator and the regulatory authority.

C6. The public attaches a high value to protecting the marine environment, as it does to the preservation of other remote places such as Antarctica. The deep ocean is perceived as uncontaminated and in need of extra protection compared with coastal waters. This perception is not entirely accurate, and there is no technical basis for the view that the marine environment should be protected from all waste disposal. However, **we recommend that some means should be sought to take public acceptability into account in evaluating future marine environmental impact assessments** (See Section 1.1).

C7. The public is concerned that any decision about the Brent Spar might serve as a precedent for future deep sea disposal operations, and not necessarily only of off-shore oil installations. Existing procedures require the case-by-case evaluation of disposal options, which is necessary, but not sufficient, because continued disposals with small individual impact might give rise, by small increments, to an unacceptably large overall impact. The capacity of the oceans to deal with wastes is finite, and has to cope with all disposals, both deliberate and accidental. **We recommend that assessments of both cumulative and case-by-case impacts be made, using procedures which avoid any unnecessary duplication of effort** (See Section 4 and Annex 1).

C8. To provide an initial limit on such a possible cumulative impact, **we recommend that a competent body be requested to supply a definitive estimate of the number of installations which are potential candidates for deep sea disposal in the North Atlantic.** UKOOA as a representative of most of the companies operating in the UK sector and elsewhere on the NE Atlantic margins may be willing to undertake such a study (See Section 1.5).

Engineering Aspects

C9. Further study in depth of the risks, hazards, engineering procedures, and financial assessments would need to be made before an unequivocal conclusion for deep-sea disposal of the Brent Spar as against other viable disposal options could be reached (See Section 5.2).

C10. If deep-sea disposal is to be retained as a short-listed option, further studies of the state of the buoy, its integrity, and the perforation procedures will be required, as will predictive studies of its behaviour during descent (See Section 5.2).

C11. For the deep sea disposal option, the most likely scenario is that, even if there is no partial break-up during descent, the Brent Spar will break up on impact with the sea bed (See Section 5.2).

C12. From an engineering point of view, the difficulties and hazards of on-shore disposal are no more than have already been encountered and successfully overcome for other installations. In view of the studies carried out by W.S. Atkins, **vertical dismantling and disposal on land should not be ruled out** (See Section 5.2).

Environmental Impact

C13. The physical impact of Brent Spar and the resuspension of bottom sediments will result in the smothering and destruction of the deep sea benthic community over a relatively small area (less than 1 square km) (See Section 5.4).

C14. A comparison of the quantities of potentially toxic materials on the Brent Spar with relevant environmental quality standards indicates that any adverse effects would be confined to the immediate vicinity of the wreckage (See Sections 5.5 - 5.10).

C15. The precise impact of the oil contents of Brent Spar is uncertain because this is largely dependent on the degree to which the structure remains intact during its descent. The oil contained within the overflow pipes (20 tonnes) will be released into the water column during the descent of Brent Spar. This will result in lethal effects on pelagic organisms within a volume of 0.02 cubic kilometres, and sublethal effects within a larger volume of 2 cubic kilometres (See Section 5.7).

C16. The Brent Spar is likely to break up on impact with the bottom and the rupturing of the tanks will result in the fast release of the oil contaminated water in the storage tanks. The oil contaminated water (48,000 tonnes of 40mg oil /l) will produce a plume which will result in lethal concentrations within a volume of 0.002 cubic kilometres and sublethal concentrations within a volume of 0.2 cubic kilometres (See Section 5.7).

C17. The release of the oily sludge upon impact with the bottom will have a direct smothering effect killing the benthic community in the immediate vicinity (about 0.5 square kilometres). The water accommodated fraction of oil will enter the water column and become dispersed by the bottom currents. The oil concentrations will be rapidly diluted to sublethal levels which will reduce the growth and productivity of organisms living on or near the bottom in the area surrounding the Brent Spar (See Section 5.7).

C18. Metals associated with the structure and the contents of Brent Spar are unlikely to reach toxic concentrations (lethal or sublethal) in the water column. However, metal structures incorporated into the sediments are likely to have an impact on the benthic community due to elevated metal concentrations in the sediment pore waters, but this effect is likely to be very localised (within metres of the structure) (See Section 5.9).

C19. If the structure of the Brent Spar were to remain intact, resulting in the slow release of oily sludge and oil contaminated water, the impact on the benthic and pelagic community would be reduced (See Section 5.7).

C20. The process of recovery from the physical disturbance and oil impact will begin within months, but the benthic community is likely to take from 2 to 10 years to recover fully (See Section 4.2.6).

C21. The global impacts on the environment and on human health of the deep sea disposal of a structure such as the Brent Spar would be very small, roughly equivalent to the impacts associated with the wreckage of a fairly large ship (See Section 4.2.2).

C22. The local effects would be appreciable only within a small area, not more than a few square kilometres. The precise nature of these effects is not certain, as the environmental impacts of shipwrecks in deep water have not been studied sufficiently (See Section 4.2.2).

C23. The available evidence indicates that the environmental impacts of deep sea disposal of structures such as the Brent Spar are not likely to be large enough to be a crucial factor in the selection of the best disposal options, or for this option to be excluded from consideration.

Monitoring

C24. Pre-disposal site survey(s) and post-disposal monitoring are essential to provide public assurance of the acceptability of any disposal, and should be designed to test whether the assumptions and calculations made in selecting the disposal option are correct check that the environmental impact is not greater than expected (See Section 6.1 and Annex 2).

C25. The scale and frequency of monitoring to be undertaken should be determined adaptively, in the light of information obtained as the programme progresses. They should be appropriate to the level of environmental impact observed or expected, and where this is small and very localised, one or two post-disposal surveys may be sufficient. More extensive monitoring would however be appropriate if a disposal is novel in some way, or if useful scientific information on the fate of contaminants can be obtained (See Section 6).

Other

C26. The Group recommends that further work should be undertaken on :

- the environmental impacts of existing shipwrecks (See Section 4.2.2)
- monitoring of the effects of past dumping at sites such as UK/d (See Section 2.3)

C27. In addition, **basic and strategic research programmes in marine science must be maintained** to provide the information base required for the evaluation of future proposals not yet anticipated

C28. The Brent Spar is a unique design and is not typical of the great majority of offshore installation in the North Sea. Therefore the problems associated with the decommissioning of this particular installation are not necessarily typical of most offshore installations. In view of this, **the Brent Spar may not be a good example on which to base general policy decisions** (See Section 1.5).

C29. **Nothing in this report should be taken as promoting the deep sea disposal of decommissioned off-shore structures, or of any other wastes.** Any decision to proceed, or not to proceed, with such activities involves social, economic, ethical, and aesthetic considerations which are outside the competence of the Group, and judgements in which the technical assessment of the environmental impacts is only one factor, and not necessarily the most important one.



HOT 96 - 9 FEBRUARY 23 MARCH 1996

A team of French and American biologists has just returned from a joint expedition at 9°50' and 13°N on the EPR. HOT 96 was lead by Dr. Francoise Gaill (French Chief Scientist) within the research joint-group associating IFREMER, CNRS and the University of Paris 6, on board of the *Nadir*, mother-ship to the submersible *Nautil*. Also present on site was the US Research Vessel *Wecoma*, with Chief scientist Dr. Horst Felbeck of SIO. A total of 26 French and 20 US scientists participated in at least one of the two legs of the expedition. One dive during this cruise was funded by the European Community and made by to the young scientist Cordelia Arndt of the Institut für Ostseeforschung in Warnemünde /Germany.

Analyses performed on the Nadir

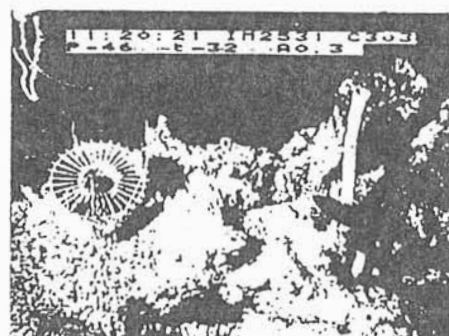
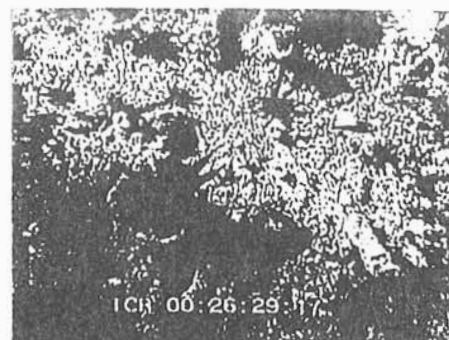
Various *in situ* experiments and measurements of the main chemical and physical vent parameters were conducted by the French team in order to study the organism/environment interactions among different sites.

Water samples were taken at several selected sites from 13° and 9°N, and allowed new sampling 150 ml bottles to be successfully tested. These bottles are based on a vacuum depression and were deployed by the *Nautil*. Analyses were done by P.M. Sarradin and J.C. Caprais to characterize accurately the chemical environment around the vent organisms in order to correlate both the organism and the chemical constituents present. The chemical constituents studied were pH sulfide, methane, carbon dioxide, oxygen, nutrients, copper and lead, sulfur compounds and magnesium, as tracer. First results obtained on board show methane traces among the 9°N vent sites and high CO₂ and H₂S concentrations which differ between *Riftia* and *Alvinella*. Animals of selected sites were also collected in order to define a specific biological signature which includes carbon fixation (A.M. Alayse) and concentrations of metals (R. Cosson, CNRS, University of Nantes).

Hydrothermal vent particles were also sampled at the Totem site (13°N) to study direct sedimentation around chimneys. The settling particles were collected using time-series sediment traps on which current meters were fixed. Two traps were deployed by the *Nautil* at 1 m and 2.5 m from the chimney base. The aim of such studies, conducted by A. Kripounoff, was to measure how the particle flux exported by hydrothermal springs varies at a micro scale. The third trap was used as a pelagic reference and was moored outside of the vent region.

Totem was also an excellent site for analysis of various ecological aspects of the fauna associated with smokers, especially *Alvinella* worms, and will be used as a population reference in the near future. This includes population dynamics and genetics, studied by P. Chevaldonné and D. Jollivet. Populations of additional smokers were also sampled for further ecological and genetical analyses in order to know how populations have evolved since 1991. It includes a fine tune analysis among cohorts already settled. Moreover, mRNA was also extracted on board in order to identify genes coding for enzymes sensitive to environmental parameters (e.g., temperature) and to assess adaptive mutations.

A major thrust of the French ecological experiments was the deploy-



ment of SAMO, an *in situ* instrument designed to monitor with time an array of biologically important parameters and equipped with a time-lapse video system. SAMO uses an array of four thermistors which are positioned in the field of view of the video camera, which can be aimed and focused by the *Nautille*. In addition to the temperature measurements, SAMO also yielded a transistometer, CTD and current-meter. All these data, including digitized video images were acoustically sent to the surface and monitored from the *Nadir* in real time.

Protective surfaces (tubes and body wall) were collected from various vestimentiferan and annelid species by the F. Gaill team and Jean Delachambre (University of Dijon CNRS) for further studies on the properties, molecular structure and phylogeny of collagen and chitin protein complexes. The molecular characteristics and behaviour of such biopolymers are specific to the vent species and may be used as environmental markers. Additional *in vitro* experiments were done on the *Wecoma* to analyze various aspects of the tube secretion process, including growth rate, polymerization and enzymatic activities. Other tissues were also sampled from a various set of bivalves and crustaceans by A. Pruski from the A. Fiala group (Banyuls, University of Paris 6) and J.Y. Toullec (ENS, Univ. Paris 6) for complementary studies related to their ecophysiological adaptations and molecular evolution.

During a previous *Alvin* expedition, Francoise Gaill and Charles Fisher (Pennsylvania State Univ.) initiated *in situ* tube-worm growth experiments using a staining device, and alvinellid recruitment experiments using titanium and basalt settlement surfaces. Both experiments were collected during HOT 96 and additional short-term experiments on tube-growth and recruitment were conducted by the two scientists during the cruise. Some of these are still underway at 13° and 9°N vent areas. Similarly, another type of recruitment experiment, "SMAC", was deployed for Daniel Desbruyères (IFREMER) at 9°50'N during a November 1995 *Alvin* cruise conducted by Richard Lutz (Rutgers Univ.), recovered during HOT 96 and supplemented by 3 additional short-term identical experiments during the cruise.

Richard Lutz used a *Nautille* dive to describe the ecological state of most vent fauna aggregations situated along the 1.3 km long stretch of the axial summit caldera known as "Biotranssect" (9°49.6'-9°50.3'N). Observations made during the course of the transect run suggest that the amount of iron oxides may have substantially increased since November 1995 in the vicinity of a site recognized as "Bio-9" inside the "Hole-to-Hell" region, associated with a steadily increasing mortality of vestimentiferan tube worms at this site.

Studies on the Wecoma

Jim Childress and his group (Univ. of California, Santa Barbara) were on board the R. V. *Wecoma*. They had an array of pressure aquarium systems capable of simulating *in situ* vent conditions for the maintenance of and the experiments on living vent animals. Their studies focused on estimating the rates of metabolite uptakes by *Riftia* and processes by which these metabolites are taken up. Measurements under a high pressure respirometer system demonstrated rapid rates of net inorganic carbon uptake by *Riftia* and *Tevnia* and the effects of temperature, oxygen concentration, sulfide concentration, pH, and PCO₂ on these rates. Experiments were also conducted using pressure aquaria to determine the relationships between external conditions and internal pools of metabolites using inhibitors to elucidate the uptake processes involved. Collaborative studies were carried out with French scientists on tube accretion in *Riftia*, crab population biology, and *Riftia* physiology.

Horst Felbeck's group (Scripps Inst. Oceanography) concentrated on molecular and metabolic studies of vent fauna using their pressure aquarium systems, *in situ* experiments and on-board laboratory experiments. Excretion of succinate by endosymbionts was investigated and new studies on the immunological reactions between symbionts and hosts were initiated. The recently discovered potential for nitrate respiration and nitrate concentration mechanisms by *Riftia pachyptila* were further investigated. *In vitro* egg fertilization was also performed to study larval development in *Riftia* both on board (pressure chambers) and on the seabed (*in situ* experiments). Collaborative efforts driven by the German researcher Cordelia Arndt (Institut für Ost-seeforschung, Warnemünde) were focused on the elucidation of a switch in metabolic pathways towards the anaerobic metabolism in vent organisms. Initial results indicate that *Riftia pachyptila* can survive extended periods of anoxia and can overcome these conditions by producing extremely high concentrations of succinate in all body tissues.

André Toulmond and François Lallier (Univ. of Paris VI/CNRS at Roscoff) collected blood from various vestimentiferan and annelid species for further studies on the physiological properties, molecular structure and phylogeny of the giant, extracellular hemoglobins. *Riftia* tissues were also sampled and fixed in various conditions for immunological studies on the so-called "band-3 proteins", important components of the chloride-bicarbonate

transport system in the vertebrate red blood cell. Experiments were done on board, using a Ussing chamber, to tentatively measure bicarbonate fluxes through the body wall. Another member of the group, Stéphane Hourdez, was on the *Nadir* to sample blood and tissue from alvinellid and branchiopolynoid worms in order to continue ongoing work on the elaborate coelomic-vascular oxygen transfer systems.

Guy Hervé (CNRS and Univ. of Paris 6), also hosted by *Wecoma*, pursued his group's studies on the localisation and properties of enzymes of the pyrimidine nucleotides pathway in *Riftia* and its related symbionts. Previous studies had shown that aspartate transcarbamylase (ATCase) was only found in the trophosome. Preparations of symbionts and vestimentiferan gonads were made during the cruise in order to precise the cellular origin of such a restricted activity. If this enzyme is indeed located inside the symbiont, its high specific activity would suggest that the symbiont is growing actively. Carbamylphosphate synthetase (CPSase), the enzyme which provides carbamylphosphate to ATCase, was not found in the trophosome but in the vestimentum and the plume, and raises the problem of a carbamylphosphate source in the trophosome. This problem has been reinvestigated by tests of CPSase activity performed immediately after samples were collected.

The cruise was very successful for all members of the scientific party involved and was a model for international collaboration. A variety of very sensitive experiments were conducted and are still underway at these sites and utmost care needs to be made by all the scientists involved to respect the ongoing work of others. In these days of dwindling resources truly collaborative expeditions like this are an excellent way for the participating countries to get the most out of the limited funds available for submersible expeditions.

F. Gaill, H. Felbeck, D. Desbruyères, F. Lallier, A. Toulmond, A.M. Alayse, P. Briand, J. P. Brulport, J.C. Caprais, P. Hevaldonné, J.Y. Coail, R. Cosson, P. Crassous, J. Delachambre, C. Durif, L. Echardour, G. Hervé, S. Hourdez, D. Jollivet, J. Kerdoncuff, A. Kripounoff, J.P. Lechaire, A. Pruski, J. Ravaux, P.M. Sarradin, B. Shillito, J.Y. Toullec, C. Arndt, C. Fisher, R. Lutz, & J. Childress

CNRS INSU Roscoff, IFREMER, University of Paris 6, Banyuls, Dijon, Nantes, ENS (France), Institut für Ostseeforschung Warnemuende (Germany), Marine Biological Station Plymouth (UK), Scripps Institute of Oceanography and Universities of Penn State, Rutgers and Santa Barbara (USA)

RUSSIAN DEEP-SEA STUDIES IN 1996 ABOVE THE HYDROTHERMAL VENT FIELD "BROKEN SPUR", MID-ATLANTIC RIDGE

Introduction

In August-September 1996, R/V "Akademik Mstislav Keldysh" with D.S.R.V. (Deep-Sea Research Vessel) "Mir I" and "Mir II" aboard, investigated the Mid-Atlantic vent field "Broken Spur" (29°10'N, 43°10'W, depth about 3100 m) and its close vicinities. The biological studies were aimed at problems of interaction between hydrothermal- and water-column communities. In this context, the following questions were asked:

- (1) What are the patterns of the vertical distribution of the plankton in the area influenced by the plume?
- (2) Is there any significant concentration of the hydrothermal animals in the water column above the hydrothermal field?
- (3) If so, what are the patterns of the micro-scale distribution of the plankton associated with hydrothermal vents?
- (4) What is the general pattern of reproductive biology of the dominant vent shrimp, *Rimicaris exoculata*, and is it possible to describe the vertical organic-matter fluxes related to ontogenetic migrations of the shrimp?
- (5) Do the hydrothermal ecosystems have any significant influence on the background water-column communities?
- (6) If so, what is the scale of this influence?

The material obtained still needs further detailed analyses, but some preliminary conclusions can be drawn. They are numbered in the chapter "Preliminary results" according to the numbers of the questions above.

Materials and methods

Plankton in the water column (especially at distances of tens and hundreds of meters above bottom) was sampled with closing plankton net BR 113/143 (mouth area 1 m²) and with big water bottles (volume 150-180 l). Sampling gears were equipped with pingers "Benthos".

Plankton in the water column at distances 80-500 m above the hydrothermal field was sampled with slurp-guns attached to a D.S.R.V. During each sampling, about 200 l was filtered through an 0.18 mm sieve.

Benthic animals and adult shrimps were sampled with slurp-guns, baited traps and "pump"-traps installed by the D.S.R.V.

Visual observations were made, including counts of the plankton in the water column during vertical and oblique movements of the D.S.R.V.

Plume borders were estimated with use of STD and nephelometers.

Preliminary results

(1) Broken Spur is situated in the centre of the ultraoligotrophic zone of the Northeast Atlantic Gyre, where the flux of organic matter down to the bottom is extremely low. Below 1000-1500 m, the biomass of small zooplankton (<3 mm) was as high as 0.01-0.03 mg C per m³, the biomass of larger planktonic animals was about 0.02 mg C per m³. Even under these conditions, traditional samplers revealed no significant increase of the plankton biomass in the plume area. At the same time, direct visual observations from the D.S.R.V. showed that the distribution of the pelagic plankton in the plume area is different from that in the background deep sea. The inner plume area (depth 2800-2900 m, 200-300 m above bottom) was characterised by extremely low plankton biomass, ranging from 0 to 0.05 mg C per m³. The biomass near the upper (depth 2700-2750 m, 350-400 m above bottom) and lower (depth 2700-2750 m, 350-400 m above bottom) plume borders was much higher, reaching 0.4-0.8 mg C per m³, mainly due to the increased concentration of gelatinous animals (medusae and ctenophores). A very thin (about 20 m) layer with a high concentration of copepods was also recorded near the upper plume border: about 0.07 mg C per m³, which is one order of magnitude higher than in the waters above and below. Thus, the inner plume zone, characterised by the high concentrations of poisonous elements (e.g., manganese) appears to be avoided by the pelagic animals. Due to this avoidance, local vertical fluxes of planktonic animals may originate in the plume area. Aggregations of gelatinous animals along the borders appear to be filter-feeding upon smaller migrants.

(2-3) Visual observations in the water column revealed unexpectedly high concentrations of animals related to the vent fields; the main bulk of these animals was composed of shrimp larvae and swimming polychaetes. At distances of about 5-50 m around the black smokers, dense aggregations of shrimp larvae exist with concentration of about 1 individual per m³. Sampling of these aggregations by slurp-gun revealed only *Chorocaris chacei*. At distances of about 100-300 m, shrimp populations became more sparse with concentration of about 1 individual per 10 m³. Plankton-net sampling and visual observation in this area revealed the dominance of *Alvinocaris* larvae. At distances of more than 300 m from the vent field, no shrimp larvae were recorded.

Slurp-gun samples taken in the warm flow of ascending water from 80 to 500 m above the hydrothermal field contained eggs of *Rimicaris* (5-20 eggs per m³) and inflated hydrothermal copepods with eggs (10-70 ind. per m³). Shrimp eggs dominated the biomass and usually comprised 1/2-2/3 of the total catch biomass. In addition, in the plume waters above the field, *Globigerina*-like foraminiferans were numerous. The proportion of "ordinary" water-column plankton (mainly copepods) was rather low and noticeable only at 400-500 m above the field.

Thus, the 200-300-m zone above the vent field is densely populated by various animals associated with the vent field, from mesoplankton (copepods, shrimp eggs and, probably, foraminiferans) to macroplankton (shrimp postlarvae). Some zonality of this above-field fauna appears to exist. Thus, the hydrothermal community should be regarded as 3-dimensional, extending to about 300 m above the field, its water-column component mainly being represented by the larvae of benthopelagic vent shrimps.

(4) Since direct observation on the reproduction of *Rimicaris* is impossible, several facts were gathered for further conclusions:

(a) Most adult females possessed well-developed ovaries with large oocytes (about 0.5-0.6 mm in diameter) and looked ready to copulate.

(b) A single ovigerous female was sampled at a distance of several meters from the main shrimp aggregations; eggs were loosely attached to pleopods; the only other ovigerous female was observed from the D.S.R.V., also outside the main aggregation. No other ovigerous females were recorded.

(c) Numerous eggs, identical to those attached to ovigerous female of *Rimicaris*, were found in the water column.

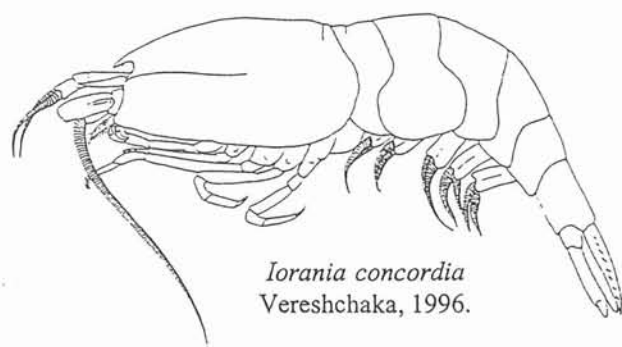
(d) Most *Rimicaris* larvae and postlarvae (carapace length 4-12 mm) were found close to hydrothermal vents.

The above data may be combined in the following picture: Mature males and females copulate outside the main aggregations (observed once), then the females release the eggs and immediately return to the swarms. The eggs are dispersed and develop in the water column above the field. As soon as they hatch, *Rimicaris* larvae return to the swarms in the black smokers, where they grow and mature. This kind of reproductive biology may look strange and is certainly different from that of most of other carid shrimps. Taking into account the feeding biology of *Rimicaris*, possible only in the hot sulfide waters, and the chemical composition of hydrothermal fluids, with high turbulence and temperature, unfavourable for the development of eggs, the suggested scheme of *Rimicaris* reproductive biology seems plausible.

Other dominant shrimps, *Chorocaris* and *Alvinocaris*, carry the eggs until hatching. Larvae live above the hydrothermal field, for *Chorocaris* about 5-50 m above the bottom, for *Alvinocaris* about 100-300 m above the bottom.

(5-6) The existence of a water-column component of the hydrothermal community that feeds on chemosynthesized organic matter and creates a multilayered filter provides evidence of the semi-closed character of hydrothermal ecosystems when the flux of the produced organic matter directed outside is comparatively low. The bottom projection of this filter is composed of the adult shrimps *Rimicaris*, *Chorocaris* and *Iorania*; bythograeid crabs; coelenterates; polychaetes; and syphonognathid fish. Already at a distance of several hundred meters, hydrothermal animals are so scarce that they can not be found by our methods, either on the bottom, or in the water column. From this point of view, the influence of the hydrothermal system upon background ecosystems is very local and exists on the scale of a few hundred meters only.

Another mechanism of the influence is associated with reorganisation of the vertical distribution of the pelagic plankton in the plume waters. It is probable that the plume patches may exist down the rift valley with inversely distributed planktonic communities supported by migrating or dead plankton from the inner plume zones. In this sense, the hydrothermal influence may probably be traced horizontally at distances of some kilometres from the vent fields.



Iorania concordia
Vereshchaka, 1996.

Alexander L. Vereshchaka
P. P. Shirshov Institute of Oceanology
Russian Academy of Sciences, Moscow

G. M. Vinogradov
A. N. Severtzov Institute of the Problems of Evolution
Russian Academy of Sciences, Moscow

STRUCTURE AND SPATIAL DISTRIBUTION OF BENTHIC COMMUNITIES ASSOCIATED WITH COLD SEEPS ON CONTINENTAL MARGINS: EXAMPLES OF ZONES OF SUBDUCTION

Expulsion of methane-rich fluids along continental margins allows the development of luxuriant benthic communities based on bacterial chemosynthetic processes. An inventory of the discoveries shows that these communities are located across a wide bathymetric range and in various geological contexts in subduction zones and on passive margins. A detailed study, based on videos, photographs and faunal samples taken during submersible dives on an accretionary prism and along an erosive margin, made it possible to show unique properties of cold-seep communities and differences related to the environmental conditions. These communities

are dominated by invertebrates that live in symbiosis with chemoautotrophic bacteria: large bivalves of the families Vesicomidae and Mytilidae, and vestimentiferan worms.

The specific richness of this symbiotic fauna is relatively high (four species on an average, up to seven species on the same site). These species show different physiological adaptations to particular biotopes and different demographic strategies, permitting an optimal exploitation of the fluids in space and time. A lot of carnivores/scavengers, suspension feeders and deposit feeders also live on the chemosynthetic production by consuming free-living bacteria in the water or sediment. Megafaunal aggregations linked to a high fluid flow show juvenile community structure, but long-time fluid emissions favour the addition of species from the neighbouring environment and the diversification of trophic behaviours.

The spatial distribution of cold-seep communities is controlled at all spatial scales by the geological context that determines the fluid patterns. This distribution is contagious in relation to microstructures that drain the fluids at small scale on a site, and at the scale of a margin with geological structures like mud volcanoes, ridges and sliding scars due to massive fluid expulsion.

A correlation was observed between the total biomass of bivalves and the total volume of fluid expelled on sites or geological structures (1000 m² to 100 000 m²) affected by fluid expulsion. These biomasses (50 to 3000 kg) and the volumes of fluid expelled (10³ to 10⁶ m³/year) are very variable on a margin and depend on the functioning and the stage of activity of each structure. Type-structures that allow the development of chemosynthetic communities were identified, and their wide occurrence along subduction zones suggests that the exploitation of cold-fluid seeps is largely spreaded.

Karine Olu

(Abstract of Doctoral Thesis in Biological Oceanography
University of Paris VI, Feb. 1996, 319 pp.)

Institute of Marine and Coastal Sciences, Dudley Road, Cook College
Rutgers University, New Brunswick, NJ 08903, USA

Publications

Chevaldonné, P. & K. Olu, 1996: Occurrence of anomuran crabs (Crustacea: Decapoda) in hydrothermal vent and cold-seep communities: a review. - *Proc. Biol. Soc. Wash.* 109 (2): 286-298.

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STRUCTURE AND DIVERSITY OF DEEP BENTHIC COMMUNITIES IN RESPONSE TO CONTRASTED TROPHIC CONDITIONS IN THE TROPICAL AND TEMPERATE NORTHEAST ATLANTIC OCEAN

The most important and unexpected feature of the deep-sea ecosystem is the unusually high species diversity of the benthic fauna. Some theoretical patterns attempted to explain the processes maintaining this high diversity without, however, considering the trophic resource parameter and its variability. Nowadays the numerous data obtained through the pluridisciplinary program EUMELI in the tropical Northeast Atlantic make it possible to analyse the structure and diversity of the benthic communities at three deep-sea sites with different bathymetric, physical and trophic conditions. Megafaunal communities become important when the macro- and meiofaunal compartments are well developed in the environment. There is a strategy of installation of the communities controlled by the trophic input.

Densities of the different faunal size-groups follow a decreasing gradient with depth, following firstly a steep decrease up to 3100 m and a more gentle slope afterwards.

At the species level, a detailed analysis of polychaete communities, the dominant macrofaunal taxon, has made it possible to show the influences of environmental conditions on the communities' structure. This is conveyed by assemblages of species that are more or less specialized for a given habitat and by changes in the polychaetes'

spatial dispersion: a random distribution replaces aggregation when the distance from the margin of the continent is increased. Species diversity of polychaetes is particularly high on the continental slope, induced by interactions between production and disturbance with physical parameters enabling a reduction in competitive exclusion. On the other hand, communities at abyssal depths are weakly diversified in response to a high constraining environment characterized particularly by very limited trophic resources. The station at 3000 m shows an intermediate species diversity arising from the combined effect of relatively high organic flux and moderate physical parameters. In the tropical region, there is a parabolic diversity gradient from the coast to the abyssal plain that reaches a maximum diversity at 2000 m depth.

The extension of the study to two temperate regions of the Atlantic makes it possible to describe the high regional variability of polychaete diversity. In temperate zones, the rather moderate diversification of the community results from the interactions between nonpredictable physical events related to the proximity of the margin and the relatively high organic carbon flux, but is very concentrated in time.

The biological diversity analysed on 15 groups of benthic invertebrates revealed high variation functions of each taxon independent of the faunal size distinction. Contrary to the case with polychaete communities, communities of isopods, aplacophores and bivalves show a higher diversity near 3000 m depth where environmental parameters are relatively homogeneous. Whereas most megafaunal taxa have low diversity but are well represented on the continental slope, the holothurians seem to prefer more stable physical conditions, as observed by their high diversity and high density at 3000 m depth in the tropical Atlantic. Trophic analysis of the communities makes it possible to show the role of species interactions and particularly predation in regulating competition and maintaining high diversity.

Nathalie Cosson

(Abstract of Doctoral Thesis in Biological Oceanography,
University of Bretagne Occidentale)

Ifremer, DRO/EP, Laboratoire d'écologie abyssale B.P. 70
F-29280 Plouzane cedex, France - E-mail <ncosson@ifremer.fr>

Publication

Cosson, N., M. Sibuet & J. Gáleron (In press). Community structure and spatial heterogeneity of the deep-sea macrofauna at three contrasted stations in the tropical northeast Atlantic. - *Deep-Sea Res.*

DEEP-SEA CUMACEA

For several years I have worked on cumacean crustaceans from coastal and shelf areas of the southern hemisphere. I started with material from the Antarctic-Subantarctic shelves, continued with those from southern Africa, and now I am working up material from the Indian Ocean. These studies include primarily taxonomic and zoogeographical aspects. Deep-sea material is available only from very few stations of the SE Pacific and western Indian Ocean. However, the very first analyses of two deep-sea samples resulted in one new genus and species, and two new species in described genera: *Iphinoe* n.sp., and *Makrokyllindrus* n.sp., to be published in *Beaufortia*.

I am interested in the following questions:

- 1) Is there a connection on the species level between shelf and deep sea?
- 2) Is there a higher degree of eurybathic or stenobathic species?
- 3) Does the degree of diversity increase with water depth?
- 4) Can we detect the centre of radiation of certain genera?

In general the deep-sea cumacean fauna is poorly known although cumaceans are very widely distributed and should occur in almost every deep-sea core sample. I therefore would appreciate greatly if deep-sea biologists or geologists who have found unidentified cumacean specimens in their samples would make them available to me for taxonomic analyses.

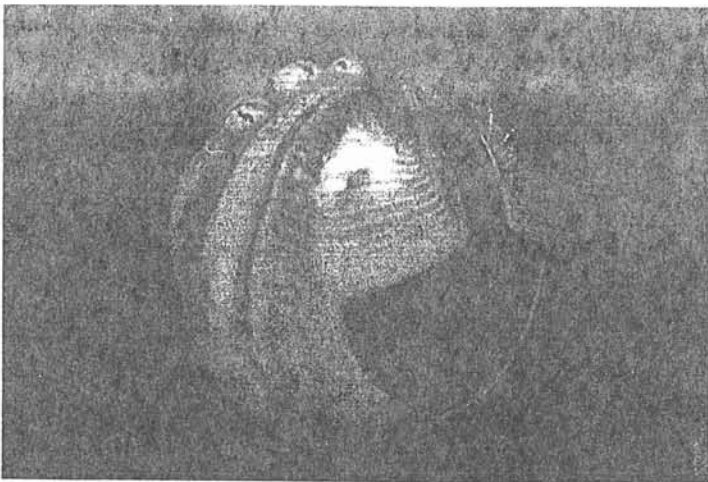


Ute Mühlenhardt-Siegel
Zoological Institute and Museum
Martin-Luther-King-Platz 3, D-21046 Hamburg
FAX: +49-40-4123-3937

NEW WOOD-BORING BIVALVES FROM THE N.E. ATLANTIC

The family *Xylophagidae* of the order *Pholadacea* contains around 40 described species in three genera. Most come from depths >1000 m, 17 new species of the genus *Xylophaga* having been described by Knudsen (1961) from the *Galathea* collections. *Xylophaga* is the most speciose genus and comprises species mostly <10 mm in length, with an almost spherical shell. Unlike many other molluscan wood borers, *Xylophaga* has no calcareous lining to the burrow, forming a 'chimney' of compacted wood pellets. Deployments of 'Bathysnap' camera systems by the Southampton Oceanography Centre provided the opportunity to place wood panels on the sea bed at a number of locations. A 20 month deployment on the Madeira Abyssal Plain in 5000 m resulted in the recovery of over 400 specimens of a new species of *Xylophaga*. The large specimens measured

6.3 mm, indicating a rapid growth rate of an opportunist species. Growth rates appeared to be similar in pine and mahogany substrata. The presence of a wide range of sizes down to postlarvae <0.5 mm suggests that recruitment may have been more or less continuous. It is not known whether recruitment came from within or outside the population (or both), as the reproductive maturity of the larger individuals has not yet been examined. In some species, juveniles are found attached to the shells of adults, prompting the suggestion that they are brooded, thus ensuring repopulation of isolated wood 'islands'. This further suggests an ability to switch from a nondispersive mode of development to a teloplanktic larva when the wood island is becoming exhausted. Developments in DNA analysis of very small samples, together with studies of larval development in coastal species, may ultimately shed some light on these questions. The demands of EC MAST and other 'thematic' programmes currently in vogue unfortunately leave little time for following up such fascinating questions at present.

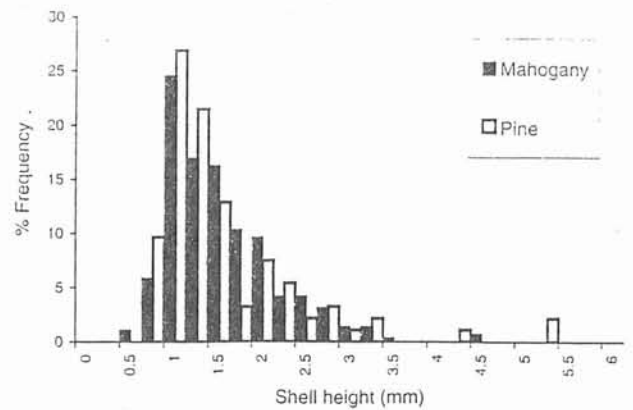


Oblique view of anterior end of *Xylophaga* n.sp. from 1383 m, Rockall Trough. Note juveniles attached to dorsal region of shell, which is 4.5 mm high.

is currently attaching wood packages to every 'Bathysnap' that goes down (!) and I am grateful to him and other S.O.C. staff for making their samples available to me.

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- Knudsen, J., 1961: The bathyal and abyssal *Xylophaga* (Pholadidae, Bivalvia). - *Galathea Rep.* 5: 163-209.
Turner, R.D., 1972: *Xyloredo*, a new teredinid-like abyssal wood-borer. - *Breviora* 397: 1-19.



Xylophaga n.sp. from 5000 m, Madeira Abyssal Plain. For mahogany, n = 289; for pine, n = 93.

The discovery of these specimens prompted a closer look at wood fragments trawled by SAMS in the Rockall Trough since 1973. Two additional new species of *Xylophaga* were discovered, one of which is shown here. Specimens of *Xyloredo ingolfia* (Turner, 1972), which has a calcareous burrow lining, were also found in several wood fragments from depths of 1383 and 2900 m. This taxon was previously known only from wood panels placed in 3000 m in the NW Atlantic, and from wood dredged off Iceland by the *Ingolf*. A paper on these findings will appear shortly in the *Journal of Conchology*. I would be pleased to hear from anyone who may be able to deploy wood panels (which I would supply) on or <10 m from the sea-bed. Brian Bett of S.O.C.

Robin Harvey

Scottish Association for Marine Science
Dunstaffnage Marine Lab., P.O. Box 3,
Oban, Argyll Scotland, U.K.

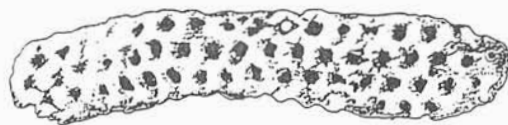
LITTLE MYSTERIES OF THE DEEP

Mystery No. 1 - the perforated tubes

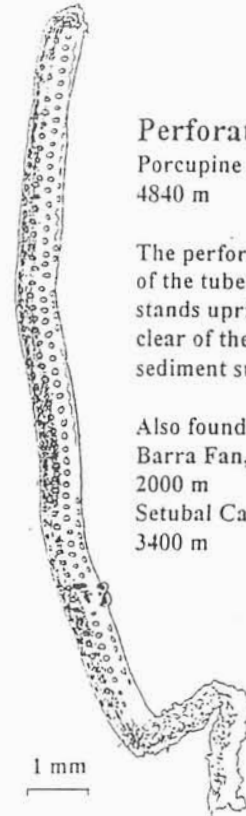
Deep-sea macrobenthos samples often contain weird and wonderful structures in miniature, besides new and interesting species. Early in my sorting I came across fragments of tube which had a regular pattern of perforations. These tubes are about 1 mm across in their flattened state and the fragments up to 3-4 mm long and were noticed in 3400 m samples from the Setubal Canyon off Portugal. A few years after the first finds of the tubes I then came across a species of polychaete belonging to a family called Sphaerodoridae, meaning 'balls on the back'. The only specimen I have is from an apparently undescribed species which has six rows of 'balls' along its back. These balls, or tubercles, resemble miniature golf balls set on their driving tees. At first it seemed that this might be the animal which had made the tubes, as the spacing of the perforations matched the spacing in the tube fragments. Although from 2000 m on the Barra Fan, W of Scotland, the specimen was found in the same samples as more of the perforated tube fragments. The spacing of the tubercles matched the spacing of the holes in the tube fragments. There the matter rested - the worm apparently stuck its tubercles through the holes in the tube - the mystery was solved!-?

In September 1996 we collected core samples from the Porcupine Abyssal Plain (4840 m) and there, on the surface of a mud core, was one of the same perforated tubes, this time intact and standing up vertically to about 15 mm from the mud surface. Several more were found and carefully collected along with subsurface mud but none have so far yielded any sphaerodorids. The pattern of perforations in the intact tubes was more apparent in that each succeeding row of holes is offset from the preceding row. Since the tubercles on the worm are in a regular arrangement they would no longer seem to be a good fit!

The search is on again - who or what makes the tube?



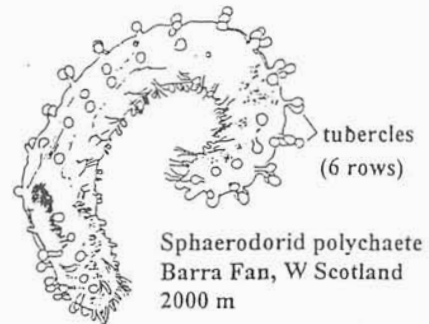
old, perforated tube fragment
from Barra Fan samples



Perforated tube
Porcupine Abyssal Plain
4840 m

The perforated portion
of the tube
stands upright &
clear of the
sediment surface

Also found at :
Barra Fan, W Scotland
2000 m
Setubal Canyon, Portugal
3400 m



tubercles
(6 rows)

Sphaerodorid polychaete
Barra Fan, W Scotland
2000 m

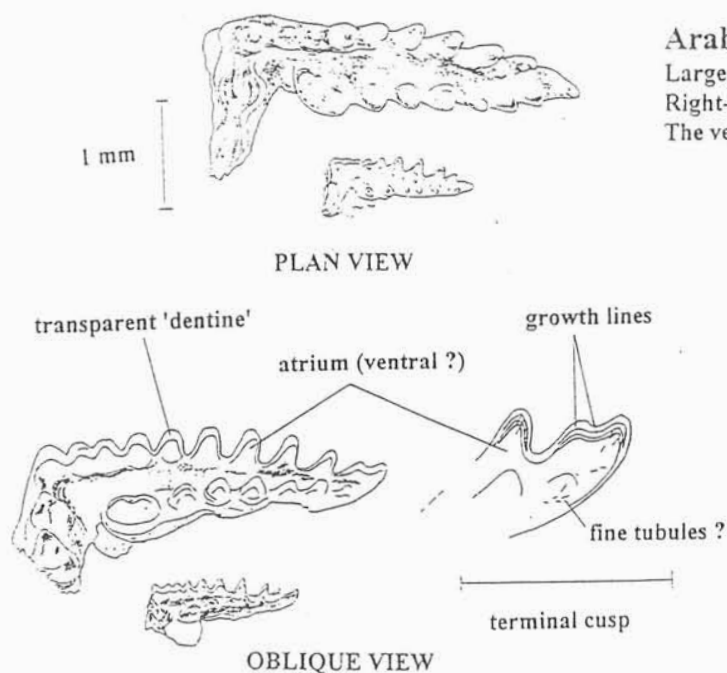
Mystery No. 2 - the right-angle jaws, the right-angle teeth? or what?

These little structures turned up in samples from the Arabian Sea off Oman. At first I thought they were terrestrial in origin, but as no more fragments of any arthropod were present this idea was unsupported by any evidence. Like the tubes, no colleagues came up with any positive identifications. Pharyngeal teeth or any other origin was discounted by fish experts and colleagues with long experience of polychaetes had not seen the like before.

In some of the larger 'jaws' can be seen what are apparently growth bands. Up to three lines have been observed. The nature of the material has not been tested so its composition is not known at present. Results for



the eighteen 92 mm square subcores examined seem to indicate increasing frequency closer to the coast, but there are no data for samples shallower than 400 m.

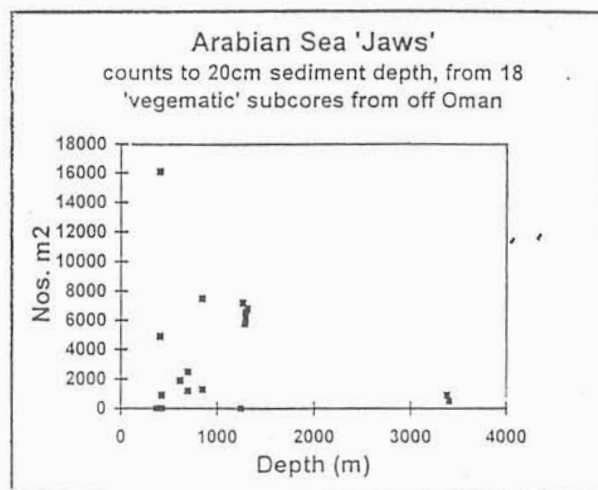


Arabian Sea "jaws"

Large and small left-hand jaws are illustrated.

Right-hand jaws are also found.

The ventral (?) atria are almost always filled with sediment.

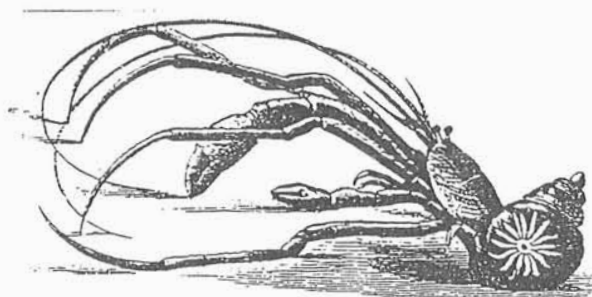


Suggestions, please, on a postcard to me or the Editor.

Peter Lamont
Scottish Association for Marine Science
Dunstaffnage Marine Lab., P.O. Box 3,
Oban, Argyll, Scotland, U.K.
E-mail <pal@wpo.nerc.ac.uk>

DEEP-SEA ECOLOGY AT THE ISOPE '97 CONFERENCE

From 25-30 May 1997 ISOPE '97, the 7th International Offshore and Polar Engineering Conference will occur in Honolulu, Hawaii. Most of the about 700 (!) papers announced will not cover deep-sea ecology, but six of the sessions will be concerned with environmental studies. Three of them will discuss the impact of oil drilling in deep water, specifically of the Arctic Ocean, and the other three sessions will be mainly concerned with environmental impact studies to pre-evaluate environmental influences of the potential mining of manganese nodules. A total of 9 papers originates from large-scale impact experiments conducted during the last years. Other papers will discuss the manufacturing of tiles, ceramics and other useful products from the manganese nodule tailings, the storage of CO₂ and dredged materials in the deep ocean, the impact of sand mining and a discussion on research topics thought to be of importance in relation to future uses of the deep sea and its resources. A plenary presentation will introduce the environmental problems of the deep sea to a large audience (2000 participants are expected to attend the conference) of offshore and polar engineers. The organizers of the symposium and of the sessions concerned with the environment hope that the results of the conference will have a strong impact on the technical world.



THE ATLANTIC DEEP SEA: EXPLORATION AND ANIMAL LIFE

Richard Ellis: *Deep Atlantic: Life, Death and Exploration in the Abyss*. Knopf, New York, Oct. 1996. 393 pp., 32 photographs, 102 orig. drawings. US\$ 35.

This new book on the deep Atlantic Ocean is an attractive companion to Gage and Tyler's more scientifically oriented *Deep-Sea Biology* and is the first one to combine a fairly thorough account of the history of deep-sea exploration, particularly the most recent events, with a description of oceanic life, both pelagic and benthic.

Richard Ellis, the author, has written articles and books on whales, dolphins and sharks and the recent *Monsters of the Sea*. His book on the deep ocean benefits greatly from his profound knowledge of both the scientific and popular-scientific literature (the bibliography contains about 1100 references!), and also from his interviews and discussions with a significant number of key persons and specialists on both historical, technical and biological items.

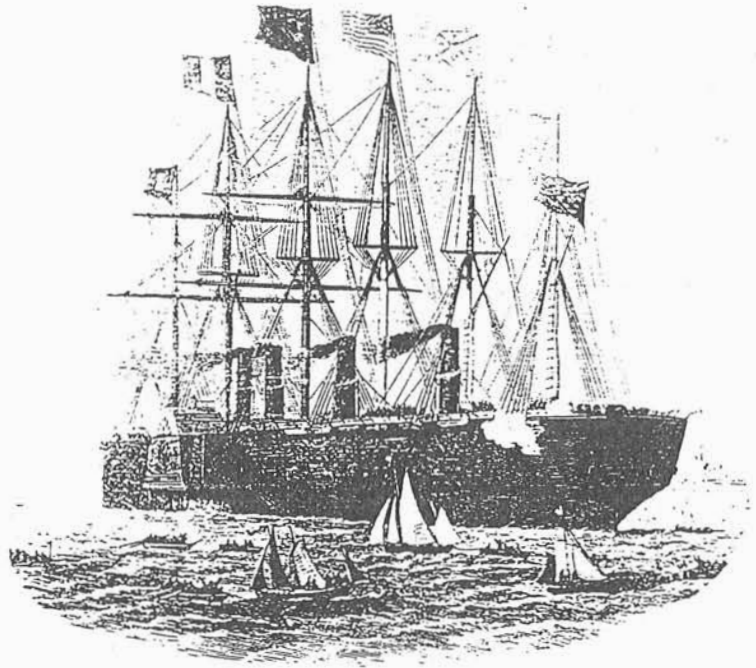
The general presentation is well written, entertaining, even exhilarating, and with relevant citations from scientists, writers and a few poets. Much of the more anecdotal or elaborating evidence has been placed in a wealth of footnotes in minor type.

The author has restricted himself to the depths and that the main stress should be laid on the deep Atlantic Ocean, which is the best known and is where exploration first began. Much, however, e.g., hydrothermal vents, can only be adequately explained with reference to another ocean. Thus, even though discussions are primarily about Atlantic Ocean phenomena, where needed, digressions have been made to another body of water.

Two-fifths of the text is devoted to the history of exploration. The first chapter, on the study of the Atlantic, deals with the controversy about its actual depth and whether or not any life existed at all beyond 300 fathoms. Less known to biologists than the work of the pioneers like John Ross and his nephew James, Edward Forbes, Michael and G.O. Sars (not Danish, as stated, but Norwegian), Maury and Wyville Thomson, is the fascinating story of laying of transatlantic telegraph cables, culminating with the fabulous *Great Eastern*. The scientific exploration during those active last three to four decades of the 1800s mentions only British, American and Monacan efforts, leaving out the work of great ships like *Vøringen*, *Travailleur* and *Talisman*, *Ingolf*, *Pola*, *Valdivia* and *Siboga*.

After a brief account of the Gulf Stream, the chapter on geology pays particular tribute to Wegener, Ewing and Heezen, and to sea-floor spreading ("the wound that never heals"). It also recalls the story of the ill-starred Mohole, "the project that went awry", and the well-documented *Glomar Challenger*.

Then follows a vivid description of all sorts of diving devices from Alexander the Great, who is said to have observed a fish that took three days to pass, over the first and often fatal development of submarines and Beebe's and Barton's bathysphere, to Auguste Piccard, the father of modern submersibles, and the incredible underwater flotilla in his wake. (A minor error appears on p. 69 where 1949 is given as the year when the *Challenger II* discovered in the Mariana Trench the greatest ocean depth. Actually the ship made her first record soundings in mid-July 1951, in exactly the same week as we on the *Galathea* recovered the first animals from the Philippine Trench, up till then regarded as the deepest place on Earth!).



The *Great Eastern*, up to 1857 the largest ship ever built, proved uneconomical for passenger transport. Converted to a cable ship, she laid the first transatlantic cable in 1866. The 2700 miles of cable, coiled six stories high, weighed an estimated 5000-7000 tons. She also carried a veritable village aboard, consisting of 500 men, 20 pigs, 120 sheep, 20 oxen, a barnyard of chickens and a single cow.

Next we join the author in an imaginary voyage by submarine across the Atlantic, with explanation of, e.g., turbidity currents, bottom topography and nodules. Before traversing the Mid-Atlantic Ridge, the story of Bob Ballard's discovery of the remnants of the *Titanic* and the *Bismarck* is recorded. The final chapter of the first part is devoted to hydrothermal vents and the Florida seeps.

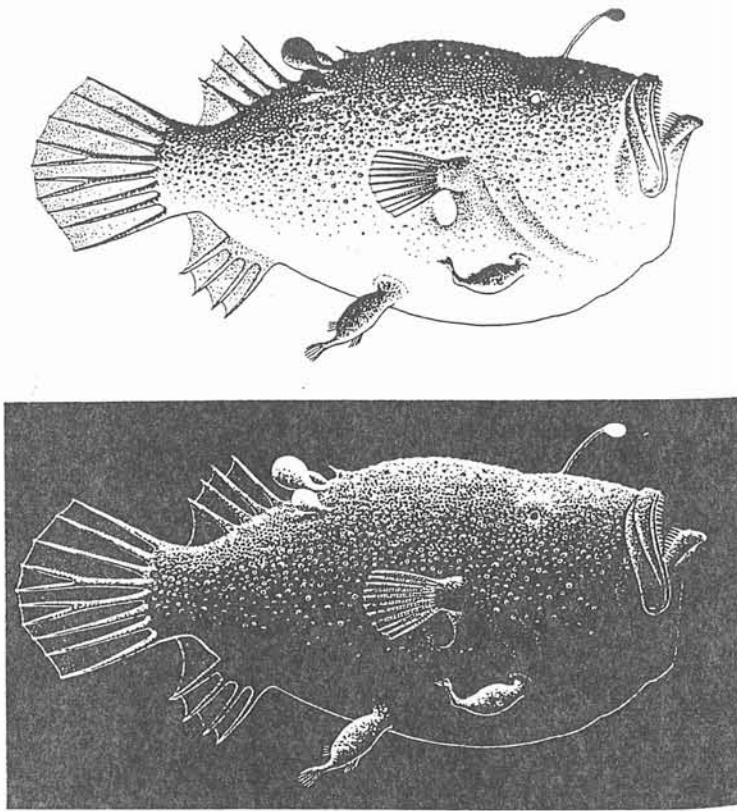
The second part, "Creatures of the Abyss", deals primarily with the fish. Amongst the invertebrates, all major groups are adequately, although rather briefly, covered, with the main emphasis rightly being laid on the abundant holothurians and the spectacular cephalopods, including the reclusive giant squids.

As stated above, the interpretation of the pelagic and bottom-living fish is very exhaustive and informative. What makes it particularly appealing is the copiousness of excellent illustrations, amounting to no less than 75 of which on fish. Richard Ellis is not only an author but also a celebrated marine artist. All his illustrations are redrawn from the originals, and stand out as negatives against a black background. This unique procedure is also adopted in illustrations of invertebrates like holothurians, decapods and cephalopods and in the final chapter on deep whales and whaling.

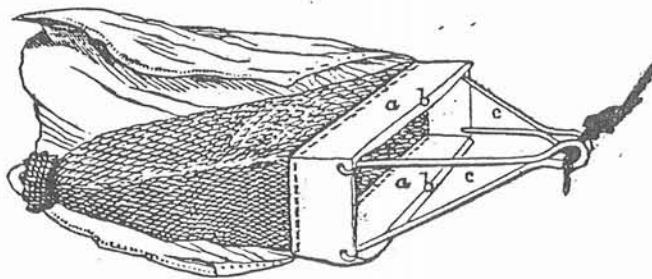
An extremely detailed index rounds off this highly recommendable book on our favourite environment.

Torben Wolff

Zoological Museum, University of Copenhagen



In order to make his drawings appear in contrast to the black of the deep sea, Ellis first drew them in black ink on white background, with reversed shading, before the final negative photostats were made. Shown here is a female anglerfish, *Cryptopsaras couesi*, with two parasitic males attached.



THE DEADLINE FOR THE NEXT ISSUE OF D-SN IS 1st JULY 1997

Contributions may be sent as e-mail attachments in WordPerfect 5.1 DOS or ASCII to TW c/o Else Højgaard: <ekhojgaard@zmuc.ku.dk>. For further information, see <http://www.aki.ku.dk/zmuc/inv/staff/tw.htm>

Editor: Torben Wolff, Zoological Museum, University of Copenhagen
Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark

