DEEP-SEA NEWSLETTER

No. 15, February 1989

THE FIFTH DEEP-SEA BIOLOGY SYMPOSIUM - BREST
26 JUNE - 1 JULY 1988

When it was announced in the Newsletter in October 1986 that the next symposium on deep-sea biology was to be held in Brest two years later, our hearts started beating a little faster in expectation of a visit to the famous IFREMER headquarters, the French *cuisine* and the *Vitis vinifera* products, a *revoir* with friends present at previous meetings, and news about recent exciting developments in deep-sea research and discussions of mutual interest.

The meetings took place in the newly built conference hall of the Centre de Brest which covers 30 hectars of typical Breton landscape on a promontory just west of Brest and overlooking a beautiful fiord leading to the Atlantic. Coffee breaks were spent in the vestibule of the hall where the posters were also located. Lunch could be obtained in the spacious - and cheap - canteen of the Centre.

The attendance was even considerably greater than at Hamburg: France 57, USA 31, UK 19, FRG 14, Spain 11, Canada 5, Belgium 4, Denmark and Japan 3, Norway 2, and Australia, Egypt, Holland, Iceland, Ireland and Sweden 1 plus another 14 who had not enlisted in advance, totalling 169 dedicated deep-sea enthusiasts. To these may be added another 20-25 persons who attended the Symposium for only a short time.

The general theme of the symposium was Biology and Ecology of the Deep Sea: bathyal and abyssal to hadal environments, including hydrothermal and cold seep communities. The following topics were considered:

1. Biogeography, Evolution (15 papers, 7 posters)
2. Structure and distribution of deep-sea assemblages (21 papers, 12 posters)
3. Biology, Ecophysiology (9 papers, 3 posters)
4. Chemosynthetically based ecosystems (21 papers, 14 posters)
5. Benthic fluxes, processes and foodwebs (21 papers, 7 posters)

On arrival each participant received a nicely produced book (184 pages!) with program, list of participants and all the abstracts. Since it has been decided that the papers will be published in *Progress in Oceanography* (with Martin Angel and Myriam Sibuet as editors), their titles will not be given here.

Four Round Table Discussions were arranged. Reports by the coordinator(s) are given below.

In addition there were at least three film shows - on Louisiana hydrocarbon seepage sites (Craig Cary), on hydrothermal communities (IFREMER/TELECOM), and on behaviour of mainly pelagic holothurians (John E. Miller). Another memorable presentation was Tony Rice's essay "Oceanography and stamps". There were also opportunities to visit institutes at the Centre and R/V *Jean Charcot*.

Like at previous meetings, a great number of exciting new discoveries were presented. A general trend was the increasing orientation towards integrated studies which allow analyses of the factors controlling the distribution of specific communities and their adaptive strategies. This applies not only to life based on hydrothermal and cold seep activities, but also to dense aggregations of certain animals and deep-sea seasonality probably due to periodic fluxes of particles.

French hospitality was shown on several occasions: a welcome cocktail party at the IFREMER Centre one sunny late afternoon with a splendid view of the fiord and a bagpipe band playing; at a grand reception offered by the City of Brest at the town hall, followed by a "crêpe party" (pancakes with seafood) in a large, rebuilt warehouse in the Brest harbour; and particularly during the afternoon excursion through the Breton countryside, taking us via the impressive Kerjean Castel and Saint-Thegonnec one of the old churches with their famous calvaries (stone miniatures from the life of Christ), to the Roscoff Biological Station. Here Pierre Lassère, its Director, welcomed us at a reception and there was time for a quick view of the station and its aquarium. Finally, we were brought to the "Chateau de Brèzal" and served a splendid dinner; the more spiritua entertainment was supplied by a flute and guitar duo, the less spiritual by deep-sea biologists and the chef who all more or less willingly volunteered to act...

The overwhelming success of the Brest Symposium is due first and foremost to Myriam Sibuet, our charming hostess, and her helpers who had put a lot of work into preparing and running the meeting. They certainly did a fine job. It should also be acknowledged that the Symposium was sponsored by IFREMER, the National Center for Scientific Research (CNRS), the Ministry of Foreign Affairs, and the City of Brest.

Torben Wolf

Round Table Discussions in Brest

Four special workshops had been proposed and were carried through. We wish to thank the chosen coordinators for preparing the following - very extensive - reports for "Deep-Sea Newsletter".

1. Impact assessment studies in mining the deep-seabed

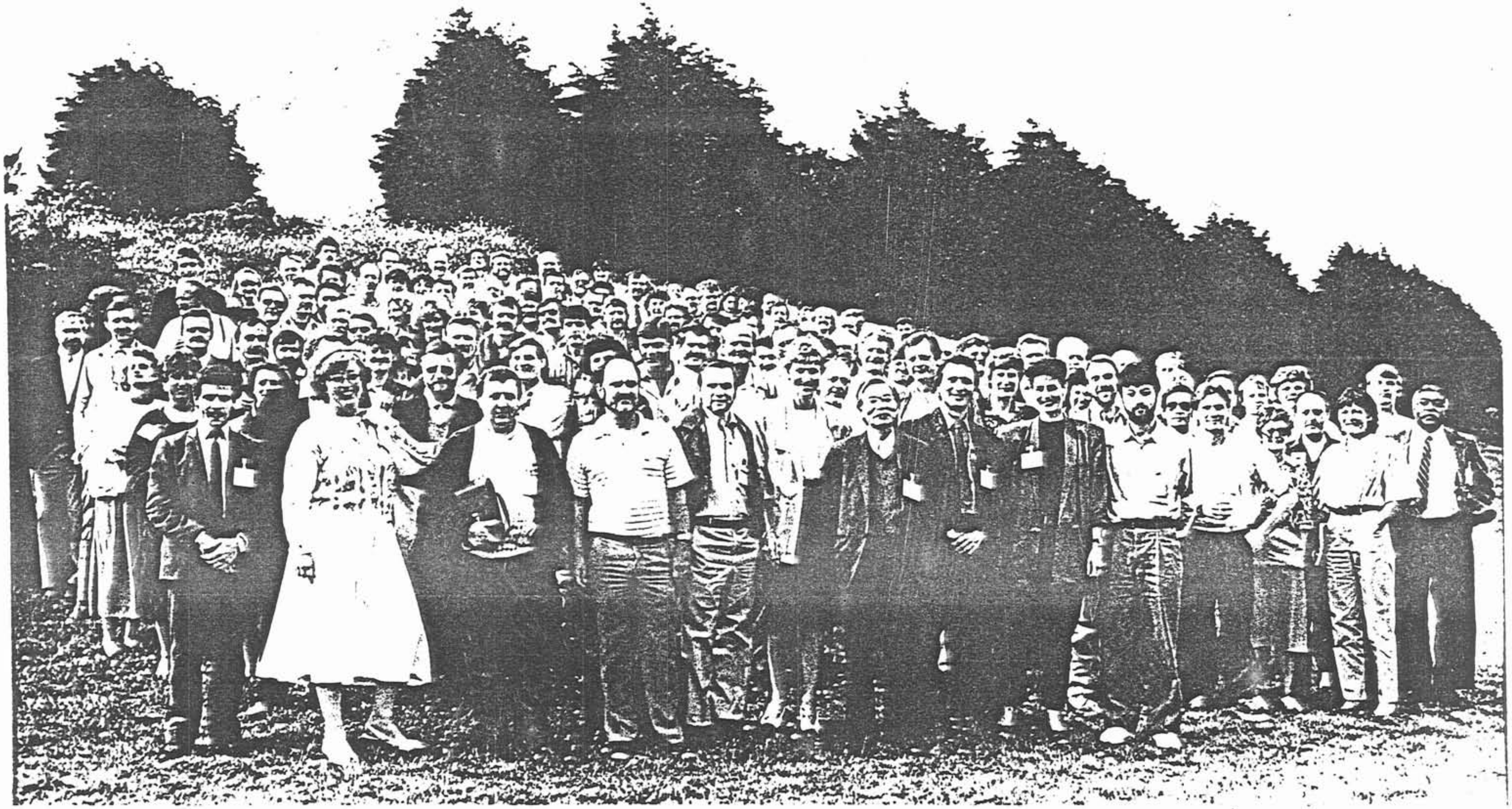
- Case of polymetallic nodules -

Although arranged in parallel to a symposium lecture session, 21 scientists from 6 countries participated in this discussion.

H. Thiel introduced the subject by presenting arguments for the environmental impact evaluation in the context of manganese nodule mining. The potential impacts are:

- disturbance of the sediment surface through
    - collector uptake,
    - creation of a bottom-near plume,
    - sediment surface blanketing;
- creation of a surface and/or midwater plume;
- tailings disposals in the sea or on land.

Impact studies should



An enlarged copy of the official photo (in colour).
The photos on the following pages were taken by the Editor (p. 4, left side and p. 5, left side top and middle), the remainder by David L. Pawson, National Museum of Natural History, Washington, D.C.

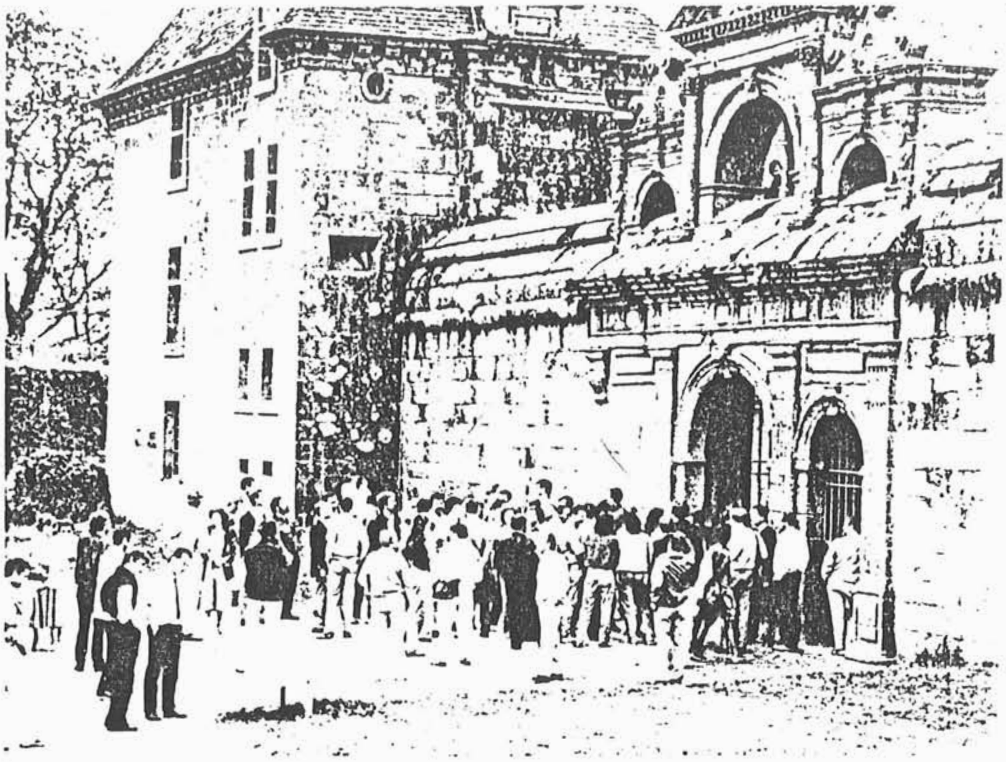
Our charming hostess Myriam Sibuet,
with Alain Guille, Paris

Three musketeers - Hjalmar Thiel,
Daniel Desbruyères and Tony Rice

A small section of IFREMER

Your Editor stripping -

- and presenting the ferocious war cry, the haka, as an old Maori chief leading his 2000 men



Martin Angel singing lustily (?lustfully)

Torleiv Brattegard presenting Norwegian lyric

Visit to Kerjean Castle

French performance of "Alouette"

The chef contributed too

- produce sound arguments for discussions with governments, industries and nature advocats (Greenpeace etc.),
- minimize costs for technical developments, i.e.,
  - are the impacts deleterious - no development is necessary, no efforts, no costs have to be met with,
  - is environmental concern expressed early enough, can the industry develop appropriate techniques?

To obtain convincing arguments different types of impact studies were suggested:
- small scale experiments,
- large scale experiments,
- small scale monitoring: Pre-Pilot Mining Tests (PPMTs),
- large scale monitoring: Pilot Mining Operations (POMs).

The large scale experiments must be viewed additionally as exercises for PPMTs and POMs.

M. Angel (IOS, UK) added the arguments for nature protection established by the International Union for the Conservation of Nature (IUCN):
- the conservation of genetic diversity,
- the conservation of natural reserves,
- the conservation of ecological processes.

All participants agreed on the need for environmental impact studies (EIS) and emphasized their immediate continuation. Mining techniques are developed to an extent that mining can begin soon after the political problems have been solved. As impact studies need many years (ten or tens), they should be carried on as soon as possible.

Earlier EIS

Mining tests in 1978 were observed and monitored by US scientists.

Recolonization of the 1978 mining tracks was studied in 1983, but no clear conclusions could be drawn from the results (Hessler & Wilson, in Spiess *et al.* 1987).

Planned EIS

US scientists will repeat their sampling of mining tracks at DOMES cite C in the North Pacific with improved methods, a newly developed remotely controlled underwater manipulator, RUM III.

Additionally, small scale experiments on the order of meters will be conducted to learn about the ability of benthic organisms to cope with sediment covers of varying thickness. Obligatory equipment for studies on this scale are submersibles or remotely operated vehicles.

FR Germany scientists plan a large scale disturbance/re-colonization experiment in the Peru Basin: DISCOL - Disturbance and Recolonization Experiment in a manganese nodule area of the deep S Pacific. (After the symposium in Brest, the DISCOL proposal was approved by the FRG Ministry of Science and Technology.)

Following a thorough investigation of the benthic and epibenthic fauna, an area of about 12 km^2 will be disturbed and immediately afterwards the first reinspection will occur. These samples will indicate the degree of disturbance. Half a year later and subsequently every second year, the community development of the disturbed area will be investigated to learn about the re-colonization and its pace.

No other EISs were reported to the participants, although some of the French exploration studies in the N Pacific will be useful for environmental impact evaluations. This should be applicable as well for results from investigations by other "pioneer investors" (UNESCO 1988) which are Japan, the USSR and the International Sea-Bed Authority.

The problem of harbour mud dumping into the deep sea, being a large scale disturbance and blanketing of the sea-bed, was brought up by M. Angel (UK). The discussion centered around the question whether impact limits can be set responsibly by scientists without any prior investigations. The majority of the participants expressed the view that large scale experiments must be a prerequisite before decisions on dumping can be made.

The round table session was closed at 16.30 hours with slides of the RUM-vehicle shown by G. Wilson and H. Kukert, USA.

H. Thiel, V. Tilot and G. Schriver

2. Pressure Physiology

Participants: Robert Y. George (USA) and Anne Marie Alayse (France), Coordinators. Ruth William (UK), Workshop Secretary. C. Cary (USA), S. Charmasson (France), J. Childress (USA), J. Deming (USA), A. Fiala-Medioni (France), H. Felbeck (USA), C. Fisher (USA), L. Floury (France), B. Julia (France), G. Graf (FRG), P. Linke (FRG), J. Patching (Ireland), M. Van Praet (France), and R. Vetter (USA).

George: The purpose of this Workshop is to define the 'state of the art' today with reference to two important areas of pressure physiology of deep-sea animals. The first area deals with techniques for retrieval of deep-sea organisms at *in situ* pressure. The second area involves pressure incubation of deep-sea organisms in laboratory chambers for long time maintenance under pressure.

Childress: The problem with pressure *in situ* recovery is the high cost. Therefore, we should use temperature protection for animals from 500 to 1000 m. Below 1000 m we need to pressurize the retrieval system. Technology is there to build these pressure vessels, but the method only yields little data. *In situ* experiments yield more results. But such studies are limited to simple experiments wherein we cannot control conditions, e.g., temperature.

George: We should use pressure trap systems below 3000 m. If an animal is retrieved at 1500 m it can be maintained alive at 150 atm. It is advisable to develop a pressure trap with heavy plexiglass for pressures up to 150 atm. The problem is deployment. We may need to use submersibles.

Childress: The development of a pressure retrieval system depends on how important the question is. There has been very little work on pressure tolerance.

George: Much more is known about pressure tolerance of shallow water organisms.

Deming: Microbiologists have only worked on decompressed and then recompressed organisms.

Cary: For studying the physiology of deep-sea infauna we need to develop pressure containing box-corers. We should do controllable kinetic studies.

Vetter: We have isolated mitochondria at sea and called them mini-living structures. Work done is mostly in the vents. The pressure retrieval technique is easier with mitochondria than whole animal approach.

George: With proper temperature control it looks as though we can retrieve deep-sea animals down to 2000 m without any provision for pressure conservation.

Vetter: You can work quickly with non-pressured animals. We hope to build enzyme respirometers.

Fiala-Medioni: There seems to be no effect on scale of pressure inhibition of normal behaviour. We can put probes in membrane. Lipid membrane does not melt.

George: We may want to do *in situ* pressure experiments. We need to look at questions involving barophilic macroorganisms. It is also useful to look at cross adaptations of pressure and temperature in animals with wide vertical range.

Childress: This has not been done yet.

George: Let us now focus on the second question for this workshop, namely the problem revolving around long-term pressure incubation.

Deming: We microbiologists work on decompressed and recompressed bacteria from the deep sea. The approach is work-intensive and with low data return. We look at enzyme at high temperature + high pressure. We have problems with seals; our fixed control times were high. It is very labour-intensive to work with a pressure retaining vessel.

Fisher: We build an inexpensive system to collect large quantities of mussels at 2000 psi. Pressure retrieval is not necessary for mussels as they come up alive. But our trap design is simple, and the cost is $3000. The trap is aluminium with one window and with a blow-off valve which is set at any pressure. There is a screening mechanism to stop particulates damaging seals.

George: At IMBR in Wilmington, we have acryllic deep-sea traps which can be used down to 500 m with the capability of retaining pressure of 50 atm. I think it is useful to capture a vertically-migrating, bathyal animal of its upper depth range of 500 m and bring it up alive under pressure.

Vetter: At some stage we need to work on abyssal animals. We need pressurized respirometer + other apparatus.

Linke: We have developed a steel chamber *in situ* respirometer and a calorimeter.

George: We have used ZoBell's bacteria chambers to define pressure tolerance in invertebrates. They are blind chambers of 150 ml in volume. We also have observation chambers with windows for video-camera attachments. We have succeeded in keeping large crabs for 1 week experiments in a flow-through pressure system. We can measure NH_4 excretion and O_2 consumption. Our 3rd step was to continue the experiment over months, periodically removing water (transfer pump) under pressure.

Childress: We kept a vent crab for 18 months. Low pressure acryllic vessels cost $3000 to $4000. Material is available 'off the shelf' from industrial sources.

Patching: We developed pressure vessels with IOS (Karen Lochted) for an approximate cost of £800-900, 6 cm in diameter, samples incubated in plastic bags, valves located at top + bottom, 0-rings also at top + bottom, so easily repaired if broken. We used a reservoir + low pressure pump. A firm in UK makes a pump which can be used for pressure experiments.

George (summary statement): From the foregoing discussion it is apparent that there is a lot of work in progress both in terms of retrieving deep-sea organisms under pressure and retaining deep-sea organisms in pressure incubators for long-term studies. It appears that, from a technological point of view, we are better off to capture upper bathyal creatures down to 2000 m only with thermal protection. Undoubtedly, it is cost-effective to use simple pressure traps in aluminium or even acryllic plastics for low pressure retrieval. Evidently, we need to arrive at better engineering concepts and designs for high pressure retrieval systems and pressure aquaria.

Robert Y. George and Anne Marie Alayse

3. Biological Flux Studies

Participants in Brest were invited to a round table discussion of biologically important fluxes and how studies of these fluxes are fitting into international programs concerned with the global ocean. A group of 10 to 15 individuals met twice on June 30, during which the theme of discussion focused on the biologists' roles in the various national and international programs that had been initiated.

Claude Lambert and Martin Angel prepared the following summary, which has been revised slightly by the reporter based on suggestions by other participants:

"The concensus of deep-sea biologists interested in fluxes was that the link between studies of global geochemical fluxes and biological processes needs to be reinforced. Knowledge of intricate biological processes can help chemists explain fluxes, and data from the Global Ocean Flux Study (GOFS) can aid biological studies by putting important bounds on rates of carbon cycling within communities.

The ad hoc group that met discussed in some detail a number of reasons for the importance of increasing biological involvement in global flux programs. Whenever possible, deep-sea biology cruises should be organized in places where organic matter fluxes are regularly measured by sediment traps. Furthermore, those few sites at which regular biological observations have been conducted over several years should be given high priority by new studies in water column fluxes and processes. It also is important that these sites be set within a context of larger scale physical and chemical data.

To achieve such objectives, and to measure as many fluxes as possible at one site, there must be a sharing of skill and expertise. Opportunities must be created for biological and chemical oceanogrpahers with appropriate skills to participate in cruises to areas of a particular common interest. If the science is to advance, international collaboration must be encouraged; at present, this is best achieved at the level of individual scientists.

Some of the key areas about which the biologists expressed concern and a need for added biology were the follwing:

1. Vertical versus horizontal "margin-generated" fluxes in the water column (One cannot model biological processes from only the vertical input of organic matter. Continental margins, fluvial inputs and chemosynthetic processes all need to be assessed in comparison with central gyre, non-margin processes.),
2. Dissolved (versus particulate) organic matter in carbon cycling,
3. Biological "pumps" that accelerate fluxes (active biological transport such as pelagic vertical migration; sinking carcasses; irrigation, bioturbation, etc. of sediments; etc.) need to be included in studies of carbon cycling,
4. Bacteria in benthic and pelagic food chains,
5. Time-dependent coupling between primary production and consumption in the water column and on the bottom (at various depths and latitudes), and
6. Secondary production."

Considerable discussion was concerned with mechanisms available that would allow biologists to interact at an international level in collaborative studies of fluxes. Barry Hargrave at Canada's Bedford Institute, who was not at the meeting, had suggested previously to Rowe that the Scientific Committee on Oceanic Research (SCOR) might be interested in sponsoring, at least in philosophy, Hargrave's idea for a single cruise during which all fluxes presently within our capabilities would be measured. Hargrave and Rowe had discussed sharing shiptime at different latitudes and at different seasons in the western North Atlantic in order to consider seasonal variations in fluxes and how pervasive such variations might be throughout a deep water column. With this philosophy of shared shiptime in mind, Rowe suggested that the group could generate a common list of programs that could incorporate foreign investigators and a list of investigators and their special interests who would be interested in joining such programs. This could act as a starting point for future collaborations. Whether or not these are incorporated into official programs must be left to the organisations themselves and to the individual investigators.

Jarl Strömberg suggested that he could explore the issue of biological flux cruises at the next SCOR meeting.

The following is a list of investigators, their interests in, and their potential contributions, to a biological "fluxes" program:

John D. Gage, Dunstaffnage Marine Lab., P.O.Box 3, Oban, PA34 4AD, UK, **P.A. Tyler**, University College, Singleton Park, Swansea, SA2 8PP, UK and **G.J. Davies**, Heriot-Watt University, Chambers Street, Edinburgh, UK

The time series of samples of the benthic macrofauna from the Rockall Trough Permanent Station has enabled study of the life history biology (including reproduction, recruitment and growth) of the key species that numerically dominate the community. Development of demographic models for echinoderms and molluscs has allowed us to calculate preliminary estimates of secondary production which can be expressed in terms of turnover of carbon in benthic biomass per unit area. We feel these data are of importance in consideration of overall benthic fluxes. We feel also our data from Rockall will be relevant and applicable to benthic flux processes at stations of roughly equivalent latitude along the 20°W GOFS/BOFS/JGOFS transect in the North Atlantic.

A.L. Rice, IOS, Wormley, Godalming, Surry GU8 5UB, UK

Benthos: What are the responses of deep ocean communities to climatic variations?

Variability in time (seasonal and interannual) - Variability in space (small to large scale) - Food web structure - Life history characteristiscs - Use of size spectra.

Martin V. Angel, IOS, Wormley, Godalming, Surrey GU8 5UB, UK

Water column: What are the responses of the pelagic biota to climatic variations?

Vertical structure - Diel vertical migration - Food web structure - Use of size spectra.

(The extent of winter mixing varies both north to south and east to west in the eastern North Atlantic, so variations in space may mimic variations in time on an interannual scale.)

Barbara Hecker, Lamont-Doherty Geological Observatory, Palisades, NY, USA

Use of camera sled system to estimate megafaunal abundances and biomass.

Francis de Bovee, Laboratoire Arago, F-66650 Banyuls-sur-Mer, France

Meiofaunal energy flow: Sediment community oxygen consumption, shipboard measurements.

Marine free-living nematodes: Respiration, production and consumption.

Presently involved in ECOMARGE program in western Mediterranean. This "warm" sea at depth would be a useful comparison with other basins that have distinctly different temperature-depth relationships.

Laurence Guidi, Laboratoire Arago, F-66650 Banyuls-sur-Mer, France

Feeding ecology: Macrofaunal organisms, experimentation using radiolabelled isotopes, presently in the laboratory but eventually *in situ*, use of chloropigments as tracers of food inputs in the water column and in the sediment.

J.W. Patching, Dept. of Microbiology, University College, Galway, Ireland

Activity of bacteria in deep ocean waters; has pressure vessels.

Karen Wishner, Graduate School of Oceanography, Univ. of Rhode Island, Narragansett, RI, USA

Feeding rates and fecal production of benthic boundary layer zooplankton; presently submersible dependent but may be able to develop ship-deployed system.

A facility that could be used (at URI) for methodological or equipment trials is the Marine Ecosystem Research Laboratory (MERL) mesocosm tanks (8 tanks with water and sediment, 10 m deep).

Richard L. Haedrich, Ocean Science Center, Memorial University of Newfoundland, St.John's, Nfld. A1C 3T3, Canada, fax 709-737-4569

Food chains; fishes; vertically migrating hyperbenthos (esp. Mysidae); stable isotopes of different trophic levels; coordinates Cold Ocean Productivity Experiment (COPE); studying rates of transfers and processes in cold water marine systems; now working in deep fiords off Newfoundland.

The Ocean Sciences Center (under RLH's direction) could make fully equipped laboratory available to visiting investigators, including infrastructure support and most analytical equipment required by potential visiting scientists (scintillation counters, spectrophotometers, oxygen electrodes, epifluorescence microscopes, ICPMS, etc.; small boats, divers, etc.).

Roselyne Buscail, Laboratoire Sedimentologie et Geochemie Marines, Université de Perpignan, F-66025 Perpignan, France

Organic matter transformations in the benthic boundary layer, including comparison of the nature of organic matter in sediment traps and in the surficial layer of the sediment, proportion of the organic matter which is labile (sugars, lipids, amino acids, etc.) versus inert (humic and humin substance (geopolymerization)).

Mechanisms of transformation, experiments using radiolabelled organic tracers.

Yoshihisa Shirayama, Ocean Research Institute, University of Tokyo, 1-15-1 Minamidai, Nakano-ku, Tokyo 164, Japan

Interests: Abundance of and fluctuations in meiobenthos - Respiration, feeding and absorption rates of meiobenthos - Estimate of secondary production of meiobenthos on the basis of seasonal sampling.

Facilities available: R/V *Hakuho Maru*: maximum of two cruises per three years of 30 to 60 days per cruise. Berths available to foreigners: max. of 7, with travel costs paid by participants and possibly per diem costs covered by ORI. All areas in the Pacific are available. In 1991 the ship wil go to the Atlantic.

R/V *Tansei Maru*: maximum two cruises per year of 7 to 10 days each. Berths available to foreigners: max. of 5. Other conditions as above.

H. Thiel and O. Pfannkuche, Institut für Hydrobiologie und Fischereiwissenschaft, Zeiseweg 9, D-2000 Hamburg 50, FRG, **F. Riemann**, Alfred Wegener Institut für Polar- und Meeresforschung, D-2850 Bremerhaven 1, FRG, and **K. Lochte**, Inst. für Meereskunde, Düsternbrooker Weg 20, D-2300 Kiel, FRG

Abundance, respiration and organic carbon degradation of the benthos in the BIOTRANS area, Central NE Atlantic Ocean (47°20'N, 19°30'W).

G. Graf and U.V. Bathmann, Institut für Meereskunde, Sonderforschungsbereich 313, Düsternbrooker Weg 20, D-2300 Kiel, FRG

Sedimentation in the Norwegian Sea - Seasonality of primary production, zooplankton production and food web interaction in correlation to vertical particle flux. The pelagic flux is correlated to benthic seasonality in pigment content, ATP and heat production, life cycles of benthic organisms and benthic respiration. Funded until 1990.

R/V *Meteor*: May to July 1989, 20°W, from 10-70°N - Summer 1990, Norwegian Sea. R/V *Polarstern*: June 1989, Norwegian Sea.

H. Weyland and E. Helmke, Alfred Wegener Inst. für Polar- und Meeresforschung, D-2850, Bremerhaven 1, FRG

Microbial decomposition of organic matter in the Southern Ocean.

M. Sibuet, A. Khripounoff, D. Desbruyères, A.M. Alayse, G. Auffret, M. Mahaut, and A. Vangriesheim, IFREMER, Centre de Brest, B.P. 70, F-29263 Plouzané, France, in collaboration with **C. Lambert** and **P. Geistdoerfer** of the CNRS.

Community structure and the cycling of organic matter in benthic boundary layer food webs - sediment trapping - *in situ* experimentation with labelled substrates - models of attraction to carcasses by amphipods and fishes - colonization of artificial substrates - reproductive periodicity - bioturbation - spatial structure of benthic fauna.

JGOFS proposed studies: R/V *Eumeli* on central Atlantic transect off NW African upwelling, use of free vehicles and submersibles *Épaulard* and *Nautile* for surveys and *in situ* experimentations.

Gilbert T. Rowe, Departm. of Oceanography, Texas A&M University, College Station, TX, USA

Benthic lander development: Fluxes of oxygen and nutrients across the sediment water interface - Diagnostic models of deep-sea food chains.

R/V *Gyre*, operated by Texas A&M University: Three 10-day cruises per year to investigate fluvial (Mississippi River) influences on oceanic water masses on a global scale. Several berths and wire time would be available for visiting scientists. These studies are:

Spring cruise (March 1989) to investigate Mississippi River outflow on continental shelf; satellite remote sensing ashore to be ground-truthed with extensive sampling around drogues tracked by both the ship and the satellite. Chief Scientist: Bill Merrell.

Summer cruise (June 1989) to investigate stratified conditions on the shelf that lead to hypoxia, vertical fluxes of particulates in deep water, and trapping of larger organisms in deep water, including *Bathynomus giganteus*, the giant isopod. Space available for visiting foreign scientists, but travel costs must be borne by the individuals themselves.

On each trip two standard sections will be made off Galveston and Corpus Christi, Texas, along which standard data will be collected at 20, 50, 100 and 200 m depth stations. These will be extended to deeper water as needs arise. Three similar cruises (including one to warm ring structures off Texas and Mexico) are planned for the following year on which space for collaborators would also be available. One purpose of these standard sections is to develop a data base for the western Gulf of Mexico from which the impacts of climatic variations on the Mississippi River and fisheries resources can be assessed.

Jody W. Deming, Dept. of Oceanography, University of Washington, Seattle, WA, USA

Bacterial processes under extremes of heat, cold and pressure.

Robert Y. George, Inst. for Marine Biomedical Research, University of North Carolina at Wilmington, Wilmington, NC 28403, USA

Regulation of metabolic rates in large and small deep-sea animals.

J.J. Childress and C.R. Fisher, Marine Science Inst., University of California, Santa Barbara, CA 93106, USA

Physiological and biochemical adaptations of deep-sea animals, including animals in hydrothermal vents and methane seeps.

Craig Smith, H. Kukert, R.A. Wheatcroft and P.A. Jumars, School of Oceanography, University of Washington, Seattle, WA 98195, USA

Dynamics of trace assemblages, burial and bioturbation.

Ann Mauviel, Universitè du Quebec, Rimouski, Quebec G5L 3A1, Canada

Trace assemblages and bioturbation.

A.J. Gooday, IOS, Wormley, Godalming, UK, **P.J.B. Lambshead**, British Museum, Cromwell Road, London SW7 5BD, UK, **P. Linke**, Sonderforschungsbereich 313, Kiel, and **A.V. Altenbach**, Albrechts Institute, Kiel, FRG.

Seasonally deposited phytoplankton detritus and its effects.

H.S.J. Roe, D.S.M. Billett and R.S. Lampitt, IOS, Wormley, Godalming, UK

Midwater-benthic interactions: Observations with trawls and camera systems.

In summary, individual scientists are encouraged to use the above list to promote collaborations among themselves and with geochemists on fluxes that are important to living systems.

Gilbert T. Rowe

4. Interest of visual means in the assessment of patterns of distribution and behaviour of the benthic deep-sea fauna

Alain Dinet, the Chairman, welcomed the 17 participants who covered a broad spectrum of deep-sea scientific work. He then gave a short survey of the visual means in current use and opened the discussion.

1) Stereophotography was considered useful because of the 3-dimensional effect. Accessories are, however, very expensive. Work of this kind is very time consuming. Pseudostereo (a mono-camera used with overlap of exposures) is certainly acceptable but is technically difficult to manage on the sea bottom.

2) Film types were eagerly discussed, and many technical details were reported on, with some of the participants explaining their own practice. Films must be fast, fine-grained, and in colour. Considering the price of shiptime, the extra cost for best film quality is negligible.

3) Design of photographic surveys was obviously a theme of great interest. In the discussion on general design, transects were preferred for network patterns, although transects have the drawback that spatial distribution is often poorly covered. The idea of 'regularly spaced transects' partly overcomes this drawback.

Using submersibles in large transects or in a network is often difficult because of the interplay between currents, time, and velocity differences.

Among the techniques discussed was video, which was considered good for survey, but so poor in details that it was recommended to use it only in combination with a still-photo camera.

Measurement of heights over the bottom can nowadays be done reliably with the installation of a cheap 'paired laser' equipment.

If a statistically dependable treatment of the photographs is the aim, then also those photos not showing animals must be considered a kind of evidence and should be included. If the idea is to define scale distributions, both overlap and 100% coverage of the bottom in question are necessary; this means that photographs should be taken with 20-30 seconds intervals.

The problem of comparing photographs taken vertically with those taken at an angle was touched upon and considered difficult.

4) Remote-controlled types of gear have a limited working time because they run on batteries. Many new designs are supplied with power from the surface. Photographs and diagrams of modern Canadian and French equipment were shown.

5) Databanks in different institutions were mentioned and explained. A new one is established at Brest (Epaulard); the system will be flexible for new and additional codes. It was considered important that the user can get information on particular geographic areas, and that it is possi-

ble to go back and re-analyze earlier data. The problems concerning common databanks and the access to data need much further consideration.

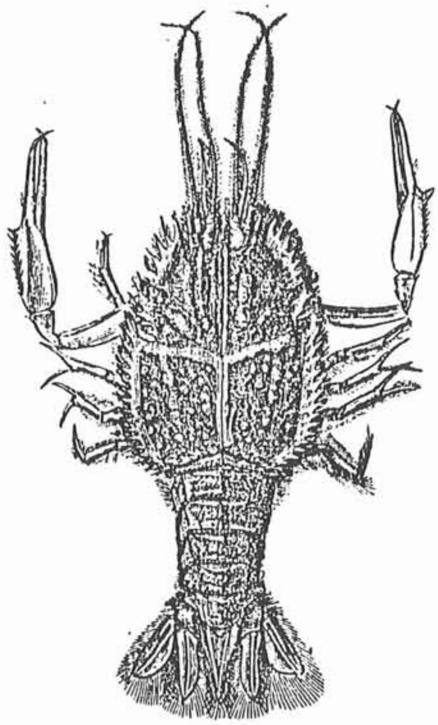
6) Taxonomy represents a serious problem as so many photographic investigations are made in the deep sea, not only by biologists but also by, e.g., geologists, without animals being sampled or kept. The need for (preferably) simultaneous sampling in the same areas where photographs are taken was emphasized. Also mentioned were two other problems: animals being photographed on or above the bottom but being too fast to be caught by the sampling gear, and animals living deeply buried in the bottom but leaving tracks on the surface.

7) The group touched upon the idea of creating a deep-sea photographic atlas of the megafauna. The launching of the idea may be premature but a soft start could be made. The first step might be the compilation of a list of people and institutions being in charge of deep-sea photographic material and possibly being willing to let others make use of them.

A form was made up and distributed at the meeting. Eleven forms were returned (Carey, Cary, Hecker, Miller, Tunnicliffe, Wishner, JAMSTEC, Ohta, Christiansen, Desbruyères, and Sibuet).

It was further agreed to publish a form in "Deep-Sea Newsletter" and that completed forms should be returned to Myriam Sibuet within three months. The final list will be published in "Deep-Sea Newsletter".

Ole S. Tendal



NEXT TIME IN COPENHAGEN -

Towards the end of the Brest Symposium there were several who asked the evident question: Where to meet next?

At the closing ceremony I announced that before the edition of this issue of the Newsletter the matter would have been settled.

It so happened, and my colleagues and I are pleased to welcome you in Copenhagen in 2 1/2 years' time. The meeting will take place in the first week of July 1991 at the August Krogh Institute (Zoophysiology) which is located on the Natural Sciences Campus of the University just north of Copenhagen central. Further details and a preliminary application form will be brought in the next issue of the "Deep-Sea Newsletter".

Torben Wolff

DEEP-SEA FILM DIRECTORY

NAME : ____

ADDRESS : ____

____

____

Type of film (35mm colour slides, prints, B+W, colour video, B+W video, etc)

Location of where films were taken

Estimate of quantity

Original purposes and manner in which taken (bounce camera, sledge, sled, submersible, etc).

PLEASE PRINT

To be returned to: Dr. Myriam Sibuet, Centre de Brest
P.B. 70, F-29263 Plouzané, France.

HISTORY OF OCEANOGRAPHY

at the 18th International Congress on the History of Science

West Germany 1989

A one day symposium titled Historical research on oceanography 1800-1950 will be held in Hamburg between 1st and 4th August 1989 (exact day still uncertain) during the Eighteenth International Congress on the History of Science (ICHS-XVIII). Speakers from the UK, FRG, Monaco, USA and Canada will consider topics such as the interest of the German Reichsmarine in oceanography between the wars, the early organization of oceanography in Britain, the history of expeditions, and recent historiography of oceanography. Time has been scheduled for discussion at the end of morning and afternoon sessions.

A meeting of the Commission of Oceanography, Division of History of Science, International Union of the History and Philosophy of Science will be held at the end of the afternoon session. It is open to all.

For information and registration forms for the ICHS-XVIII contact CPO HANSER SERVICE, Postfach 1221, D-2000 Hamburg, Barsbüttel, FRG.

Eric Mills

DEEP-SEA NEWSLETTER 1-15

The distribution of the present Newsletter has grown considerably since No. 1 was published in October 1978. It has therefore been suggested to me that it might be useful to present a list of contents of previous issues.

I gladly use the coming-of-age of our child (15 numbers) to respond to this suggestion. Smaller notes and editorial remarks, announcements and references to the deep-sea symposia and other meetings etc. have been omitted. It should be noted that many contributions include highly useful literature references.

Hopefully on behalf of all readers, I also wish to use this anniversary to thank our faithful "agents" (i.e., the correspondents) who are listed below. Most of them have - almost without complaints - reproduced the master copy they receive from me and mailed copies to institutions, libraries and individual scientists in their country or region - a total of between 200 and 300 addresses.

Torben Wolff
Editor

- Latest news from hydrothermal and cold vents in the Pacific. - R.R. Hessler.
- Abyssal work in the Polar Ocean: The FRAM I drift-ice expedition. - J. Just.
- Reproductive biology in deep-sea ophiuroids and holothurians from the Rockall Trough. - P.A. Tyler.
- Towards a better understanding of the Atlantic xenophyophore fauna. - O.S. Tendal & A.J. Gooday.

No. 3, February 1980, 16 pp.
- Deep fjords as convenient research areas. - C.D. Levings.
- Deep-water bottom trawling surveys of the ISH (Hamburg). - M. Stehmann.
- A research request: zoogeography of the Atlantic Ocean bathyal regions. - E.B. Cutler.
- Recent French deep-sea activities. - M. Sibuet & A. Dinet.
- News from the Institute of Oceanographic Sciences, Wormley. - T. Rice.
- The new IOS epibenthic sledge. - R.G. Aldred.
- Near-bottom RMT 1+8 sampling. - M. Angel.
- Investigations in the Soviet Union of the deep-sea bottom fauna 1975-1979 (P.P. Shirshov Inst. of Oceanology, Moscow). - N.G. Vinogradova.
- The Symposium "Biology of the Pacific Ocean Depths", XIVth Pacific Science Congress (USSR, Khabarovsk, August 1979). - N.G. Vinogradova.
- Conservation of the Cortes-Tanner Banks, Southern California. - J. Mohr.

No. 4, November 1980, 8 pp.
- Report on benthic studies in Ocean Research Institute (O.R.I.), Univ. of Tokyo, Japan. - M. Horikoshi.
- Recent German deep-sea activities. - Hj. Thiel.
- Ymer 80. - J.-O. Strömberg.
- News from the Institute of Oceanographic Sciences, Wormley. - T. Rice.
- Bathysnap. - R. Lampitt.
- French report on deep-sea ecology. - L. Laubier.

No. 5, September 1981, 7 pp.
- Investigations of the deep-sea fauna by the P.P. Shirshov Institute of Oceanology of the Academy of Sciences of the USSR in 1980-81. - N.G. Vinogradova.
- Recent French research activity. - L. Laubier.
- Holothurian swarms in the Porcupine Seabight. - B. Hansen & D. Billett.
- Infaunal xenophyophores from the Ogasawara and Japan Trenches. - D.D. Swinbanks & Y. Shirayama.
- Histological and enzymological approach to the nutrition of abyssal sea anemones. - M. van Praet.

No. 6, June 1982, 16 pp.
- International Deep-Sea Biology Symposium, La Jolla, California, 4-6 November 1981. - T. Wolff.
- Final cruise of the SUBTROPEX Upwelling Program. - Hj. Thiel.
- Meiofauna studies in the Rockall Trough. - P. Barnett, B. Hardy & J. Watson.
- "HAKON MOSBY" - the new oceanographic research vessel of the University of Bergen, Norway.
- R/V DANA, Denmark.
- Fact Sheet: Biology of the hydrothermal vents at 21°N East Pacific Rise (EPR). - Ed., based on a report by K.L. Smith.
- Recent hydrothermal vent investigations, Oasis Expedition (Legs 1 and 2) (11 April - 19 May 1982). - K.L. Smith.

No. 7, March 1983, 11 pp.
- John Murray Expedition - 50th Anniversary. - M. Angel & T. Rice.

- Joint cruise to the northern Rockall Trough and Wyville Thomson Ridge on RRS Challenger, 29 July - 12 August 1982. - J.D. Gage.
- Reproduction in marine benthic invertebrates from the N.E. Atlantic deep-sea. - P.A. Tyler.
- Seasonal sedimentation of phytoplankton to the deep-sea benthos. - D. Billett, R. Lampitt & T. Rice.
- Call for taxonomists' help! - M. Türkay & Hj. Thiel.

<u>No. 8</u>, December 1983, 11 pp.
- A new SCOR working group on Ecology of the deep ocean floor. - T. Wolff.
- Deep seabed mining research cruise. - J. Snider.
- New submarine thermal springs. Preliminary results of a biological expedition. - L. Laubier.
- The vertical distribution of Foraminifera within the sediment: Preliminary results from the bathyal Porcupine Seabight. - A. Gooday.
- No progress on phyto-detritus by I.O.S. - T. Rice.
- A bonellid echiuran worm, the maker of a star-shaped lebensspur on the surface of the deep-sea floor. - M. Horikoshi & S. Ohta.

<u>No. 9</u>, August 1984, 36 pp.
- In Memoriam. Dr. Zinaida A. Filatova 1905-1984. - T. Wolff.
- Porcupine Newsletter. - T. Wolff.
- Deep-sea cirrate octopuses observed from a submersible. - K.N. Nesis.
- High levels of ^{210}Po and ^{210}Pb in the infaunal xenophyophore *Occultammina profunda*. - D. Swinbanks & Y. Shirayama.
- Hydrothermal vent references: I. Biology; II. Geology; III. Geochemistry; IV. Other vent references. - T. Wolff.
- News from France: Recent expedition to the hydrothermal vent at 13^{o}N. - L. Laubier.
- Institution changes in France. - L. Laubier.
- A sulfur-based seep community in the Gulf of Mexico. Preliminary results of an accidental find. - B. Hecker.

<u>No. 10</u>, April 1985, 13 pp.
- Radiation-induced mutation in deep-sea animals. - O. Tendal.
- There is a time for monoplacophore ecology... - O. Tendal.
- Bathyal and abyssal Bryozoa collected during the Woods Hole Oceanographic Institution research programme. - J.-L. d'Hondt.
- Canadian studies in deep ocean ecology 1983-1984. - B.T. Hargrave, P. Kepkay & P. Schwinghamer.
- Investigations on deep-sea bottom fauna at the P.P. Shirshov Institute of Oceanology in 1982-84. - N. Vinogradova.
- Biogas program - Publication announcement. - L. Laubier.
- Hydrothermal vents of the East Pacific Rise - Biology and Ecology of the 13^{o}N area. First announcement. - L. Laubier.
- Cruise "BALGIM" (<u>B</u>iologie <u>A</u>t<u>L</u>antique <u>GI</u>lbraltar <u>M</u>editerranée). - L. Laubier.

<u>No. 11</u>, December 1985, 17 pp.
- The International Deep-Sea Biology Symposium, Hamburg, FRG, 23-29 June 1985. - T. Wolff.
- Man's impact on the deep-sea. - Hj. Thiel. (From the Hamburg Symp.).
- SCOR Working Group 76 ("Ecology of the Deep Sea Floor") at the Hamburg Symposium. - T. Rice.
- Salad days for swimming sea-cucumbers. - D.S.M. Billett & B. Hansen.
- The composition and distribution of the hydrothermal vent fauna. - T. Wolff. (A complete list of animals as of December 1985).
- Mode of occurrence of *Calyptogena soyoae* observed from the Japanese submersible "Shinkai 2000" in Sagami Bay. - M. Horikoshi & T. Ishii.
- Cold seep communities at 3800 and 5850 m off Japan. - L. Laubier.

No. 12, October 1986, 15 pp.
- New research project on the "seep communities" at the slope foot of the Hatsushima Island, Sagami Bay, central Japan. - S. Ohta & J. Hashimoto.
- Ecology of Japan cold seep benthic communities analysed from photo and video records: Problems and surprises. - K. Juniper & M. Sibuet.
- Is *Akebiconcha* synonymous with *Calyptogena*? - M. Horikoshi.
- Black Smokers on the Atlantic seafloor: Preliminary dive report. - P.A. Rona.
- News from the Center of Brest (France): Deep-sea ecology investigations in the North East Atlantic. - M. Sibuet.
- Deep-sea questions and demands. - Hj. Thiel.

No. 13, September 1987, 21 pp.
- The Hanging Gardens hydrothermal vent site. - C.L. Van Dover, C.J. Berg & K.S. Orr.
- Hydrothermal processes at the Mid-Atlantic Ridge: Recent developments. - P.A. Rona.
- Discovery of a hadal representative of Loricifera. - R.M. Kristensen & Y. Shirayama.
- Notes on a deep-sea caprellid from Japanese waters. - M. Horikoshi.
- Current work on the crab *Geryon tridens*. - M. Attrill.
- *Rhizammina algaeformis* - a giant komokiacean foraminifer? - A. Gooday & N. Cartwright.
- Erratic stones as substrate for encrusting organisms. - A. Gooday.
- Deep-sea biology cruise to the Portuguese slope. - P.A. Tyler.
- The first major assault on the Indian Ocean. - J. Knudsen. (Review).
- The ships that laid the foundations. - T. Wolff. (Review).

No. 14, April 1988, 12 pp.
- Wood island community discovered on Alvin Dive 2000. - C.L. Van Dover.
- A hydrothermal vent community in the western Pacific. - R.R. Hessler.
- Canadian and US coast xenophyophores. - O.S. Tendal.

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DEEP-SEA NEWSLETTER

JOINT GLOBAL OCEAN FLUX STUDY (JGOFS)

You will have heard and read about the JGOFS program and it will not be necessary to give details. Those of you who have questions may contact us, and we will try to inform you on respective sources.

JGOFS intends to study the carbon cycle in the oceans, but currently it is a predominantly plankton program. SCOR has set up a steering committee which has hardly discussed bathy- and abyssoplankton or benthos surveys. This fact indicates that JGOFS in its pilot studies in 1989 will consider processes in the euphotic and the mesopelagic zones, and nothing or little will be done in deeper water layers or on the bottom.

In my opinion the complete water column and the bottom must be considered to study the total organic carbon transport in the oceans. Of course, processes at the ocean surface are of importance, but those in the deeper water column and at the bottom have to be taken into account simultaneously. It seems to us rather ridiculous to cut off a C-budget study at some depth and to declare the deeper parts of the oceans to be the earth's abyss or the hades, i.e., the hell which is to be disregarded. There will never be another chance for a total water column flux study in the foreseeable future - therefore the extreme deep pelagos and the benthos must be brought in!

What is to be done?

First of all, we have to ask which important processes determine the C_{org} transport in the deep ocean and in which way these can be studied. Although we usually complain about the lack of broader contributions on plankton research in our Deep-Sea Newsletter, this time we will not consider the plankton, since comprehensive coordination has already been achieved for JGOFS plankton research, although mainly for the epi- and mesopelagic zones. During 1989, the JGOFS pilot study will be conducted with 6 ships and a total of 14 ship-months (overlapping during March-October) on the 20^{o}W meridian. For all participating research groups concerned with the upper water column, core measurements were selected which will be carried through with identical methods. The ships' schedules are set up to meet individual, national and international interestes. Compromises have been sought, found and accepted in view of the entire JGOFS ideas and aims.

JGOFS was discussed in Brest under the chairmanship of G. Rowe (see his report), and many colleagues indicated interest in this program.

In September 1988 (in The Hague) we reported to the planning committee for the JGOFS pilot study, and we were asked to try a coordination of benthos studies.

A "Benthos coordination table for deep-sea studies (JGOFS)" was sent to all (benthos) participants of the Brest roundtable discussion and to some other interested groups. The aim of the circular was to learn about the actual plans for JGOFS and about methods to be used. We received a total of 8 answers (including our own) which revealed

- a rather limited involvement of benthos researchers in the JGOFS pilot studies,
- a keen interest in participation and coordination.

Directly involved in JGOFS pilot studies are:

1. The Netherlands: The NIOZ group, Peter de Wilde, Wim Helder and others. R.V. *Tyro* scheduled for
   1989, October, Madeira to 48°N along 20°W,
   1990, Spring, Madeira to 48°N along 20°W.
   (Based on The Netherlands ... Pilot Program of JGOFS, September 1988).
2. FRG: The BIOTRANS group, Bernd Christiansen, Karin Lochte, Olaf Pfannkuche, Hjalmar Thiel and others. R.V. *Meteor* is scheduled for
   1989, July/Aug. on the 20°W transect in 60° and 47° N (BIOTRANS area),
   1990, May/June on the 20°W transect in 33°N and 47°N (BIOTRANS area).

Related to JGOFS are:

3. FRG: Sonderforschungsbereich Kiel, Alexander Altenbach, Gerd Graf, Lutz Meyer-Reil, Peter Linke, Thomas Heeger, Marion Köster. R.V. *Meteor* is scheduled for
   1989, June/July at 10°W and 72°N.
4. UK: IOS Deacon Laboratory, Anthony L. Rice, Michael Thurston, Nigel Merrett, Andrew Gooday, David Billett. R.V. *Discovery* is scheduled for
   1989, August/Sept., 2 stations at 4800 m (not JGOFS, but close to the 30°N station),
   1990, August/September, proposal submitted for same but differing in emphasis.

Although there are differences in sampling and analytical methods, there is quite an overlap between the 4 programs, and this is promising for a closer coordination in future.

Other indications of interest came from:

5. Roselyne Buscail, mainly geochemistry and nicely overlapping in part,
6. John Lambshead, British Museum (Nat.Hist.) with general interest,
7. Gilbert Rowe, Texas A&M University, see his report,
8. Yoshihisa Shirayama, interested to participate.

Of further interest may be the (or part of the)

- French *Eumili* program,
- US sea-bed program, and the
- British BOFS program with its sediment bound components.

These are the programs and interests we know of. We would appreciate to receive further information on all of these as well as of those which may have escaped our notice so far.

How do we go ahead?

For the JGOFS pilot studies in 1989 it is now too late for long discussions, and we will not go into detail in this report. Coordination between the groups 1-4 is guaranteed or must be achieved by direct contact, with the main aim to produce comparable results on the carbon flux in the benthos.

The pilot studies must teach us how to proceed in future, in planning and conducting the JGOFS main studies. We will keep in touch with you via the Deep-Sea Newsletter or by special circulars. If you are not yet on our JGOFS benthos mailing list we would appreciate a short note on your interest.

Based on the information collected and the achievements reached within the forthcoming 2 1/2 years, we should arrange a workshop during the next Deep-Sea Symposium in 1991 in Copenhagen for further discussions leading benthos studies into JGOFS.

The BIOTRANS Group
(Hjalmar Thiel)

CALCAREOUS SPONGES IN THE ABYSSAL NORWEGIAN AND GREENLAND SEAS*

A tradition which seems to have been established by a categorical statement by Hentschel (1925), for many years held that sponges of the class Calcarea are not to be found deeper than 700 m. However, calcareous sponges had already at the time been reported from even greater bathyal depths, at more than 800 m, by Polèjaeff (1883), Hansen (1885), and Topsent (1892, 1895), and from abyssal depths, at more than 2000 m, by Hansen (1885).

The most recent survey of the bathymetric distribution of the Calcarea was given by Reid (1968), who based his statements on data from Burton (1963) and, probably by an oversight, mentioned fewer species from the deep sea than had actually been recorded.

Apart from the above-mentioned records, calcareous sponges have been found in bathyal depths near the Azores by Topsent (1934), off Spitzbergen by Koltun (1964), in the Bay of Biscay by Borojević & Boury-Esnault (1987), and off the Norwegian coast and East Greenland by Tendal (unpublished).

From abyssal depths, altogether 11 records of calcareous sponges have been reported by Hansen (1885), Koltun (1964), and Borojević & Graat-Kleeton (1965), eight of which were from the Norwegian Sea (Figure).

In June 1987, during a cruise with the *Håkon Mosby* of the University of Bergen, Norway (cruise leader T. Brattegard) between East Greenland and the island of Jan Mayen, calcareous sponges were again found at abyssal depths. They appeared in most of the sledge samples, often in large numbers (>100 may be found in a single sample) but always representing only a few (2-5) species.

Back at the Institute of Marine Biology, Bergen, some days of sorting samples from earlier cruises revealed scores of specimens collected at abyssal depths in different parts of the Norwegian Sea (Figure).

Later, it turned out that the group is also represented in the materials from the Danish Ingolf Expedition (collection of the Zoological Museum, Copenhagen) and the French-Swedish NORBI Expedition (CENTOB, Brest) (Figure).

Considering the history of sampling, the distribution of sampling sites, and the large number of specimens occurring in many of the samples, calcareous sponges must be regarded a constant and characteristic element of the abyssal fauna of the Greenland and Norwegian Seas.

It is remarkable that apart from three localities south of the Greenland-Iceland Ridge reported by Borojevic & Graat-Kleeton (1965) the group has not been found in other abyssal areas. It seems unlikely that its representatives can have been overlooked in, e.g., the Bay of Biscay, the BIOTRANS area, and off Northwest Africa, just to mention a few examples of well-investigated Atlantic areas.

It is also interesting to note that the combination of high pressure and very low temperatures (in most of the area even negative) does not prevent this $CaCO_3$ depositing group from keeping their spicules intact. It is not known how they avoid dissolution, but perhaps the organic sheath described by Jones (1967) and Ledger & Jones (1977) protects the spicules. In view of the existence of some such mechanism it is surprising that in the Antarctic Calcarea have not been reported deeper than the 460 m mentioned by Burton (1929).

I heartily thank Dr. Torleiv Brattegard of the Institute of Marine Biology, University of Bergen, for inviting me on cruises onboard the "Håkon Mosby" and for placing his collections at my disposal. I also thank Dr. Jon-Arne Sneli of the Biological Station, Trondheim, for his support and help during sampling and sorting.

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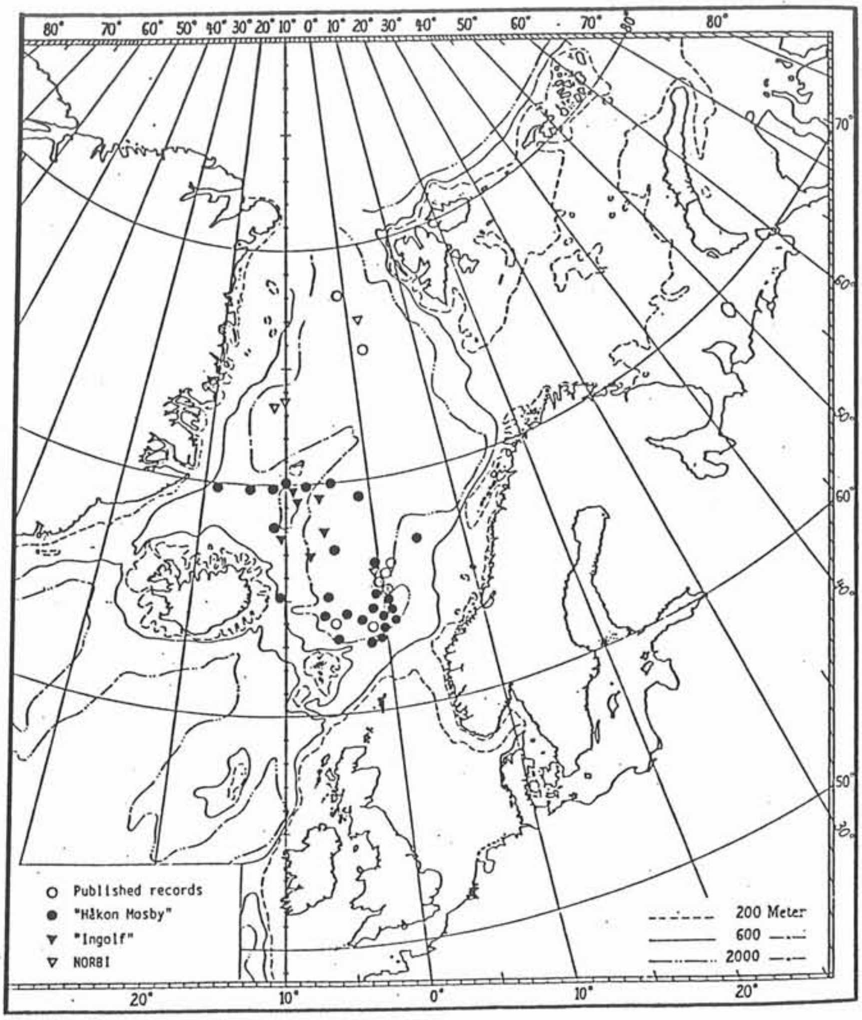
*) This and the following paper were sent to D.-S.N. independently - a funny coincidence! (Ed.)



The distribution of Calcarea at abyssal depths of the Norwegian and Greenland Seas. The localities indicated vary in depth from 1795 m to 3455 m, the latter being the deepest record for the area (*Håkon Mosby*; June 17, 1987; 66°28'N, 01° 04'W; *Sycon* sp., 1 specimen). Only few samples, using appropriate gear, have been taken north of 70°N (sledges, Brattegard *et al.* 1988).

References

Borojević, R. & G. Graat-Kleeton, 1965: Sur une nouvelle espèce de *Sycon* et quelques Démosponges récoltées par le "Cirrus" dans l'Atlantique Nord. - Beaufortia *13*: 81-85.

- & N. Boury-Esnault, 1987: Calcareous sponges collected by N.O. Thalassa on the continental margin of the Bay of Biscay: I. Calcinea. - Pp. 1-27 *in*: Vacelet & Boury-Esnault (eds.): Taxonomy of Porifera. NATO ASI Series, vol. G.13.

Brattegard, T., J.-A. Sneli & O.S. Tendal, 1988: Calcareous sponges in the abyssal Norwegian Sea. - Abstracts, Fifth Deep-Sea Biology Symposium, Brest, p. 50 (poster).

Burton, M., 1929: Porifera. Part II. Antarctic Sponges. - Br. Antarct. Terra Nova Exped. 1910, nat. Hist. Rep. Zool. *6*: 393-458.

- 1963: A Revision of the Classification of the Calcareous Sponges. - British Museum (Natural History), 693 pp.

Hansen, G.A., 1885: Spongiadae. - Norweg. N.-Atl. Exped., Zool.: 1-25.

Hentschel, E., 1925: Porifera. - Pp. 307-418 *in*: W. Kükenthal (ed.): Handbuch der Zoologie, Band I.

Jones, W.C., 1967: Sheath and axial filament of calcareous sponge spicules. - Nature, Lond. *214*: 365-368.

Koltun, V.M., 1964: Porifera. - Pp. 143-166 *in*: "Scientific results from higher latitudes. Oceanographic investigations in the northern part of the Greenland Sea and the adjacent Arctic Basins." Trudy arkt. antarkt. nauchno-issled. Inst. *259*. (In Russian).

Ledger, P.W. & W.C. Jones, 1977: Spicule formation in the calcareous sponge *Sycon ciliatum*. - Cell Tiss. Res. *181*: 553-567.

Poléjaeff, N., 1883: Report on the Calcarea. - Rep. scient. Results explor. Voyage Challenger *24*: 1-76.

Reid, R.E.H., 1968: Bathymetric distributions of Calcarea and Hexactinellidae in the present and the past. - Geol. Mag. *105*: 546-559.

Topsent, E., 1892: Contribution a l'étude des Spongiaires de l'Atlantique Nord. - Résult. Camp. scient. Prince Albert I, *2*: 1-165.

- 1895: Notice sur les Spongiaires recueillés en 1894 et 1895. - Bull. Soc. zool. Fr. *20*: 213-216.

- 1934: Apercu de la faune des éponges calcaires de la Méditerranée. - Bull. Inst. océanogr. Monaco No. 659, 20 pp.

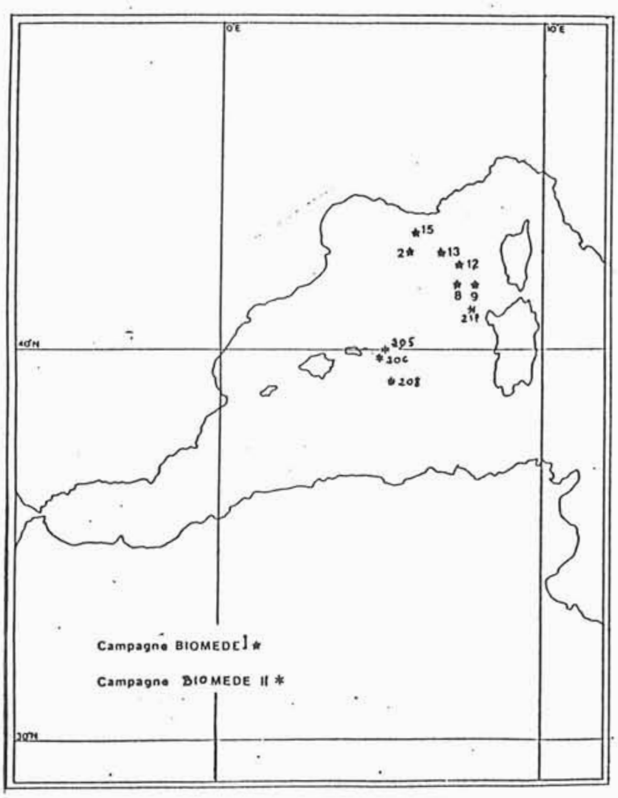
Ole S. Tendal
Zoological Museum, Copenhagen

UNEXPECTED DEEP-WATER RECORDS OF CALCAREOUS SPONGES (CALCAREA)

Calcareous sponges of the class Calcarea are usually regarded as shallow-water forms. Moreover, the erroneous old statement (written before the Challenger Expedition) that they are typically intertidal is still transmitted in recent treatises. In fact, Reid (1968) estimated, using data compiled by Burton (1963), that 261 species of Calcarea live between 0 m and 200 m and 134 species in the bathyal zone below 200 m. Furthermore, a few records indicate that some Calcarea, mainly *Sycon* sp., live between 1972 and 3800 m (Hansen 1885, Koltun 1964, Borojević & Graat-Kleeton 1965). With the exception of an unidentified specimen reported by Koltun (1970) from 5045 m in the Kurile Trench, all deep-sea Calcarea have been found in the Norwegian and Greenland Seas (Brattegard *et al.* 1988). So it would appear that only under the special conditions prevailing in these areas (low water temperatures from the surface to the bottom) are Calcarea able to withstand deep-sea conditions and high pressures.

The discovery of specimens of various *Sycon* sp. at great depths of the western Mediterranean demonstrates that the occurrence of calcareous sponges in deep-water is in fact more common than it was thought, and is not dependent on low temperatures. The Mediterranean specimens were collected on 2 cruises of the N.O. *Noroit*, BIOMEDE 1 and 2 (1976 and 1981), at 10 stations between 1500 and 2775 m (map). The hydrological conditions differ widely from those characterizing the Norwegian and Greenland Seas: salinity 30.40-38.42% , temperature 12°65-12°70 C (Guibout 1987). Most probably, calcareous sponges - and especially the calcaronean genus *Sycon* (which contains pioneering species with a large distribution) - are more widely distributed in deep waters down to ab. 3000 m but have been overlooked due to their small size and fragility.

BIOMEDE 1 station BS 15, at 1600 m, also provided several dead skeletons referable to *Plectroninia* Hinde. This genus belongs to the polyphyletic "pharetronids", hypercalcified, relict Calcarea with the skeleton consolidated by a fusion of calcareous spicules similar to that of siliceous spicules in the lithistid demosponges. The Recent species of *Plectroninia* form small crusts with a rigid basal skeleton due to fusion of the deformed extremities of three rays of special tetractines, the fourth actine remaining free and pointed outwards. These sponges, which were first described from mid-Miocene strata and which have many Mesozoic relatives, are known in Recent seas from cryptic habitats, such as caves and cavities in coral reefs, down to 90 m. Originally, their distribution was thought to be restricted to the tropical Indo-Pacific. However, *Plectroninia hindei*, the most common Indo-Pacific species of the genus, has also been found in Mediterranean shallow-water caves (Vacelet 1967). Accordingly, this species could be interpreted as a remnant in the Mediterranean of the Mesogean fauna.



The new specimens from cruise BIOMEDE 1 prove that *Plectroninia* is also present in the deep Mediterranean. Furthermore, the distribution of the genus proved to be considerably wider than expected, and not necessarily indicates paleobiogeographic relationships between the Indo-Pacific and the Mediterranean. About 30 specimens belonging to several species of *Plectroninia* have been obtained from 25 stations at bathyal depths (150-1020 m) worldwide, in warm, temperate and cold areas. According to these new observations, the presently known distribution of *Plectroninia* comprises the Mediterranean, the Azores, Brazil, South Africa, the southern Indian Ocean (Crozet Is., St. Paul and Amsterdam Is.), the tropical Indian Ocean (the Comoro and Reunion Is.) and the western Pacific (New Caledonia). The worldwide distribution of *Plectroninia* suggests that these tiny incrusting sponges, which are not uncommon on various deep-water substrates such as corals, shells and stones, have widely been overlooked in the previous studies.

The fossil record of Calcarea is restricted to forms which had a rigid skeleton of fused spicules. From a paleoecological point of view, it may be of interest to note that their survivors in Recent seas have a worldwide distribution in the bathyal zone and are not limited to shallow-water cryptic habitats.

References

Borojević, R. & G. Graat-Kleeton, 1965: See above (O.S. Tendal's list of references).
Brattegard, T., J.-A. Sneli & O.S. Tendal, 1988: See above.
Burton, M., 1963: See above.
Guibout, P., 1987: Atlas hydrologique de la Méditerranée. I-XV, 150 pp. Publ. IFREMER Paris, SHOM Paris Naval.
Hansen, G.A., 1885: See above.
Koltun, V.M., 1964: See above.
- 1970: La faune de la fosse Kouriles-Kamchatka et ses conditions d'existence. - Trudy Inst. Okean. *96*: 165-221. (In Russian).
Poléjaeff, N., 1883: See above.
Reid, R.E.H., 1968: See above.
Vacelet, J., 1967: Quelques Eponges Pharétronides et "silico-calcaires" de grottes sous-marines obscures. - Rec. Trav. St. Mar. Endoume *42* (58): 121-132.

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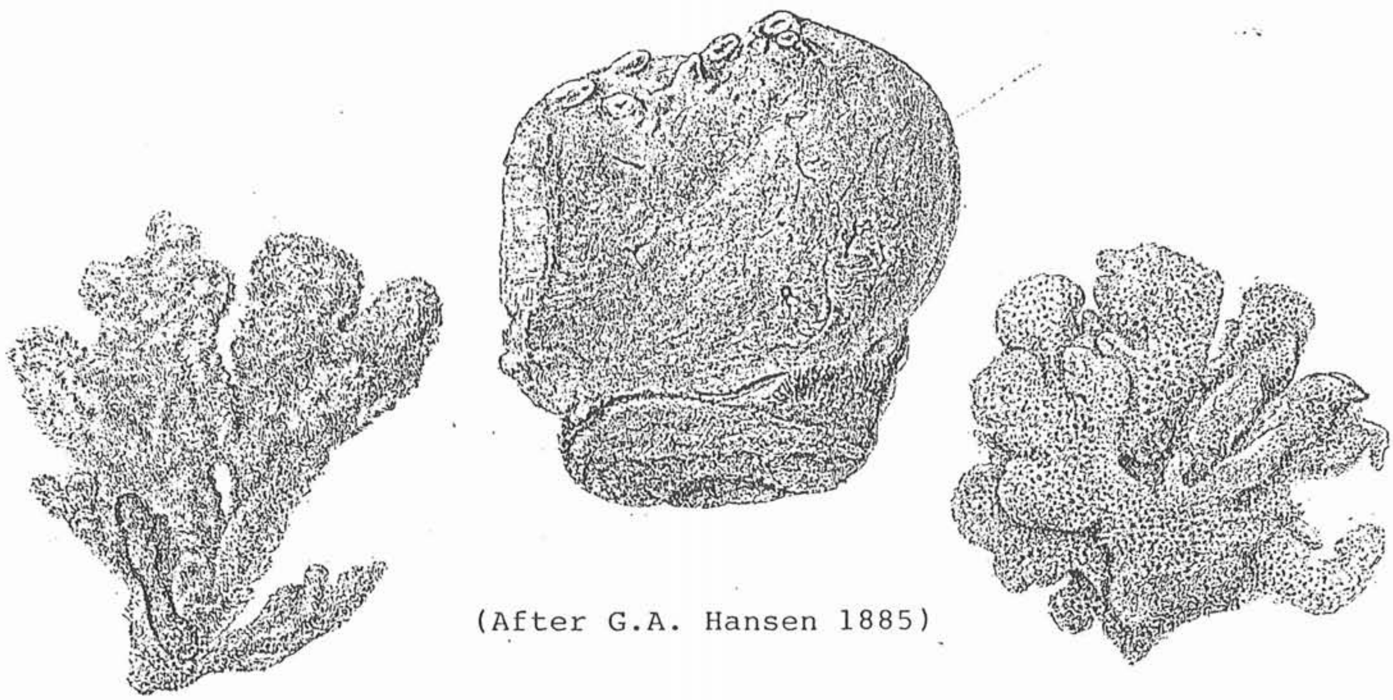

(After G.A. Hansen 1885)

COASTAL VOLCANISM AND A SPECIFIC ECOSYSTEM IN THE CRATER OF USHISHIR VOLCANO (THE KURILE ISLANDS)*

Volcanic activity and its different manifestations are widespread along oceanic coasts. However, there are only limited data on the effect of volcanic gas and water effluents upon plant and animal life in coastal marine ecosystems. Earlier reports have only shown that composition of flora and fauna in areas of volcanism is impoverished (Kussakin 1976, Gallardo *et al.* 1977).

In 1985, an expedition of the Institute of Marine Biology found in Kraternaya Bight (Ushishir Isles, the Kuriles) shallow-water hydrothermal fields and areas with volcanic water seeping, bacterial mats and rich bottom fauna (Tarasov *et al.* 1986, Tarasov & Propp 1987). Kraternaya Bight is a crater of the Ushishir volcano and sunk under sea level several thousand years ago.

Further expeditions in 1986, 1987 and 1988 showed that the volcano displays hydrosolfatar activity which is connected with a ring fracture in the sea floor (Figs 1, 2). Numerous terrestrial and underwater springs with water temperatures of 10-38 up to $96^{o}C$ occur near the fractures and produce per day about 21,000 m^3 volcanic water. This is saturated with carbon dioxide, hydrogen sulphide (up to 340 µM), other reduced sulphur compounds (to 470 µg - $eq.S.l^{-1}$), ammonia (to 28 µM), silicon (to 3 mM), phosphorous (to 3 µM) and have low salinity (21-25 %). Hot springs have a low content of sulphates (201 $mg.l^{-1}$) and pH 2-3.5. These waters contain high concentrations of dissolved manganese (to 3 $mg.l^{-1}$), iron (300 $\mu g.l^{-1}$), zink, copper, cadmium, arsenic, nickel and chromium in concentrations of 2-3 orders of magnitude higher than in the waters around neighbouring islands (Shulkin 1989, in press).

Vent gasses contain 44-66% CO_2, 27-42% N_2, 0.01-0.03% CH_4, and up to 0.05% H_2 and He.

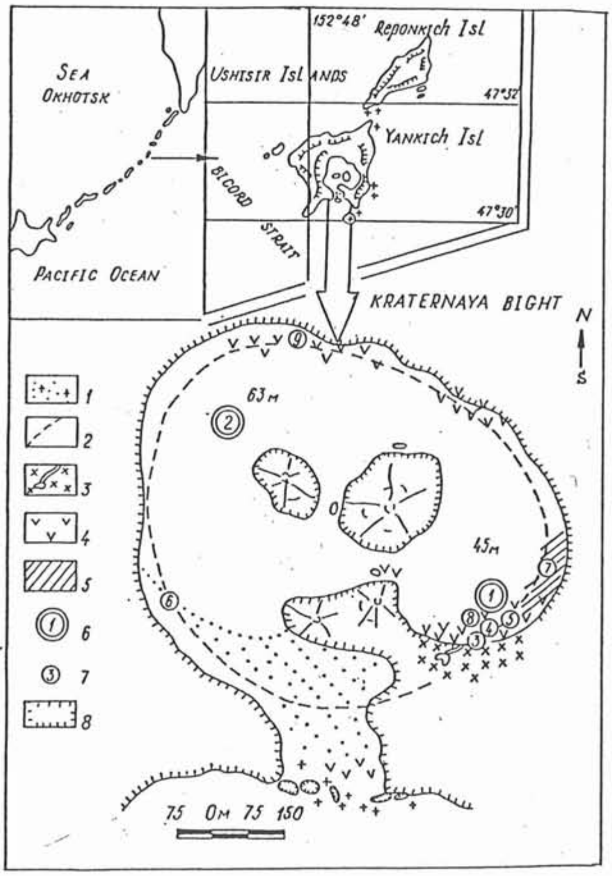

Fig. 1. Location of areas of volcanic activity and sampling stations in Kraternaya Bight.
1. sandbank and stones in the bight strait
2. circular fracture in the bight floor
3. terrestrial hydrosolfatares field, boiling volcanic springs and a brook
4. areas of intertidal and underwater gasohydrothermal vents
5. area of volcanic seep
6. permanent hydrochemical stations
7. stations of sampling for microbiological analysis and measurements of metabolism of bottom communities
8. crater slopes.

*) Although this paper deals with shallow-water phenomena we are pleased to publish it here in view of the many previous - and hopefully many future - exciting contributions in our Newsletter on hydrothermal activities. - Ed.

Vast areas of the bight bottom near gasohydrothermal vents at depths of 0 m to 24 m are occupied by bacterial mats looking as a white film of elementary sulphur deposits with numerous filaments of colourless sulphur-oxidizing bacteria of the genera *Thiothrix* and *Beggiatoa* and thiobacilli. In the same areas spots were seen of mats of "sulphur-iron" bacteria of the genus *Thiodendron* (Fig. 3).

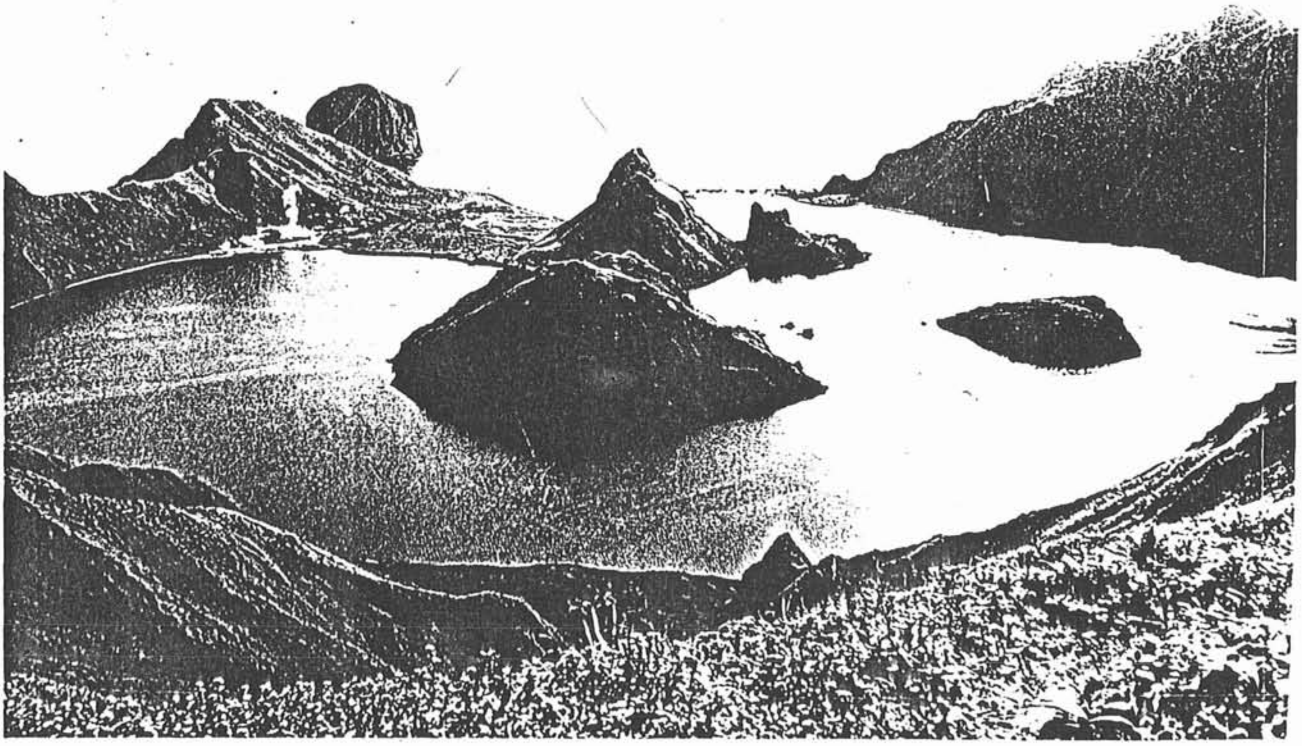

Fig. 2. View of Kraternaya Bight from the northern part of the circular ridge.

In seep sites of warm, volcanic waters at a depth of 1 to 12 m and ground surface temperatures of 10 to 35°C algobacterial mats predominate, forming a 2-3 cm thick film on the sea bottom. The film contains elementary sulphur, thiobacilli, colourless sulphur-oxidizing bacteria, diatoms, purple thiobacteria and other physiological groups of microorganisms. Mass development of the typically planktonic diatom *Thalassiosira anguste lineata*, along with benthic and benthoplanktonic diatoms like *Navicula* sp., *Nitzchia* sp. and *Poralia maniliformis* (= *Melosira*) as well as the absence of cyanobacteria are typical features of algobacterial mats. The majority of the mat-forming diatoms are highly tolerant to hydrogen sulphide and were cultivated in Pfennig medium with 800 mg sulphide per litre (Starynin *et al.* 1989, in press).

In algobacterial mats and in water samples, iron bacteria of the genus *Seliberia* were found, and a new genus of extremely thermophilic archebacteria of the order Thermoproteales, with an optimum of development at temperatures of 73-75°C, was obtained from samples and cultured (Miroshnichenko *et al.* 1989, in press).

All samples of bacterial and algobacterial mats contained benthic infusoria, nematodes (more than several hundred per cm^2) and tiny polychaetes.

In the other part of the bight at 5-15 m and on a bottom slope among boulders and stone blocks, diatom mats flourished. *Poralia sulculata* dominated and formed dense filamentous colonies in the areas of gasovolcanic springs free of hydrogen sulphide. Mats were here 15-20 cm thick and inhabited by accumulations of single, six-rayed corals (*Cerianthus* sp.), bivalves (*Macoma* sp.) and the sedentary polychaete *Myxicola infundibulum*.

The production of bacterial and algobacterial mats in Kraternaya Bight is extremely high, reaching over 30 g organic carbon per m^2 per day. Chemosynthesis accounts for 90% of the total production (Starynin *et al*. 1989, in press). The rate of photosynthetic production in diatom mats was estimated to over 1 $gC.m^{-2}$ per day.

Volcanic activity determines the warm regime and chemical composition of sea water in the bight. The surface waters are as warm as 9-12°C (surrounding waters being 2.5-3.5°C in June-October) and somewhat distilled. Dissolved chemicals from gasothermal waters (Mn, Fe, etc.) precipitate at weak alkalinity on suspended particles, the content of which in the surface water layer reached 12.5 $mg.l^{-1}$ (Gavrilenko *et al*. 1989, in press). The suspended particles are mostly of organic origin and enriched with iron and manganese. High concentrations of dissolved metal forms were recorded in the surface water layer. In comparison with surrounding sea water, the coefficients of enrichment were 70 for Mn, 15 for Fe, 7 for Zn and 2-3 for other elements (Shulkin 1989, in press) and the concentration of dissolved organic matter 50-60 times higher (Khristoforova 1989, in press).

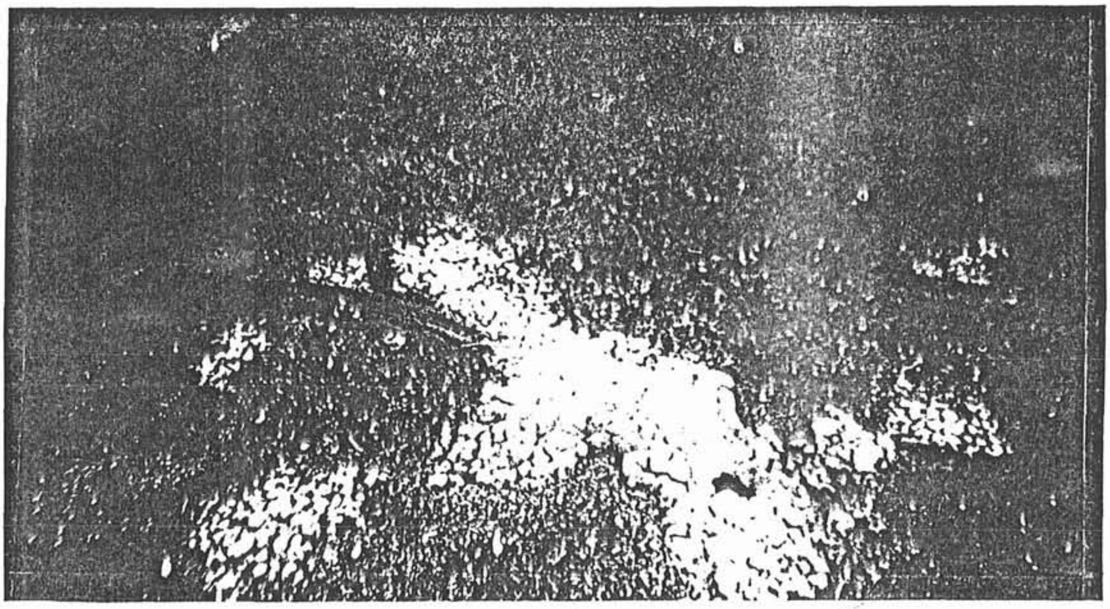

Fig. 3. Bacterial mats of *Thiodendron* sp. developed in areas of volcanic vents. Depth 15 m.

Considerable acidity connected with a high concentration of free carbonic acid was another notable distinction of bight waters. Water acidity and high partial pressure of CO_2 were more pronounced in the southeastern part at 0-3 m and at 15 m (Fig. 4). Hydrogen sulphide appeared in the surface water layer and in water samples from a depth of 15 m (5-40 µM) simultaneously with a pH decrease. This was connected with an inflow of volcanogenic carbon dioxide and hydrogen sulphide from powerful gasohydrothermal vents on the shore slope and at a depth of 22 m in this part of the bight. Sometimes the partial pressure of carbon dioxide at 0-3 m reached more than 2000.10^{-6} torr, and carbon dioxide was discharged into the atmosphere.

In the surface water layer, the oxygen content depended mostly on photosynthesis which was most intensive in August 1986, 1987 and 1988; we recorded oxygen oversaturation of up to 200% (to 14.5 $mlO_2. l^{-1}$). The photosynthetic layer was extremely thin (1-2 m), and a sharp fall of oxygen concentration was observed immediately under the layer, decreasing 4-fold between 3 and 4 m depth (Fig. 4).

The surface water layers were characterized by very high contents of chlorophyll a (to 85 $mg.m^{-3}$) and pronounced daily variations in chlorophyll concentration at 0-10 m. Below 10 m the content was always low, generally equal to the estimates obtained for the surrounding waters (0.2 $mg.m^{-3}$ and less).

A phytoplanktonic community flourished down to a depth of 10-13 m, consisting of the diatom *Thalassiosira anguste lineata* and the ciliate *Mesodinium rubrum* which contained symbiotic microalgae-cryptophytes of the genus *Chroomonas*, with a total biomass of 40 $g.m^{-3}$. In August (1985, 1986 and 1987), we observed "red tides" connected with diurnal migrations of infusoria in the surface waters which sometimes were quite red-brown in colour. In September-October, *M. rubrum* and diatoms become less plentiful, and other ciliates (*Holophrya* sp.), colourless mastigophores and rotatorians develop abundantly and form "white tide" spots. Locations of high gasohydrothermal activity showed maximal concentrations of these organisms.

Zooplankton was characterized by development of numerous copepods, chaetognaths, larval bivalves, and Ceriantharia. In the layer between 20 and 40 m zooplankton biomass reached maximum values of up to 1 $g.m^{-3}$. Many zooplanktonic organisms which were of common occurrence in Kraternaya Bight were not found outside Yankich Isle (Kosikhina & Malakhov 1989, in press).

Bottom macrofauna of the bight was composed of a moderate number of species (about 200) but had high population density and great animal biomass.

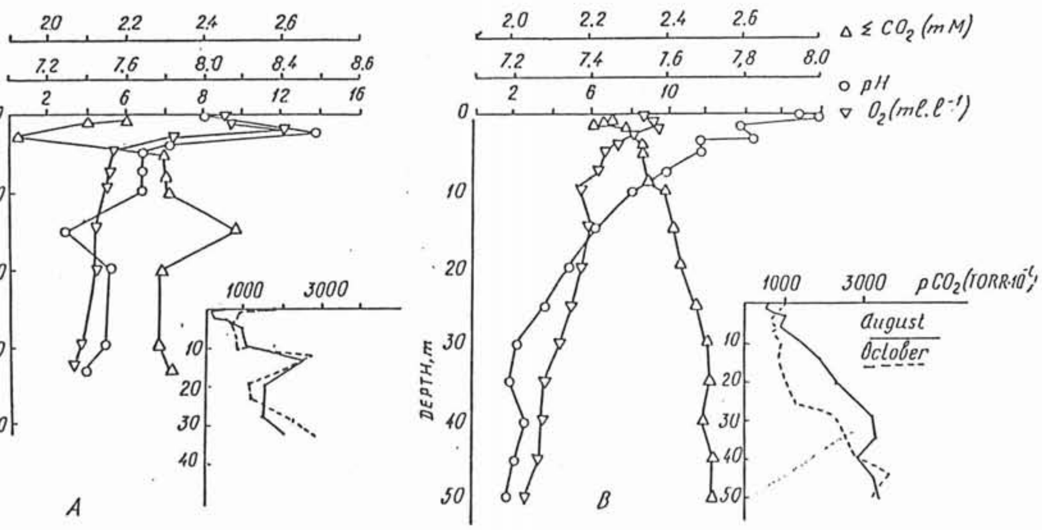

Fig. 4. Partial pressure of carbon dioxide, pH, oxygen concentration, and total content carbonates in the southeastern (A) and central (B) part of Kraternaya Bight (August 1987).

Barnacles (*Balanus crenatus*) predominate in the intertidal zone, and a community of the sea urchin *Strongylocentrotus droebachiensis* inhabits depths of 2-3 to 10-15 m (Fig. 5). At greater depths the holothurians *Psolus* sp. and *Eupentacta pseudoquinquesemita* completely cover the surface of stones and boulders (Fig. 6).

The benthic animals which dominate on soft sediments - single, six-rayed corals *Cerianthus* sp., burrowing bivalves like *Mya priapus, Macoma* sp. and *Axinopsida orbiculata orbiculata* and the large sedentary polychaete *Myxicola infundibulum* - typically form dense accumulations around gasohydrothermal vents. Population density can reach hundreds and thousands of specimens per m^2 and a biomass of up to 10 $kg.m^{-2}$ (Fig. 7).

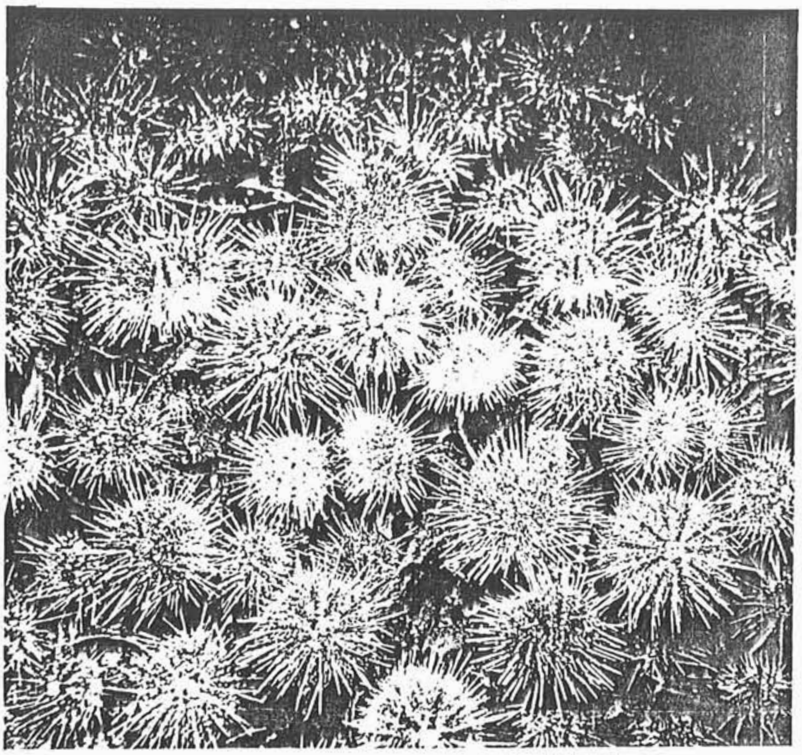

Fig. 5. Community of the sea urchin *Strongylocentrotus droebachiensis*, with a maximal density of 1500 specimens per m^2.

Fig. 7. Single, 6-rayed corals *Cerianthus* sp. dominate on soft sediments and accumulate around gasohydrothermal vents. Bacterial mats develop on the bottom around the vents. Depth 22 m.

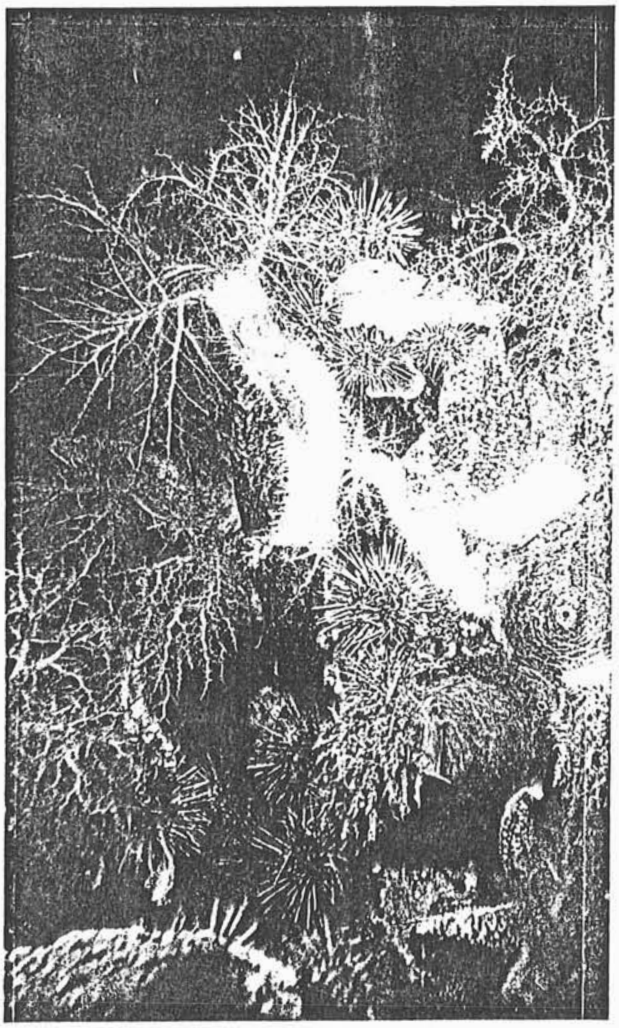

Fig. 6. The holothurians *Eupentacta pseudoquinquesemita* and *Psolus* sp. cover the rock surface densely. Depth 15 m.

Underwater gasohydrothermal activity of the Ushishir Volcano significantly determines physical and biogeochemical processes in Kraternaya Bight. The bight is a eutrophic reservoir with high rates of organic matter production, transformation and destruction in the surface water layer which is particularly affected by volcanic products. The high concentrations of nutrients are a result of discharge of volcanic waters, inflow of seawater with tides and bottom regeneration. Concentrations of nutrients reached 5µM for PO_4, 13.5 µM for NH_3, 1 µM for NO_2, 30 µM for NO_3 and 130 µM for SiO_2. Hydrogen sulphide was not found in the near bottom water layer. The production of bacterial, algobacterial and diatom mats is not limited by the nutrients provided by the gasohydrothermal activity. It seems to be determined by competition between different physiological groups of microorganisms for substrate and may be significantly affected by the influence of numerous benthic animals inhabiting the mats. Chemosynthetic production of mats can make a very considerable contribution to total production of organic matter in the bight. The sulphur cycle and the associated processes of chemosynthesis and sulphate reduction seem to be responsible for the carbon balance of this ecosystem. The sulphur cycle may be significantly affected by different forms of iron.

The communities of thermophilic archebacteria which were found in water samples and algobacterial mats (but not in shore hydrosolfatares and in the brook) reduce elementary sulphur to hydrogen sulphide.

The results obtained have shown that shallow-water gasohydrothermal activity significantly change the structure and species diversity of the ecosystem, resulting in a reduction of species number and a significant increase in population density and biomass of particular species. Probably abundant development of small and giant invertebrates is connected with their ability to adapt to a change in chemical composition, adaptations which may be formed in a comparatively short time interval.

Being a relatively closed water basin, Kraternaya Bight is probably a "trap" for those species which are brought to the bight by tidal flows, and only those adapted to these conditions can survive. We can assume that micro-evolutional processes have occurred in the bight animals during several thousand years. Two of the larger mass species, *Psolus* sp. and *Macoma* sp., are new to science, and the holothurian *Eupentacta pseudoquinquesemita* was for the first time recorded from the Kurile Islands.

Thus, this ecocystem where photosynthesis coincides with chemosynthesis extends our knowledge of hydrothermal communities. Metabolic and energy cycles in the ecosystem appear to be very complicated.

In 1988 Kraternaye Bight was announced a nature reserve. The marine ecosystem and the biochemical adaptations of marine animals and plants to impact of volcanic products will be further studied in the future.

References

Gallardo, V.A., J.G. Castillo, M.A. Retamal, A. Yánez, H.I. Moyano & J.G. Hermosilla, 1977: Quantitative studies on the soft-bottom macrobenthic animal communities of a shallow Antarctic Bay. - Pp. 361-387 *in*: G.A. Llano (Ed.): Adaptations within Antarctic ecosystems. Proc. 3rd SCAR Symposium on Antarctic Biology.

Gavrilenko, G.M., V.I. Bondarenko & A.P. Sazonov 1989: Survey of the Kraternaya Bight (Volcano Ushishir, Kurile Islands). Results of complex marine volcanological studies. - Marine Biology, Vladivostok (Biologiya morya). (In press).

Khristoforova, N.K., 1989: Dissolved organic matter in waters of Kraternaya Bight (Kurile Islands). - Ibid. (In press).

Kosikhina, O.V. & V.V. Malakhov, 1989: Zooplankton of the Kraternaya Bight (Ushishir Islands). - Ibid. (In press).

Kussakin, O.G., 1976: Structure and distribution of the macrobenthos in the intertidal zone of the Simushir (Kurile Islands). - Pp. 5-21 *in*: Coastal Communities of the Far Eastern Seas, *6*. Vladivostok.

Miroschnichenko, M.L., E.A. Bonch-Osmolovskaya & V.A. Alekseev, 1989: Extremely thermophilic bacteria from Kraternaya Bight. - Marine Biology, Vladivostok (Biologiya morya). (In press).
Schulkin, V.M., 1989: Geochemistry of metals in the ecosystem of Kraternaya Bight, Kurile Islands. - Ibid. (In press).
Starynin, D.A., V.M. Gorlenko, M.V. Ivanov, O.V. Karnachuk & B.B. Namsaraev, 1989: Algobacterial mats of the Kraternaya Bight (Ushishir Islands). - Ibid. (In press).
Tarasov, V.G., M.V. Propp, L.N. Propp, S.V. Blinov & G.M. Kamenev, 1986: Shallow hydrothermal vents and a unique ecosystem of Kraternaya Caldera, Kurile Islands. - Ibid. *2*: 72-74.
- & M.V. Propp, 1987: A unique sea community. - Priroda 1987, 2: 41-49.

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CAPTURE OF VENT SHRIMPS WITH A MIDWATER TRAWL

In May and June 1986 Discovery cruise 159 (Chief Scientist W.R. Simpson) undertook a chemical and particulate examination of the water column and hydrothermal plumes over the TAG hydrothermal field on the mid-Atlantic ridge, 26°N 45°W, depth 3650 m (see "Deep-Sea Newsletter" No. 12: 10-11 and No. 13: 7-8). During this cruise the Institute of Oceanographic Sciences RMT 1+8 midwater trawl system was deployed in a long deep trawl along the median valley over TAG. The nets were opened at a depth of 2930 m and closed at 3460 m after a two-hour tow (maximum wire out 7274 m). The calculated horizontal range of the net from the ship adn the dead reckoning ship positions were used to "aim" the net at the vent area. It was estimated that at its nearest approach to the bottom the net was approximately 200 m above it.

On return to the surface the RMT 8 catch, which was otherwise very small, was found to contain four unusual decapods, subsequently identified as juvenile *Rimicaris chacei*, ranging from 4.5-9.5 mm c.l. All were still alive, moving feebly. These shrimps have not previously been obtained in midwater, all specimens having been taken by submersibles or dredges in direct proximity to the vents. Their capture well above the vents, albeit only of a few juveniles, suggests that they may not be restricted to the bacterial mats of the vents but may range more extensively, with the consequent ready colonization of other vents in the area.

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A BURROWING SPECIES OF "*BATHYMODIOLUS*"

The *Bathymodiolus* species hitherto known from both the eastern Pacific and the Atlantic are epibiotic in their mode of life. However, a burrowing species of the same group of mussel was collected by the Japanese submersible *Shinkai 2000* of JAMSTEC (Japan Mar. Sci. Technol. Center), during her research operations on a submarine volcano which is situated west of Ogasasara (Bonin) Is., approximately 26°40'N, 141°00'E.

The volcano, Kaikata Seamount, is a dormant volcano, consisting of 4 peaks, one of which has a caldera and small cinder cone (Fig. 1). The bottom of the caldera is 910 m deep, while the top of the cone is 460 m.

A mussel, which is thought to be a member of Bathymodiolinae, was found burrowing in sandy sediments on a gentle slope near the top of the crater cone (Fig.1, star-mark). Ambient water temperature was 12°C, while the temperature at 30 m deep within the sediment was 18°C. Thus, the habitat of this mussel is not a cold water but a warm water seepage, if not a hot vent.

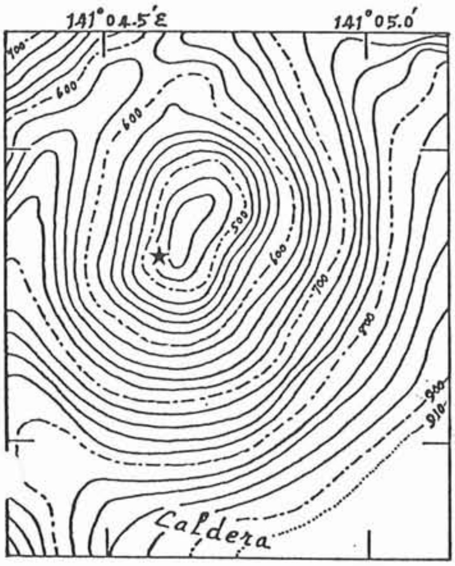

Fig. 1. One of four peaks of a dormant, submarine volcano, Kaikata Seamount west of Ogasawara (Bonin) Island. This peak has a caldera and a cinder cone. The locality of burrowing species of Bathymodiolinae is indicated by a star-mark.

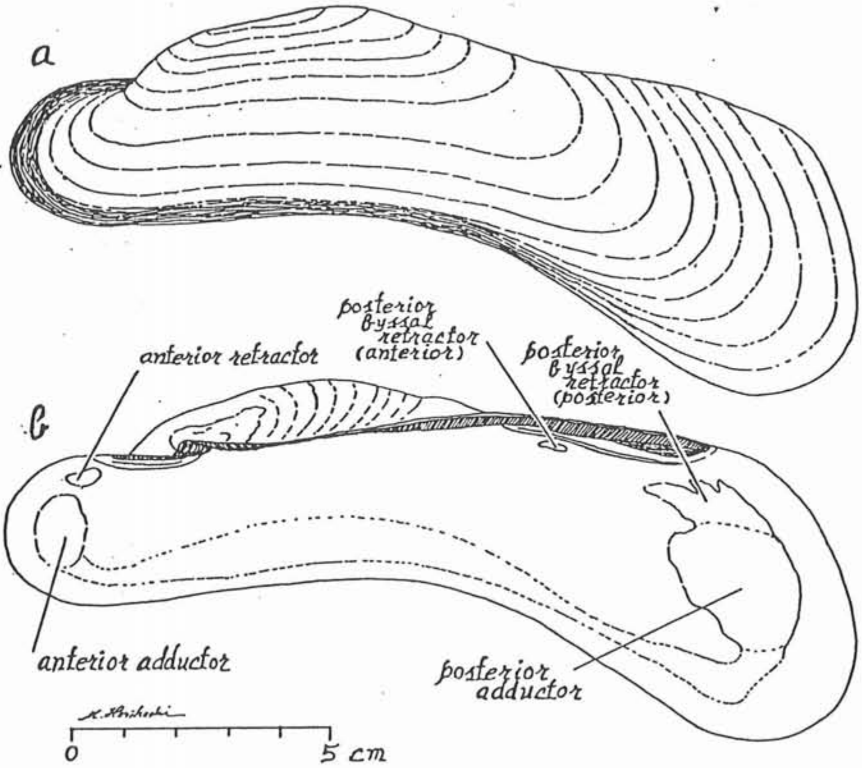

Fig. 2. A burrowing species of Bathymodiolinae from Kaikata Seamount.

The mussel in not modioliform (Fig.2). Its outline is rather reminiscent of the genus *Adula* of Lithophaginae or *Adipicola* of Modiolinae. The umbo is situated well behind the anterior end, and the posterior part of the shell is broadly expanded postero-ventralwards, giving the shell an outline (Fig.3) similar to *Adipicola longissima* (Thiele & Jaeckel, 1931).

Nevertheless, the present species has a sub-ligamental ridge, and also its posterior retractor muscle scars are divided into the small anterior and the large, posterior parts with a large gap between them (Fig. 2b) as in the Galapagos hydrothermal vent mussel *Bathymodiolus thermophilus* Kent & Wilson, 1985. The anterior retractor scar, however, is differ-

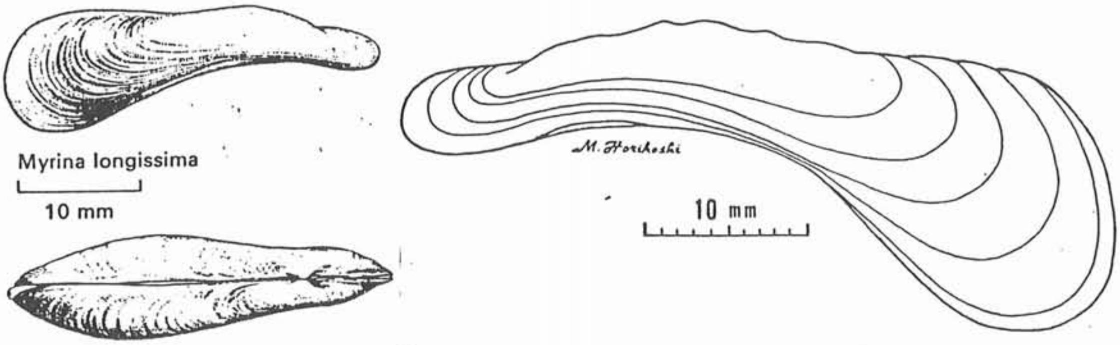

Fig. 3. *Adipicola longissima* Thiele & Jaeckel. Left: Knudsen 1979; right: Horikoshi & Tsuchida 1984.

ent from *B. thermophilus*, being situated just dorsal to the anterior adductor scar instead of the umbonal cavity. The gill is also similar to *B. thermophilus*, its gill filament being wide and fleshy, and the demibranch has no food grooves. The excurrent siphon is well developed, but has no fusion of the inner mantle folds. Nor another Japanese species of *Bathymodiolus* associated with the "*Calyptogena*" colony with a vestimentiferan has any fusion of the inner mantle folds. The symbiotic bacteria were observed also in the present species. For these reasons, the present species can be referred to Bathymodiolinae, the subfamily of hydrothermal vent mussels, within the family Mytilidae.

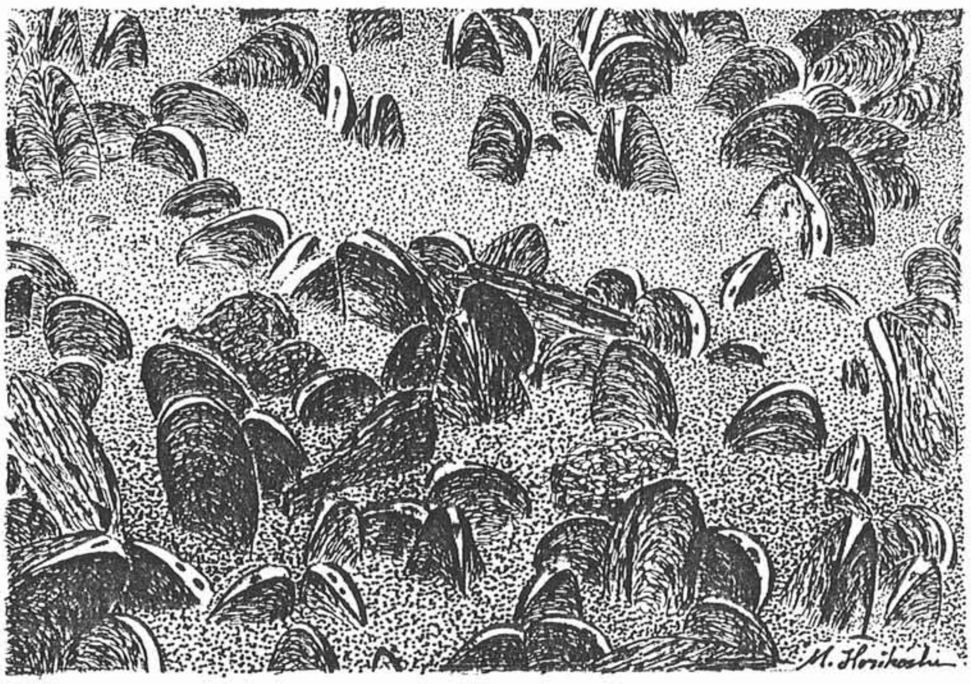

Fig. 4. The mode of living of a burrowing species of Bathymodiolinae in a coarse sandy sediment (drawn from a photograph).

The mode of living of the species is quite peculiar, burrowing deep into the sediment of coarse sand and exposing only its posterior portion (Fig.4). The mussel anchors itself firmly with its well developed byssus, attaching to a great many large sand grains. The area of the mussel colony was 5x10 m, and the biomass was estimated as high as 30 kg/m^2.

References

Horikoshi, M. & E. Tsuchida, 1984: Distribution, mode of life and allometric growth of a deep-sea mytilid bivalve, *Adipicola longissima* (Thiele *et* Jaeckel). - Venus *43*: 86-100.

Kenk, V.C. & B.R. Wilson, 1985: A new mussel (Bivalvia Mytilidae) from hydrothermal vents in the Galapagos Rift Zone. - Malacologia *26* (1-2): 253-271.

Knudsen, J., 1979: Deep-sea bivalves. - Pp. 195-224 *in*: S. van der Spoel, S.C. van Bruggen & J. Lever (eds.): Pathways in Malacology. Scheltema & Holma, Utrecht.

Thiele, J. & S. Jaeckel, 1931: Muscheln der Deutschen Tiefsee-Expedition. - Wiss. Ergebn. dt. Tiefsee-Exped. "Valdivia" *21*: 159-268.

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BACTERIAL RESPIRATION IN HOT DEEP SEA SEDIMENTS

In February 1988, a deep-sea diving cruise was organized by Dr. Holger W. Jannasch, Woods Hole Oceanographic Institution, to study the microbiology of hydrothermal vents in the Gulf of California. The R/V *Atlantis* and the DSRV *Alvin* operated in the 2000 m deep, central Guaymas Basin for 10 days with a group of microbiologists and geochemists.

The hydrothermal vent area of the Guaymas Basin is of particular interest because of the relatively high deposition rate of the sediments. In contrast to most other vent sites, the Guaymas Basin has about 400 m of sediment overlying the basaltic rock. Hot seawater is therefore emitted both through chimneys rising above the sediment surface and more diffusely by percolation through the sediment itself.

During our dives with the *Alvin*, the hot spots of the sediment were clearly visible from the shimmering seawater just above the sediment surface which indicated the mixing of hot hydrothermal fluid and cold bottom water. Around these hot spots grew whitish and orange mats of filamentous, colourless sulfur bacteria, *Beggiatoa* spp. The *Beggiatoa* of the area are of unusual size, some over 100 µm in diameter, and it has not yet been possible to grow them in culture.

The geochemistry of the sediments is also extraordinary due to the high temperature. Fig. 1 shows three temperature profiles measured with a 1 m long thermistor probe held by the arm of *Alvin*. The temperature at the sediment surface was 2-3°C, which is the normal temperature of the deep water in the Gulf. At 0.5 m, the temperature reached 50-100°C and continued to rise with depth to a maximum of 126°C at 75 cm. Due to the high temperature of the deeper sediment layers, the deposited organic matter is thermogenically altered within a very short time period. Aliphatic and aromatic hydrocarbons are formed and rise with the percolating fluid to the sediment surface where it appears as blobs of crude oil. When sediment cores were recovered to the deck of *Atlantis* they had a strong smell of diesel fuel.

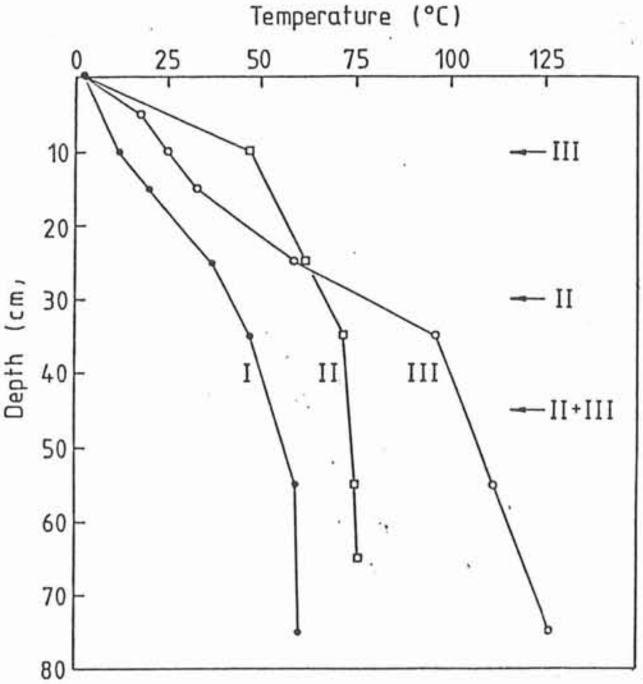

Fig. 1. Temperature profiles in the sediment of Guaymas Basin, Gulf of California, measured in an area of intensive percolation of hydrothermal fluid from below.

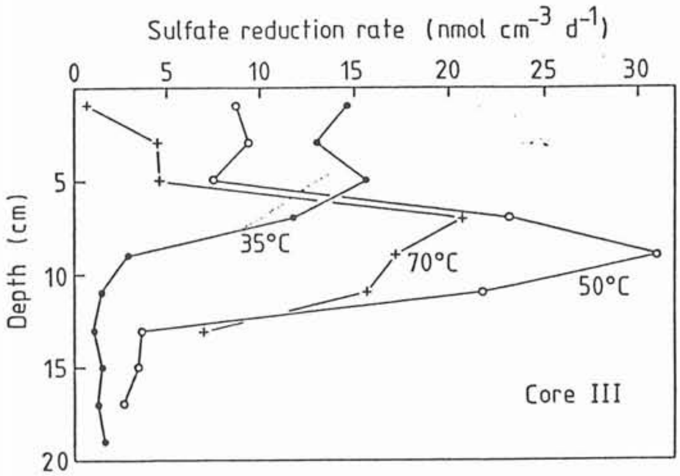

Fig. 2. Sulfate reduction rates measured in cores of sediment recovered by *Alvin* from hot sediments in the Guaymas Basin. With increasing depth below the sediment surface, the bacterial populations were adapted to strongly increasing temperatures. (Data from B.B. Jørgensen and H.W. Jannasch, in prep.).

We were interested to learn what kind of microbiology was responsible for the degradation of organic matter in these sediments. Sediment cores of a few dm depth were therefore collected and brought to the ship where they were immediately subcored and incubated for measurements of anaerobic respiration. We measured the bacterial reduction of sulfate which is the dominant type of terminal, anaerobic metabolism below the sediment surface in most regions of the continental shelf and upper slope. A special group of sulfate reducing bacteria convert the sulfate to sulfide, and they oxidize the organic matter of the sediment to CO_2. A very sensitive technique exists for this measurement, based on the use of S-35 labelled sulfate as a radiotracer. A few µl of the tracer is injected into intact sediment cores. After about 12 h incubation at specific temperatures the formation of radio-labelled sulfide is detected. The bacterial activity was measured at a range of temperatures: 4^o, 20^o, 35^o, 50^o, and 70^o.

Figure 2 shows examples of the results from measurements at three temperatures. At 35^oC (as well as at lower temperatures), the highest activity was found close to the sediment surface where the lowest *in situ* temperatures were also found. At 50^oC and 70^oC, maximum activity was found deeper in the sediment where the bacteria were adapted to higher temperature. In even deeper layers, the respiration rates were very low, but bacterial sulfate reduction could be detected even up to 85^oC. This seems to be the most extreme temperature adaptation yet recorded for biological metabolism in natural marine environments. Dr. Karl O. Stetter (Regensburg, FRG) is presently working on the isolation of the extremely thermophilic sulfate reducing bacteria inhabiting these sediments.

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BENT HANSEN
26 March 1925 - 18 July 1988

The sad news of Bent Hansen's premature death came as a shock, also to those who knew that his health condition was serious. The loss is deplored not only by all specialists on holothurians but also by the deep-sea community at large.

Bent Hansen was born in a small provincial town in Zealand. The family later moved to Copenhagen where Bent Hansen attended school. After graduating he started studying zoology at the University of Copenhagen.

In 1949, one year before the start of the Galathea Deep-Sea Expedition, he was chosen as one of the persons (with Anton Bruun and myself) to participate for the full period of two years.

Due to this appointment he concentrated on holothurians, a dominating part of the deep-sea megafauna. The Galathea Expedition provided a very rich material which was studied onboard and during the following years, and eventually resulted in not only the actual animals but also an invaluable reference collection of ca. 3000 slide preparations of the skin with calcareous bodies for the study of taxonomic variation.

After returning home Bent Hansen held a position at the Institute of General Zoology for five years, and for another four years he was the librarian at the Natural Sciences Section of the University Library (with one fourth of the working hours spent on holothurian studies at the Zoological Museum). In 1961 he became the head of the Museum library. Major tasks here were the complete rearrangement of the general and many departmental libraries following the Museum's transfer to a new building and the preparation of catalogues of periodicals and of the rich archives of this centuries-old museum.

Along with the demanding obligations as a librarian, Bent Hansen continued the study of his beloved sea cucumbers within the limited working hours and particularly during his spare time.

One of his first two publications (1956) dealt with the exciting holothurians collected at hadal depths in five trenches, the other (with F.J. Madsen) with two pelagically caught species, one large and medusa-like, the other cushion-shaped and previously collected by the Challenger Expedition but considered to be benthic. Other papers on pelagic holothurians were a result of his close cooperation with colleagues at Wormley in England.

Bent Hansen's pièce-de-résistance was his monograph on the Elasipoda, the order with the majority of deep-sea species. It was published in 1975, after 20 years of hard work, and was rewarded with the D.Sc. degree. It occupies an entire volume of the Galathea Report and has since become the handbook of deep-sea holothurians. A total of 171 described species are reduced to 95, and 11 n.spp. are added. Topics in the General Part include an evaluation of taxonomic characters and variation, feeding and reproduction, relationships and adaptations, geographical and vertical distributions and their relation to ecology, the hadal fauna, and origin and evolution of the deep-sea fauna.

Photographs of deep-sea animals have in the last decades become a significant tool in science. Together with colleagues at the Zoological Museum he identified animals shown on photos from hadal depths in the SW Pacific (1976); pictures of wandering *Scotoplanes* made him suggest (1972) a unique type of locomotion in Elasipoda: peristaltic movements alternately press fluid into the large tubefeet and empty it back into the dermal cavities; and with David Billett he analyzed (1982) the remarkable abyssal aggregations of small, mature *Kolga* of similar size over a wide area in the Porcupine Sea Bight and suggested that these aggregations indicated periodic accumulations of organic matter. In later years numerous deep-sea people have had holothurians on their photos identified by Bent Hansen.

In 1979 Bent Hansen took up another major task: a revision of the holothurians occurring in the large area covered by the series "Marine Invertebrates of Scandinavia" (MIOS). The study was well under way at his death, and F. Jensenius Madsen of the Copenhagen Museum is now completing it.

Two manuscripts (one with D. McKenzie) on various dendrochirote genera are in press, as is a biography (in Echinoderm Studies) of Hjalmar Théel, who worked up the Challenger holothurians and served as an ideal for Bent Hansen. The MIOS contribution interrupted his study of the remaining orders of holothurians from the Galathea Expedition, but the preparatory work is so well advanced that it may hopefully be completed by another specialist.

All those who met Bent Hansen cherished him as a kind, obliging and considerate person. His holothurian colleagues will miss his expert knowledge and valued opinion, and we, his friends at the Museum, will have to do without his helpfulness, gentle humour and profound insight into all kinds of bibliographic questions.

Torben Wolff

THE DEADLINE FOR THE NEXT ISSUE OF D.-S.N. IS 1st NOVEMBER 1989

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ISSN 0903-2533