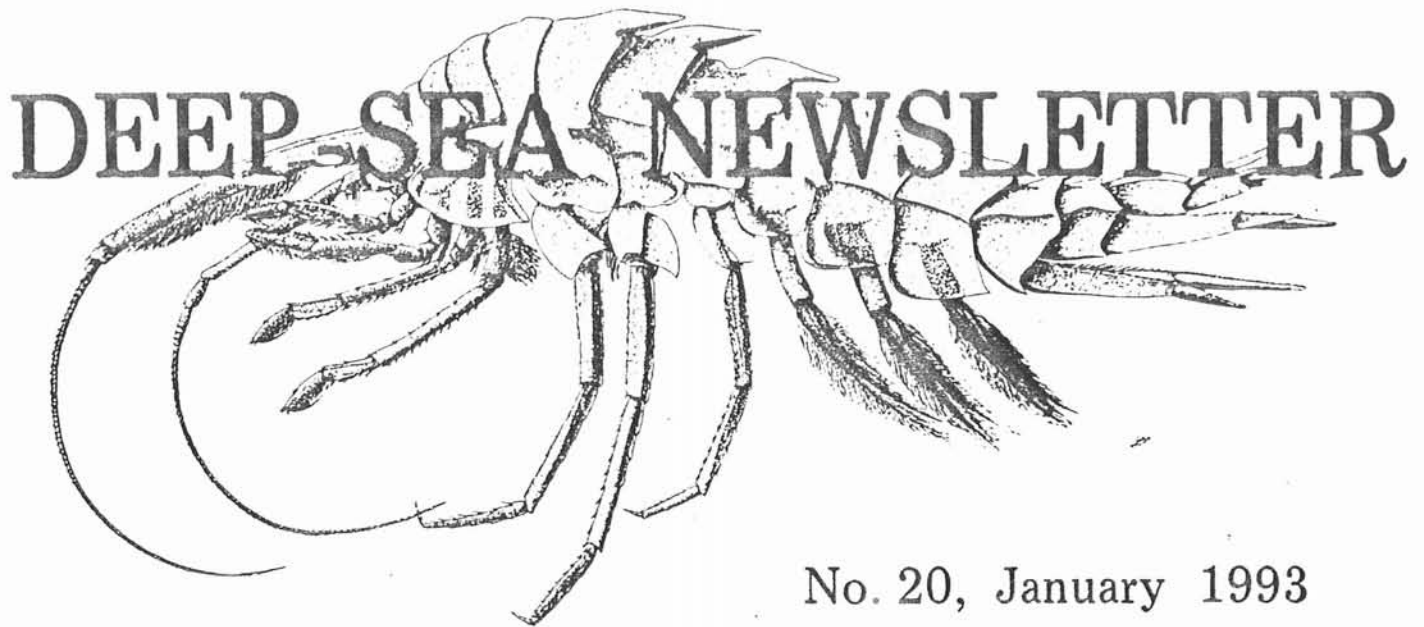


# DEEP-SEA NEWSLETTER



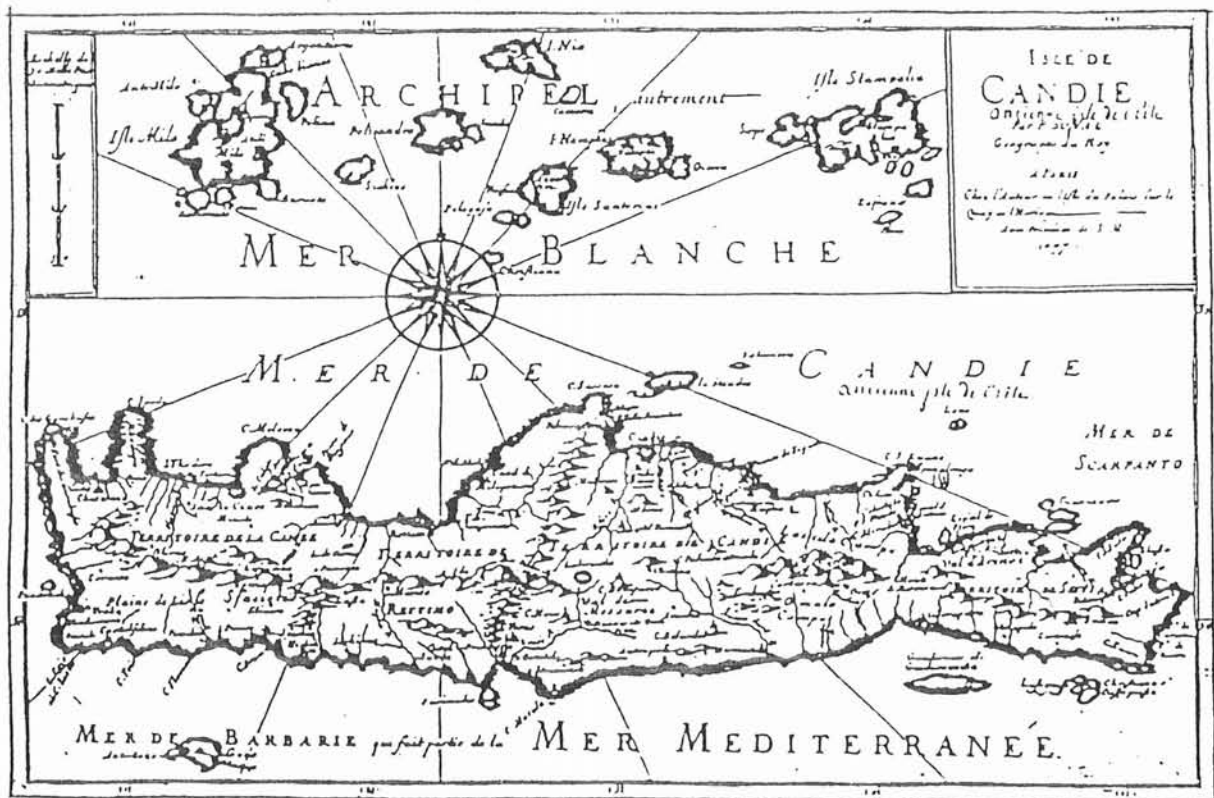
No. 20, January 1993

THE SEVENTH DEEP-SEA BIOLOGY SYMPOSIUM  
IRAKLION, CRETE, 29 SEP. - 4 OCT. 1994

First Announcement

As mentioned in DEEP-SEA NEWSLETTER, No. 19 the 7th Deep-Sea Biology Symposium will be hosted by the Institute of Marine Biology of Crete in Iraklion, during the last week of September 1994 (potential dates, 29/9-4/10/1994). We are looking forward to having all the members of the deep-sea scientific community participate in the event and hope to satisfy, and if possible to surpass, the standards set by the previous meetings at Scripps 1981, Hamburg 1985, Brest 1988 and Copenhagen 1991.

The symposium will take place in Limin Hersonissos, a small seaside town with extensive tourist facilities located 30 km east of Iraklion. The symposium meetings will tentatively be held at the KNOSSOS ROYAL VILLAGE HOTEL, a large seaside unit with appropriate conference facilities (which will also



host the 28th European Marine Biological Symposium in 1993, Sep. 23-28). Accommodation will also be arranged in two adjacent hotels (Cretan Village and Chrissi Amoudia) which offer a wide range of negotiated prices. Additional accommodation at a lower cost may also be found in the vicinity.

For the time being the symposium is scheduled to start on Thursday, September 29 and end on Tuesday, October 4.

A one-day mid-symposium excursion will take place, in order to visit some of the most important archaeological sites on the north (Knossos) and south (Phestos) coasts of the Island. A Symposium dinner will also be arranged on the last day.

As in Copenhagen, the program will consist of oral and poster presentations on issues concerning deep-sea organisms and ecosystems. Papers with a multidisciplinary approach will be greatly welcome. Topics that could potentially be presented are:

- Deep-sea biota in general
- Deep-sea community structure
- Organic carbon flux to the deep-sea
- Deep-sea metabolic studies
- Deep-sea sediment diagenetic studies
- Microbiological and biochemical studies
- Specific studies or projects (Hydrothermal Vents, Cold Seeps, JGOFS etc.).

Other suggestions and ideas will be appreciated; we therefore urge you to put them forward as soon as possible.

A keynote speaker will be invited to introduce each topic.

We are investigating the possibility of publishing an extensive abstract of the presentations (similar to the CIESM publication) if the cost is not prohibitive. If this is not feasible we will follow the procedure held at Copenhagen.

Please fill in and return the preliminary form, so that we are able to arrange accommodation requirements and negotiate hotel prices.

Hotel prices and additional expenses for 1994 will approximately be the following:

	<u>Single</u>	<u>Double</u>
Knossos Royal Village (5 star)	22,000	16,400
Cretan Village (4 star)	20,000	12,145
Chrissi Amoudia (3 star)	14,535	11,000
Youth Hostel	5,000-8,000	
Food per day	5,000	
Excursion (lunch included)	12,000	
Symposium dinner	10,000	
Symposium fee	20,000	Students 10,000

All hotel prices quoted are in drachmae for half board (bed, breakfast and dinner) per person per day. The current exchange rate is 200 drachmae to a US dollar.

Institute of Marine Biology of Crete  
c/o Prof. A. Eleftheriou / Dr. A. Tselepides  
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Crete, Greece  
Tel. +30 81 242022, Fax +30 81 241882

SYMPOSIUM ON DEEP-SEA BIOLOGY

First announcement (December 1992)

1. I am planning to attend the symposium. Yes  with  persons  
2. I wish to present a paper on

Subject not decided

3. I wish to present a short communication on

Subject not decided

4. I wish to present a poster on

Subject not decided

5. I intend to participate in the mid-symposium excursion yes  no

6. I intend to participate in the Festival dinner yes  no

Please type or use block letters for the following:

7. Name and title: \_\_\_\_\_

Institution: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

The following contributions unfortunately arrived two days after the conclusion of the last issue of DEEP-SEA NEWSLETTER.

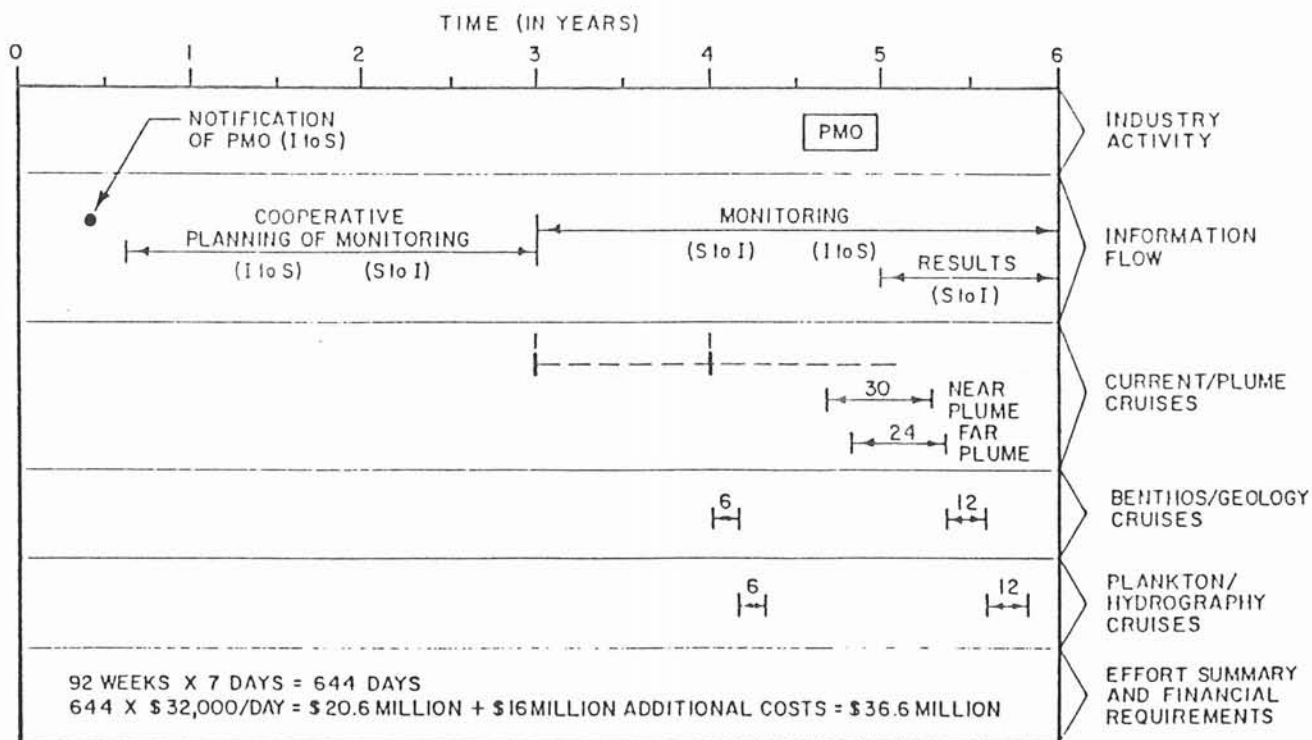
Editor

THE SIXTH DEEP-SEA BIOLOGY SYMPOSIUM, COPENHAGEN, 1991

Main results from an evening discussion on environmental impact studies

During the symposium, an evening discussion was offered on the environmental problems introduced into the ocean as the result of commercial mining of manganese nodules and other ores from the deep sea. Over the preceding months, we had been engaged in preparing a report on the "Potential impacts from deep seabed mining". We considered various types of oceanographic studies for risk evaluation and arrived at the conclusion that only the monitoring of a pilot mining operation (PMO), an industrial endurance test, would be of sufficient scale (in terms of duration, volume of transported and discharged muds, and extent of environmental impacts) to allow extrapolation to commercial mining risk assessment.

While developing ideas and concepts for PMO monitoring and discussing its extent, we encountered a severe problem which one day may heavily impact the oceanographic community: The costs of PMO monitoring will be tremendous! Our calculations are admittedly very rough and by the time a PMO becomes a reality, perhaps in 10 years or so, the calculations will be out of date. Nevertheless, the only important statement is that PMO monitoring will be very expensive and this fact is not likely to change no matter when a large scale mining test is ultimately conducted.



Hypothetical flow chart scheme for cooperative PMO monitoring. (S = science, I = industry; numbers above the cruise interval ranges represented by double-headed arrows provide an estimate in number of weeks at-sea time required for respective activity. In current/plume cruises I = 1 week for current meter deployment and exchange.)

In the accompanying figure, we have compiled a flow chart scheme for a PMO monitoring project including the early information and mobilization phases. The table summarizes our recommendations and conclusions. In our opinion the international oceanographic community should be aware of the demands that may be made upon it and of the potential risks to the oceans. We feel that risk evaluation of this scale and importance should be assigned to independent scientists. It is vital to bring this issue to the attention of decision makers, industry and science.

Hjalmar Thiel, Eric J. Foell, Gerd Schriever

#### HYPOTHETICAL SCHEME FOR PMO MONITORING (COMPARE FIGURE)

##### Recommendation for planning phase:

- PMOs should be done in close cooperation and with optimum information flow between industry and science.
- Industry should notify science latest 4 years ahead of PMO commencement, since mobilization from proposal to first work at sea for environmental studies needs such a period of time.
- Science should develop environmental research plans in the near future to be prepared for accompanying the first PMO. These plans should be updated regularly.

##### Time calculations for PMO environmental research phase:

- Current speed and directions: from 1.5 years before and throughout PMO, shiptime 2 x 1 week 2 weeks
- Sediment:
  - near to collector system and mining platform: 30 weeks
  - far from mining actions: 24 weeks
- Benthos, sediments and biogeochemical components:
  - baseline studies before PMO 6 weeks
  - control studies after PMO 12 weeks
- Plankton, Nekton and Hydrography:
  - baseline studies before PMO 6 weeks
  - control studies after PMO 12 weeks

##### Conclusions for an environmental PMO:

- Based on daily charter rate of US\$ 32,000,-  
92 weeks shiptime amount to US\$ 20.6 x 10<sup>6</sup>
- Additional resources for personal, equipment, consumption and travel amount to US\$ 16 x 10<sup>6</sup>
- Mobilization of these considerable material, financial and human resources will exceed those available in any of the nations with mining interests.
- With increasing knowledge on impact levels, environmental monitoring of later PMOs can successively be reduced.
- All nations or companies with mining interests will equally benefit from the knowledge gain resulting from PMO environmental studies.
- The ultimate conclusions and recommendations (Thiel et al., 1991) are international cooperation in PMO environmental research, data evaluation and risk assessment with cost sharing in the common interest of all parties and the oceans.



THE STANDARDIZATION OF METHODS FOR  
BENTHOS STUDIES AND BIOCHEMICAL MEASUREMENTS IN SEDIMENTS

Recommendations based on a workshop  
held in Copenhagen, 6 July 1991

Following the Deep-sea Biology Symposium in Copenhagen, 30 June - 5 July 1991, a workshop on the standardization of methods was held (comp. Deep-Sea Newsletter 17, p.7; 19, p.9). The methods to be applied to benthos studies and to biochemical sediment measurements were discussed by four working groups and later compiled by Antje Boëtius, Marina Carstens, Eric Foell, Karin Lochte, Olaf Pfannkuche, Gerd Schriever and Hjalmar Thiel. Parts of the resulting recommendations were further discussed by correspondence with other colleagues.

A draft version of the recommendations exists, but with some 30 pages it has become too voluminous to be distributed via the Deep-Sea Newsletter. Therefore we have to restrict printing to the introductory chapter and the table of contents. Everyone is asked to participate in the further improvement of the recommendations. We suggest that those of you willing to contribute by reviewing parts of the text, writing comments and sending corrections should return a copy of the table of contents indicating which you would like to review. We will send copies of the chapters requested, and on the basis of the answers received we will compile a further draft version.

Standardization of sieve size classification of the benthos became a major topic during the Copenhagen workshop, and the members of the working groups were far from agreement at the end of the day. To stimulate this discussion again, controversial issues are presented in an article (see below).

How do we proceed further? We feel that the recommendations should receive authorization by an international scientific body, and the Scientific Committee on Ocean Research (SCOR) seems to be the appropriate one. The Joint Global Ocean Flux Study (JGOFS) is organized under the umbrella of SCOR, and this international program is most advanced. The need for standardization of methods for benthic research was expressed by the JGOFS Benthic Task Team.

We are looking forward to receiving your chapter checklist, and we will mail the respective copies for your cooperation.

Thank you!

The draft-writers

Introduction:

CORE MEASUREMENTS FOR ECOLOGICAL STUDIES  
OF BENTHOS AND SEDIMENT BIOCHEMISTRY

The need for standardization of methods is obvious in view of joint international programmes demanding compatible data sets for comparative and modelling purposes. For deep-sea investigations this aspect is particularly important, since large-scale future research topics demand international cooperation:

- comprehensive studies of deep-sea ecosystems
- global change studies
- investigations of early diagenesis
- monitoring of anthropogenic impacts
- modelling of deep-sea ecosystems

The general aim of these recommendations is to obtain an internationally accepted set of standard methods in biological deep-sea research which should be available when large cooperative deep-sea projects are being planned and put into action. This is equivalent to the efforts of JGOFS for water column measurements. The development of benthic core measurement protocols is considered by the "JGOFS Benthic Task Team" as a most important step for the establishment of benthic research within JGOFS.

The techniques suggested as the benthic core parameters were chosen according to the following criteria:

- simple, standardized methodology for routine measurements
- widely applicable
- amenable to ship work

They cover various methods for biomass determinations, based both on microscopic and chemical measurements, and a range of activity measurements including growth, respiration and enzymatic activities. These determinations, which reflect the presence and activity of organisms, are complemented by measurements indicative of organic carbon content or input into the deep seabed.

Since the methodology for the determination of nanobenthos abundance and biomass is extremely difficult, this aspect has been dealt with in more detail than the other methods.

All results should be reported, as far as possible, on the basis of organic carbon as the common unit.

Table of contents:

Sampling procedures ( )	Electron transport activity ( )
Total organic carbon ( )	Extracellular enzyme activity ( )
Chloroplastic pigments ( )	Hydrolytic enzyme activity ( )
Desoxyribonucleic acid ( )	Picobenthos (bacteria) ( )
Phospholipids ( )	Nanobenthos ( )
Adenylates ( )	Meiobenthos ( )
Carbon dioxide fixation ( )	Macrobenthos ( )
Oxygen consumption ( )	Megabenthos ( )

Please, mark those chapters you wish to review and return to:

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Zeiseweg 9, D-2000 Hamburg 50, Germany

## BENTHOS SIZE CLASSIFICATION

The most controversial issue of the workshop on method standardization (6 July 1991, Copenhagen) has certainly been the classification of the benthos into size groups. No agreement was reached on the mesh size of sieves to separate the different size groups, and it remained an open question whether sizes of individuals in higher taxa should determine size group limits, or whether size classes should be defined independently from taxa.

Mesh sizes for benthos research often were arbitrarily chosen. When DAHL (1897) began quantitative studies of infaunal benthos in the eulitoral zone of River Elbe estuary, he chose the 1 mm mesh as the lower limit of the "benthos", probably because at that time flour was sieved with 1 mm mesh bolters. For many years there was no need for another term, since smaller organisms were rarely studied, at least not quantitatively. REMANE used "mesofauna" and "mesopsammon" for interstitial fauna, but this was not related to quantitative studies. A new term had to be introduced, when MARE (1942) became interested in quantitative studies of smaller organisms and she coined the expression "meiofauna" (meio = smaller) for this size group, smaller than the benthos of earlier researchers, which then had to be called "macrofauna".

The further development of benthos size classification is characterized by two independent and justified lines of thinking. Taxonomists aimed at the collection of their total taxon and adjusted the lower mesh size to their needs. Ecologists aimed at the assessment of the total benthos, and it is for the comparison of total benthos studies that comparable size classes are established. Both these types of studies may be termed "quantitative", but for taxonomic research general size classes may not be applicable, since lower and upper size limits vary with taxon.

The development of size classification for total benthos quantitative studies always had an arbitrary and/or pragmatic character. For example, when I started my work in the deep sea, I used the 42, 65 and 100  $\mu\text{m}$  sieves known from other scientists' work in shallow water, and the 150  $\mu\text{m}$  mesh sieve was available and seemed appropriate to separate larger particles from deep-sea oozes. No scientific reason argues for the 150  $\mu\text{m}$  sieve.

Benthos size classes slowly adjusted to what had been proposed as a basis for the discussions at the Copenhagen workshop, modified by the discussions during the workshop:

picobenthos:	0.2	-	2 $\mu\text{m}$
nanobenthos:	2	-	31 $\mu\text{m}$
meiobenthos:	31	-	1000 $\mu\text{m}$ with the two subgroups
			smaller meiobenthos:
			larger meiobenthos:
macrobenthos:	1 mm	-	40 mm
megabenthos:	> 40 mm		



This grouping seems to be insufficient in the meiobenthos category and additional sieves may be applied. It was suggested that 63  $\mu\text{m}$ , 125  $\mu\text{m}$ , 250  $\mu\text{m}$  and 500  $\mu\text{m}$  or some of these should be used. Such a series of sieves corresponds to the Wentworth Scale used by geologists for grain size analysis and may be appropriate for benthos research. These mesh sizes do not deviate too much from what has been used in recent studies, it covers the variably chosen limits between macro- and meiobenthos (except the 420  $\mu\text{m}$ ), and it allows everyone in future projects to choose a set of sieves that gives best comparison with results from other studies.

However, other classifications are conceivable and should be discussed before a final decision is made. For plankton studies, the classification presented in Figure 1 (SIEBARTH et al. 1978)

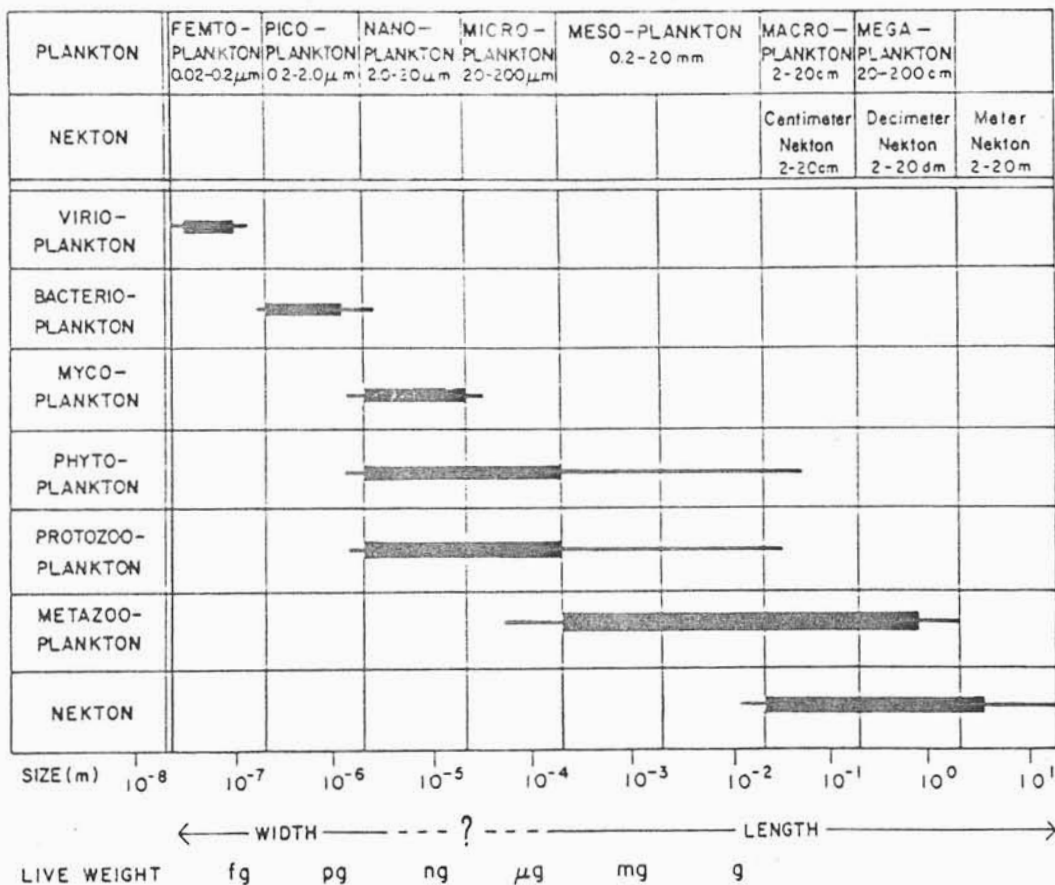


Figure 1: Distribution of different taxonomic-trophic compartments of plankton in a spectrum of size fractions, with a comparison of size range of nekton.

is generally accepted or at least widely used. Based on the same principles soil fauna is classified (Fig. 2). This was first published by DRIFT (1951) and is generally used. For scientific and theoretical reasons it should be useful and desirable to

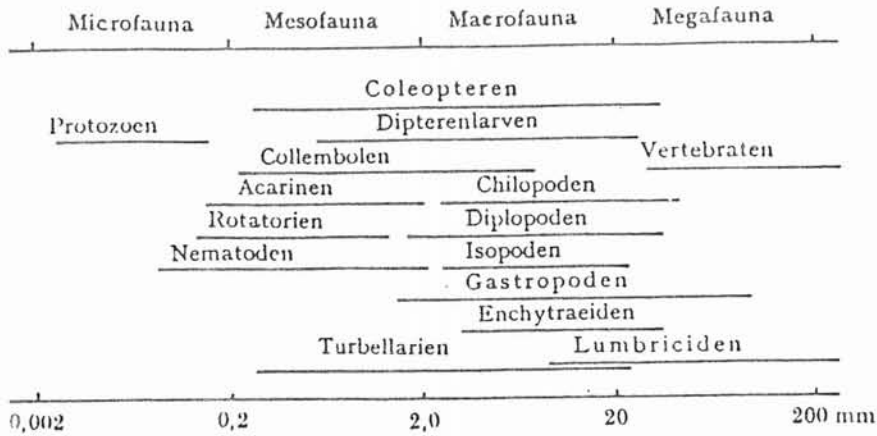


Figure 2: Size classification of soil fauna and approximate sizes of soil taxa (from DUNGER 1964 after DRIFT 1951).

apply the same systems throughout all ecological systems. Figure 3 divides the benthos into size classes based on a logarithmic scale on the base 2, and the plankton size class terms are given (right) and compared with the proposal listed above (left):

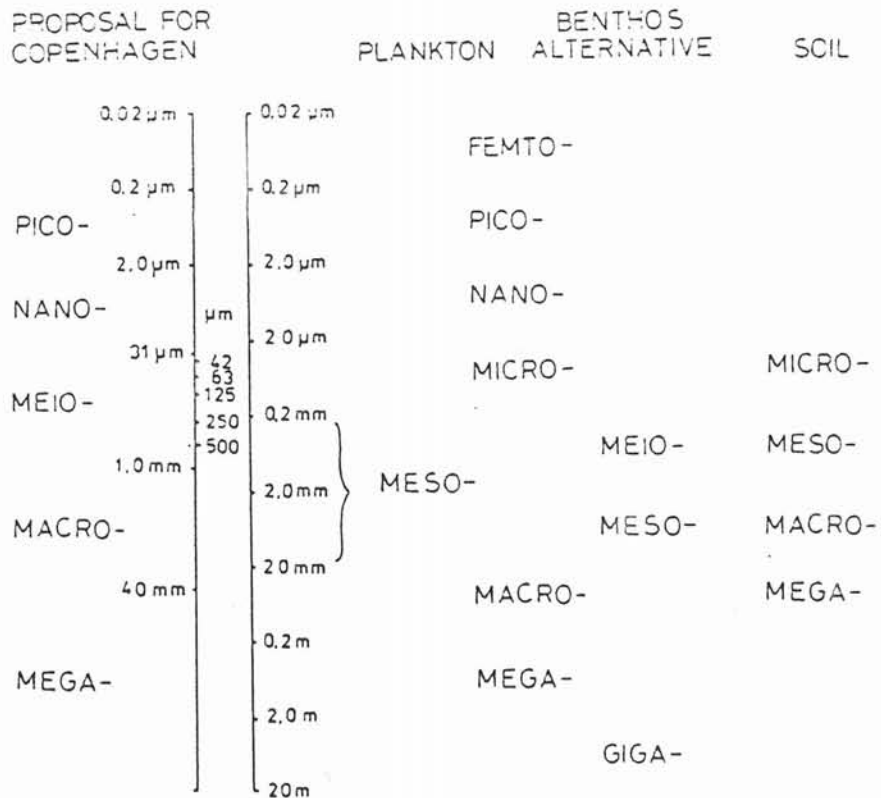


Figure 3: Different size classifications: Right scale: Plankton size classes with femto- to megaplankton, including the double-class "mesoplankton" (from SIEBÜRTH et al. 1978). Benthos size classes alternative proposal with meio-, meso-, and gigabenthos. Soil fauna size classes. Left scale: proposal for the Copenhagen workshop.

To my mind, the deviations are not too wide for harmonization:

Femtobenthos seems rarely known, but it should be present and might be more abundant than expected.

Picobenthos is mostly constituted by the bacteria, and the classes are the same.

Nanobenthos covered a somewhat wider range in the former system, but it seems acceptable with the limits of 2 - 20  $\mu\text{m}$ .

Microbenthos would cover part of the former nano- and only part of the former meiobenthos. The limit of 200  $\mu\text{m}$  would split the former meiofauna. Microbenthos would need standard subdivisions at 42  $\mu\text{m}$ , 63  $\mu\text{m}$  and 100  $\mu\text{m}$ .

Meiobenthos should be introduced for Mesobenthos 1. For comparison with earlier results standard subdivisions at 0.5 and/or 1 mm should be used.

Mesobenthos (now without 2) would cover parts of the former macrobenthos.

Macrobenthos would overlap for sampling and observation reasons with

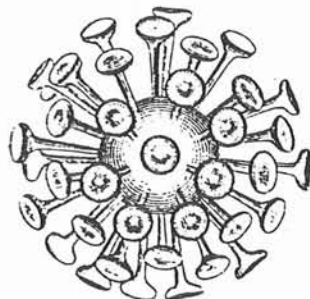
Megabenthos which was never well defined in the former benthos system.

Gigabenthos should be used as a new term, instead of Meter Benthos (compare Meter Nekton), to remain in the same style of expressions. This size class would rarely be found in animals, although gorgonians and vestimentiferans at hot vents may become longer than 2 m, but plants e. g. kelp and trees in terrestrial environments would fall into this or even a following size class.

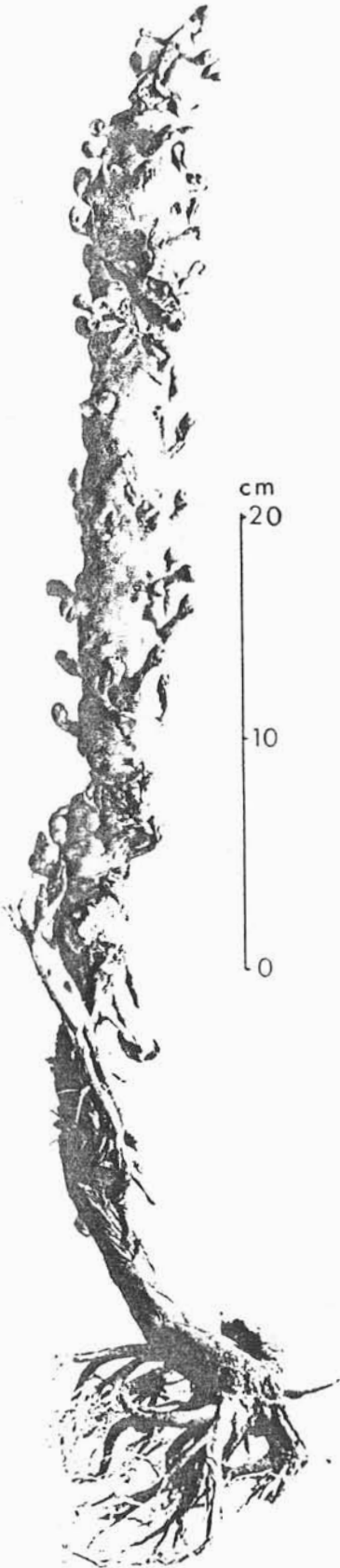
This plankton and soil fauna related system would break up the size classes benthos investigators are used to. But, whatever standardized system is decided upon, changes in size class limits cannot be avoided. Why then should we not adjust to and harmonize into one system which is valid throughout the organismic realm?

Masked by the above discussion of size classes and terms is the important issue behind all this: International programs must assure the comparability of data as it has already been achieved for JGOFS in respect to plankton research by definition and obligatory acceptance of plankton core parameters. The same must be reached for benthos research - recommendably concerning terms, but absolutely stringent in respect to the specific size classes of the fauna. Deep-sea research is such an expensive engagement that we have the obligation to maximize the results. One chance to achieve this aim is to agree on the full comparability of data collection and results.

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CHONDROCLADIA GIGANTEA (DEMOSPONGIAE) -  
THE GIANT CLUBSPONGE OF THE NORTHEAST ATLANTIC



*Chondrocladia gigantea* is a most remarkable stalked sponge living on soft bottoms and attaining a height of 60 cm or more (Fig. 1). An elaborate branched "root"-system can reach 20 cm down into the bottom, anchoring the club-shaped sponge body, which is supported by a thick, spirally twisted stem of fibers of siliceous spicules and spongine. The surface of the sponge is velvetlike, light pink in life and has numerous longer or shorter papillae with spherical distal ends.

*C. gigantea* was first found by "The Norwegian North-Atlantic Expedition" (1876-1878) and described by Hansen (1885). Taken again by The Danish Ingolf Expedition 1895-96 and the Norwegian Michael Sars Expedition 1902, it was redescribed by Lundbeck (1905). Later, published and unpublished records have added substantially to the knowledge of its geographic and bathymetric distribution (Figs. 2, 3).

Most records are from the southern part of the Norwegian Sea and the Iceland Sea (the area between the island of Jan Mayen and Iceland), on the northern flank of the ridge from Scotland to Greenland. A single record south of the ridge, at 1960 m, is uncertain (Lundbeck 1905). Another well documented area is the Davis Strait and Baffin Bay (Brøndsted 1933). If it turns out that *C. gigantea* and *C. grandis* Verrill, 1879 are synonyms, a third area is off Nova Scotia. Three records are outside the mentioned areas; one is between Greenland and Svalbard (Koltun 1964), and two are in the Northwest Pacific, off Sakhalin and the Kuriles (Koltun 1958).

Koltun (1958, 1959) gave the bathymetric distribution as 238-615 m and 1450-2127 m. Because the 1450 m depth in the station list seems to be given as "1,0-1450 m" (Koltun 1964), his opinion about the distribution gap is not clear. The two Pacific records seem to have come from 200-400 m depth. In the deep interval four records are known of which the two deepest must be considered uncertain so far. One is referred to above (Lundbeck 1905, 1960 m), and the other is a small fragment from off the Norwegian coast (Hansen 1885, 2127 m). In the collections of the Zoological Museum, University of Copenhagen, there is a perfect specimen from 1600 m off West Greenland, and the fragmentary specimen taken deepest off Iceland originates from "860-1200 m". Our present records thus place the reliably known bathymetric distribution of *C. gigantea* from 240 to 1600 m, with the main occurrence between 500 and 1000 meters.

Fig. 1. *Chondrocladia gigantea* from 893 m depth, north of Iceland. The largest specimen ever recorded. BIOICE St. 2082. July 4, 1992.

The temperature range for the species, according to Koltun (1959), is  $+0.66 - +2.7^{\circ}\text{C}$ . However, these are the temperatures for the two Pacific records, and Koltun may have overlooked that Lundbeck (1905) concluded the main occurrence of *C. gigantea* to be in water of negative temperature, a matter further supported by the information given by Brøndsted (1933). All old and new records deeper than 500 m are from water of negative temperature ( $-1.1^{\circ} - -0.3^{\circ}\text{C}$ ), except for the dubious one at 1960 m ( $3.1^{\circ}\text{C}$ ).

The shallowest record from West Greenland is at about 300 m depth with about  $2^{\circ}\text{C}$ , and another one is at 490 m with  $+0.7^{\circ}\text{C}$ . Off East Greenland there is one record at about 240 m at  $0-1^{\circ}\text{C}$ . North of Iceland the shallowest record is at 285 m with about  $2^{\circ}\text{C}$ , and on the top of the Iceland-Faroes Ridge there is one at 490 m with  $2.5^{\circ}\text{C}$ . The shallowest record from the Norwegian coast is at 669 m and  $-0.5^{\circ}\text{C}$ . Thus, it seems possible that the upper distribution limit of *C. gigantea* is determined by temperatures of  $2-3^{\circ}\text{C}$ , the species accordingly occurring at shallower depths in West Greenland than off the Norwegian coast under the warm North Atlantic Current.

The lower distribution limit has another explanation than temperature. Judged from the distribution patterns (Fig. 2) it seems that at depths greater than about 1500 m the ecological niche occupied by a stalked, large,

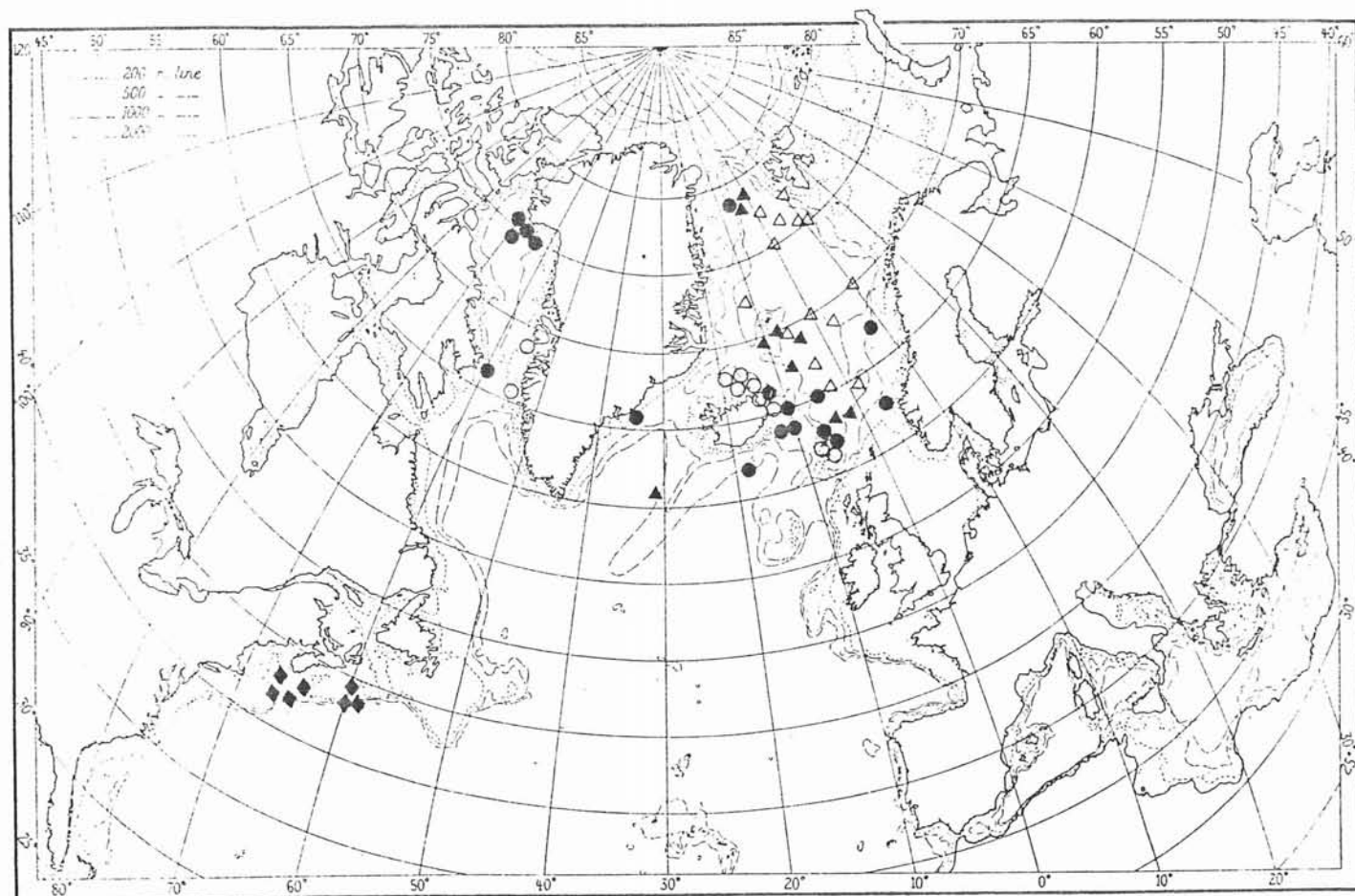


Fig. 2. The distribution of *Chondrocladia gigantea* and *Caulophacus arcticus*. Records are published by U.S. Comm. Fish. Fisheries (1882), Hansen (1885), Fristedt (1887), Lundbeck (1905), Topsent (1913), Burton (1928), Brøndsted (1933) and Koltun (1959, 1964, 1967). Unpublished records are from the Tjalfe Expedition 1908-1909, the NORBI Expedition 1975, the "Meteor" Cruise 13 (SFB 313) and cruises with the Faroese "Magnus Heinason" and the Norwegian "Håkon Mosby" around the Faroes and Iceland. Open symbols are unpublished records. Filled symbols are published records.

● *Chondrocladia gigantea*      ◆ *Chondrocladia grandis*      ▲ *Caulophacus arcticus*



flat-bottom sponge in the Greenland and Norwegian Seas is taken over by the hexactinellid sponge *Caulophacus arcticus* (Hansen, 1885). This species attains stem lengths of more than 25 cm, and the body can be at least 15 cm in diameter, with the form of a mushroom, although with a somewhat folded edge. It lives at temperatures of  $-1.1$  to  $+0.4^{\circ}\text{C}$  (in a single case at  $2.4^{\circ}\text{C}$ ), at 1450-4379 m (Koltun 1967). The change may be related to the lower sedimentation and food availability at great depths.

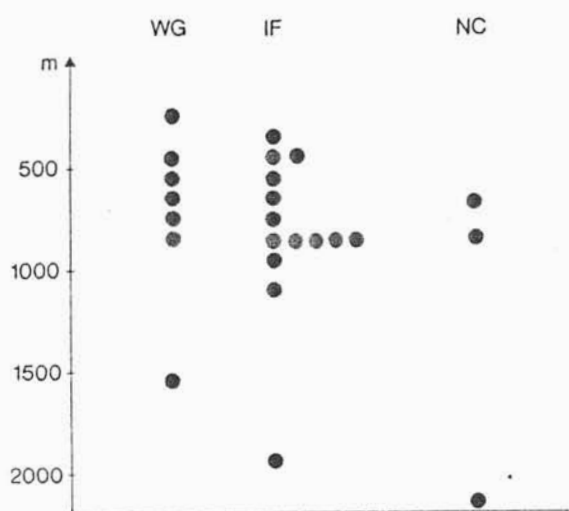


Fig. 3. The depth distribution of the records of *Chondrocladia gigantea* off West Greenland (WG), Iceland & the Faroes (IF) and the Norwegian coast (NC).

A number of problems concerning the morphology and biology of *C. gigantea* are tackled now as more material is collected during the ongoing BIOFAR and BIOICE programmes around the Faroes and Iceland:

1) Our present material partially supports the observation of Koltun (1959) that specimens from the lower end of the bathymetric range have short knoblike papillae, while specimens living at greater depths have long ones. We observe specimens with rather long papillae over the full depth range, while it seems that those with short ones

occur only in the shallower part. The condition does not seem to be size related.

2) Very large (up to 5 mm in diameter) "embryos" containing spicules were described by Lundbeck (1905). We only find them in some specimens, but there they often fill the interior of the sponge. So far they have been seen in material collected during May, June and July (different years).

3) According to Lundbeck (1905) the papillae may bear the oscules. We have the impression that, additionally, they may serve in asexual reproduction as buds, falling off and growing into small sponges. However, we lack the early stages of this process and will carry through a special search for them during future cruises.

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Dagmar Barthel  
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#### SPONGE SPICULES IN ABYSSAL AND BATHYAL SEDIMENTS OF THE NE ATLANTIC

Siliceous sponge spicules are concurrently mentioned in deep-sea expedition reports as constituents of abyssal and bathyal sediments, although generally comprising only a few percent of the single samples.

#### Abyssal and lower bathyal depths

In the North Atlantic, a very comprehensive documentation has been given by Murray & Chumley (1924). In 1426 samples, mostly from north of the Equator, they found sponge spicules in 1365 (96%). All the localities were at depths greater than about 200 m, and by far the largest number came from more than 1000 m depth.

Murray & Chumley (1924) mention only few localities north of 50°N, but the results from the Danish Ingolf Expedition 1895-96 support their main views as far as to 70°N. Boeggild (1900) found in the *Ingolf* material that out of the 143 stations taken, samples from 90 (63%) contained sponge spicules; of the 80 stations taken deeper than 1000 m, 64 (80%) contained spicules.

Dahl et al. (1976) mentioned "fairly large quantities of sponges, especially in the trawl samples from the Greenland basin", taken by the NORBI Expedition; most of these are spicule masses and dead skeletons (Tendal, unpubl.). In the report from the Norwegian North-Atlantic Expedition 1876-78 Schmelck (1882) stated that at depths greater than about 1800 m "most of the samples were found to contain delicate spicules of sponges"; the expedition worked in the whole area east of the island of Jan Mayen, from West Spitzbergen to the Norwegian coast. Barthel et al. (1991) found spicules in all sediment samples from bathyal and abyssal depths off West Spitzbergen. During the YMER-80 Expedition spicule masses and dead skeletons were taken at 1000-3900 m in the Nansen Basin of the Polar Sea (Tendal, unpubl.). Our general observations during several cruises with the "Håkon Mosby" (University of Bergen) indicate that siliceous sponge spicules are common in abyssal samples from the Iceland Sea and parts of the Norwegian Sea.

The taxonomic identity of the spicules is stated for only few of the samples mentioned in the literature. In broad terms spicules from abyssal depths south of the Scotland-Faroes-Iceland-Greenland Ridge complex seem to come from hexactinellids, as do most of those found in the Iceland, Greenland and Polar Seas, while those from the Norwegian Sea and the area off West Spitzbergen appear to be mostly from choristids and other demosponges.

#### Upper bathyal and lower shelf depths

Here, sponge spicules have been found in the sediments of many places in the NE Atlantic, the amount varying from loose single spicules to mass occurrences, sometimes forming felt-like layers. Reports on mass occurrences so far are very scattered, and the taxonomic identity is not always stated: Off Mauretania, 800-900 m, hexactinellids (Lutze & Thiel 1989); Porcupine Seabight, 1000-1300 m, hexactinellids (Bett et al. 1992; Bett & Rice 1992; Rice et al. 1990); off Scotland, 800 m, hexactinellids (Thomson 1870); between Scotland and the Faroes, 700-1000 m, hexactinellids (Schulze 1882); several places around the Faroes, 300-900 m, choristids (our observations); north of the Faroes, 890-1300 m (Boeggild 1900); north of Iceland, 500 m, demosponges (our observations); southwest of Iceland, 1000-1200 m, hexactinellids (our observations); south of Iceland, 1200 m, demosponges (our observations); between Iceland and Greenland, 220-365 m (Boeggild 1900); all the way from Spitzbergen to western Norway, roughly between 900 and 2000 m, Schmelck (1882) found what he called "transition clay".... "which is absolutely interwoven with these minute silicious needles, so that, on touching the dried bottom sample, the hand gets covered with them."; several places along the edge of the Norwegian Trough, 500-700 m (T. Brattegard, pers. comm.); Tromsøflaket off northern Norway, 280 m, demosponges (Könnecker 1989); off Finmark up to 70°N, about 200-400 m (Schmelck 1882, Rezvoj 1928, Zenkevitch 1963); off West Spitzbergen, 400 m downwards (Schmelck 1882; demosponges, Barthel et al. 1991); north of Spitzbergen, 650-1000 m, hexactinellids (Schulze 1900, Hentschel 1929).

#### Autochthonous and allochthonous spicule deposition

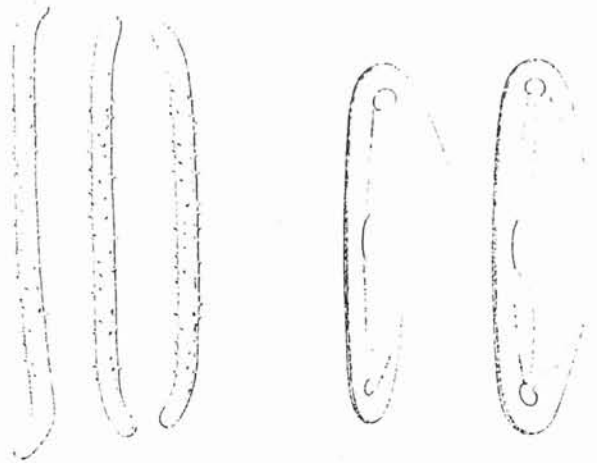
It is our impression that at abyssal depths the spicules set free after the death of the sponges are mainly deposited locally. One example is extensive beds of *Caulophacus* (Hexactinellida) stalks and loose spicules in the deepest parts of the Greenland Sea, where the sponge is abundant. Another is stalks of *Hyalonema* (Hexactinellida) commonly dredged in some areas of the abyssal plains of the North Atlantic.

Along the continental slope, downward transport of spicules can be caused by currents, resuspension and sediment gliding. Local topography and hydrographic events define the spreading pattern. An example is from the Faroes, where in some places choristid sponges are found at about 250 m depth on gravel, and spicules of choristid types occur as thin mats on the soft sediment only few km away at 350-400 m depth (own observations). A second example is from between Spitzbergen and Björnøya, where large amounts of sediment are transported away from land into the deep Norwegian Sea, probably by cascading of very cold water from the Barents Sea shelf. Choristid and other demosponge spicule types are here found very far at sea, at depths where the sponges in question do not live (Barthel et al. 1991) (Fig. 1). If in such cases recognizable spicules are abundant and the distribution of sponges living in the area is known, the occurrence of the spicules can be taken as an indication of the direction and distance of the sediment transport.

Figure 1. Examples of spicules found at 2500 m depth off Björnøya.

Left: macroscleres (skeleton spicules), 200-240  $\mu\text{m}$  long, from *Metschnikowia spinispiculum* Carter, 1876. The species is known from the western Barents Sea at about 200 m depth.

Right: microscleres (free spicules), 140-200  $\mu\text{m}$  long, from *Hamacantha* sp. *Hamacantha* has not been taken in the area, but in the southwestern Barents Sea down to about 360 m.



### Ecological importance

Where sponge spicules occur in large masses, and particularly where they form thick coherent mats, they have a profound effect on the physical properties of the bottom and on the composition of the local fauna (Barthel 1992, Barthel & Gutt 1992).

In localities where spicules are abundant, but do not form coherent mats, their biological impact is more difficult to assess. They seem to give the bottom a loose structure, making it easier for small organisms to find space. One might also expect the activities of larger mud eaters and burrowers to be influenced. A certain vertical sorting and concentration of spicules in distinct layers is sometimes seen in box cores, and may be caused by bioturbation (J. Rumohr, pers.comm.).

For some foraminifers sponge spicules are a suitable substrate (Jumars & Eckman 1983, Lutze & Thiel 1989), while others use spicules from the sediment as material for their agglutinated tests (examples are found in: Christiansen 1958, 1964 and Heron-Allen & Earland 1912). There are also cases of use of sponge spicules for more special purposes, such as expanders for the pseudopodial network (Lutze & Altenbach 1988). Certain sponges use foreign spicules instead of own spicules in their skeleton fibers, and in such cases spicules of many different origins can be found together (Barthel et al. 1991).

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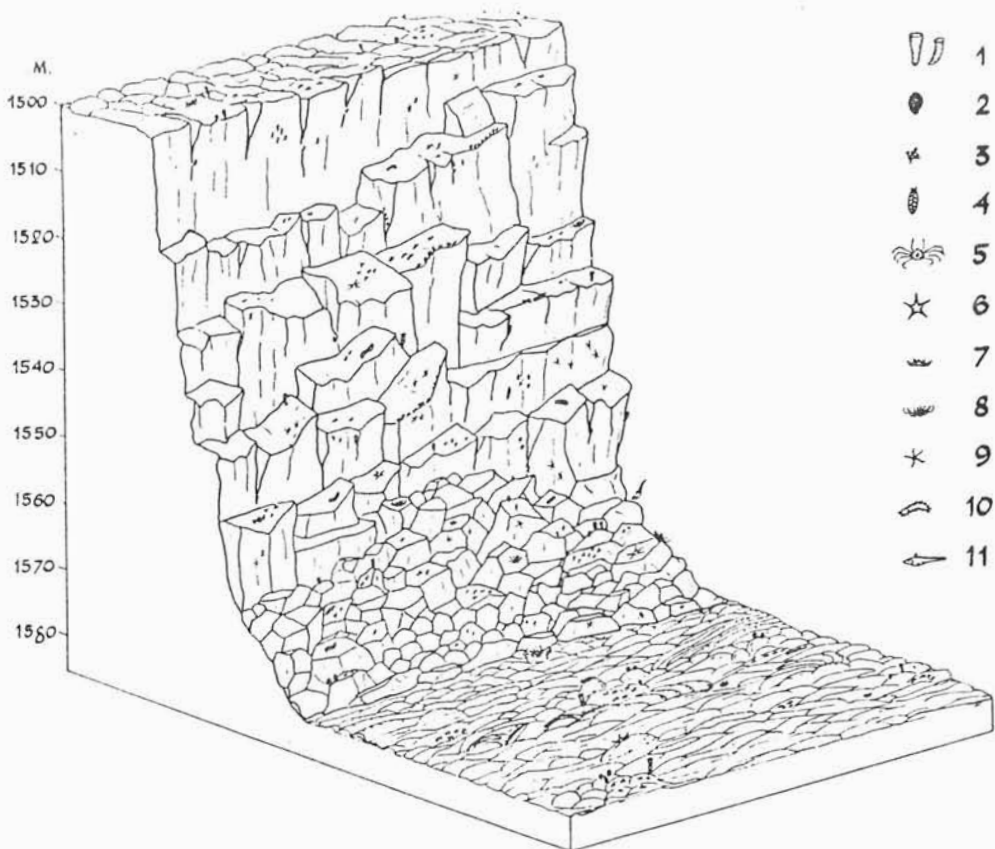


#### DEEP-SEA HYDROTHERMAL LANDSCAPES

Modern submersibles afford a unique opportunity for direct close-up study of deep-sea landscapes. Because of this, the microdistribution of animal populations with respect to each other and to environmental conditions (bottom topography, currents, etc.) has become an important aspect of international deep-sea research.



Fig. 1. North wall of the caldera, Axial Seamount, Juan de Fuca Ridge, 1570 m. The surrounding (non-vent) fauna. - 1, *Hyalospongia*: *Rhabdocalyptus heteraster* (non *Bathydorus* sp.). - 2, *Hyalospongia*: *Staurocalyptus fuca* Tabachnik, 1989. - 3, *Coelenterata*, *Hydrozoa*. - 4, *Polychaeta*, *Polynoidae*. - 5, *Decapoda*, *Brachyura*, *Majidae*: *Macroregonia macrochira*. - 6, *Asteroidea*, *Astropectinidae*. - 7, *Asteroidea*. - 8, *Asteroidea*, *Brisingidae*. - 9, *Ophiuroidea*: *Ophiura* sp. - 10, *Holothurioidea*, *Stichopodidae*. - 11, *Pisces*, *Macrouridae*.



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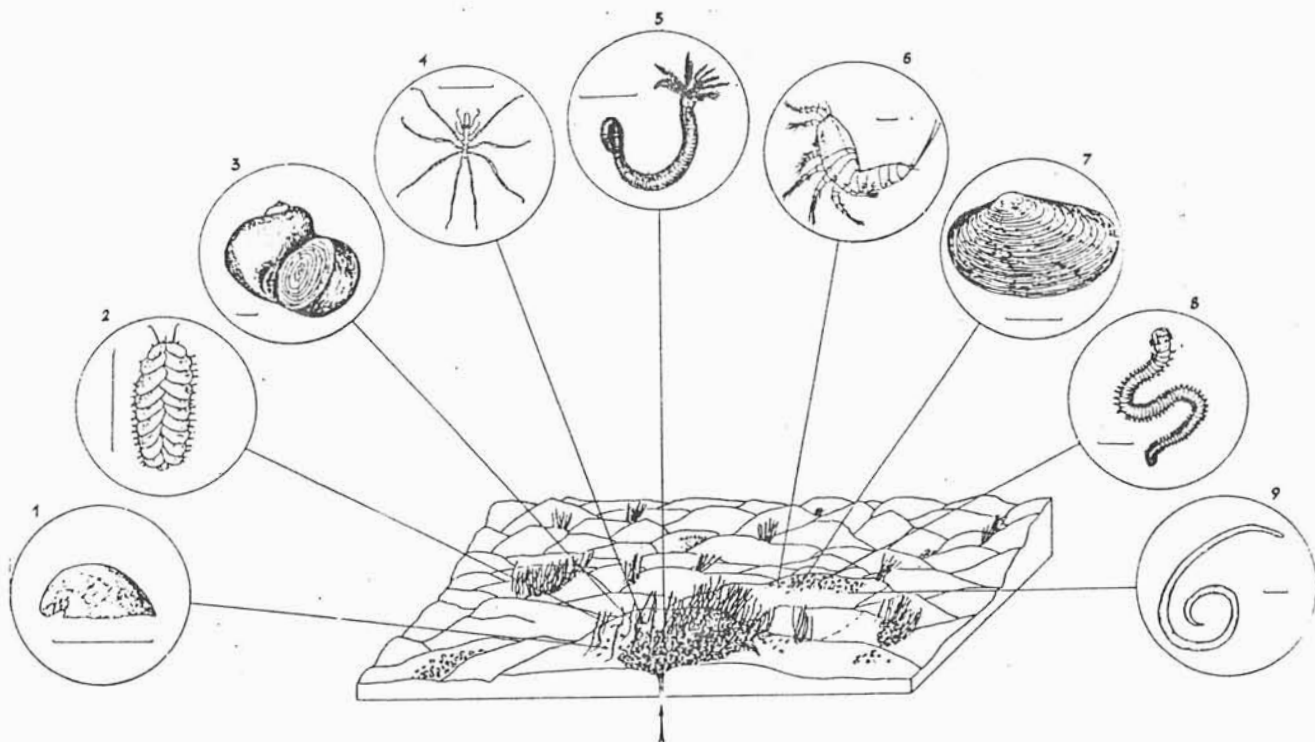


Fig. 2. Axial seamount of Juan de Fuca Ridge, 1570 m. Distribution of animals in the vent area. 1-5: *Vestimentiferan* assemblage (*Ridgeia*); 6-9: *Calyptogena* assemblage. - 1, *Gastropoda*, *Lepetodrilacea*: *Lepetodrilus fucensis*. - 2, *Polychaeta*, *Polynoidae*: *Lepidonotopodium piscesae*. - 3, *Gastropoda*, *Peltospiridae*: *Depressigyra globulus*. - 4, *Pantopoda*, *Ammotheidae*: *Ammothea verenae*. - 5, *Polychaeta*, *Alvinellidae*: *Paralvinella palmiformis*. - 6, *Copepoda*, *Cyclopoida*. - 7, *Bivalvia*, *Vesicomidae*: *Calyptogena* sp. - 8, *Polychaeta*, *Nereidae*: *Nereis* sp.nov.. - 9, *Nematoda*.

Fig. 3. Axial Seamount of Juan de Fuca Ridge, near-vent area. Left side: Assemblages of *Calyptogena* sp.: non-vent shrimp (surrounding fauna); between *Calyptogena* their faecal pellets with *Nereis* sp. on them (cf. Fig. 1, 6-9). Right side: Assemblage of *Ridgeia* sp. (Vestimentifera) with the same animals as in Fig. 1, 1-5; in addition, *Amphisamytha galapagensis* (Ampharetidae) on vestimentiferan tubes and along the chinks of basalt and 'beards' and 'carpets' of bacterial mats. Arrows: Flow of fluid.

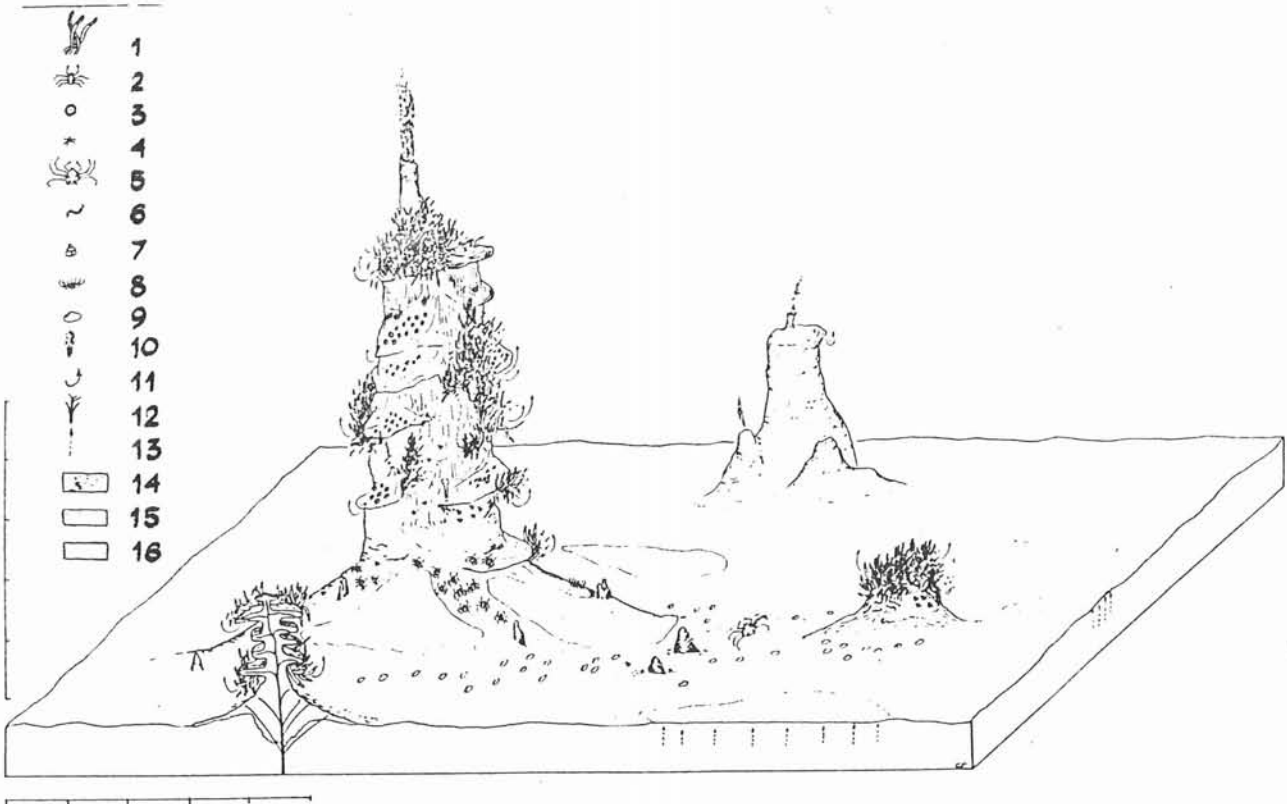
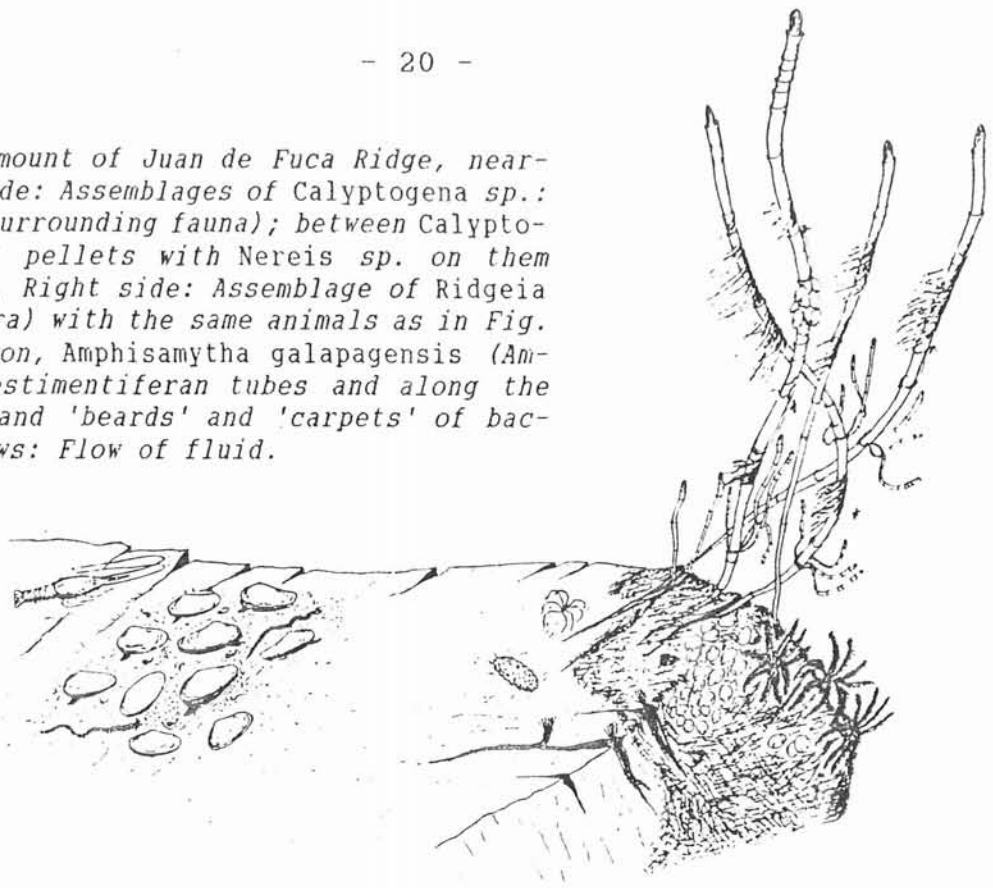


Fig. 4. Hydrothermal chimneys and associated fauna in the Guaymas Basin, Gulf of California, 2000 m. - 1, Vestimentifera, Riftiidae: *Riftia pachyptila*. - 2, Decapoda, Anomura, Galatheidae: *Munidopsis alvisca*. - 3, Coelenterata, Anthozoa, Actiniaria. - 4, Polychaeta, Alvinellidae: *Paralvinella grasslei*. - 5, Decapoda, Anomura, Lithodidae: *Neolithodes diomedea*. - 6, Polychaeta Sedentaria. - 7, Gastropoda, Littorinoidea: *Provanna goniata*. - 8, Asterozoa, Brisingidae. - 9, Bivalvia, Vesicomidae: *Calyptogena pacifica*. - 10, (smoke from) black smokers. - 11, water discharge. - 12, fluid flow. - 13, diffuse venting (seeping). - 14, hydrothermal deposits. - 15, bacterial mats. - 16, soft sediment. Scales = 5 m

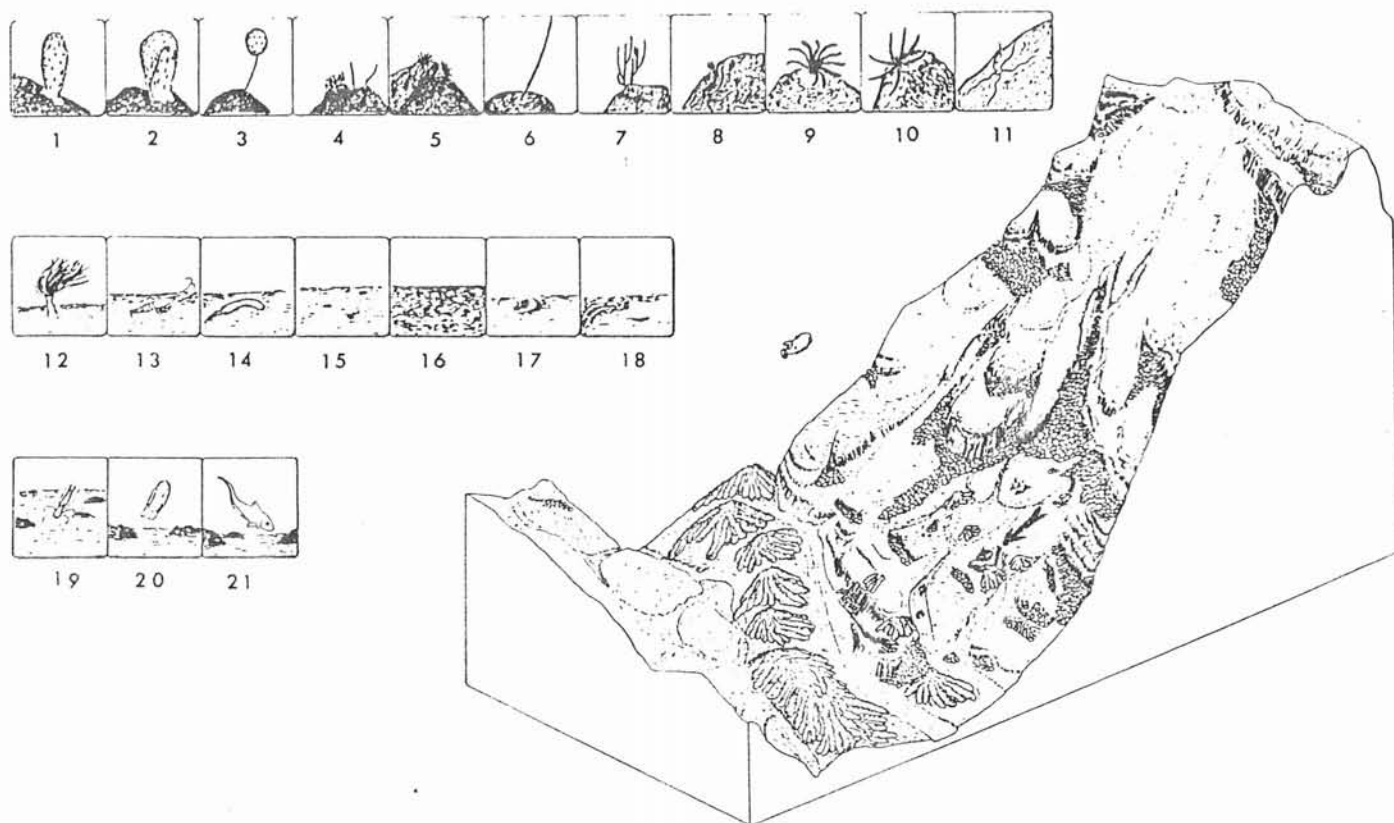


Fig. 5. The eastern slope and adjacent inner floor of the median valley in the Trans-Atlantic Geotraverse area. The arrow in the centre indicates the black smokers area; above: the extinct hydrothermal vents; below: neovolcanic zone. 1-11: epifauna on basalt, surrounding (non-vent) fauna; 12-18: vent animals. - 1, 2, *Hyalospongia*, *Pheronematidae*: *Poliopogon* sp. - 3, *Hyalospongia*, *Hyalonematidae*: *Hyalonema* sp. - 4, *Coelenterata*, *Hydrozoa*. - 5, *Coelenterata*, *Anthozoa*, *Actiniaria* (white). - 6, 7, *Coelenterata*, *Anthozoa*, *Gorgonaria* (whip form and candelabrum form). - 8, *Polychaeta*, *Spionidae*. - 9, *Crinoidea*. - 10, *Asteroidea*, *Brisingiidae*. - 11, *Ophiuroidea*. - 12, *Coelenterata*, *Anthozoa*, *Actiniaria* (violet). - 13, *Decapoda*, *Natantia*. - 14, *Holothurioidae*. - 15-18, "Lebensspuren", sedimentary structures produced by such animal activity. - 19, *Decapoda*, *Anomura*, *Galatheidae*: *Munidopsis* sp. - 20, *Holothurioidae* (swimming), *Pelagothuriidae*. - 21, *Pisces*, *Macrouridae*: *Coryphaenoides armatus*.

The highly specialized appearance of hydrothermal oases allows us to consider them as a specific type of abyssal bottom landscape. As is commonly known, the vent communities are characterized by a diffuse zonation centered around vent openings and based on the different ecological requirements of the animals. In reality, this zonation is not clear-cut, and the untidy distribution of vent openings combined with complexities in topography result in patchiness which is often difficult to explain.

Vent-fauna investigation at the Russian Academy of Sciences, Institute of Oceanology, began in 1986. Since then many sites in the Pacific and Atlantic oceans have been visited by the RV "Akademik Mstislav Keldysh" carrying two submersibles: "Pisces" (capable of diving down to 2000 m) or "Mir" (down to 6000 m). Direct observations were made from the submersibles, together with photography, videotape recordings, and sampling. Material for biochemical and physiological analyses was collected as well. Special attention was paid to the spatial distribution of vent animals in the vent areas.

In the final stage of each study the landscape of the investigated area was reconstructed, using all available data. Some of our generalized reconstructions are presented in Figs. 1-4. A number of types of stable fauna

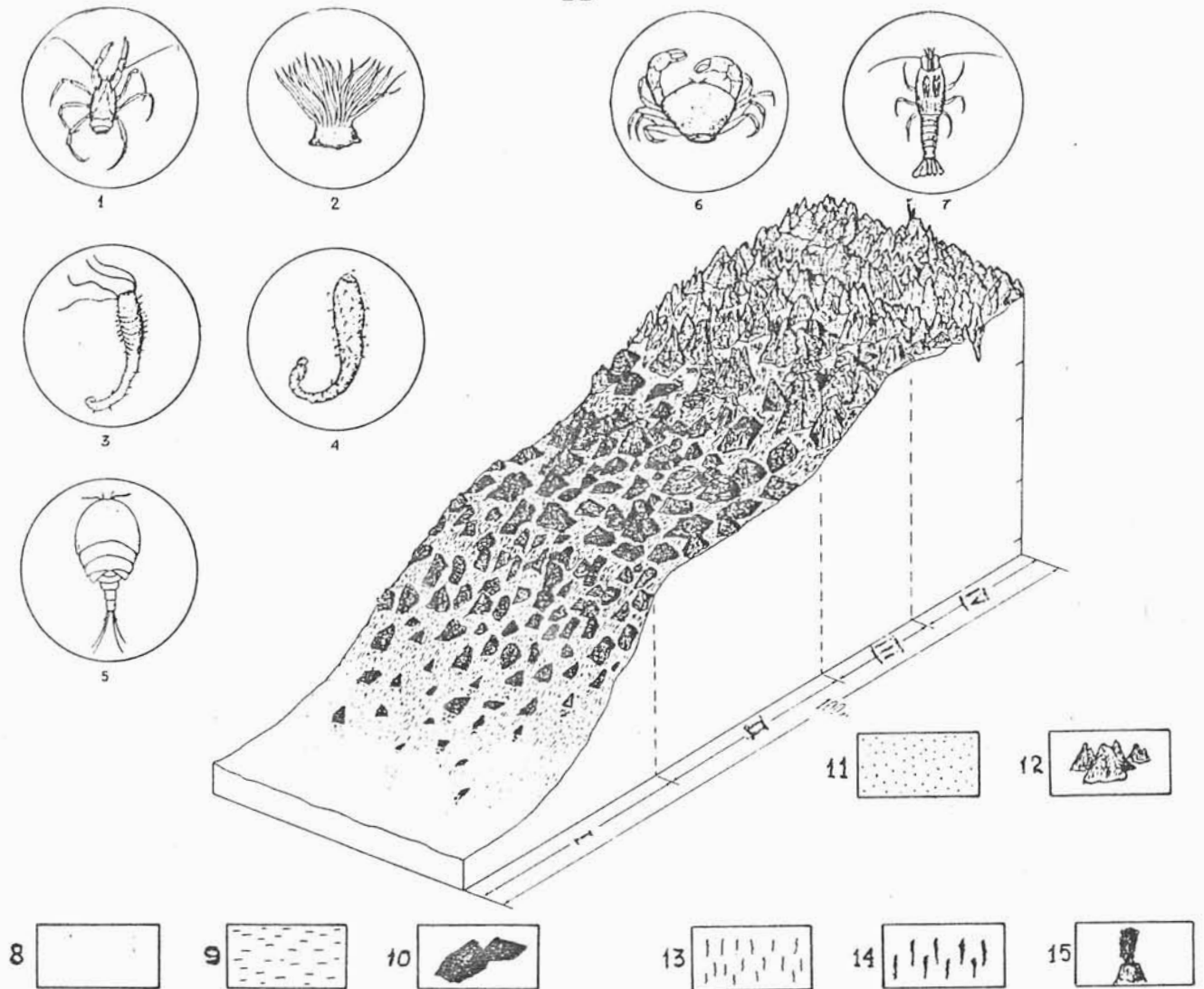


Fig. 6. Mid-Atlantic Ridge, 26°N (TAG). Hydrothermal mount, 3660-3700 m. I, outer slope, II, outer ledge, III, inner slope, IV, upper ground. Recent hydrothermal activity present in areas III and IV. Principal fauna in periphery (1-5) and in near-vent area (6-7); substratum (8-12); evidence of hydrothermal activity (13-15). - 1, Decapoda, Anomura, Galatheididae: *Munidopsis* sp. - 2, Coelenterata, Anthozoa, Actiniaria. - 3, Polychaeta, Ampetidae. - 4, egg capsule of unknown invertebrate animal [athecate hydroid?]. - 5, Copepoda, Calanoida. - 6, Decapoda, Brachyura, Bythograeidae: *Segonzacia mesatlantica*. - 7, Decapoda, Natantia, Bresiliidae: *Rimicaris exoculata*. - 8, soft sediment. - 9, soft hydrothermal deposit. - 10, oxidized sulfide debris (yellow and red). - 11, quartz sand. - 12, reduced sulfide blocks (gray and black). - 13, shimmering water. - 14, warm smoke. - 15, high temperature black smoker.

assemblages in each near-vent area can be defined. These assemblages are usually dominated by symbiotrophs and/or bacteriophages belonging to different taxa. The distribution of primary consumers directly affects the distribution of some other animals. Species composition varies in different areas of the ocean, but the ecological structure of the assemblages in each microhabitat is similar. Recognition of specific assemblages seems to be important for establishing a typology of deep-sea hydrothermal vent ecosystems. In this context the method of landscape reconstructions seems to be rather helpful.



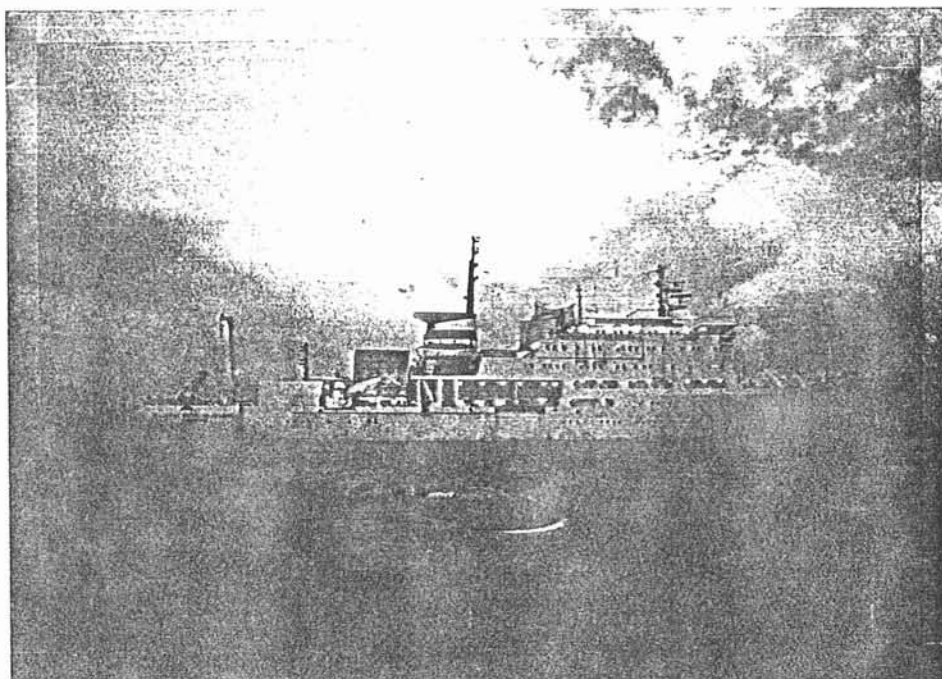
## FEEDING SPECIALIZATION OF BRESILIIDAE SHRIMP IN THE TAG SITE HYDROTHERMAL COMMUNITY

Two caridean shrimps of the family Bresiliidae, *Rimicaris exoculata* and *Chorocaris chacei*, dominate the megafauna of the TAG site hydrothermal community found on the Mid-Atlantic Ridge (26°08'N, 44°49'W) at depths of 3620-3700 m. Many thousands of shrimps form dense swarms that hide the surface of rocks around hydrothermal chimneys (see DEEP-SEA NEWSLETTER No. 13, 1987, p. 8). Both species were described as *Rimicaris* (Williams & Rona 1986), on the basis of dredged material. Later *R. chacei* was transferred to the genus *Chorocaris* (Martin & Hessler 1990). During a number of cruises on the TAG site in 1986-1991 with submersibles Alvin, Mir-1 and Mir-2 (Rona 1986, Rona et al. 1986, Galkin & Moskalev 1990), and during some previous expeditions (Rona 1980) it was shown that shrimps in this community always keep close to black smokers or shimmering water.

Van Dover and colleagues (Van Dover 1988, Van Dover et al. 1988, 1989) found that Atlantic hydrothermal shrimps are blind but have a dorsal (bilobed) organ with a thermosensory function. According to the feeding biology of these shrimps it was suggested (Van Dover et al. 1989) that they graze on free-living bacteria growing on the surface of chimney sulfides, picking up particulate sulfide material with their chelae and brushing them off with their modified mouthparts. The bacterial source of feeding was proved by carbon stable isotope analysis (C = -11.6-12.1 ‰) and by lipopolysaccharide assays of shrimp gut contents. The presence of sulfide crystals in the gut contents was also reported. The role of symbiotic bacteria in the feeding of shrimps was suggested to be unimportant (ibid.). Jannash et al. (1991) recently discussed the suspension mechanism of feeding of Atlantic hydrothermal shrimps, based on the filamentous bacterial that cover their carapaces.

### *Akademik Mstyslav Keldysh and submersible Mir-2*

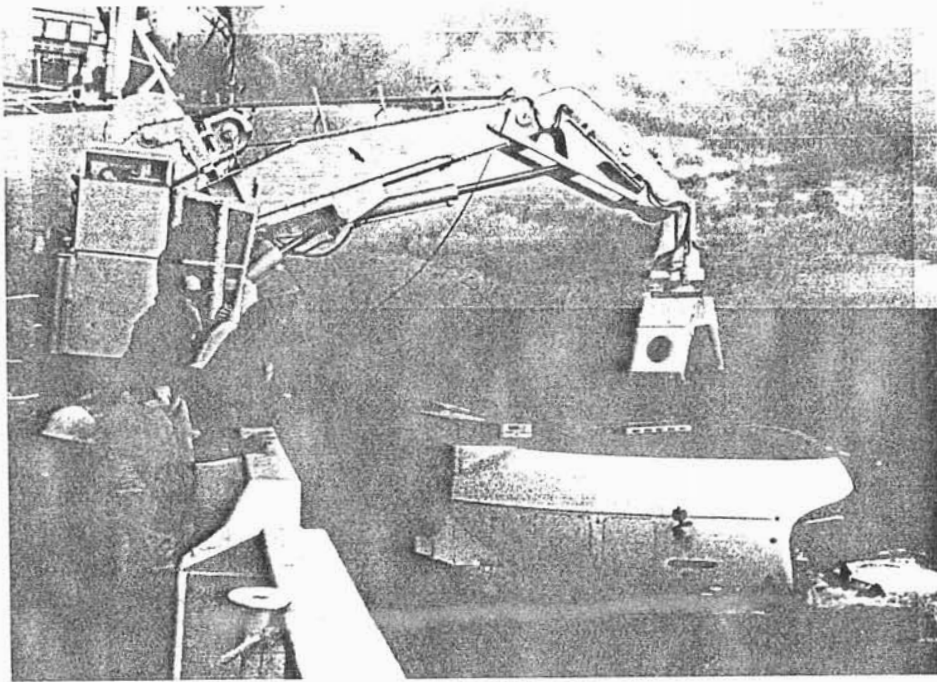
During the 23rd cruise of the R/V Akademik Mstyslav Keldysh on the TAG site (26°08'N, 44°49'W; 3620-3670 m) in May-June 1991, the investigation of shrimp feeding biology was continued. 67 individuals of *Rimicaris exoculata* and 18 of *Chorocaris chacei* were collected during 6 dives of submersibles Mir-1 and Mir-2 on the active hydrothermal mound at the TAG site during this cruise.



Our observations suggest that both species feed on exosymbiotic bacteria that form a dense covering on the mouthparts and the inner surface of the carapace. The associated bacterial community includes different morphological forms and types of bacteria and is full of sulfide crystals from black smokers. SEM showed the symbionts to be mainly comprised of two dominant morphological types of filamentous bacteria with trixome widths at 0.2-



0.5  $\mu\text{m}$  and 1-3  $\mu\text{m}$ , and with elemental sulfur inside cells and attaching disks; both forms resemble *Triotrix*.



*Mir-2 being lowered*

Details of the external morphology indicate that the shrimps are highly specialized for caring for bacterial symbionts and utilizing them: cavities formed by the carapace along either side of the body, hypertrophied exopods of maxilla 2 and maxilliped 1, and dense fields of setae on the mouthparts enlarge the attaching surface for symbionts. We suggest that the bacteria are picked up by the chelipeds, either from the surface of the carapace or from the mouth-

parts, transferred into the basket formed by maxilliped 2 and other mouthparts; from here they are brushed into the mouth by the endopodite of maxilliped 2. Brushing by the scoop-shaped chela of pereopod 1 is also possible (Van Dover et al. 1988). It is supposed that shrimps keep close to the hydrothermal fluid and farm their bacterial symbionts on the moderate current with a low concentration of hydrogen sulfide. The assayed level of ribulose-1.5-bisphosphate carboxylase activity in associated bacterial community is low (2.2  $\mu\text{mol}/\text{min g}$  protein), indicating dominance of heterotrophic forms among symbionts. The source of primary production in this vent community is still being discussed.

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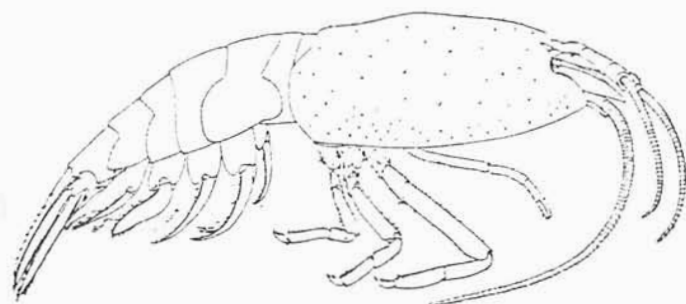
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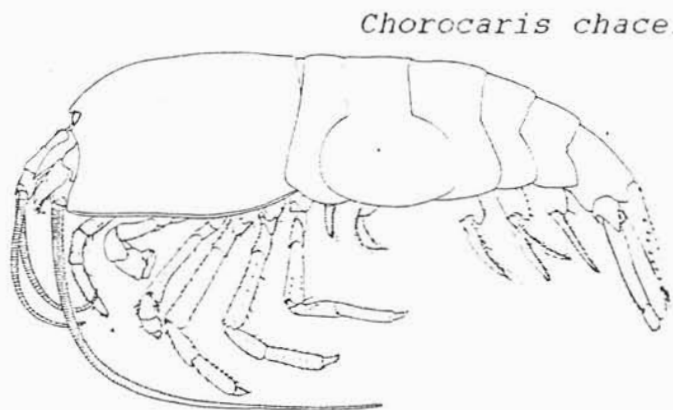
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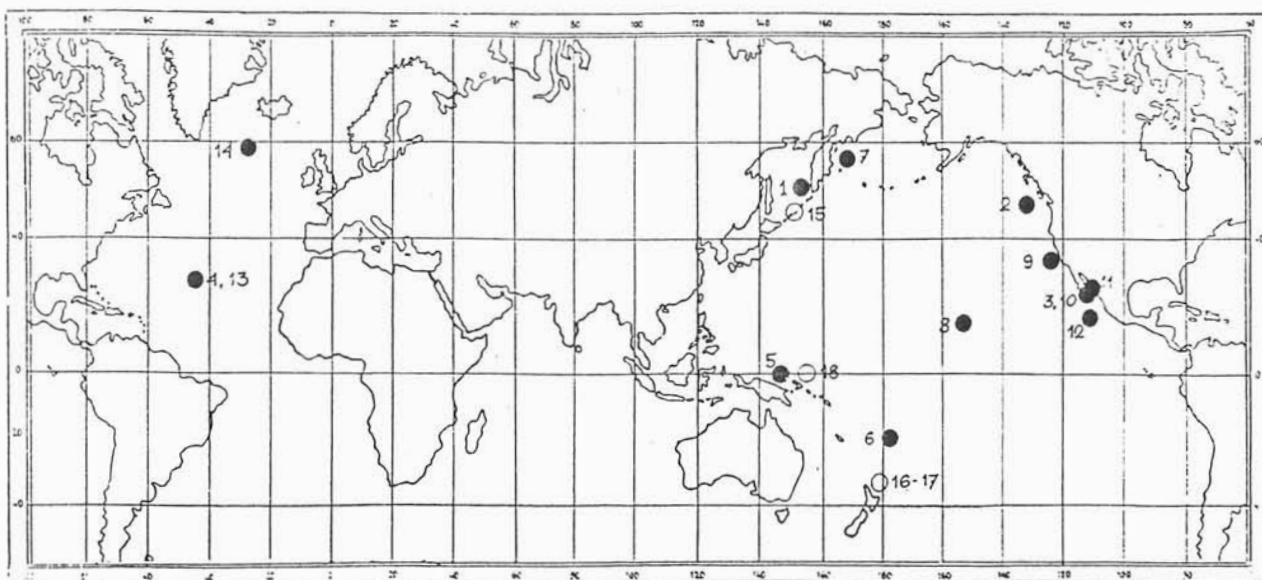
*Rimicaris exoculata*



*Chorocaris chacei*

THE INVESTIGATIONS OF CHEMOBIOS (CHEMOSYNTHETIC BASED ECOSYSTEMS)  
ORGANIZED BY THE RUSSIAN ACADEMY OF SCIENCES

compiled by L.I. Moskalev



● Operated by the Institute of Oceanology, Moscow  
○ Operated by the Institute of Marine Biology, Vladivostok  
Nos. 1-18 refer to the table on p. 26

SCIENT. ORGAN.	NN ON MAP	R E G I O N	SCIENTIFIC RESEARCH VESSEL	NUM OF VOYAGE	YEAR	METHOD OF DIVE	SCIENTIFIC STAFF
INSTITUTE OF OCEANOLOGY (MOSCOW), DEEP WATER (SUBMERSIBLES)	1	PARAMUSHIR ISL., OKHOTSK SEA	"AKADEMIK MSTISLAV KELDYSH"	11A	1986	"PISCESVII", "PISCESXI"	KUZNETSOV A.P., GALKIN S.V.
	2	AXIAL SEAMOUNT, JUAN DE FUCA RIDGE	"	12	1986	"	MOSKALEV L.I., GALKIN S.V.
	3	SOUTHERN TROUGH OF THE GUAYMAS BASIN, GULF OF CALIFORNIA	"	"	"	"	" "
	4	TRANS-ATLANTIC GEOTRAVERSE, 26° N	"	15	1988	"MIR-1", "MIR-2"	MOSKALEV L.I., GALKIN S.V.
	5	MANUS BASIN, BISMARCK SEA	"	21	1990	"	GALKIN S.V.
	6	LAU BASIN, SEPARATES THE TONGA RIDGE FROM THE LAU RIDGE	"	"	"	"	"
	7	PIIP'S VOLCANO, BERING SEA	"	22	1990	"	MOSKALEV L.I., GALKIN S.V.
	8	LOIHI VOLCANO, HAWAII	"	"	"	"	" "
	9	MONTEREY FAN VALLEY SYSTEM	"	"	"	"	" "
	10	SOUTHERN TROUGH OF THE GUAYMAS BASIN, GULF OF CALIFORNIA	"	"	"	"	" "
	11	SOUTHERN SLOPE OF THE GUAYMAS BASIN, GULF OF CALIFORNIA	"	"	"	"	" "
	12	EAST PACIFIC RISE, 21° N	"	"	"	"	" "
	13	TRANS-ATLANTIC GEOTRAVERSE, 26° N	"	23	1991	"	MOSKALEV L.I., GEBRUK A.V.
	14	REYKJANES RIDGE, ? CHEMOBIOS	"	28	1992	"	CRANE K. (USA), MOSKALEV L.I., GEBRUK A.V.
INSTITUTE OF MARINE BIOLOGY (VLADIVOSTOK) SHALLOW WATER (SCUBA)	15	KPATERNAYA BAY ON THE YANKICHA ISLAND, THE KURIL ISLANDS	"TAIMYR", "AKADEMIK ALEXANDR OPARIN" AND OTH.		1985-1992	AQUALUNG	TARASOV Y.G., PROPP M.V.
	16-17	WHALE AND WHITE ISLANDS, NORTH NEW ZEALAND	"AKADEMIK ALEXANDR NESMEYANOV"		1990	"	TARASOV Y.G., GEBRUK A.V.
	18	MATUPI HARBOUR, NORTH NEW BRITAIN	"		"	"	" "

IN ADDITION. KUZNETSOV, A.P. (1988, 1991) DESCRIBED THE FOSSIL FAUNA OF HYDROTHERMAL HILLS OF URAL'S PALEOCEAN (MIDDLE DEVONIAN).



## DEEPSTAR - A NEW DEEP-SEA MICROBIOLOGY RESEARCH PROGRAM



The Japan Marine Science and Technology Center (JAMSTEC) launched a new research project, DEEPSTAR (Deep-sea Environment Exploration Program Suboceanic Terrain Animalcule Retrieval) program, which will develop a system to make efficient, full-scale experiments with deep-sea microorganisms possible. The topics that the DEEPSTAR project first takes up will be the features of microorganisms living in the deep-sea environment. I will describe the outlines of the new research program.

The DEEPSTAR program will utilize the JAMSTEC's strong deep-sea exploration technology including manned submersibles "Shinkai 6500" and "Shinkai 2000" which can dive up to 6500 m and 2000 m deep, respectively, and "Dolphin 3K", a remotely operated vehicle. For DEEPSTAR, one of the greatest advantages in being able to utilize these submersibles is that researchers can actually select the best sampling sites for their specific purposes. For example, colonies of giant white clams (*Calyptogena*) and tube worms (*Lamellibrachia*), or individual bodies of crabs, like stone crabs (*Paralomis*), can be spotted, and even selected, (bacterially) infected specimens can be collected. It is also possible to collect sediment samples of specific sites of interest, like yellowish spongy mat (presumably bacterial origin) around the colonies of these large animals, which would be useful in studying the ecosystem of sea bottom.

Deep-sea microorganisms obtained in the course of the DEEPSTAR research program will be examined to determine their basic characteristics, classified taxonomically and made available to the scientific community. Also, Deep-sea Microorganisms Collecting and Cultivation System (DMCCS) is now under development. This system handles deep-sea microorganisms without decompression to the atmospheric pressure; thus, it allows researches to study deep-sea microorganisms under natural conditions.

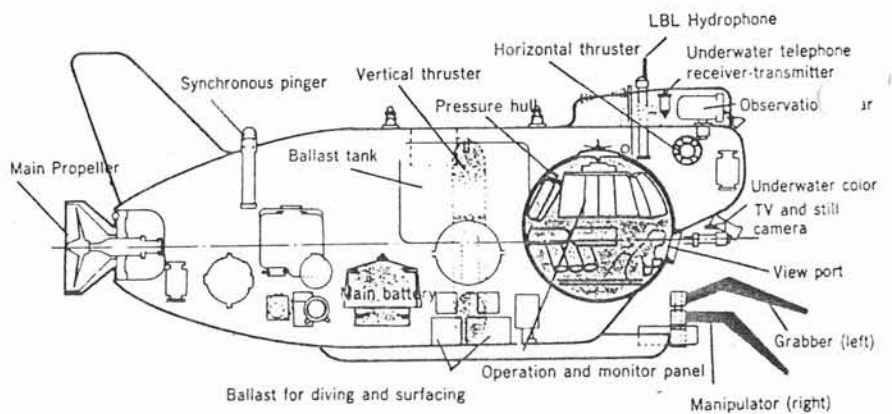
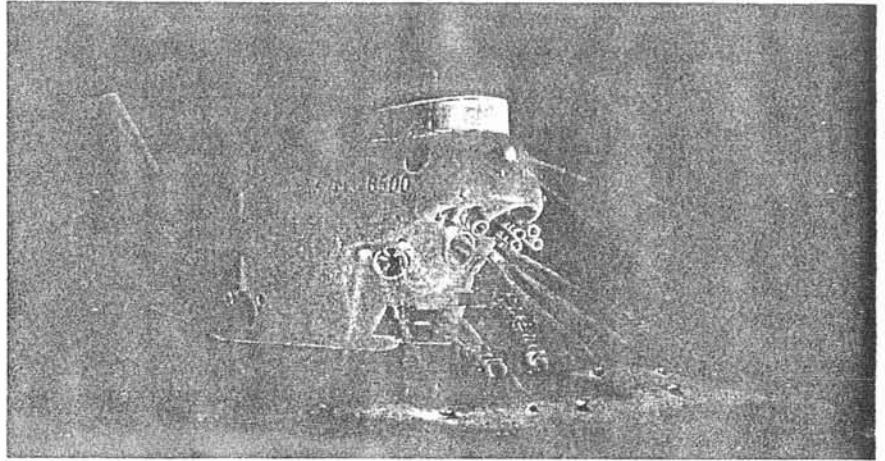
The deep sea is therefore considered to be a suitable source for the isolation of psychrophiles (cold-loving microorganisms) and barophiles (high-pressure lovers). The bacteria inhabiting the high-pressure and low-temperature deep-sea environment will be studied in our group. Furthermore, considering the properties of bacteria from the deep sea, enzymes with unique properties like barophilic or psychrophilic characteristics would be expected. Such enzymes may be useful in processing of food and biotransformation of chemicals at low temperature or high pressure. In addition, DEEPSTAR is also focusing its research on hyperthermophiles which will be screened from these subsurface hydrothermal vents.

The deep-sea environment is, however, also a relatively unexplored source of ordinary microorganisms for biotechnological screening. Most ordinary terrestrial bacteria like *Bacillus subtilis* and *Clostridium sporogenes* are known to be able to survive in a high-pressure environment (e.g. 100 MPa). In fact, the majority of bacteria readily isolated from sediment samples taken from the deep sea without intensive care on *in situ* temperature and pressure maintenance are non-barophilic, mesophilic, ordinary bacteria. It is assumed that they are originally derived from terrestrial or shallow-water environments and have fallen to the depth associated with the carbonic particles that are continuously depositing on the ocean floor. These populations of bacteria might not be ecologically significant; however, they are considered to be new sources of material for various types of microbial screening.



Research submersible  
"Shinkai 6500"

The DEEPSTAR group currently has 16 researchers in Japan Marine Science and Technology Center and RIKEN Institute. It will be expected to expand as the new facility including DMCCS on the JAMSTEC campus will be completed in 1993. The main research objectives of the DEEPSTAR group will not necessarily be restricted to hot research fields in marine microbiology, such as ecological studies utilizing molecular biological methods, and ecological and biotechnological studies of microbial community of hydrothermal vents. Although some of DEEPSTAR's research deals with them, its research area should not be limited to these trends.



DEEPSTAR is funded by the Science and Technology Agency of Japan to study basic deep-sea microbiology under a long-term basis (the first term 8 years, the second term 7 years) with the object of basic microbiological studies. This enables its research to concentrate on original deep-sea microbiological studies on a long-term basis rather than only on "hot" research. DEEPSTAR has been focusing its research also on ordinary microorganisms retrievable from the deep-sea environment as a new unique source of microorganisms with various characteristics. From the point of view described above, DEEPSTAR will expand its research in microbiology of the deep sea as an extremely low- or high-temperature environment, and screening other microbes from the deep sea. I hope we will be able to present papers at the next deep-sea biology symposium in 1994.



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