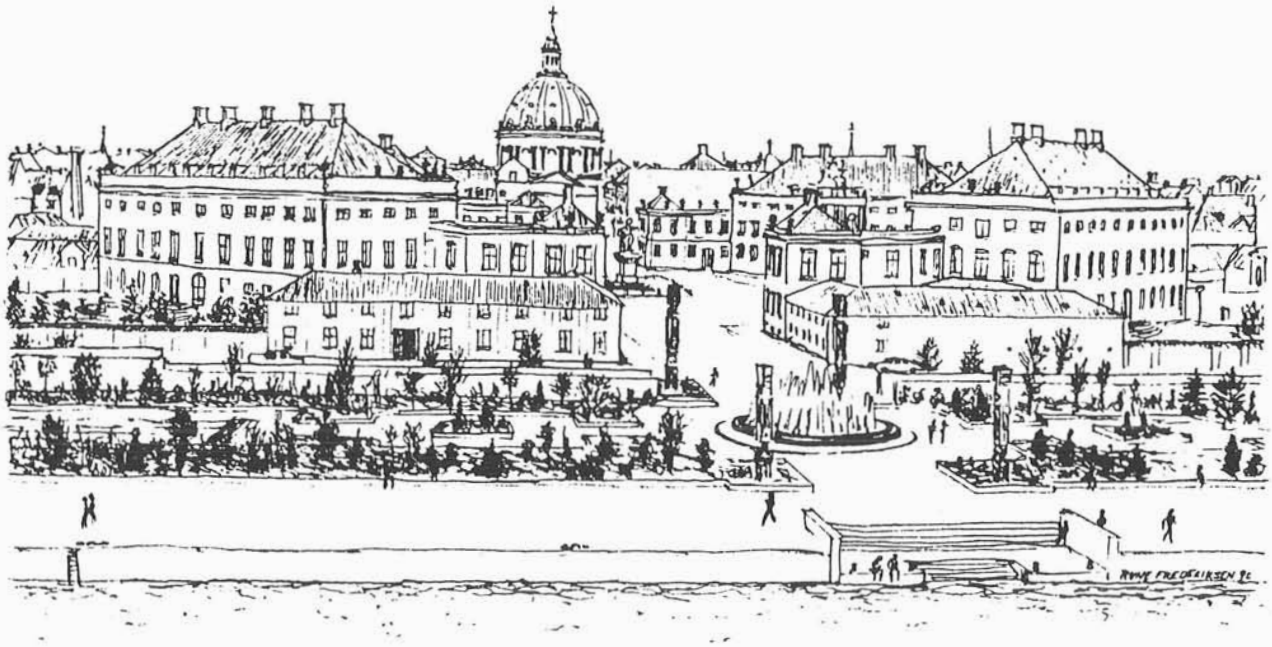
No. 17, September 1990

THE SIXTH DEEP-SEA BIOLOGY SYMPOSIUM
COPENHAGEN, 30 JUNE - 5 JULY 1991

SECOND ANNOUNCEMENT

TIME:	30 June (Sunday evening) until 5 July 1991.
SYMPOSIUM CENTER:	August Krogh Institute (Zoophysiology), Universitetetsparken 13, DK-2100 Copenhagen Ø. (The Natural Sciences Campus, next to the Zoological Museum).
SYMPOSIUM OFFICE:	For all mail (except application form): Deep-Sea Symposium, Zoological Museum, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark Telephone: (+)45 31354111. Telefax: (+45) 31398155
SYMPOSIUM BOARD:	Jørgen B. Kirkegaard, Reinhardt M. Kristensen, Ole Tendal and Torben Wolff, in cooperation with DIS Congress Service Copenhagen A/S.



PARTICIPATION: Following the first announcement in Deep-Sea Newsletter No. 16, so far 85 scientists from 13 different countries have indicated their interest. Guided by experience from former symposia, we feel convinced that many more will participate.

Australia
Gina M. Newton
Gary C.B. Poore

Canada
Kim Juniper
Verena Tunicliffe

Denmark
E. Bertelsen
Peter Kofoed Bjørnsen
Danny Eibye-Jacobsen
Tom Fenchel
Jørgen Hylleberg
Jens Høeg
Preben Jensen
Åse Jespersen
Bo Barker Jørgensen
Jørgen B. Kirkegaard
Jørgen Knudsen
Reinhardt M. Kristensen
Fritz Jensenius Madsen
Jørgen Nielsen
Arne Nørrevang
Mary E. Petersen
Ole Tendal
Bent Vismann
Torben Wolff

France
Anne-Marie Alayse
Daniel Desbruyères
Alain Dinet
Aline Fiala-Médioni
Françoise Gaill
Patrick Geistdoerfer
Laurence Guidi

F.R.G.
Dagmar Barthel
Werner Beckmann
H. Bluhm
C. Bussau
C. Borowski
M. Carstens
Bernd Christiansen
Eric Foell
Gerd Liebezeit
Karin Lochte
Olaf Pfannkuche
Gerd Schiever
T. Soltwedel
Hjalmar Thiel
Horst Weikert

Greece
Anastasios Eleftheriou
Anastasios Tselepides

Iceland
Jörundur Svavarsson

Israel
Amatzia Genin

Japan
Yoshihisa Shirayama

Norway
Torleiv Brattegard
Jon-Arne Sneli

U.K.
B. Bett
David S.M. Billett
Andrew Gooday
Lawrence E. Hawkins
Stephen Hutchinson
Caroline Maybury
Tony Rice
Alan J. Southward
Eve Southward
Michael Thurston
Robin Whatley

U.S.A.
Michel A. Boudrias
Stephen Cairns
Andrew G. Carey
Rita R. Colwell
Elizabeth P. Dahlhoff
James E. Eckman
Scott France
Mark Grygier
Ute Hentschel
Robert Hessler
Holger W. Jannasch
Lisa A. Levin
Raymond B. Manning
Michael A. Rex
Amelie H. Scheltema
Rebecca V. Streib
David Thistle
Cindy Lee Van Dover
Carl O. Wirsen
Karen Wishner
Barbara Hecker

U.S.S.R.
Andrew V. Gebruk

SYMPOSIUM FEE: Before 1 April 1991: 500 D.kr. Students: 100 D.kr.
After 1 April 1991: 700 D.kr. Students: 150 D.kr.

LANGUAGE: English.

TOPICS: So far 41 oral contributions and 6 posters have been announced. Guided by the presented topics and suggestions from several persons we have selected the following general themes as a framework:

1. Deep-Sea Biota and Community Structure
2. Seamount Biology
3. Dispersal of Deep-Sea Faunas (vents, cold seeps, wood)
4. Behaviour
5. Deep-Sea Microbiology
6. Major Projects (already in progress for some time)

PAPERS: For each paper will be allowed 15 minutes plus 5 minutes for discussion. A short communication shall not take more than 10 minutes in all.

POSTERS: Posters may concern all questions on deep-sea biology, ecology, evolution, environment etc. We may have to ask contributors to present their results as a poster, and we consider posters and papers of equal scientific value. A space of 1-2 m^2 will be allocated (1x1 m^2 screens). Use large lettering that can be read at a distance and keep the amount of lettering at a minimum. Include author(s), address(es) and institute(s). Include also a photo of yourself and indicate at what time you will be present at your poster. If possible, posters will be displayed for the duration of the symposium.

ABSTRACTS: We urge all contributors of papers and posters to prepare hard data abstracts which readily allow understanding of the contents and results of the paper to be presented. Abstracts based only on philosophy will be rejected. Abstracts should cover at most one type-written page.

PREPARATORY TIME SCHEDULE: Applications and abstracts should be received at the Symposium Office no later than 1 April 1991. If it is found necessary to reject any contribution the author will be notified no later than 1 May. Those not notified may assume that their contribution has been accepted.

FILMS & VIDEOS: Those wishing to show films or videos outside the oral presentations are asked to let us know - well in advance!

TECHNIQUES: The lecture hall is equipped with normal slide projector (5x5 cm) and overhead projector. If any other technique is needed, please indicate this on the application form. Slides should be numbered in the upper right hand corner as seen when they are placed in the projector. Try to minimize the number of words and maximize the size of lettering on slides and overhead transparencies. Check that your lettering can be read from the back of a large lecture hall.

PUBLICATIONS: There will not be any proceedings for the symposium contributions.

DISCUSSION(S): Hjalmar Thiel and Eric Foell have suggested a discussion on deep-sea mining impact (probably Tuesday evening). See separate article below. Suggestions for other discussions are welcome.

WORKSHOP: A workshop on benthos methods will be arranged in conjunction with the Symposium (6 and 7 July). See separate article below. The workshop will end early enough to allow participants to catch late afternoon/evening planes out of Copenhagen.

MID-SYMPOSIUM EXCURSION, 3 JULY: This will start immediately after lunch and take you to the Viking Ship Museum at Roskilde. Along Roskilde Fjord to Frederiksborg Castle (National Historical Museum). Past Fredensborg (the Queen's summer residence) to the Marine Biological Laboratory at Helsingør (Elsinore),

where coffee and pastry is served. Visit to nearby Kronborg (Hamlet's castle) and along the Øresund coast to Danmarks Akvarium. Supper amongst the fishes, at the invitation of the aquarium. Excursion price: 200 D.kr.

SYMPOSIUM TIME SCHEDULE: *Sunday*, 30 June: Arrival of participants. The Symposium Center will be open for registration from 1700 h. Pre-symposium gathering in the evening.
Monday: Oral presentations and posters. Late afternoon reception at the Copenhagen Town Hall, or the Copenhagen Zoo.
Tuesday and *Thursday*: Oral presentations and posters. Discussions and possibly films/videos in the evening(s).
Wednesday: Mid-Symposium Excursion in the afternoon (see above). Supper at Danmarks Akvarium.
Friday: Oral presentations and posters. Festival dinner in Tivoli Gardens.
Saturday: Departure or workshop.
Sunday: Workshop.

MEALS: Lunches will be served at the canteen of the August Krogh Institute at a moderate price. Also dinner will be served on Tuesday (and possibly Thursday).
The Festival dinner will take place at the restaurant Nimb, Tivoli Gardens on Friday evening. Price: 400 D.kr.

ACCOMMODATION: Accommodation can be booked through DIS Congress Service Copenhagen A/S, at the following hotels:
Hotel Triton and Hotel Absalon (shower/WC in room).
Ibsens Hotel (shower/WC in corridor).
Reservations will be made only if a deposit of DKK 1,000 is paid. The deposit will be deducted the hotel bill.

A$ = 4.05 kr
Oct 90

Copenhagen Youth Hostel, Sjællandsbroen 55.
Double rooms (limited number, apply early!) and 5-bed rooms, both 100 DKK, incl. breakfast.
You are kindly requested to make reservations direct in writing or by Telph. +45 32522908 or Fax +45 32522708.

FINAL APPLICATION: We ask you to send at latest 1 April 1991:
1. a copy of the attached application form (to DIS)
2. the abstract of your contribution (to us).

ANNOUNCEMENT: Please copy the enclosed poster and place it on your institution's notice board for general information.

SEE YOU LATER! AU REVOIR! AUF WIEDERSEHEN! PÅ GENSYN!

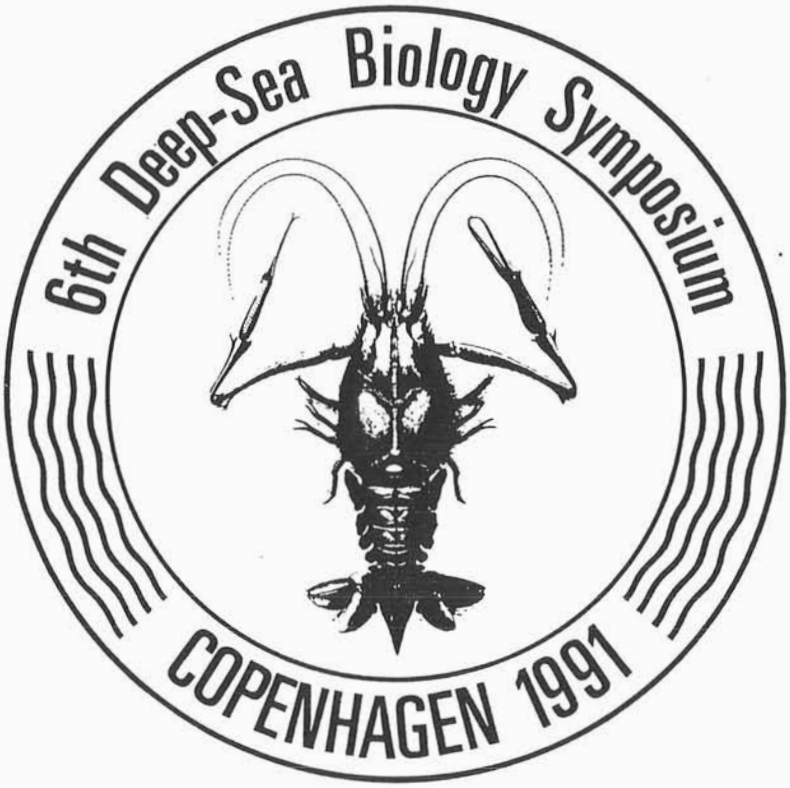
Torben Wolff

Proposal to discussion during the symposium:

ON MINING RELATED IMPACT STUDIES IN THE DEEP SEA THAT MAY BE REQUIRED UNDER UN REGULATIONS

Mining the deep sea has been under discussion for about 25 years, and environmental studies have been conducted both in conjunction with, and independent of, test mining operations. The Preparatory Commission of the UN Seabed Authority is currently occupied with the preparation of the

6TH SYMPOSIUM
DEEP-SEA BIOLOGY
COPENHAGEN, DENMARK 30 JUNI-5 JULI 1991



General themes:

1. Deep-Sea Biota and Community Structure
2. Seamount Biology
3. Dispersal of Deep-Sea Faunas (vents, sold seeps, wood, etc.)
4. Behaviour
5. Deep-Sea Microbiology
6. Major Projects (already in progress for some time)

Organizers: Jørgen B. Kirkegaard, Reinhardt M. Kristensen, Ole Tendal, Torben Wolff

For details, see "Deep-Sea Newsletter" No. 17, Sept. 1990 or contact

6th Deep-Sea Biology Symposium
Zoological Museum, Universitetsparken 15
DK 2100 Copenhagen Ø, Denmark

For secretariat use
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APPLICATION FORM

Sixth Deep-Sea Biology Symposium
30 June - 5 July 1991
August Krogh Institute, Copenhagen, Denmark

Please type or use BLOCK letters and return the form to DIS Congress Service Copenhagen A/S, Linde Allé 48, DK-2720 Vanløse, Denmark.

Participant: (Mr./Ms.)

Family name: _____ First name(s): _____

Title: _____

Full address: _____ MLV

_____

Postal code: _____ City: _____ Country: _____

Telephone: _____ Telefax: _____ Telex: _____

ACCOMPANYING PERSON: (Ms./Mr.)

Family name: _____ First name(s): _____

Date of arrival: _____ 1991. Date of departure: _____ 1991.

	No.of Pers.	FEES (all in Danish Kroner - DKK)	DKK	DKK
02	1	Participant until April 1, 1991	500	
03	or 1	Participant after April 1, 1991	700	
04	1	Student participant until April 1, 1991	100	
05	or 1	Student participant after April 1, 1991	150	
10		Accompanying person(s)	0	
		Hotel deposit (Not for Youth Hostel)	1.000	
		SOCIAL PROGRAMME/TOURS		
01		Festival Dinner, July 5 - per participant	400	
02		Mid-Symposium Excursion, July 3 - per participant	200	
		(1030000)	Total DKK	

I wish to present a

paper ☐ 50, short communication ☐ 51, poster 1 m^2 ☐ 52, poster 2 m^2 ☐ 53

with the following title: _____

_____

I wish to participate in the discussion on deep-sea mining impact: ☐ 54

I wish to participate in the post-symposium workshop July 6-7 on:

Mega- etc. fauna ☐ 60, Nano- etc. fauna ☐ 61, Organic constituents ☐ 62

Further proposals : _____

For hotel reservation and payment please turn to the next page.

PAYMENT

All payments must be made in Danish Kroner (DKK) only to the order of 6th Deep-Sea Symposium 1991, c/o DIS Congress Service Copenhagen A/S. No personal cheques are accepted. No registration or room reservation can be confirmed until DIS Congress Service Copenhagen A/S has received your payment

☐ The TOTAL amount is enclosed by banker's cheque/draft drawn on a Danish Bank.

☐ The TOTAL amount has been transferred to account No. 3112-00418-1 (Deep-Sea) in Den Danske Bank, Nytorv 7, 1450 Copenhagen K, Denmark (Not applicable for payments made in Denmark)

Please remember to state NAME og Deep-Sea Symposium 91 on all payments.

HOTEL ACCOMMODATION

Date of arrival: _____ 1991. Date of departure: _____ 1991.

Hotel	Single room DKK / night	No. of rooms	Double room DKK / night	No. of rooms
Hotel Triton	900		1000	
Hotel Absalon	735		900	
Hotel Ibsen	330		440	

The price per night includes service charge, tax and breakfast buffet.
The paid deposit will be deducted from the final hotel bill.

In case of cancellation of room reservation, an administration fee of DKK 250,- will be charged.

For Youth Hostel Accommodation please contact Copenhagen Youth Hostel direct:
Tlph.: + 45 32 52 29 08 - Fax: + 45 32 52 27 08.

I am arranging for my own accommodation in Copenhagen: ☐

My address will be: _____

_____

Special wishes: _____

_____

Return this application form together with your payment to:

6th Deep-Sea Biology Symposium
c/o DIS Congress Service Copenhagen A/S
Linde Allé 48
DK-2720 Vanløse, Denmark

Dato: _____ Signature: _____

Please remember to take a copy of this document for your own record.

Mining Code. These international regulations will include directives on related environmental investigations as a safeguard for assumed impacts from industrial activities.

Several concepts have been developed for impact evaluations:

- Presite surveys
- Preservational Reference Areas (PRA) and Impact Reference Areas (IRA)
- Monitoring of Pilot Mining Operations
- Monitoring of Commercial Mining.

Important questions on these issues are:

- What research should be conducted for impact evaluation?
- What are reasonable efforts for sampling and data evaluation?

No experience is available on these matters for deep-sea environments. Currently we are involved with these problems and suggest a discussion of these topics at the Symposium in Copenhagen.

Some background materials will be prepared for this discussion and will be transmitted to those who intend to participate. Anyone who is interested should indicate this on the enclosed application form in the appropriate place.

Hjalmar Thiel · Eric Foell

WORKSHOP ON BENTHOS METHODS

Copenhagen, 6 and 7 July, 1991.

During the last years a large international research program developed: JGOFS (Joint Global Ocean Flux Study). In Deep-Sea Newsletter 15 we drew your attention to this program and emphasized participation of deep-sea biologists (planktologists and benthologists, both including microbiologists). In 1989, the JGOFS Pilot Study was successfully conducted along the 20th meridian in the NE Atlantic. The steering committee and other groups discuss JGOFS main study for the coming years.

Other programs are under discussion and development, pertaining to environmental risk assessments from deep-sea mining, specifically from the mining of manganese nodules in the Pacific and the Indian Oceans. Whereas these programs are predominantly planned as national projects, all participants are aware of the necessity of comparability between data sets, i.e. of international cooperation to achieve optimum efficiency.

In benthos research comparability is not guaranteed by the many different methods in use today, and therefore we propose to conduct a

Workshop on Benthos Methods
immediately following the Symposium on Deep-Sea Biology
on 6 and 7 July, 1991.

For efficient discussions we suggest to split the workshop into diferent working groups, and we propose three chairpersons:

- Mega-, macro- and meiofauna	Gerd Schiever
- Nano- and microorganisms	Karin Lochte
- Organic sediment bound constituents	Olaf Pfannkuche

The working groups are asked to aim at a draft version of recommendations for future deep-sea work.

We hope for broad participation in the standardization workshop and would like to choose co-chairpersons between those indicating their interest in one of the working groups.

Discussing the workshop with several colleagues, the question was raised, whether different animal groups, abundant or rare ones, would need specific consideration. Further proposals may lead to other working groups.

Please indicate in the symposium questionnaire at the respective place your interest in participation in one of the working groups. We are also interested in receiving additional proposals. Your cooperation will be appreciated.

We shall prepare the workshop by sending information and proposals for the standardization of methods in due time before the symposium. For this we will take other international agreements on methods into account, e.g. those of the Baltic Marine Biologists.

Hjalmar Thiel *et al.*

EVIDENCE FOR THE BIOLOGICAL PUMP INVOLVING ACTIVE TRANSPORT

During *Discovery* cruise 191 we found good evidence that active transport probably plays a significant role in the sedimentation of organic carbon to the deep ocean. The cruise was a component of the three month-long Lagrangian experiment involving two ships, which was the main exercise for the year under the UK's BOFS programme (Biogeochemical Ocean Flux Study). The aim was to survey a large area in the vicinity of 50°N using the undulator SeaSoar in pre-Spring Bloom conditions, mark an eddy with a flotilla of satellite-tracked floats, and then follow the events of the bloom as it developed. The experiment was not entirely successful as the flotilla of floats deployed within 10 km of each other finished up splattered over hundreds of thousands of square kilometres. However, we were following the events around a central buoy, and for once the timing of the experiment was just right and the weather was superb.

On cruise 191, the ship arrived on site just as the bloom was reaching its peak. Photographic profiles showed large concentrations of marine snow in the surface 300 m. These aggregations were sampled, using a novel 1001 water sampler, and shown to be rich in picoplankton, Cyanobacteria and tintinnids. There was no sign of a salp swarm and there was no obvious source for these 1-3 mm aggregates other than the small medusan *Aglantha* which occurred in large numbers in the wind-mixed layer.

The dominant micronekton species was *Themisto*. It reached abundances of 1 per 2.5 m^3 and was migrating between 300-400 m and the wind-mixed layer. Examination of its gut contents and its faecal pellets showed that it was full of Cyanobacteria. Cyanobacteria had been shown to be resistant to digestion by salps and to be good indicators of rapidly transported organic material by our German colleagues in 1988. Laboratory experiments showed that the amphipod fed readily on the aggregates, and that the gut residence time was several hours. We are still only at a preliminary stage of working up the material and the data, but it is already clear that the amount of material the amphipods would have been transporting was of the same order as the sediment trap flux. Add to this "gut" flux the respiratory flux and any predation occurring at depth, then the amphipods were playing quite a part in the draw down of dissolved carbon dioxide in the surface waters.

Of course the amphipods were not the only species migrating. There were strong migrations by euphausiids, fishes like *Benthosema* and *Argyropelecus*, and by the pteropod *Cymbulium*, as well as by the macroplanktonic groups. Estimates of the vertical movement of micronekton in and out of the surface 100 m each night work out at around $4 g.m^{-2}$. The movement of macroplankton is still to be evaluated, but previous studies suggest that it will be at least double the micronekton flux. I hope I do not seem unduly prejudiced if I suggest that these data imply that active biological transport just cannot be ignored in the study of fluxes in the deep ocean.

Martin Angel
I.O.S., Wormley, Surrey, U.K.

FOSSIL HYDROTHERMAL VENT FAUNA IN DEVONIAN SULFIDE DEPOSITS OF THE URALIAN OPHIOLITES

The discovery, predicted by the theory of plate tectonics, of deep-sea hot springs in the middle oceanic ridge crests and cold seeps of the subduction areas, together with associated but previously unknown oases of life, of a unique character, have substantially altered our perception of the energy sources which stimulate the global biomachinery of the biosphere.

The sun is no longer considered the only source of heat energy capable of supporting the creation of the primary bioproduction. An influx of heat from beneath the earth's crust has been shown to be an additional and perhaps not negligible source of energy, whole role in the evolution of life and economy of the oceanic ecosystem in particular must be evaluated.

It is thus not unreasonable to regard the ophiolite formations on land as a geological record in which the hydrothermal, physicochemical and biotic events have been written by the oceanic natural history from time immemorial.

Being very impressed by this intriguing idea, we have long been trying to find some remains of fossilized organisms in ophiolites, but until quite recently without success.

Meanwhile the first, spectacular finds have been made by Hayman, Koski and Sinclair (Hayman & Koski 1983, 1985; Hayman & Sinclair 1984) in Cretaceous ophiolite rocks of Oman and Cyprus. These were the remains of tube worms resembling the extant vestimentiferans from hydrothermal communities of the East Pacific Rise and some other sites. Soon after that Banks (1985) discovered the same kinds of fossils in Ireland.

A couple a years ago we had the good fortune to find very well preserved assemblages of the fossilized remains of tube worms (vestimentiferans), vesicomyide bivalves and alvinellid polychaetes from the Uralian sulfide ophiolite deposits of the Soviet Union (Fig. 1). Sulfide ore deposits with rather numerous fossilized organic remains in them have been known in the Uralian ophiolite fields for a long time (see Kuznetsov *et al.* 1988). However, until quite recently the fossils have not been identified and properly documented.

We have found the tube-worm fossils in thick and bushy aggregations with tubes very much like those of the extant hydrothermal vestimentiferans *Tevnia, Oasisia* and *Ridgeia* (Fig. 1A). If our measurements are correct, the tubes were as long as about 30-35 cm, their cross sections having been 0.8-1.0 cm. Mineralogical analysis showed the fossil tubes to consist mainly of rhomboidal colloform pyrite and sphalerite. The same mineralogical composition is found in the sulfides which embody these fossilized vestimentiferans.

As for vesicomyid-like bivalves, their shell morphology, size and appearance (Fig. 1B) are very similar to those of extant species of *Calyptogena* from both the hot vents and cold seeps (Turner & Lutz 1984, Lutz *et al.* 1985, Juniper & Sibuet 1987, Sibuet et al. 1988).

The ophiolites in question are reasonably well dated to middle Devonian, i.e., 380 my ago, substantial evidence of the validity of dating resulting from the brachiopod fauna analysis.

Paleoreconstructions recently made by the Soviet plate tectonists (Zonenshain & Matveenkov 1984) clearly indicate that the Ural area had been covered by the Devonian oceanic waters for some considerable time. There was a back-arc spreading centre situated between the two long (= 1000 km) chains of underwater volcanoes, separated by a distance of some 900 km.

The spreading zone ran along the middle part of the area between the chains at depths a good deal below 2,500 m, or very much below the compensation level. The rate of spreading has been calculated to be about 6 cm/year, that is, very close to that in the Idzu-Mariana, Tonga-Kermadec,

and some other areas of the present ocean-continent transitional zone. Numerous hydrothermal vents were scattered over the zone. The temperature of solutions emitted from them was determined to have been as high as 220-300°C. It is clear from both mineralogical and physicochemical analyses that the conditions of fossilization of the near-smoker benthic communities at the Devonian Ural Ocean were very much similar to those in the hot springs both in Cretacious and the present-day oceans (Hayman & Koski 1985).

Our impression after consideration of all available data on Uralian ophiolites and the faunal remains investigations is that the hydrothermal communities of the Devonian spreading areas had to be as rich and abundant as the communities from the present day hydrothermal vents. There is no doubt that they, too, had mainly been based upon a bacterial chemosynthesis as a primary source of food and energy in the food chain of the community metabolism.

Like their present-day descendants, some inhabitants of the Devonian hydrothermal communities probably must have had either substantially or completely reduced digestive systems because of their having been adapted to rely upon the metabolic products produced by the symbiotic autochemolithotrophic bacteria inhabiting parts of their own bodies. Generally speaking, it might not be unreasonable to suggest that the trophic structure of the hydrothermal communities in the Devonian period were principally similar to those of the present-day hydrothermal communities, with their bacterial symbiotrophs as a dominant trophic group in the community structure.

Our finds of hydrothermal fauna remains in the sulfide deposits (Ophiolites) of the Ural are the oldest known finds of this kind (250 my older than those from Oman); they are opening the door to an intriguing "department" of "the natural chronical library".

A.P. Kuznetsov, V.V. Maslennikov, V.V. Zaikov, L.P. Zonenshain

References

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Hayman, R.M. & R. Koski 1983: Fossils of hydrothermal vent worms found in Cretaceous sulfide deposits of the Samail ophiolite, Oman. - FOS, Transactions American Geophysical Union *64*: 725.

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Juniper, S.K. & M. Sibuet 1987: Cold seep benthic communities in Japan subduction zones: spatial organization, trophic strategies and evidence for temporal evolution. - Marine Ecology, Progress Series *40*: 115-126.

Kuznetsov, A.P., V.V. Maslennikov, V.V. Zaikov & V.A. Sobetskii 1988: Fossil fauna in the sulfide hydrothermal hills from the middle Devonian paleoocean of the Ural area. - Proceedings of the Acad. Sci. USSR *303*, 6: 1477-1481.

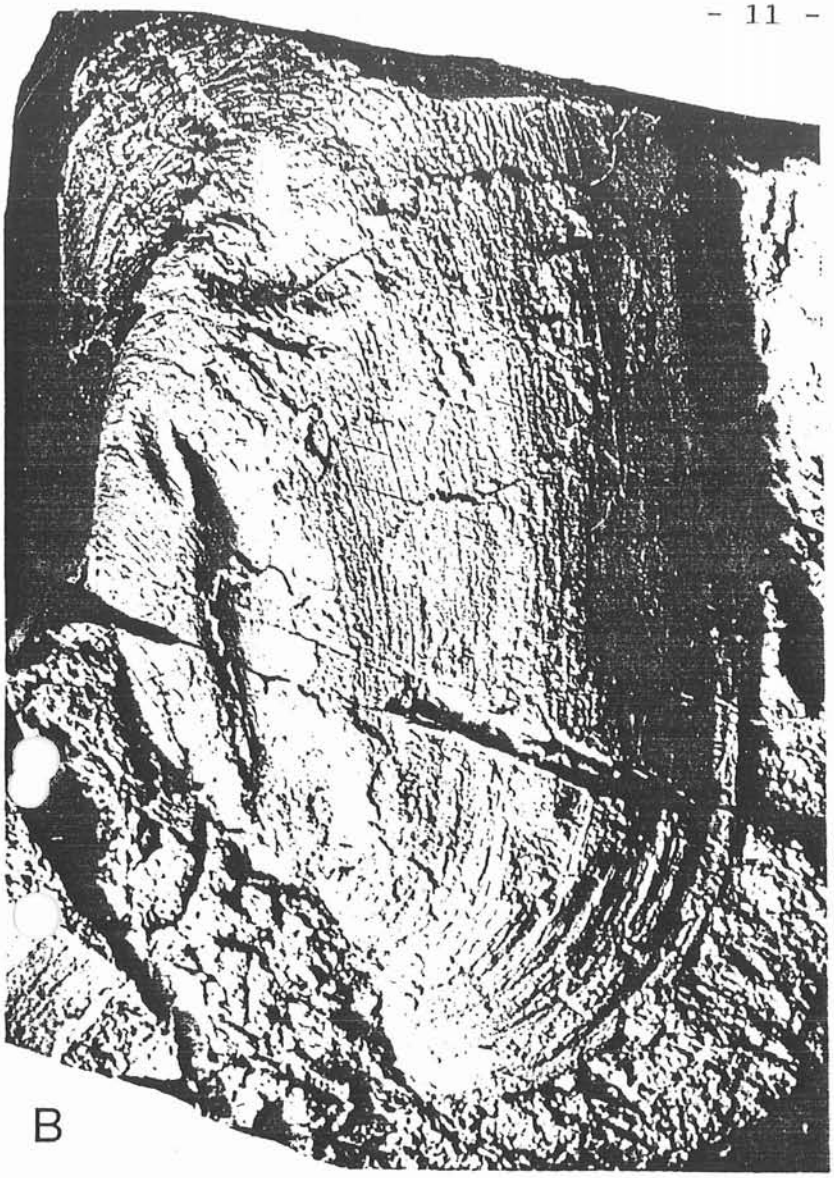
Lutz, R.A., L.W. Fritz & O.C. Rhoads 1985: Molluscan growth of deep-sea hydrothermal vents. - Bulletin Biological Society of Washington *6*: 199-210.

Turner, R.D. & R.A. Lutz 1984: Growth and distribution of mollusks at deep-sea vents and seeps. - Oceanus *27*, 3: 55-62.

Zonenshain, L.P. & V.V. Matveenkov (eds.) 1984: Evolution of the Ural Paleoocean. Acad. Sci. USSR, P.P.Shirshov Inst. of Oceanol., Moscow. 163 pp.

Fig. 1 (next page). Pyritic and sphaleritic fossil hydrothermal fauna from the Sibai pirite ore deposit (the southern Ural). - A, vestimentiferan tubes resembling those of the extant *Tevnia*, *Oasisia* or *Ridgeia*; B, Bivalvia, a representative of the probable ancestor group of Vesicomyidae; C, tubes of polychaetes related to the present family of Alvinellidae.

Fig. 1



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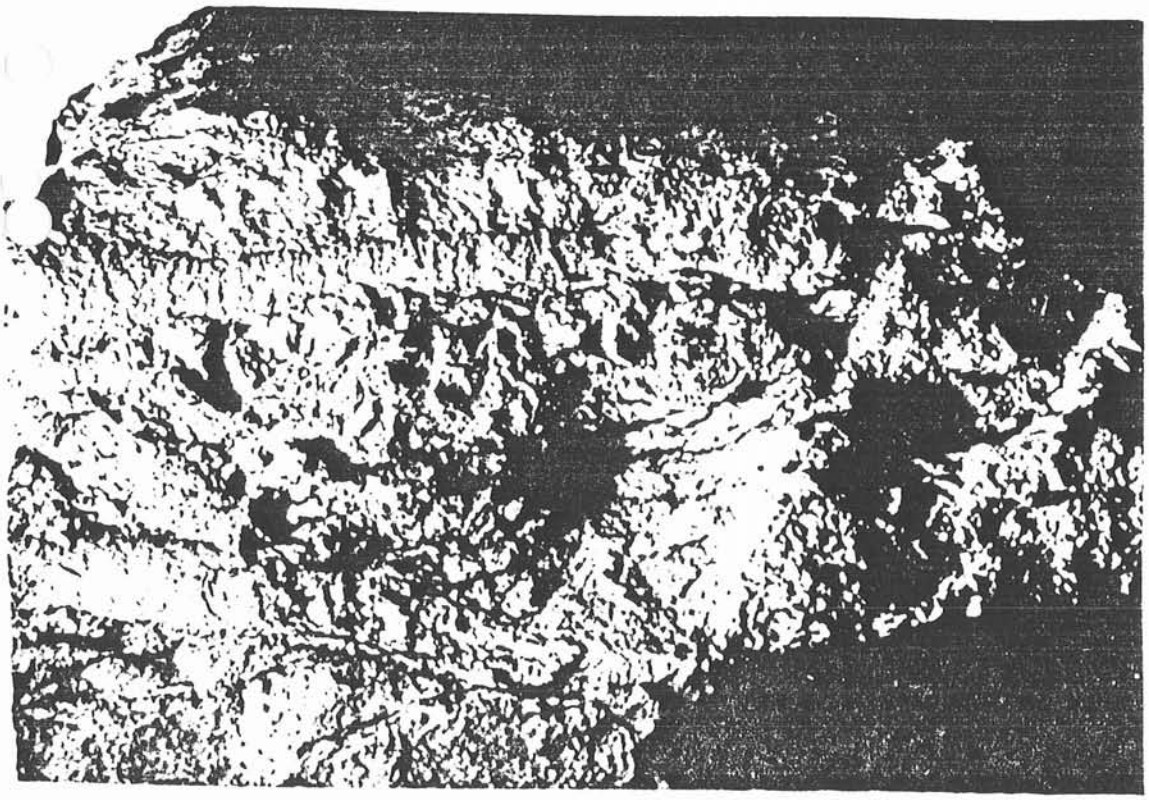
C



A

HYDROTHERMAL VENTS IN LAKE BAIKAL

During six weeks in June and July 1990 Russian and United States scientists, in conjunction with a team from the National Geographic Society, discovered hydrothermal vents in Lake Baikal, 630 km long and the oldest and deepest lake in the world. The team was on board the USSR Academy of Sciences Research Vessel *Vereshchagin*, which was outfitted with 3.5 and 12 kHZ echosounders, a deep-towed camera system, and a CTD.

The vents were found on a sediment floor at a depth of 440 m in Frolikha Bay in the northeastern corner of Lake Baikal, at the foot of an E-W trending fault. The center of the vent field is covered by a near-continuous bacterial mat, consisting of long, thick, white strands in a matrix of translucent white material. Temperatures of the sediment beneath the bacterial mat were greater than 16°C, while the ambient temperature was 3.47°C. The most obvious large organism in the region is an encrusting white sponge found on small rounded cobbles near the periphery of the vent field. Coiled gastropods and whitish-translucent shrimp are found among the sponges and on the sediment at the edge of the bacterial mat. These organisms were not seen in areas removed from the vent field. Patches of dark gray sediment and patches of sediment "pock-marked" by thousands of small holes (burrows?) are also seen at the edge of the vent field.

Future studies of the vents and local heat flow may help resolve a debate about why the Asian continent is splitting along the giant rift that created the deep lake probably about 25 million years ago. Many researchers view the rifting as a passive process driven by tectonic stress from the distant collision between India and Asia. But some think the Baikal rift results from a more active process, in which hot material rising from Earth's mantle forces the Asian plate to crack apart.

The fauna of Lake Baikal is unique in its high degree of endemism and in the number of species that have affinities to salt-water forms, leading many to believe that the lake was once connected to the oceans. How the taxa inhabiting the Lake Baikal hydrothermal vents fit into the "biogeographical arena" of vent communities awaits more detailed investigations, and promises to provide interesting clues to the evolutionary history and subsequent path of these intriguing communities, as well as of Lake Baikal itself.

Barbara Hecker & Kathleen Crane
Lamont-Doherty Geological Observatory
Palisades
NY 10964, U.S.A.

Vladmir Golubev
Institute of the Earths Crust Ul
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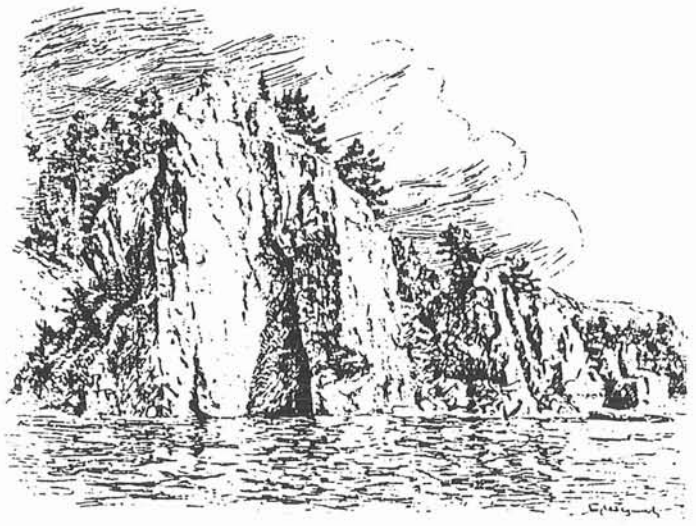
664033 Irkutsk, U.S.S.R.



IOSDL DISCOVERY CRUISE 194

The ultimate object of the present IOSDL benthic programme is to develop the ability to detect, describe and predict changes in deep-sea communities resulting from natural and anthropogenic changes. To achieve this end we will compare two sites, a northern one under a water column characterized by deep winter mixing, high productivity and strong seasonality in the supply of organic matter to the seafloor, and a southern one with shallow winter mixing, lower productivity and much less variability in the seasonal flux of organic matter.

In August-September 1989 we made our first visit under the current programme to the European Community Site at 48°30'N 16°30'W. This location had been selected as our northern site, and was sampled using otter trawl, epibenthic sledge, spade box corer and multiple corer (see Deep-Sea Newsletter, no. 16: 10-11). We had earmarked 31°N 20°W for our southern site as it fulfilled our ecological criteria, was close to the location of proposed BOFS-related sediment trap investigations and was an area of interest to IOSDL geologists.

Our second cruise sailed from the UK on 4th August with three main objectives. In addition to pursuing the benthic programme, time was to be allocated to aspects of the IOSDL midwater work, and to the fish tracking experiments of Dr. Monty Priede of Aberdeen University. Collaborators in the benthic programme who sailed with us included Dr. Dai Roberts (Queens University Belfast), Dr. George Wolff (University of Liverpool) and Stephen King (University of Southampton).

Since the initial selection of 31°N 20°W as a work site, new information from IOSDL geologists suggested that much of the abyssal sea bed south and west of Madeira had been covered by turbidites, and the most recent one had occurred 200-500 years ago. As a consequence of this, we worked a series of multiple corer stations from 33°N to 28°30'N close to 21°W. Except for the station at 4600 m in an area of steep and complex topography on the Madeira Rise, all localities were covered by sediments originating from turbidite flows. As there were constraints on working south of 28°N, we returned to 31°05'N 21°10'W and established our main work station there. Sixteen days of intensive sampling in fine, hot weather resulted in the completion of almost all the programmed work before departure for Santa Cruz de Tenerife where we arrived on 2nd Sept.

Early indications suggest somewhat heterogeneous sediments with 15-40 cm of turbidite overlying Holocene pelagic ooze. Megafauna and macrofauna were sparse with larger organisms dominated by asteroids (largely *Styracaster*) and a dearth of holothurians. The fish fauna was markedly different from that one the Porcupine Abyssal Plain, but resembled that found on the Madeira Abyssal Plain. Appreciably numbers of komoki and other foraminifers were present on the surface of box cores, although numbers were lower than those found in the EC site. Perhaps most interesting of all though is that Andy Gooday has found fluff-like material on multiple corer samples. Detritus, albeit sparse, contained diatoms, copepod exuviae and cyanobacteria - and feeding foraminifers.

Mike Thurston
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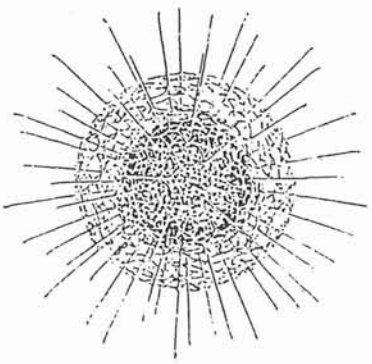
Deacon Laboratory, Wormley



THE DEEP-SEA ORANGE ROUGHY FISHERY IN THE GREAT AUSTRALIAN BIGHT

Orange roughy (*Hoplostethus atlanticus*: Trachichthyidae), along with other slope fin-fish resources, e.g. blue grenadier (*Macruronus novaezelandiae*), are heralded by industry as the hopeful new frontier in trawl fisheries. Orange roughy, a deep-sea berycoid species, is a particularly popular restaurant fish, producing very white, firm, boneless fillets. Although it is a widespread species, inhabiting slope waters (of 700-1800 m depth) of the northeast Atlantic, the Indian Ocean, the southwest Pacific and Southern Oceans, commercial fisheries occur only in the southern hemisphere. The largest commercial fishery takes place in New Zealand waters where it has been exploited since 1979 and until recently was their major fisheries resource. In Australian waters, it gained commercial importance in the mid-1980s. Today, orange roughy has grown to be Australia's major southern demersal trawl fin-fish resource, both in terms of quantity taken and value, and it is currently under a regime of management controls, such as seasonal closures and Total Allowable Catches.

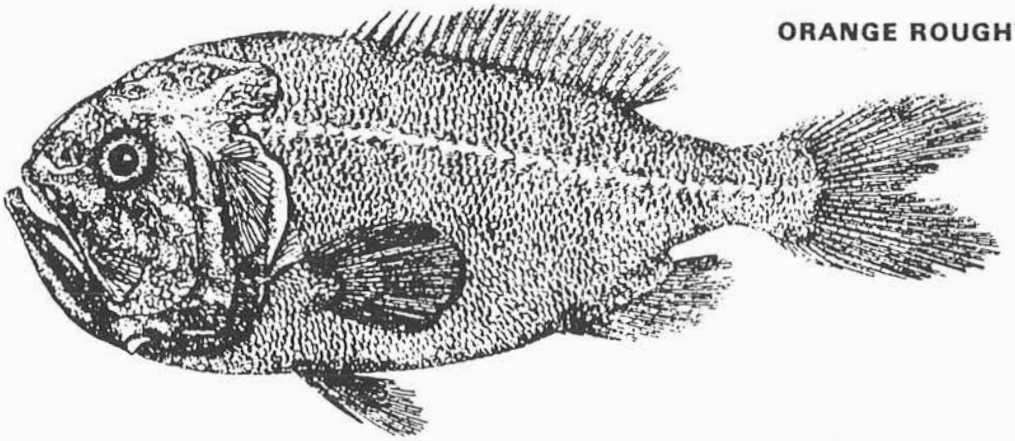
The Great Australian Bight trawl fishery

Waters of the Great Australian Bight (GAB) trawl fishery lie adjacent to the southern Australian coastline and include a large expanse of the Southern Ocean (from 138°'E to 115°E). One aim of a 4-year development plan has been to foster exploratory fishing and an assessment of the commercial viability of the deeper regions of the fishery, i.e. from 700 to 1200 m.

Within the GAB, orange roughy were first fished in 1987, when a non-spawning aggregation, or 'hot-spot', was discovered at 137°E. In about 6 months six vessels fished here some 3000 tons. The next hot-spot was discovered in 1989 at 133°E, where fishing lasted only 12 weeks, with some 2500 tons taken by 30 vessels. At another hot-spot from 1989 further west in the GAB, fishing lasted for only a few weeks, with about 1000 tons taken. Intense fishing pressure on these relatively small aggregations may apparently lead to the premature dispersal of the fish. Recently, August 1990, spawning roughy have been found for the first time in the GAB.

Aggregating behaviour

Orange roughy typically show two main phases of distribution: 1) a dispersed phase with relatively low densities and 2) an aggregated phase with dense aggregations which consist mainly of mature fish. This latter phase renders the roughy susceptible to target fishing by demersal trawlers. There also appear to be two types of aggregations: 1) spawning, which are typically large (these form the basis of the New Zealand fishery), and 2) non-spawning, which are generally much smaller in terms of fish tonnage. The Australian roughy fishery was based on these smaller,



25.2 *Hoplostethus atlanticus* Collett, 1889 [after Woods and Sonoda, 1973]

non-spawning aggregations until 1988, when the first major spawning aggregation was discovered off the east coast of Tasmania. Spawning aggregations recur and are predictable in terms of time and location, whereas non-spawning aggregations tend to be found and fished only once. The reasons why these non-spawning aggregations form are still not understood; however, they are often dominated by one sex. Maybe they are 'feeding' aggregations, but dietary studies tend not to support this assumption.

Orange roughy biology

Commercially caught roughy typically consist of mature fish in the size range 30 to 45 cm, with the modal peak at about 37 cm. Females constitute the highest proportion of the largest fish. In the GAB, the hotspots have been male dominated (63-70%), although the recently found aggregation of spawning fish had a sex ratio of 1:1. Feeding studies in the GAB have found that they are opportunistic feeders, feeding on a wide range of benthic and pelagic fish, squid and crustaceans. It is a currently held view that orange roughy are a long-lived (50+ years), slow growing fish of relatively low fecundity. In this respect, sustainable yields are likely to be of a low order. Accurate assessment of this highly aggregated, deep-sea species renders many of the more traditional approaches inapplicable. For example tagging is impractical. Along with egg surveys, acoustic and photographic techniques appear to offer the best course in tackling such assessment problems.

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PROGRESS IN DEEP-SEA RESEARCH AT THE BOTTOM FAUNA LABORATORY

based on the scientific ideas of Academician Lev A. Zenkewitch 1889-1970: A Tribute on the Occasion of the Centenary of his Birth

The main area of operations for L.A. Zenkevitch was always the Benthos Laboratory at the P.P. Shirshov Institute of Oceanology. Here he had the perfect testing ground for the planning and realization of his scientific projects. Not only was it here that he himself became an Academician, but it is also in this same Institute that his students and followers, who have inherited his scientific legacy, continue their work today.

An interesting point is that among the various fields of study included in the Laboratory's research are some which Lev Zenkevitch himself could not have foreseen twenty years ago. For example, the presence of unusual bottom biocenoses near hydrothermal vents which are visible from manned submersibles, and also underwater landscapes which have yet to be included in an adequate system of landscape classification. However, any examination of the evolution of his ideas, as re-

counted in the writings of today's deep-sea hydrobiologists, clearly demonstrates that even the most recent studies have their origin in trends initiated by Zenkevitch himself.

Lev Zenkevitch considered faunistics and systematics the foundation for deep-sea research (as for every other branch of hydrobiological work). The scientists at our laboratory continue to follow his example in their research to this day, summarising data on deep-sea Echinoidea, Brachiopoda, certain groups of Mollusca, Crustacea and Coelentera from all over the world. The giant Protozoa (Xenophyophoria and Komokiacea) have also been the subject of work by the scientists at our laboratory. In 1989 G.M. Belyaev summarised all the recent data on the deepest dwellers of the world's oceans in his unique book on the fauna of the deep-sea trenches.

The main concepts of L.A. Zenkevitch as regards the biological structure of the world's oceans are based on quantitative data. Thus the quantitative aspect is shown in the maps of benthos biomass, in the biogeographical division of the ocean floor using biomass relations of macrobenthic groups with different ways of feeding.

This typological division of the world's ocean floor and the seas was established, and the results have been published in special monographs. Biogeographical and typological divisions reflect the symmetrical quality of the biological structure of the world's oceans. Recent studies during four antarctic and subantarctic voyages strongly confirmed this symmetry in ocean processes and phenomena, a symmetry which even extends to the quantitative characteristics in the distribution of benthos in the ultra-abyssal or hadal zone. Zenkevitch's concept underwent further development as new elements emerged during the clarification of ideas on the asymmetry which is related to the ecology and history of ocean fauna.

The origin and routes of fauna formation (especially that of the deep sea) were a subject of particular interest to Lev Zenkevitch - in fact the mere thought of the antiquity of the deep-sea dwellers always filled him with enthusiasm. The historical aspects of bio-oceanology and the search for ancient elements in the abyss continue to be topics of paramount interest among our zoologists today, and there have been new developments in this field. It has been confirmed, for example, that ancient elements penetrate continuously to the deep sea, and that both old and recent primitive fauna coexist in these regions. The main question prompted by this knowledge is how organisms survive in the abyss during radical hydrobiological changes. It is also important to compare primary primitive elements with secondary simplified forms, a task now completed in the case of many systematic groups of invertebrates of the deep-sea bottom.

For a long time biological oceanologists knew very little about the bathyal zone (which includes slopes of continents and islands, underwater mountains and mid-oceanic ridges). L.A. Zenkevitch encouraged scientists to study bathyal depths, and grouped the numerous questions thus occasioned under the collective label, "The Bathyal Problem". Appropriately enough, this was the title he gave to his paper, published in "Rybnoje hozaystvo" ("Fishery") in 1968, following the scientific cruise of RV "Vitjaz", when some bottom-trawl catches from the slopes of the Kurile-Kamchatka Trench proved remarkably rich in fish.

Zenkevitch's contention that the bathyal zone would repay more detailed exploration has been repeatedly confirmed by numerous subsequent expeditions, and this branch of study is now flourishing in all the laboratories of our institute. The Bottom Fauna Laboratory prepared three special volumes on the theme, and these studies are of considerable theoretical and practical significance. For a long time it was impossible to combine deep-sea and shallow-water zoogeographical divisions, but when the fauna of the bathyal zone is analysed it is seen that the transition from the environment of the continental shelves to that of the ocean floor occurs in the bathyal zone itself.

Zenkevitch's most cherished dream was to study the biochemical processes in the ocean, with the accent on the ecological aspects. The section of our laboratory dealing with ecology is principally involved in the study of oceanic biocenoses through the trophic characteristics, using the data to obtain knowledge of ancient water basins. The second biochemical task is concerned with the estimation of the role of benthic invertebrates in transforming substance and energy at the water-sediment boundary. This makes it possible to link structure and functional characteristics in the ocean.

Practical application and the other benefits of theoretical science were a theme which always concerned Lev Zenkevitch greatly. In this general area we can include work towards the realisation of such current objectives as:

1) The ecological prediction of possible results after Fe-Mn nodules industrial mining.
2) The estimation of the bio-filter role of suspension feeders in the water basins, and their reaction to pollution.
3) The identification of species which indicate high productivity, especially at seamounts.
4) The discovery of new bioresources.

We should never forget that Professor Zenkevitch was a lifelong believer in the communication between nations; a worthy tradition wholeheartedly maintained by our laboratory to this day. The translation of papers and monographs; the publication of studies in other countries; remaining in contact with colleagues and centres of research round the world, these are all activities which we consider both vitally important, as well as extremely rewarding.

Science, like Life itself, is a river in full spate: amid the current of renewal and change one should forget neither the continuity of ideas, nor that the new growth of youth draws its sustenance from older roots and stems. In the Bottom Fauna Laboratory we maintain the scientific community in the same spirit in which we honour the memory of Academician Lev A. Zenkevitch. These are a firm foundation for every new generation of scientists, and it is in accordance with Russian scientific tradition: to found and maintain the centres of scientific learning.

Nina G. Vinogradova, Olga N. Zezina, Marina N. Sokolova

Main Publications of the Laboratory of the Bottom Fauna - since 1970

Monographs:

Belyaev, G.M. 1972: Hadal bottom fauna of the World Ocean. Publ. Smithson. Inst. Washington Israel Program Sci. Transl. Jerusalem. 199 pp.

Zezina, O.N. 1976: Ecology and distribution of recent brachiopods. Moscow, Nauka. 138 pp. In Russian.

Zenkevitch, L.A. 1977: Selected works. 1. Biology of the northern and southern seas of the USSR. Moscow, Nauka. 339 pp. In Russian.

- 1977: Selected works. 2. Biology of the Ocean. Moscow, Nauka. 242 pp. In Russian.

Kuznetsov, A.P. 1980: Ecology of bottom associations at the shelves of the World Ocean. Moscow, Nauka. 244 pp. In Russian.

Zezina, O.N. 1985: Recent brachiopods and problems of the bathyal zone of the Ocean. Moscow, Nauka. 248 pp. In Russian.

Birstein, J.A. 1985: Genesis of the fauna in fresh water, caves and deep sea. Moscow, Nauka. 248 pp. In Russian.

Sokolova, M.N. 1986: Feeding and trophical structure of deep-sea macrobenthos. Moscow, Nauka. 208 pp. In Russian.

Tsikhon-Lukanina, E.A. 1987: Trophology of aquatic mollusks. Moscow, Nauka. 176 pp. In Russian.

Belyaev, G.M. 1989: The deep-sea oceanic trenches and their fauna. Moscow, Nauka. 256 pp. In Russian.

Transactions of the P.P.Shirshov Institute of Oceanology. In Russian with summary, titles and tables of contents in English:

Vol.86. Fauna of the Kurile-Kamchatka Trench and its environments. English translation. Jerusalem, 1972.
88.Ecology and distribution of the sea bottom fauna and flora. Moscow, Nauka, 1970.
89.Oceanologic investigation in the Peru Current area. Moscow, Nauka, 1971.
91.Complex investigations of the continental slope in the Gulf of the Alaska region. Moscow, Nauka, 1973.
92.Fauna of the Kurile-Kamchatka Trench. Moscow, Nauka, 1971.
98.Biological investigations in the Atlantic sector of the Antarctic Ocean. Moscow, Nauka, 1974.
99.Deep-sea bottom fauna of the Pacific Ocean. Moscow, Nauka, 1976.
100.Scientific studies: Caribbean Sea, Gulf of Mexico and adjacent waters. Moscow, Nauka, 1975.
103.Biological investigations in the South Atlantic Ocean and in the region of Peru-Chile Trench. Moscow, Nauka, 1975.
108.Bottom fauna of deep-sea trenches of the ocean. Moscow, Nauka, 1977.
112.Biological investigations in the Australian-New Zealand region. Moscow, Nauka, 1978.
113.Deep-sea bottom fauna of the Subantarctic part of the Pacific Ocean. Moscow, Nauka, 1978.
115.Deep-sea bottom fauna of the Pacific Ocean. Moscow, Nauka, 1981.
117.Investigations of the deep-sea bottom fauna. Moscow, Nauka, 1982.
119.Structure, formation and ways of the distribution of the ocean bottom fauna. Moscow, Nauka, 1984.
120.Bottom fauna of the open-oceanic elevations (Northern Atlantic). Moscow, Nauka, 1985.
123.Adaptations to the deep-sea habitat. Moscow, Nauka, 1989.
124.Plankton and benthos at underwater ridges Nasca and Sala-y-Gomes. Moscow, Nauka, 1990.
126.Biological and geological investigations of the bottom of the Southern Atlantic. Moscow, Nauka, 1990.

Collection of scientific papers, published by the Institute of Oceanology. In Russian, with titles, tables of contents and summaries in English:

Bottom fauna of the U.S.S.R. adjacent seas. 1976.
Ecology of the sea shelf benthic fauna and flora. 1979.
Ecological investigations of the shelf. 1980.
Benthos of the submarine mountains Marcus-Necker and adjacent Pacific regions. 1981.
Ecology of the ocean coastal zone benthic fauna and flora. 1985.
Feeding of marine invertebrates in natural habitat. 1986.
Feeding of marine invertebrates and its significance in formation of communities. 1987.
Structural and functional researches of the marine benthos. 1988.

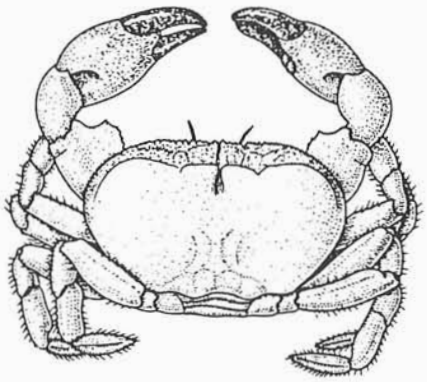
Collective monographs, in which the Laboratory took part:

Okeanologia. Biologia okeana. Biologicheskaya produktivnost okeana. Moskwa, Nauka. 1977. In Russian.
Okeanologia. Biologia okeana. Biologicheskaya struktura okeana. Moskwa, Nauka. 1977. In Russian.
Biology of the Pacific Ocean Depths. Proceedings of the XIV Pacific Science Congress (Khabarovsk, August 1979). Vladivostok, Far East Science Center. 1981. In Russian with title and summaries in English.
Research Vessel Vityaz and her Expeditions 1949-1979. Moscow, Nauka. 1983. In Russian with title and summaries in English.
Oceanology: Biology of the Ocean. Vol.2. Biological Productivity of the Ocean. Translated and reprinted by U.S. Dept. of Commerce NOAA. Woods Hole, MA. 1985. 519 pp.
Oceanobiologia, biologiczna struktura oceani, tom 1. Praca zbiorowa pod redakcja M.E. Vinogradowa. Redaktor naukowy polskiego przekladu R.Z. Klekowski. Warszawa, Panstwowe wydawnictwo naukowe. 1988. 496 pp.

NEW DEEP-SEA BIOLOGY BOOK

The publication of a general book on deep-sea biology is such a rare event that I have not hesitated to pass on to the readers John Gage's pre-publication account on his and Paul Tyler's forthcoming *oeuvre*. A review will later appear in the Newsletter.

Ed.



Paul and I have laboured on this project over the past two-and-a-bit years. We felt that our subject needs a book of this sort in order to update that by Bob Menzies *et al.*, which, of course, appeared in 1973 and is now badly out of date in many areas. We particularly felt that there are a number of new concepts (such as seasonality) and discoveries (such as the hydrothermal vents and cold seeps) that need to be assimilated into a broader canvas. We also felt that there was a need to stress the 'natural history' aspect of deep-sea biology, partly because of a wealth of new information derived from submersibles, bottom photographs, etc., and partly because 'natural history' has become undeservedly unpopular in the past in favour of more supposedly 'quantitative' approaches such as community ecology.

To emphasize the importance of the organisms themselves, we were fortunate in being offered the use of a large and impressive selection of photographs of deep-sea organisms, including time-lapse sequences, by our colleagues at the Institute of Oceanographic Sciences in Surrey, especially Tony Rice, David Billett and Richard Lampitt. We were also lucky enough to be allowed to use the beautiful artwork of Violaine Martin at IFREMER, Brest to illustrate the hydrothermal vent biota. We have also been fortunate in receiving help in this project from a great number of colleagues and friends (including our worthy Newsletter Editor) who have answered queries, provided information and data, and read whole chapters covering topics on which they are far more expert than ourselves.

The book will number 488 pages of text and figures. Its five parts are organised into 16 chapters:

Part I covers Historical Aspects (chapter 1), the *Physical Environment of the Deep-Sea* (chapter 2) and *Methods of Study of the Organisms of the Deep-Sea Floor* (chapter 3).

Part II deals with the Organisms of the Deep-Sea Benthic Boundary in two chapters, one on *The Megafauna* and the other on *Smaller Animals*.

Part III describes Patterns in Space; chapter 6 dealing with *Small-Scale Spatial Patterns*, chapter 7 with the *Abundance and Size Structure of the Deep-Sea Benthos*, chapter 8 with *The Diversity Gradient*, chapter 9 with *Depth-Related Patterns in Community Composition*, and chapter 10 addresses *Zoogeography, Speciation and the Origin of the Deep-Sea Fauna*.

Part IV looks at Processes: Patterns in Time; chapter 11 is on *Food*

Resources, Energetics and Feeding Strategies, chapter 12 on *Metabolic Processes: Microbial Ecology, and Organism and Community Respiration at the Deep-Sea Bed*, chapter 13 is on *Reproduction, Recruitment and Growth of Deep-Sea Organisms*, and chaper 14 looks at *Animal-Sediment Relations in the Deep Sea*.

Part V is entitled Parallel Systems and Anthropogenic Effects, the 2 chapters looking at *Deep-Sea Hydrothermal Vents and Cold Seeps* (chapter 15) and *Anthropogenic Impacts: Man's Effects on the Deep-Sea* (chapter 16).

It will have what we feel is a fairly complete Reference section, although it has not been possible to include every deserving paper. We have tried, however, to include as many references as possible to good reviews so that the reader can be encouraged to investigate the ever-growing and increasingly scattered literature on our subject him- or herself. We have aimed the book at senior undergraduate/postgraduate, and beginning research worker level, but we hope that the enthusiastic layman, or scientists from other disciplines won't be put off!

We hope to arrange with Cambridge University Press to have copies available for sale to participants at the Deep-Sea Symposium next year, but it should have been published a little while before then.

J.D. Gage

DISCOVERY REPORTS FOR SALE

The Discovery Reports constituted the principal results of investigations in the Antarctic and other waters in the Southern Hemisphere undertaken by the Discovery Committee during cruises of the Royal Research Ships *Discovery, Discovery II and William Scoresby* between 1925 and 1951.

The Discovery Committee acted under the Secretary of State for the Colonies on behalf of the Government of the Dependencies of the Falkland Islands from 1924 to 1949. In 1949 the National Institute of Oceanography was set up with wider terms of reference, and the staff collections and data of the Discovery Committee constituted the foundation of its work in the biological field . Publication of Discovery Reports was continued by the Institute (now Institute of Oceanographic Sciences Deacon Laboratory) in order to accommodate major papers on Southern Ocean material in the Discovery Collections.

The report series, now terminated, was published between 1929 and 1980 and consists of 187 papers in 37 volumes. Separate parts were issued in the order in which they were submitted, so that division into volumes is independent of subject matter. The papers cover a wide variety of topics including biology and ecology, hydrology and hydrography, geography and geology, fish and phytoplankton as well as complete and detailed station lists.

IOSDL will become part of a new Centre for Deep Sea Oceanography at Southampton in 1993 and we have a requirement to reduce the stock holding of the series. Complete sets are no longer available but copies of many parts are now being offered for sale at prices much below current market values.

If any institution or individual is interested in acquiring copies, please write to Pauline Simpson, IOSDL, Wormley, Godalming GU8 5UB, Surrey, UK, enclosing a self addressed envelope, for a list of what is available.

THE DEADLINE FOR THE NEXT ISSUE OF D.-S.N. IS 1st APRIL 1991

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