Deep-sea ecosystems (VME) of the Emperor Chain

Preliminary results of the marine expeditions organized by the National Scientific Center of Marine Biology, FEB RAS, Russia 2019-2021

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Background

Numerous useful mineral resources are associated with seamounts - ferromanganese nodules, cobalt-manganese crusts and phosphorites, which are attracting more and more due to the possibility of soon depletion of land mineral resources.

Seamounts, including the Emperor Chain - areas of high biological productivity of benthic and pelagic communities, including commercial accumulations of bioresources.

The Emperor Chain stays in the focus of the North Pacific Fishery Commission (NPFC) and Convention for the sustainable fishery and conservation in Pacific high seas.

Seamounts are important from a biogeographic point of view since they are associated with diverse communities of bottom and pelagic fauna.

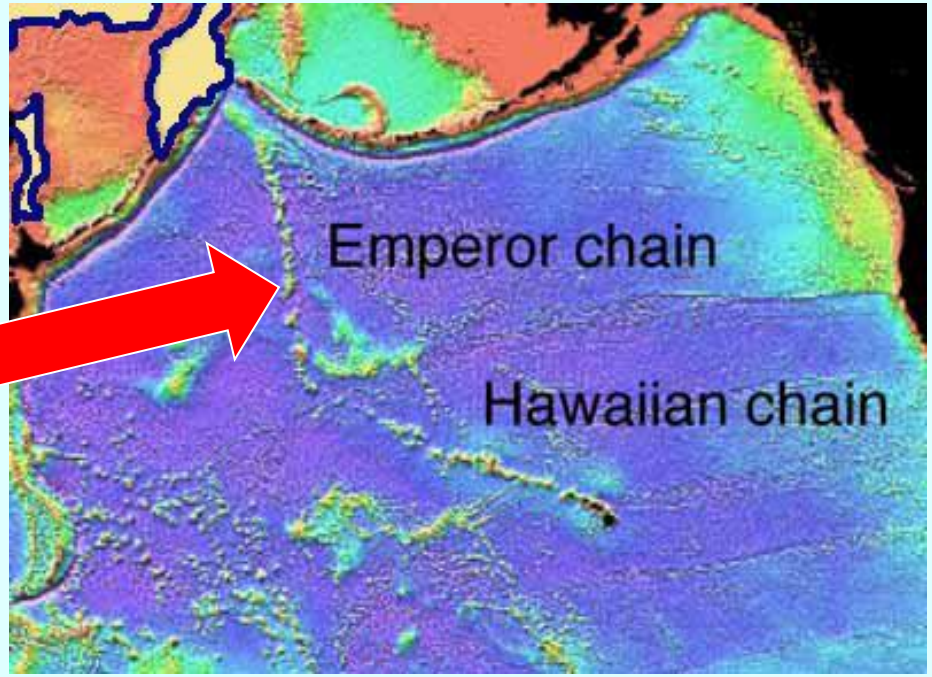
Urgent task - to develop scientifically based approaches to reasonable exploitation and conservation of biological resources of the Emperor Chain.

Goals

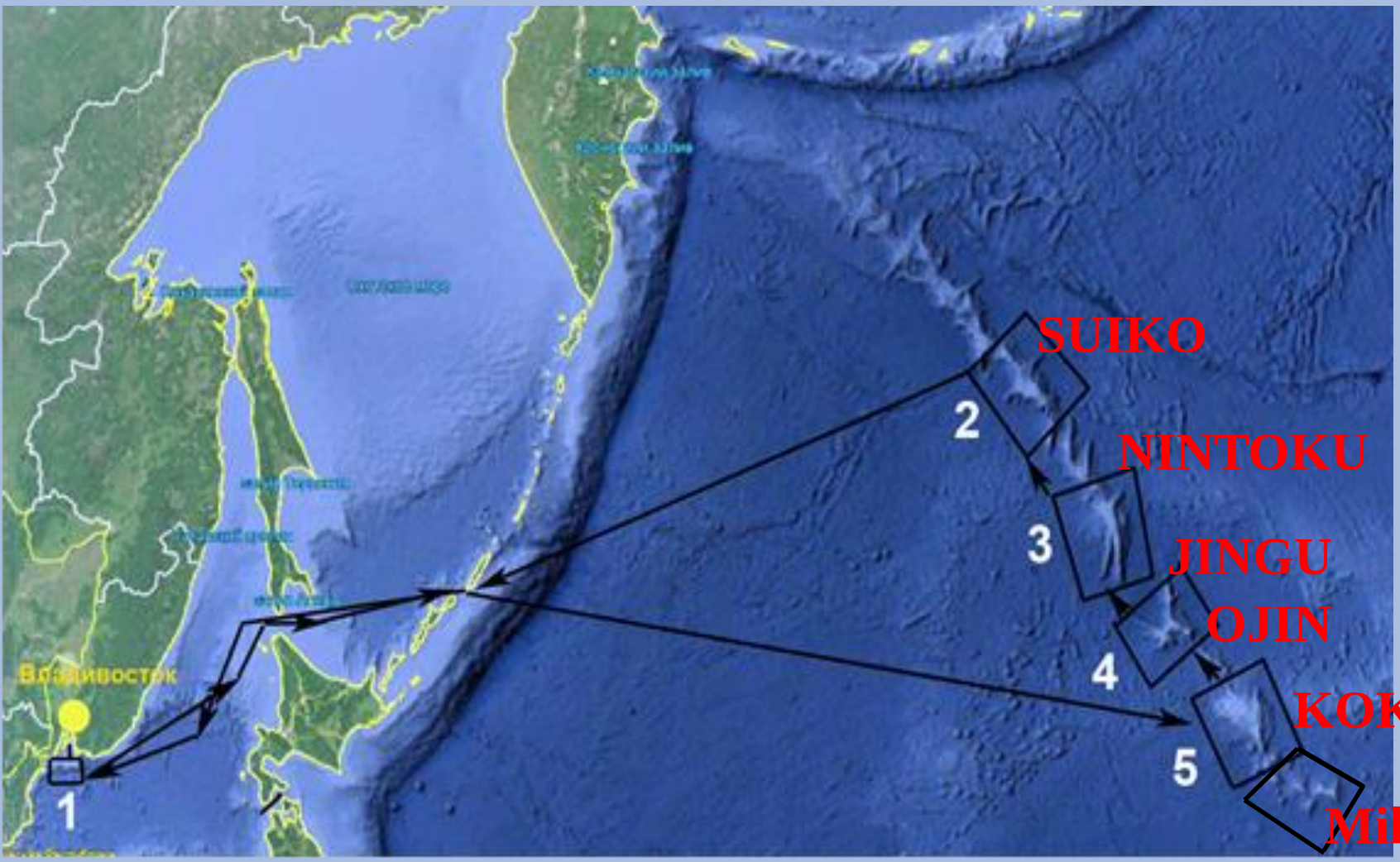
- **- A comprehensive study of the ecosystems using both standard methods and deep-sea equipment (ROV Comanche 18) included:**
- - Identification of the composition, structure and distribution of living bottom and planktonic communities;
- - Biological sampling according to the methodology, which ensures the accounting of all size groups of the bottom fauna (from the simplest forms to megabenthos according to the international standard for bio-resource center "Marine Biobank");
- - Determination of the conditions for the formation of ferromanganese and cobalt-manganese crusts for the forecast of similar mineralization at the bottom risings of the World Ocean;
- - Biogeochemical studies of hydrocarbons in the water mass and bottom sediments of the study area;
- - Hydrological (hydrochemical) studies of water masses;
- - Geology/landscape studies of bottom sediments of the study area;

Other Participants:

Far East Geology Institute FEB Russian Academy of Sciences (RAS) ;
Pacific Institute of Geography FEB RAS
Pacific Oceanology Institute FEB RAS;
V. Vernadsky Geochemistry Institute RAS;
P. Shirshov Oceanology Institute RAS;
Institute of Marine Technology FEB RAS;
V. Sobolev Geology Institute RAS;
Pacific Fishery Center;
Far East Federal University;

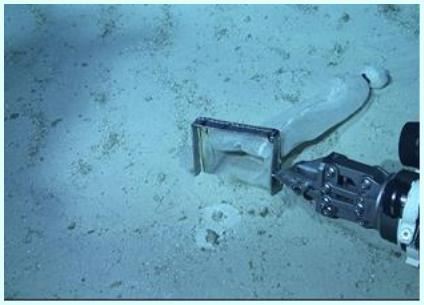


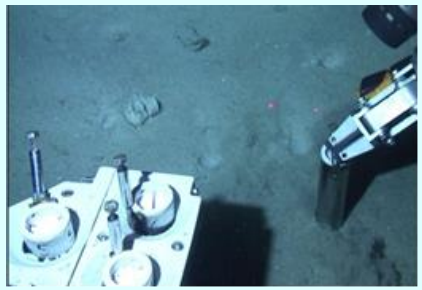
2019-2021

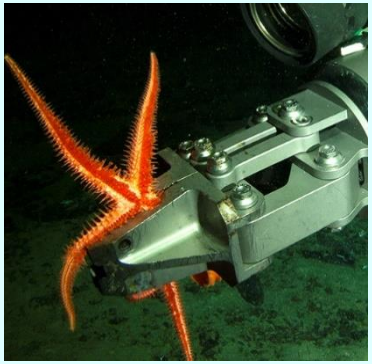


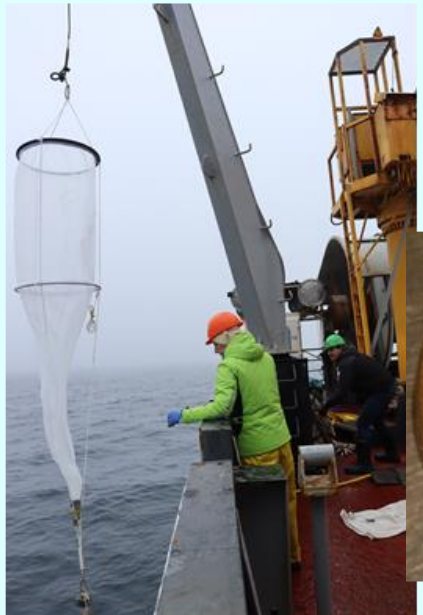
Main equipment:

- ROV Comanche 18 (sampling + video/photo)
- Automatic Niskins "Rosette"
- Plankton nets
- Geology dredges and gravity tubes
- Mineral-processing machines
- CTD zonds
- Spectrophometers
- Meteorology complex Davis VantagePro2
- Gas chromatographs
- Plasma-ionic detectors for methane and other hydrocarbons
- Sterile microbiology laboratory
- Zoology, geology laboratories, etc

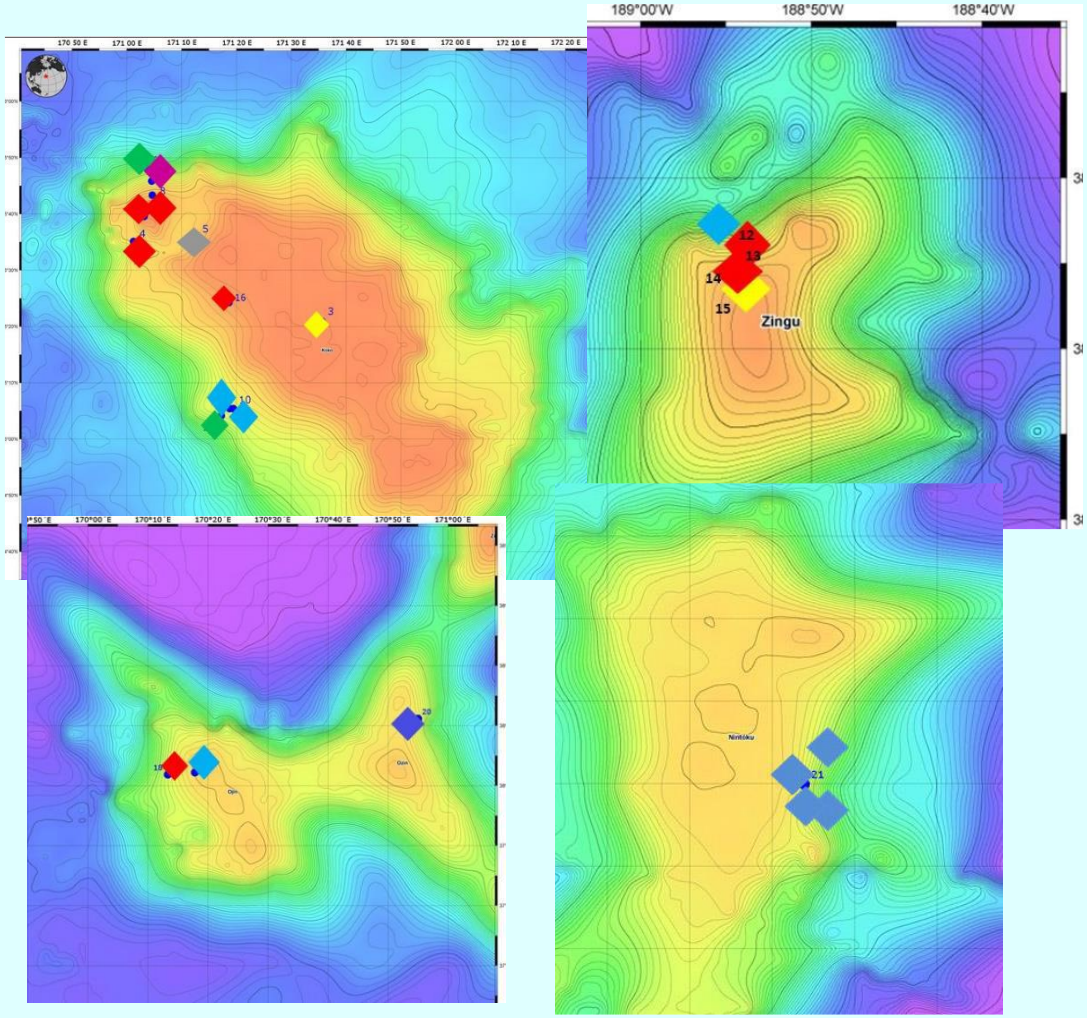




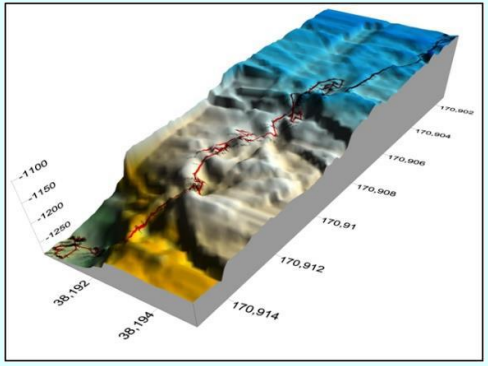


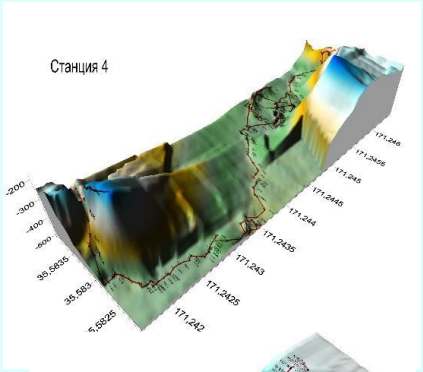


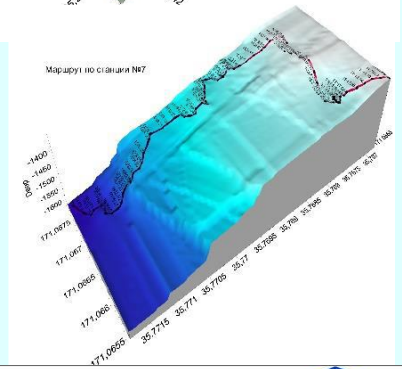
Some stations for the collection of bottom organisms and geological samples

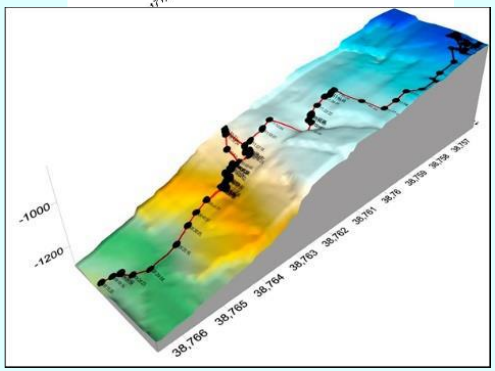


- <u>33 dives of the ROV Comanche 18:</u>
- video filming, sampling, depth
- from 2182 to 338 m;
- 158 sampling stations, 979 individual animal samples.
- 2789 5MP photos and 96 hours of video recordings in Full HD format.
- <u>To study the micro- and macrobiota, and meiobenthos</u>
- 39 sediment samples, 65 sponge samples, 91 samples
- corals, 78 echinoderms.
- Unique biosamples conserved for
- deposition in the Center for Collective Use "Marine Biobank".









Video recording of the geological structures at various depths allowed understanding the change of bottom characters to 2357 m.

Using a ROV manipulator TNLA and tubular sampler, we selected 159 geological samples and 124 sediment samples.

In the RV field laboratory sawing them was done, 876 polished sections were analized.

Complex of analytical studies, including isotopic analysis is in progress now in stationary laboratory conditions.

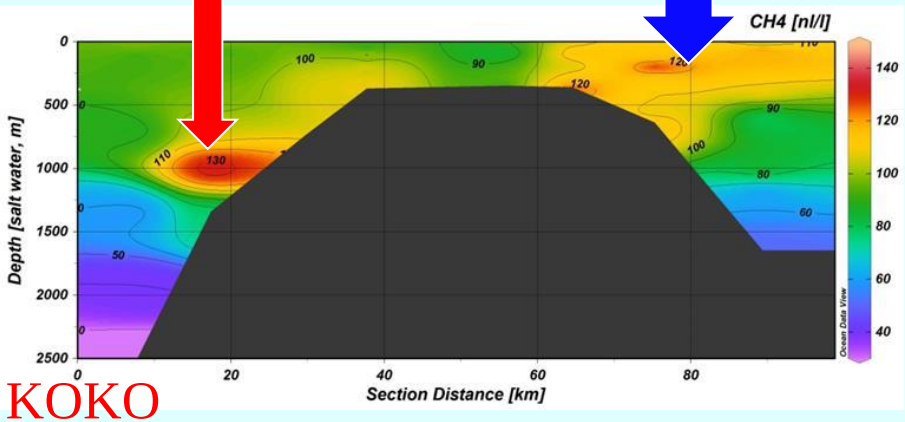
Preliminary results

Gas chemistry

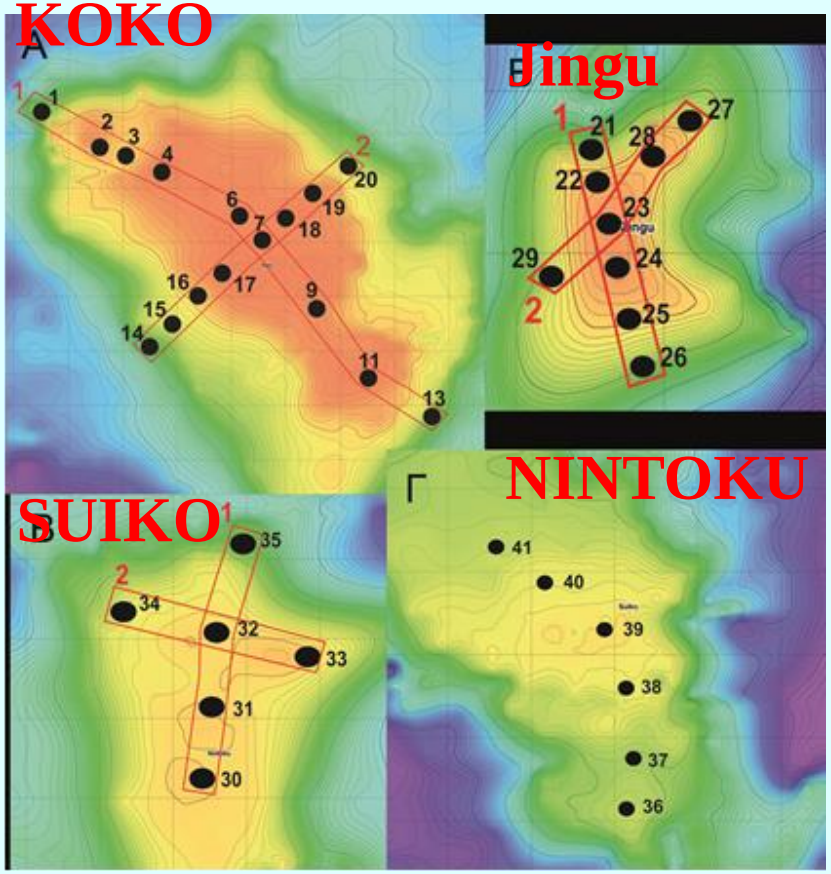
The research of the **methane content** was carried out in the Emperor Chain **first time.**

The highest concentrations of the methane in the range 0-500 m depth are due to the warm temperature and, so on, - activity of methane-producing bacteria.

The second highest concentration of methane – 1000 m depth – resulting from the *circum*-guyote current .



No any cold seeps or other super-high levels of the methane



Hydrochemistry

7 specialized hydrochemical complex stations - were worked out, with a total volume of 37 stations.

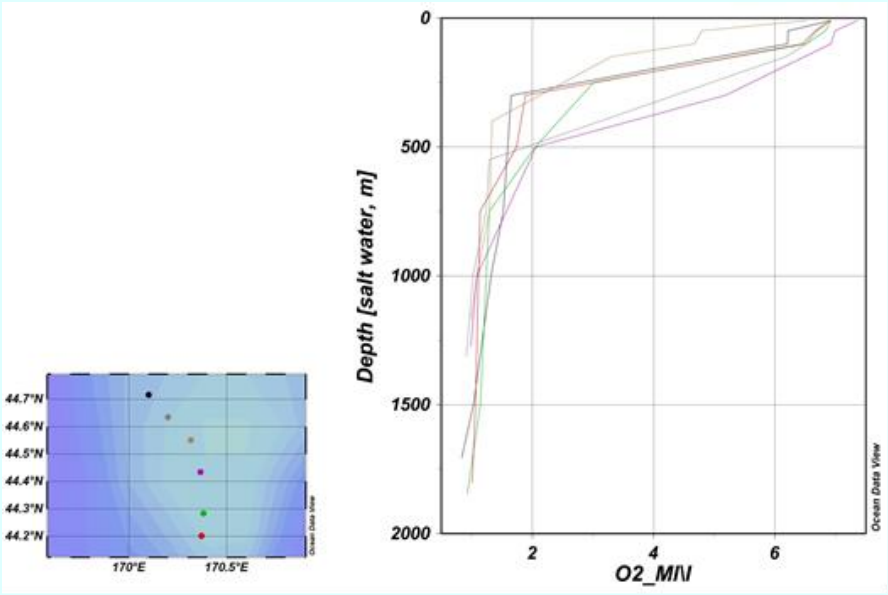
The total number of processed samples was 944.

Of these, P –304, Si – 304, and O_2 – 336 were studied.

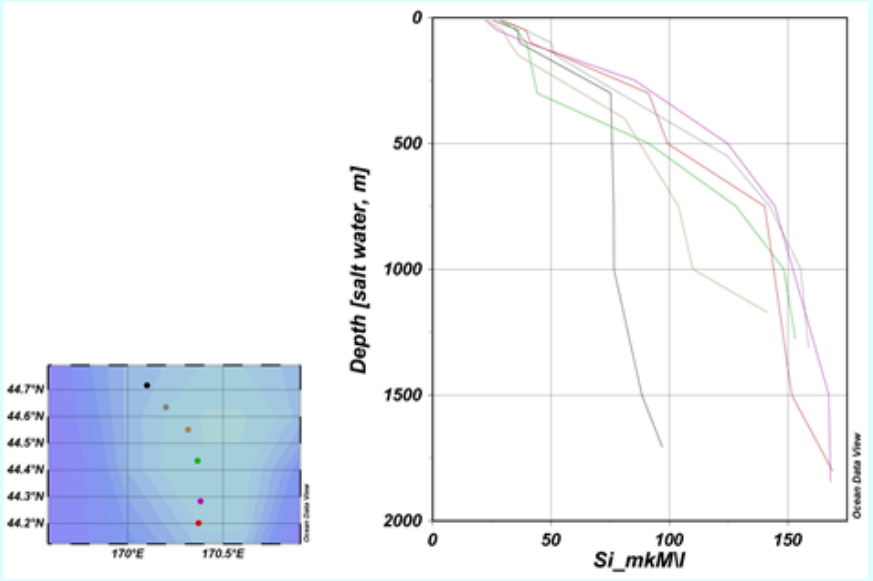
Suiko, most northern, – highest concentrations of dissolved O_2.

The biogenic elements' vertical range **were typical for the ocean water masses.**

The study to be continued in land laboratory.



Vertical distribution of the dissolved oxygen above Suiko

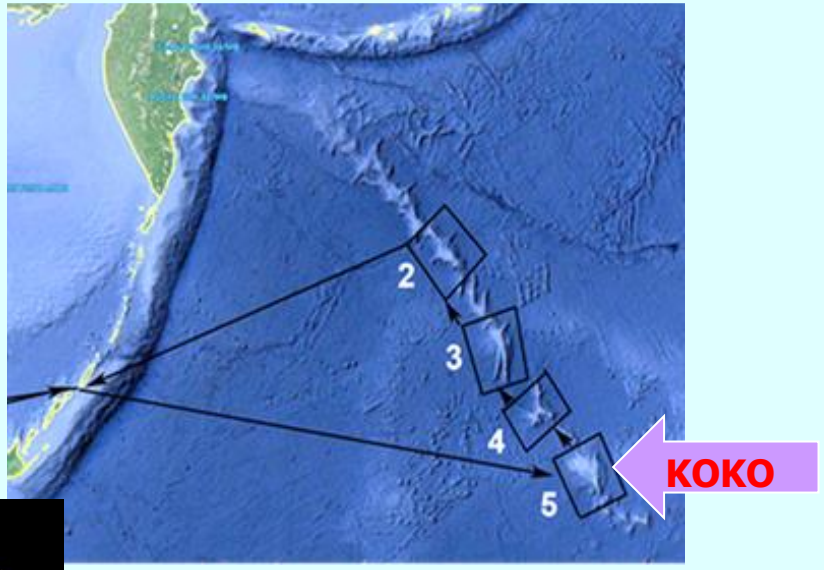


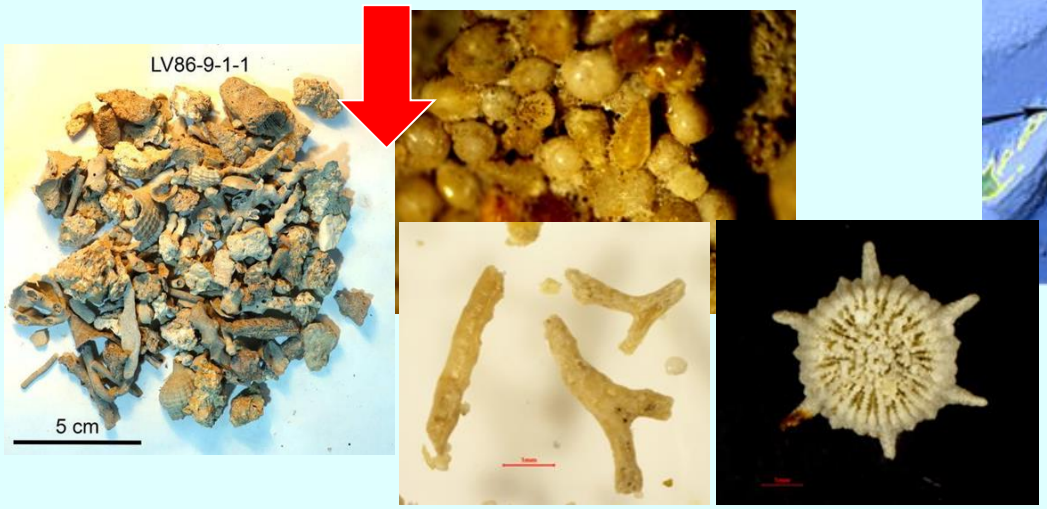
Si above Suiko

Geological survey. The Koko’ peculiarities.

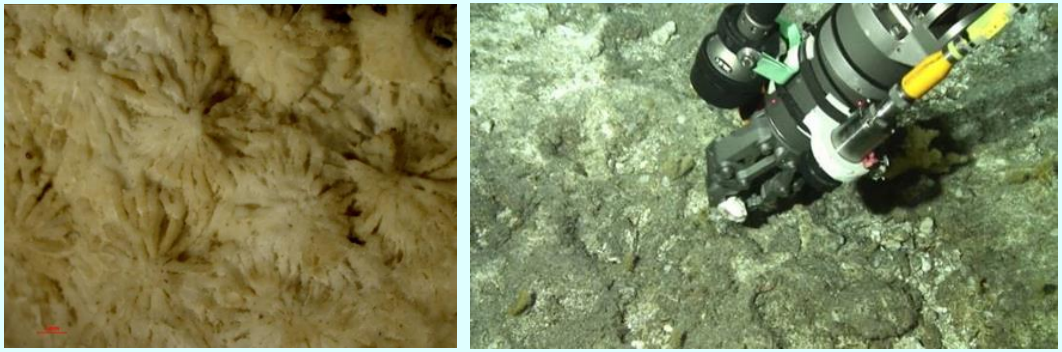
Коко has a soft layer at the top to 600 м thickness (Davies et al., 1972; Matter & Gardner 1975).

This cover is composed of sand and small debris of carbonate skeletons (reef-building corals + other reef-builders).





White reef limestone, 357 m, northwest peak.



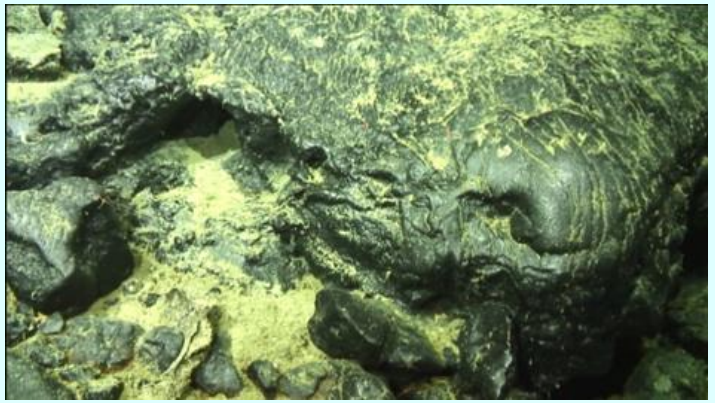
Ferrum-manganese crust is absent!

Sand dunes of 1.5-2 m height are formed as a result of active bottom hydrodynamics at the summit of the Koko guyot, which have not been previously described in the literature.

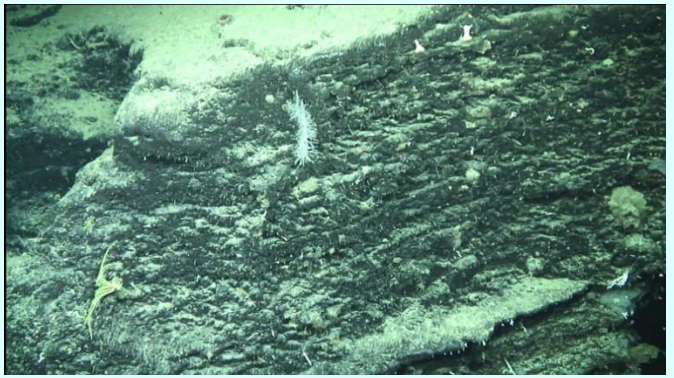
Geology. The Jingu' peculiarities.

The crater is saved. The absence of gravitational sorting of stone material along the slope of the Jingu guyot indicates the underwater explosive nature of the eruptions.

Склоны на глубине 1900-2048 м покрыты литокластическими туфами с ЖМК



Lava flows covered with ferro-manganese crust, 2042 m



A block of lithoclastic tuff, saturated with volcanic bombs, 2012 m

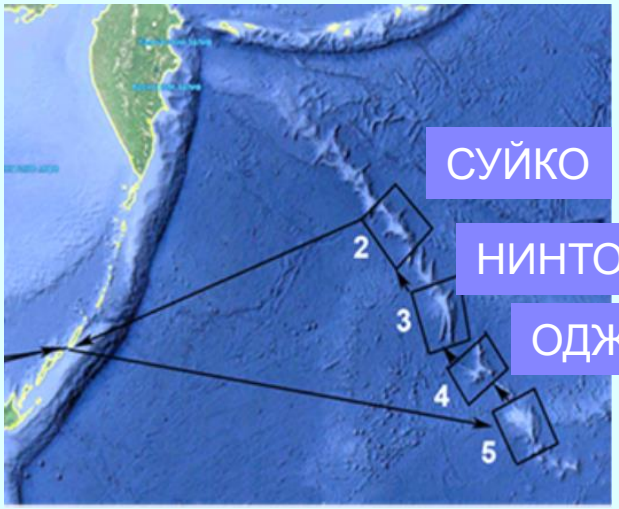
Also developed active bottom hydrodynamics, as a result of which the bedrock outcrops have a polished surface.

Separate young volcanic bombs in the slope deluvium, 2058 m

Geology.
Main results.

Revealed significant diversity of the substrata on the plateau and slopes of the guyots.

The bottom surface in most of the studied areas is a mosaic of soft-sediment and stony places.

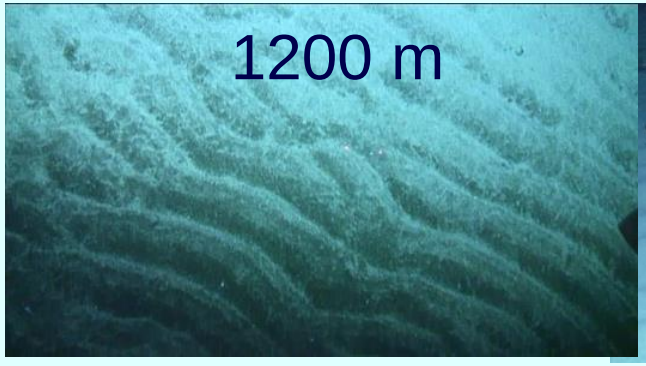


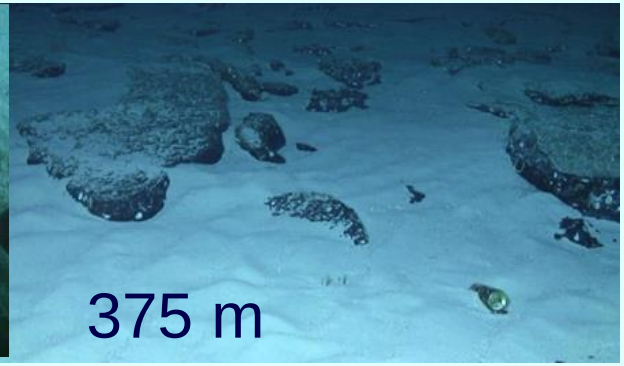
On the slopes, the solid substrate is represented by tuffs and mantle lavas of varying degrees of fragmentation, covered with a more or less thick ferrum-manganese crust.

Most thick crust - **Jingu.**

Sometimes 34 mm !!!

Active bottom hydrodynamics



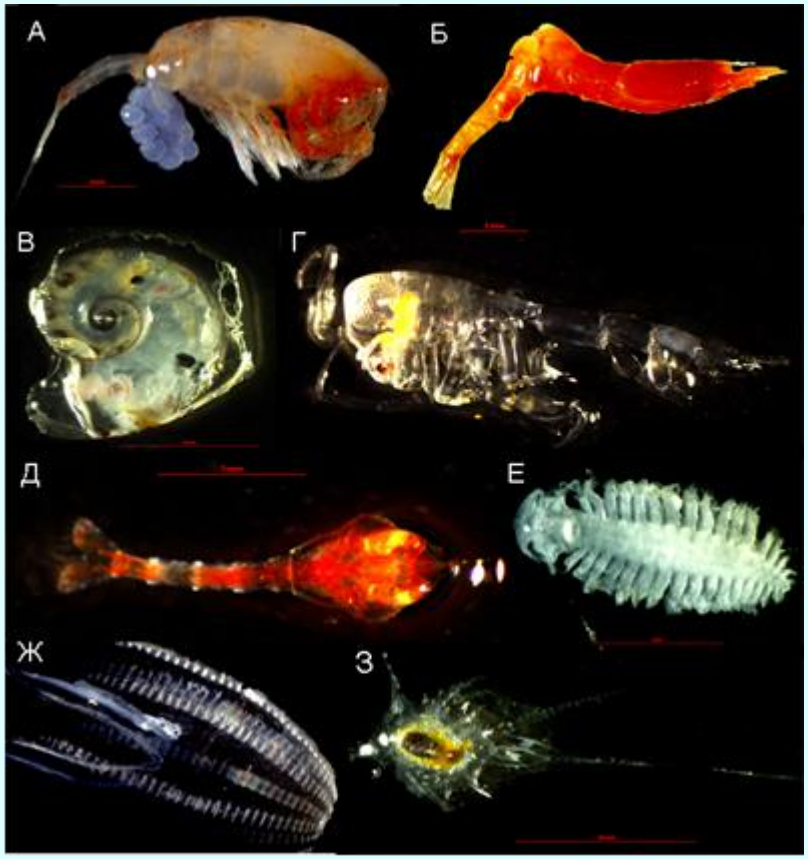


Zooplankton

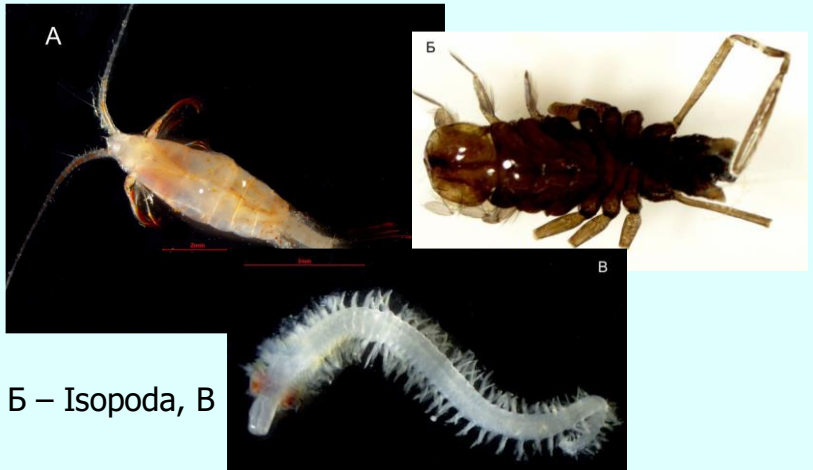
The plankton density and biomass from guyot to guyot increased to the north direction, but the species richness decreased.

Together presence of the temperate and tropic-sub-tropic Copepoda – distinct stratification of the water masses (including the bottom inflow of the cold water).

Biogeography characteristics of the fauna discovered during summer period indicate that the region belongs to the area of contact (mixing) of temperate and tropic zones.



А – Copepoda, Б – Euphausiacea, В – Pteropoda, Г – Amphipoda, Д – Decapoda larvae, Е – Polychaeta, Ж – Ctenophora, З – Cirripedia.



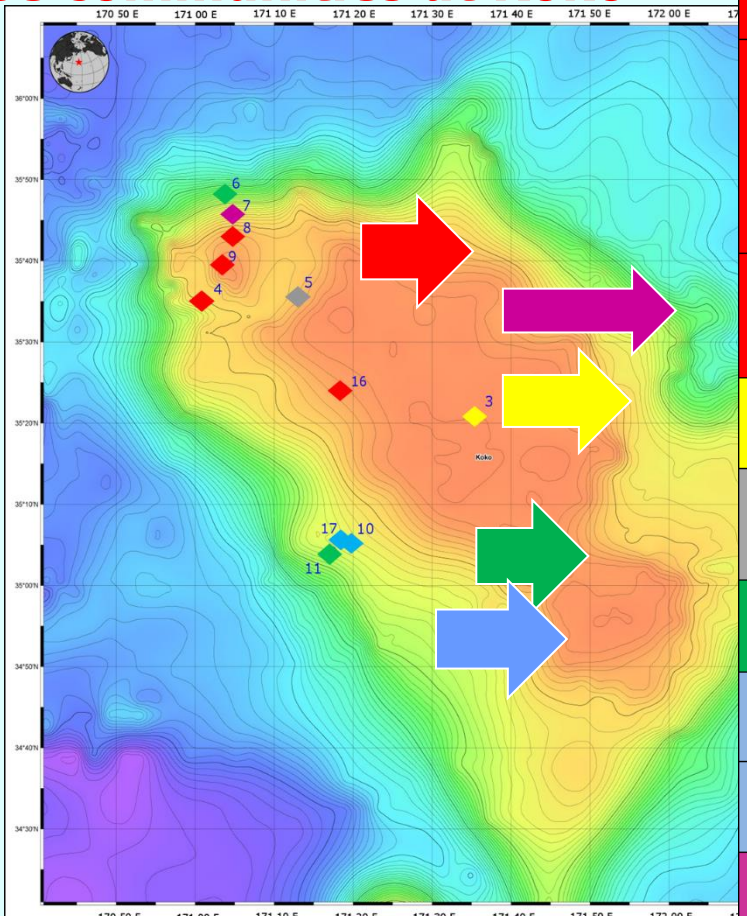
А – *Neocalanus cristatus*, Б – Isopoda, В – Polychaeta

Macrobenthic communities

Bottom landscapes (including macro-biota) of the Emperor Chain were investigate first time using ROV in 338 - 2182 m depth.

The data obtained indicate the **very mosaic pattern of distribution of the biotic complexes** and key taxa (**Octocorallia and Porifera**) which means **greater importance of local conditions than depth.**

Diverse communities at Koko



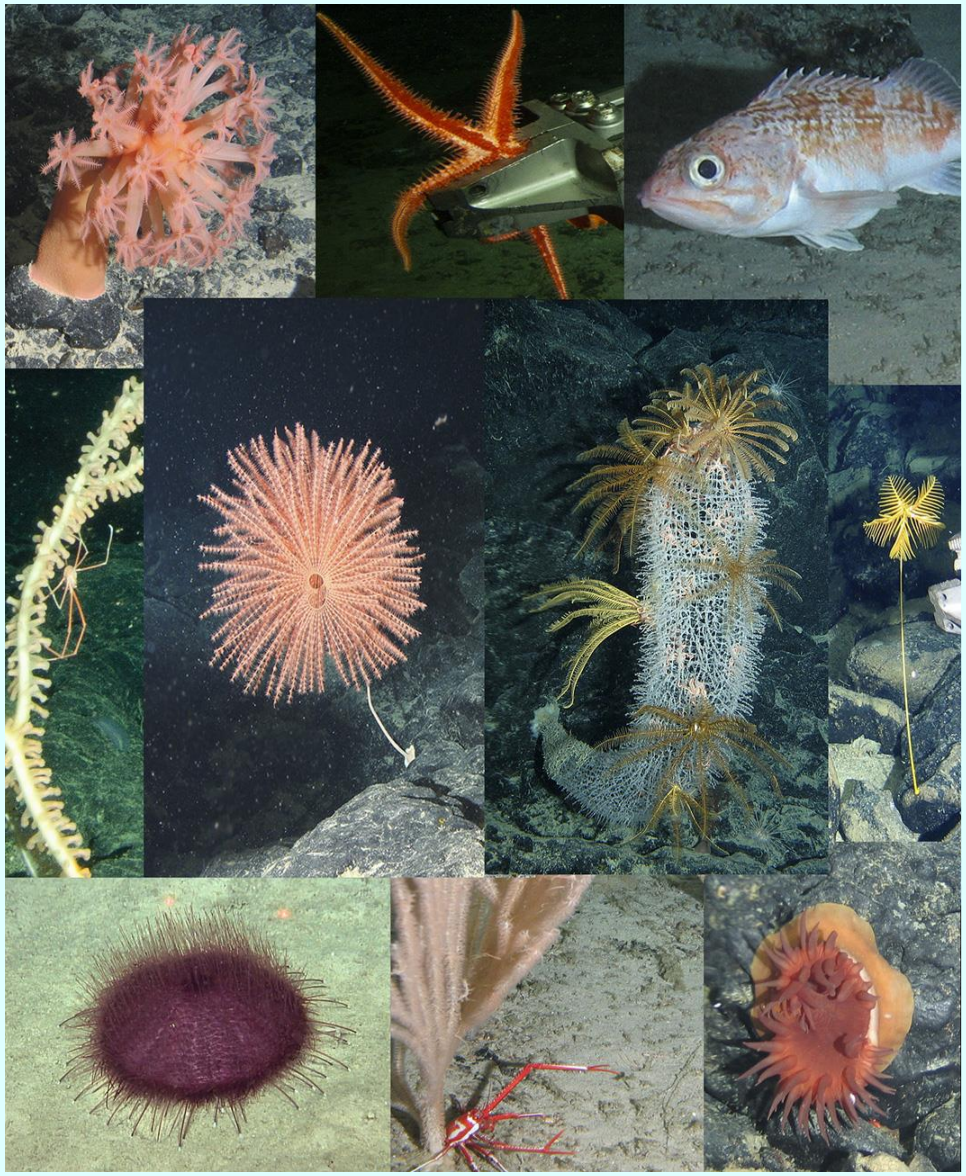
погружение	глубины	доминанты
4	492 - 507	Octocorallia + Stylasteridae + Decapoda Brachiur с фиолетовым панцирем
8	593- 581	Octocorallia + Stylasteridae + Scleractinia Echinothurioida + Decapoda Brachiura фиолетовым панцирем
9	386-365	Octocorallia + Stylasteridae + + Decapoda Brachiur с фиолетовым панцирем
16	391-397	Octocorallia + Stylasteridae + Scleractinia Echinothurioida + Decapoda Brachiura фиолетовым панцирем
3	338 – 341	Decapoda Brachiura: Portunidae + Echinoidea Cidaridae + Asteroidea: Goniastridae cf. *Ceramaste*
5	779 - 768	Ohiuroidea мелкие Holothuroidea: Elpidiidae мелкие
6	2182-1969	Ophiuroidea крупные + Holothuroidea varia
11	1882-1853	Ophiuroidea крупные + Holothuroidea varia
10	1366-1383	Octocorallia varia + Echinoidea: *Caenopedina* sp. Holothuroidea: прозрачные
17	1429-1358	Octocorallia varia + Echinoidea: *Caenopedina* sp. Holothuroidea: прозрачные
7	1621-1341	Ophiuroidea мелкие белые+ Echinoidea: *Aspidodiadema* sp.

Key (indicator) taxa of bottom communities – fauna, biogeography, vertical distribution.

OCTOCORALS

Earlier – a very few data on the Octocorallia of the Chain (two papers only).

It was shown that Octocorallia and Hexactinellida (glass) sponges, which **are indicators of VME in Athlantic**, **have important position at the Emperor Chain.**



Key (indicator) taxa of bottom communities – fauna, biogeography, vertical distribution.

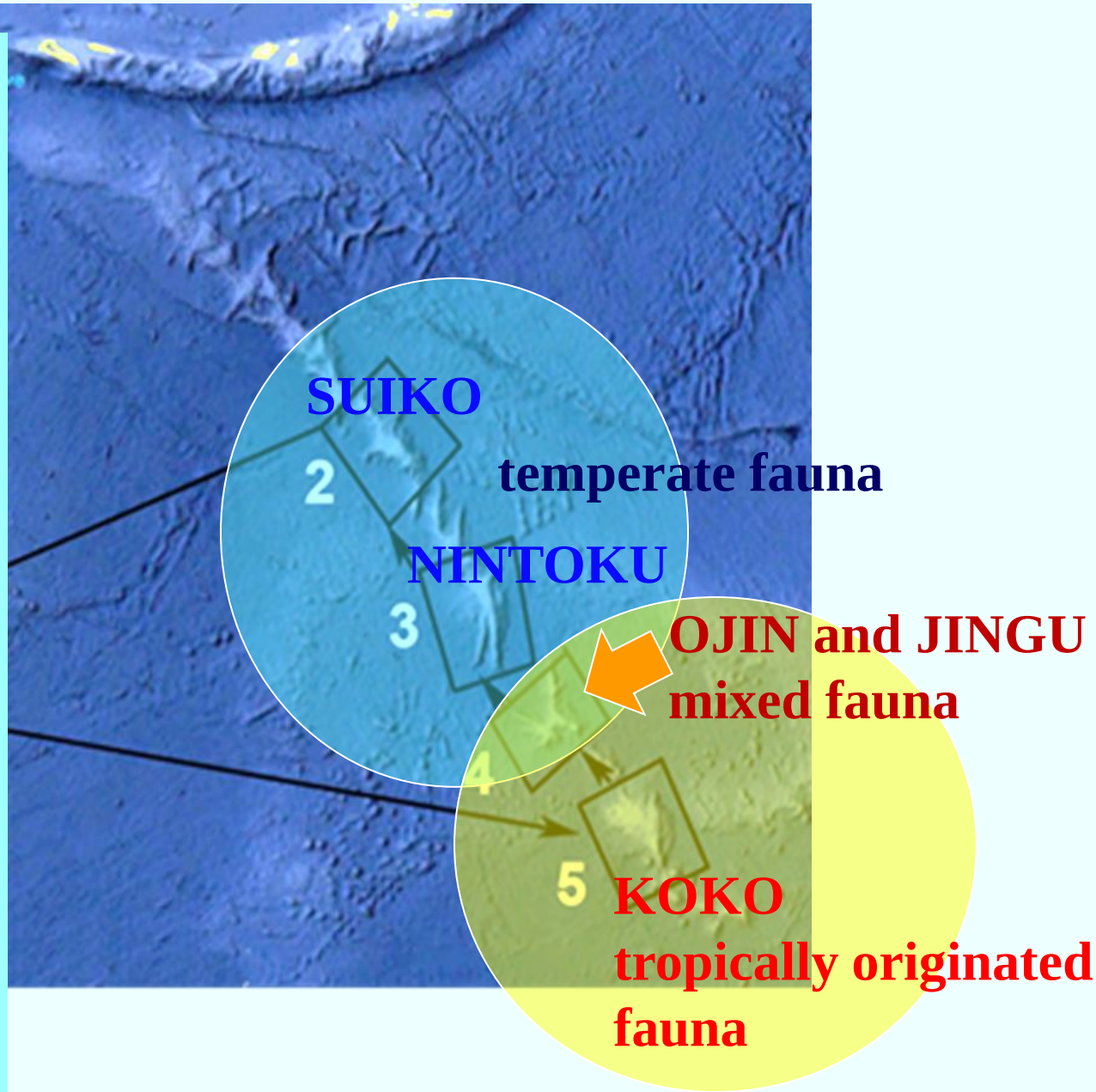
Basing on our findings, the Emperor Chain should be suggested a series of ”stepping stones” for deep-sea species dispersal.

Temperate Pacific species move to the **south** using the Chain, species of tropical genesis – to the **north**.

The driver – movement of the deep water masses.

Biogeographical boundary between the temperate and tropical-originated faunas of Octocorallia is located between 37°–39° N (**guyots Ojin and Jingu**).

After Sirenko, Smirnov, 1986 (using brittle-stars)



SUIKO
temperate fauna
2
NINTOKU
3
ODJIN and JINGU
mixed fauna
4
5
KOKO
tropically originated
fauna

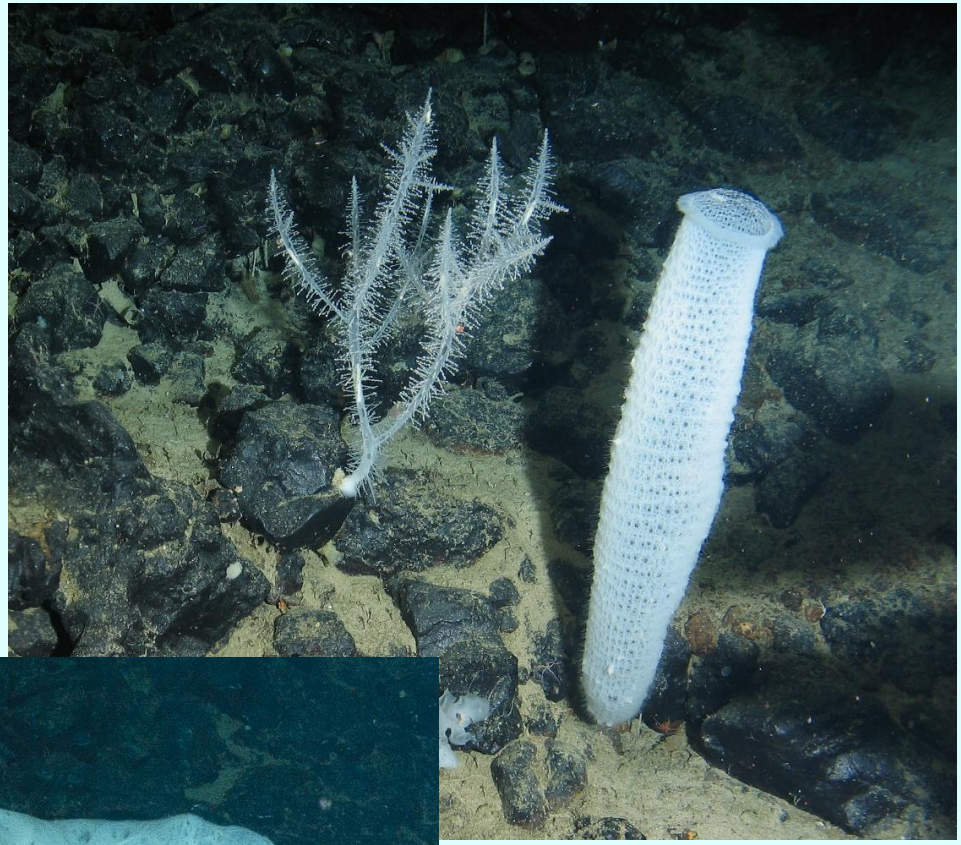
Key (indicator) taxa of bottom communities – fauna, biogeography, vertical distribution.

THE SPONGES!

Hexactinellida (glass) sponges of the Emperor Chain are studied first time.

It was shown (basing our data), Hexactinellidae fauna of the Chain belongs to the Indo-West Pacific typical fauna.

It contains bathyal taxa which taxa are common for the guyots and mid-ocean ridges (*Amphidiscella, Atlantisella, Walteria*, Tabachnick, 2002).



Subsrata-forming function

THE SPONGES!

Hexactinellida (glass) spon
Emperor Chain are studied

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Hexactinellidae fauna of th
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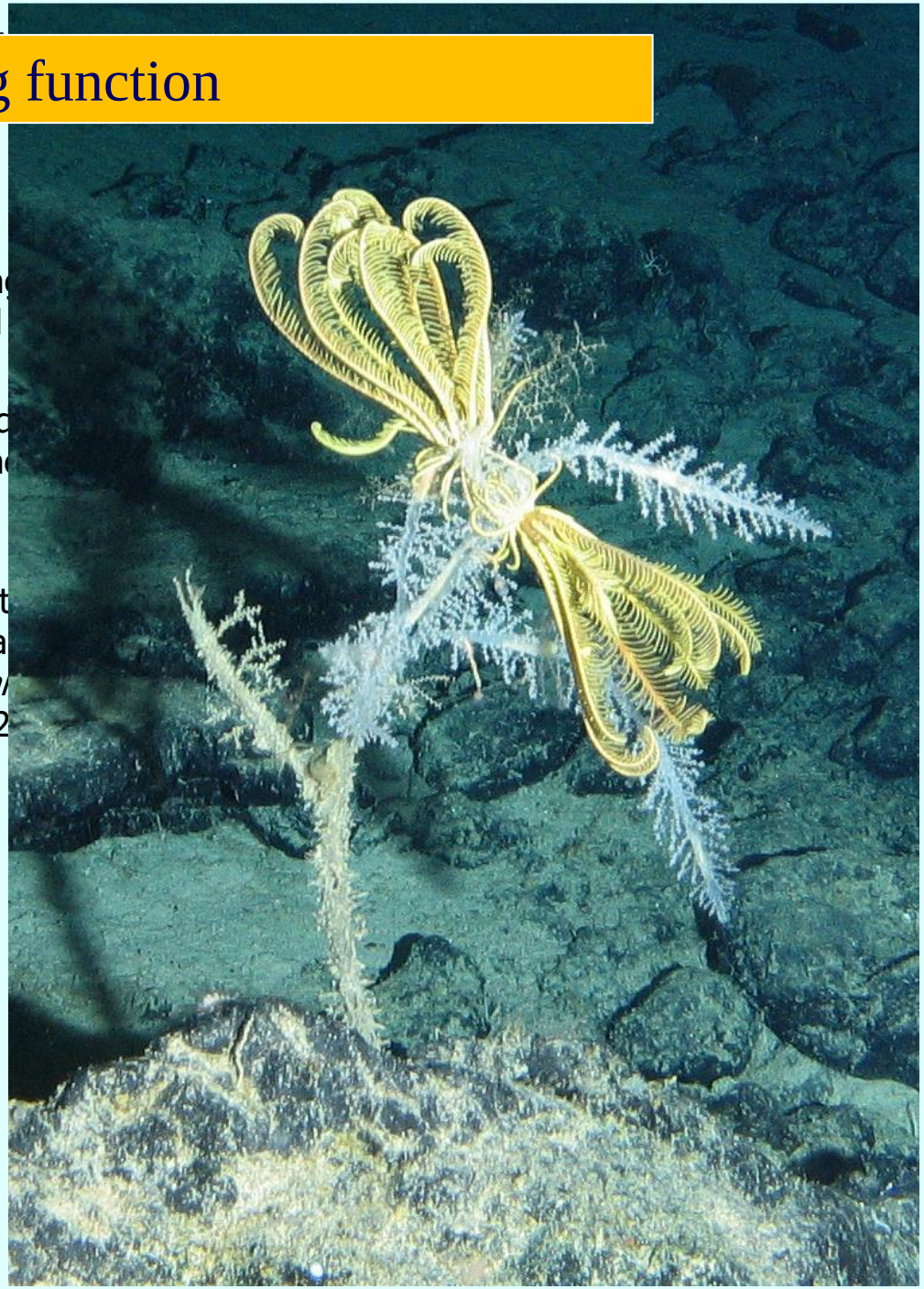

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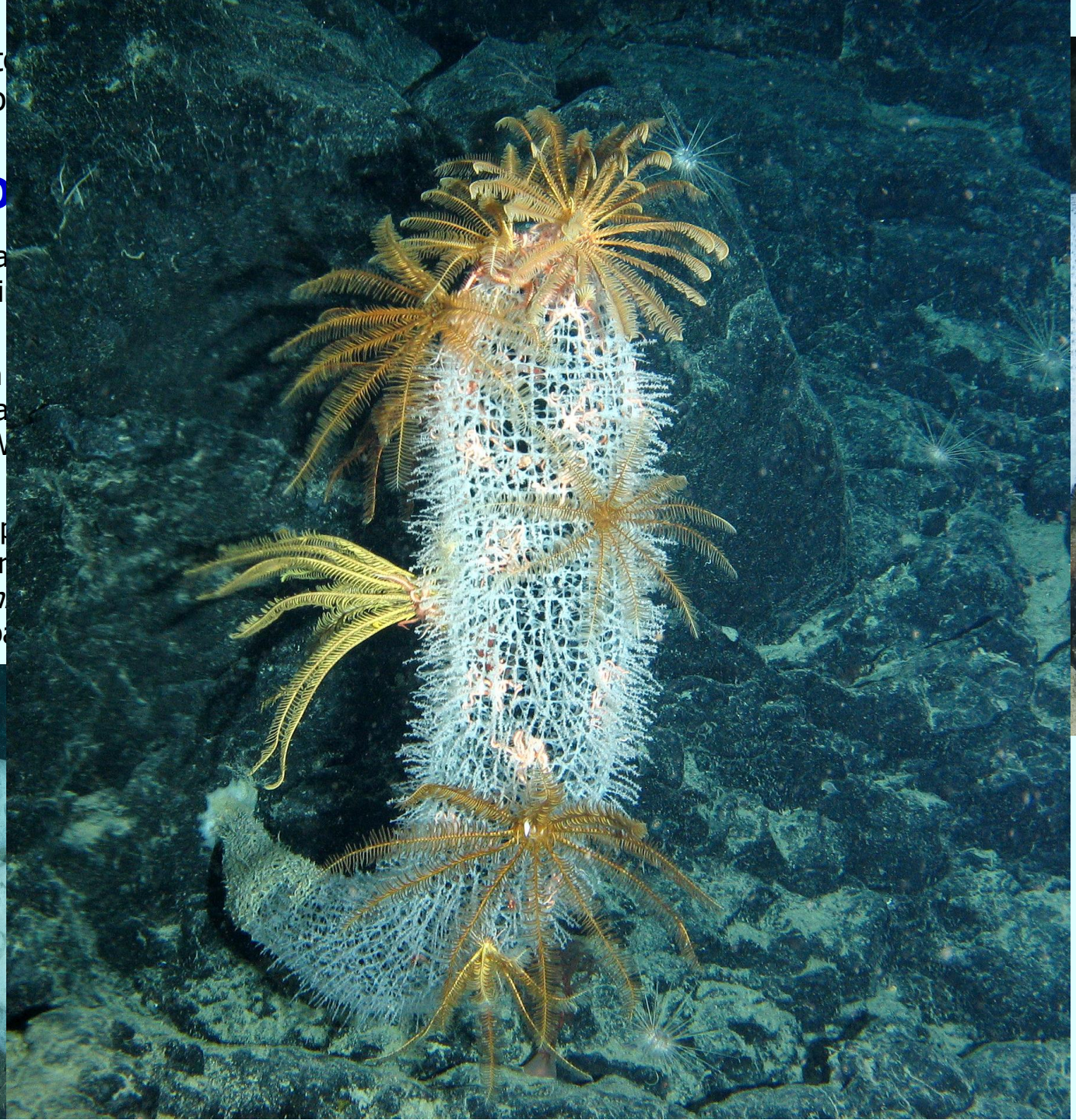


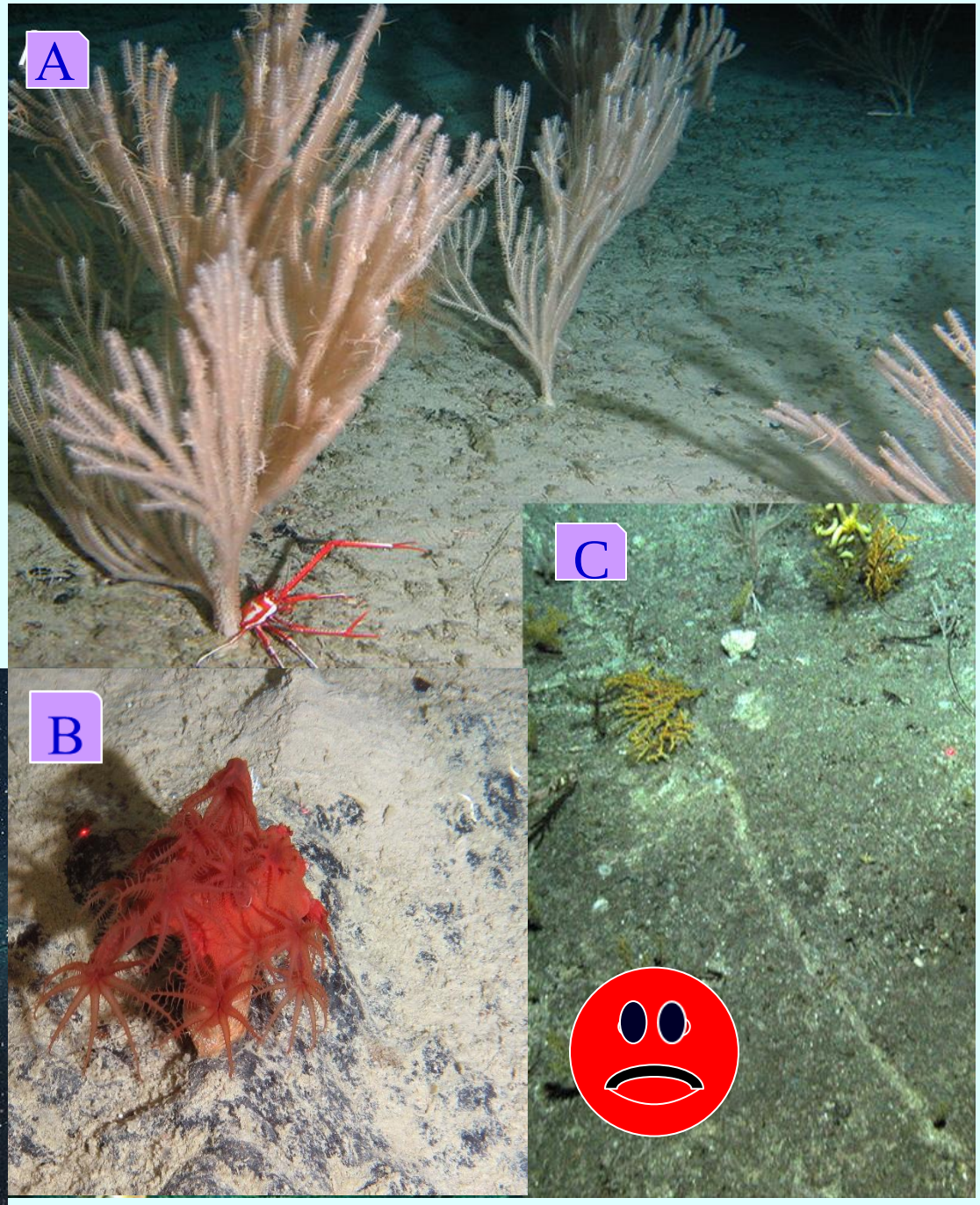
On Octocorals' life

A. Coral gardens. Коко, 550 м.

Б. Soft coral Anthomastus was recorded evewhere.

C. Footprint after the fishing bottom gear. One gorgonian broken. Коко, 680 м.

D. Gorgonians *Iridogorgia* – of tropical genesis. Коко, 1430 м.

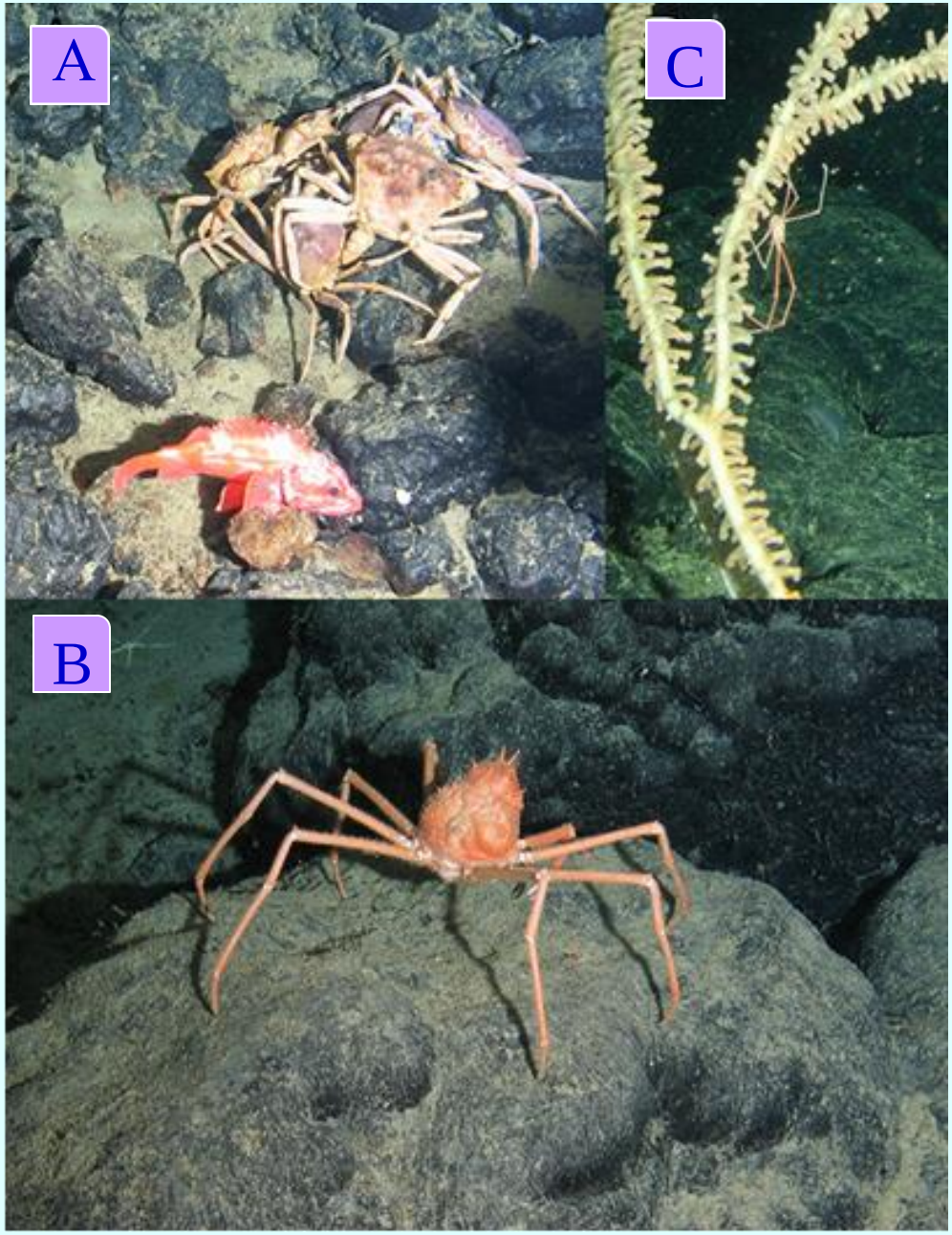


On Crustaceans' life

A. Feeding crabs. Jingu, 880 m depth.

B. Crab on the lava flow covered by the ferromanganese crust.

C. Crab-commensal of the "bamboo" octocoral Isidella.



Echinodermata

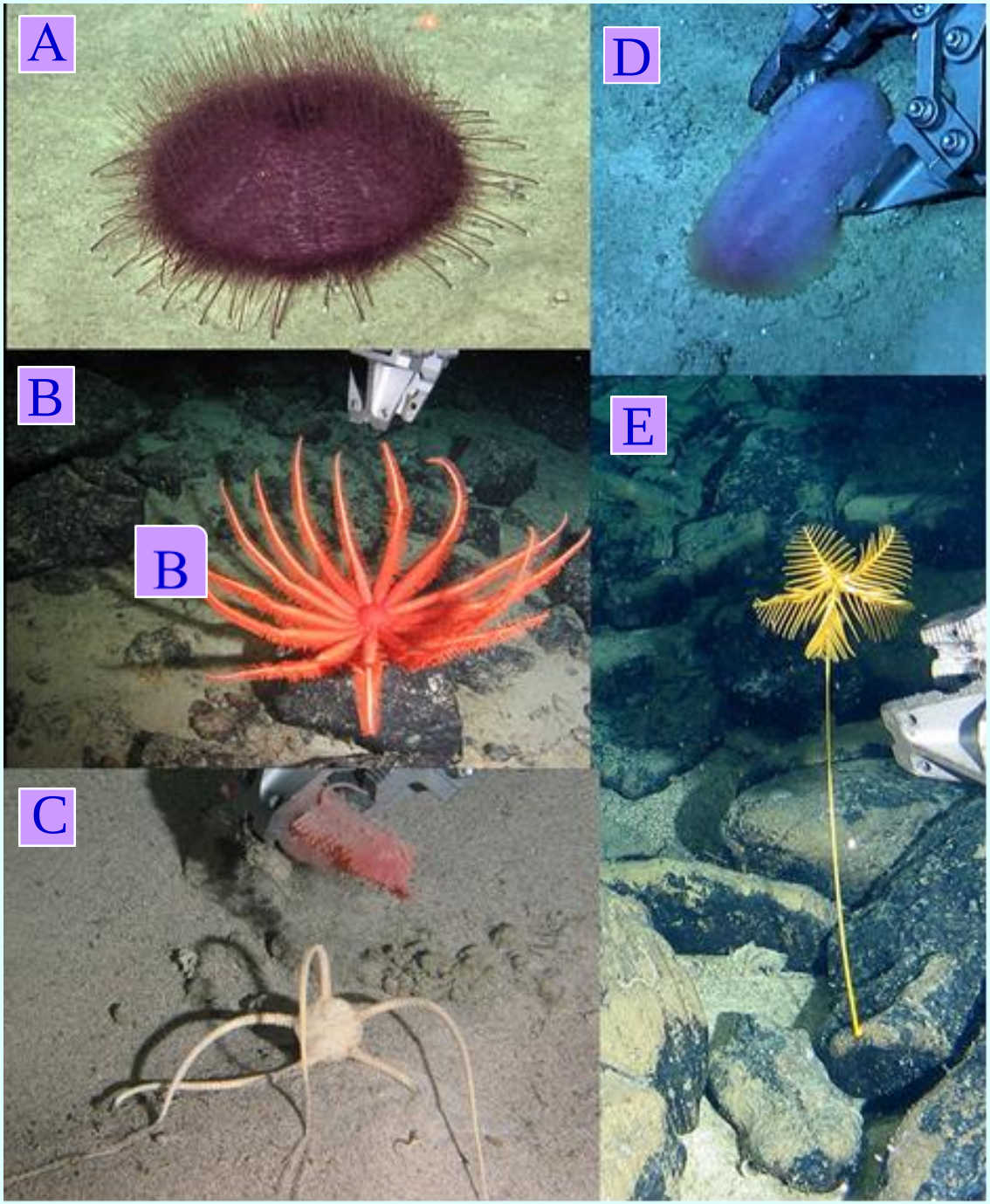
A. Soft sea urchin.

B. Sea star Brisingidae.

C. Brittle-star (white colored) – typical for 1400–2000 м.

D. Holothurian.

E. Stalked crinoid.



MANY THANKS FOR YOUR KIND ATTENTION!