ABSTRACTS

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FIRST FINDINGS OF THE MULTIPLATED LICHENOCRINUS HOLDFASTS FROM THE MIDDLE ORDOVICIAN OF THE LENSINGRAD REGION [poster]

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Lichenocrinus is formal genus that comprised of the crinoids attachment structures (holdfasts) with unique morphology. These are hollow domed structures closed on all sides and attaches to solid substrate by the flat basis. Their internal cavity is divided by radial septa; the convex side is covered with numerous plates, and there is a depression in its center, from which a thin pentagonal stem emerges. The internal cavity of such holdfasts is comparable to the internal cavity of the theca in volume, which suggests the location of some important organs (that may be gonads) or specialized storage tissue in this cavity.

Such structures were firstly described from the Upper Ordovician of the North America (USA, Ohio) as peculiar crinoids calyxes; the assumption that they are holdfasts was made later. Farther, this theory was confirmed by conjoint findings of these structures and stems with crowns of Cincinnaticrinids and Homocrinids. The term «Lichenocrinus» is still used in the literature for those holdfasts with similar structure, for which there is no established correspondence with calyxes of the certain crinoids species.

In the Baltic basin, Lichenocrinus holdfasts were previously described from the Upper Ordovician of Estonia; from Keila (11 specimens) and Pirgu (one specimen) regional stages.

New specimens were found in 2017 in the Middle Ordovician of the Leningrad Region, Russia. They are significantly different in morphology. One of them, 7 millimeters in diameter and 2 mm. in height, attached to the lateral surface of the bryozoan colony, originates from the Uhaku regional stage; its thin flat cover plates are only partially preserved, which makes its internal structure with multiple septa observable. The second one, 10–12 mm. in diameters and 10 mm. in height, with massive convex cover plates, is attached to the brachiopod valve and originates from the interval that includes deposits of the Kunda and Azeri stages (found in the scree). These specimens are older than previously known holdfasts of this type.

This research was supported by the Russian Science Foundation (project No. 19-14-00346) and it is a contribution to the International Geoscience Programme (IGCP) Project 653.
EXPLOSIVE INCREASE OF THE ECHINODERM HOLDFASTS DIVERSITY IN THE MIDDLE ORDOVICIAN OF BALTICA [talk]

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In the fossil record, the beginning of the Middle Ordovician is characterized by a strong increase of the marine organisms morphological and taxonomic diversity. For stalked echinoderms, this is a phase of wide distribution and intensive development associated with both a series of evolutionary transformations of the organisms (primarily – development of more effective type of feeding organs and long stem that allows to rise these organs higher in the water column), and with spreading of the most suitable grounds for their settlement.

The increase of the crown size and the height of its rise above the seafloor necessitated for strengthening of attachment – due to growth to larger solid objects or increase of the supporting structures coverage (which could be achieved by the lateral growth of a solid base or by branching). The result of morphological transformations was the increase in calcite production that, in turn, contributed to the further enrichment the ground with the calcite detritus and formation of hard or firm grounds suitable for attachment. Explosive increase of the attachment structures (holdfasts) diversity is associated with the increase of the grounds diversity. All the holdfasts types, excepted some extremely specialized, appeared in the Middle Ordovician.

When studying the collection of holdfasts from the Ordovician deposits of the Leningrad Region, Russia, authors identified and described number of morphotypes, which in most cases cannot be attributed with the certain species of stalked echinoderms. But they well reflects morphogenetic capabilities and characteristics, as well as the development dynamics of this group of organisms integrally.

All examined holdfasts are divided in two large groups: “unbranched” and “branched”. Holdfasts of the first group are mainly adapted for attaching to the surfaces of hardgrounds and individual solid objects (such as brachiopod shells or fragments of the trilobites), while the ones of the second group are adapted to soft or compacted grounds. There are 11 morphotypes in the unbranched group, that divided by the characteristics of their shape and internal structure (which may be quite complex, with branched grooves connected to the axial canal of the stem). Branched holdfasts are well divided by the characteristics of their branching and internal structure. Some of them have a specific feature: a sequential change in the symmetry of the axial channel during branching, from pentaradial through tetraradial and triradial to bilateral. There are transitional forms between unbranched and branched holdfasts, as well as between separate morphotypes within this subsections, which indicates a wide parallel ecological and evolutionary flexibility within separate groups of echinoderms and independent attempts to adapt to all available ground types by different groups.

The study is supported by the Russian Foundation for Basic Research, project 18-04-01046.
MODELING THE DISTRIBUTION AND SURVIVAL OF THE ECHINOID ABATUS CORDATUS IN THE KERGUELEN ISLANDS [poster]

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The Kerguelen Islands are a remote archipelago of the French Southern Lands located in the sub-Antarctic part of the Southern Ocean. Coastal marine habitats display a rich flora and fauna that are currently facing significant environmental changes and are at risk given IPCC scenarios for the future. The precise response of benthic species and communities to the current and predicted environmental changes remain largely unknown. In the framework of the Long Term Ecological Research program Proteker of the French polar institute, the response of the echinoid Abatus cordatus (Verrill, 1876) to changing environmental conditions was analyzed using a mechanistic modeling approach. A. cordatus (Schizasteridae, Spatangoida) is a deposit feeder and sediment swallower, endemic to the Kerguelen Plateau it is frequent and abundant in shallow waters. Since the 70s, it has regularly been studied by research programs that produced a significant amount of genetic, ecological and physiological data.

Based on available data, a Dynamic Energy Budget model (DEB) was developed to simulate energy accumulation and allocation along the entire life cycle of A. cordatus. The model is driven by temperature and food resources and aims at testing the potential changes of species individual physiological performances (growth and reproduction rates) and population structure (density and dynamics of the respective growth stages) according to contrasting environmental conditions. Metabolic performances were also simulated for different climate scenarios derived from IPCC reports to test for species sensitivity to future environmental changes. Such an approach is used for the first time for a sub-Antarctic species and could be expanded to other case studies to support conservation and management plans in the region.
STARFISH *ASTERINAPECTINIFERA* – SOURCE OF BIOLOGICALLY ACTIVE SUBSTANCES [poster]

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Starfish *Asterina (= Patiria) pectinifera* (Asterinidae) is an unpretentious type of starfish, widely distributed along the western coast of the Pacific Ocean from Sakhalin Island to the Yellow Sea. This is the most numerous species in the Peter the Great Bay of the Sea of Japan. *Patiria* spawn at a surface water temperature of about 20 °C. Spawning is extended from July to mid-November and has two peaks. On the Japanese island of Honshu, spawning can continue from April to September. *Patiria* tissues in large quantities contain a mixture of carotenoids, the most famous of which is astaxanthin. Carotenoids are natural fat soluble pigments. The synthesis of carotenoids is carried out only by plants, including phytoplankton algae, in particular, *Haematococcus* microalgae. Animals get them from their nutritional diet. Carotenoids determine the formation of a color from yellow (lutein, zeaxanthin) to pinkish red (astaxanthin, canthaxanthin) and act as antioxidants. They protect cells and tissues from oxidative stress, prevent coronary heart disease and blood vessels, strengthen the body’s immune system, inhibit the development of certain tumors. The most well-known physiological role of carotenoids is provitamin activity. Synthetic astaxanthin is highly toxic and unstable.

Unlike other starfish species from the Asteriidae family (*Asterias amurensis*, *Lysastrosoma anthosticta*, *Distolasterias nipon*, etc.) living in the Sea of Japan, the patyrions acquire bright colors, ranging from blue to red, due to the fact that they feed not only on animal tissues, but also on cyanobacteria and microalgae that overgrow solid substrates. Carotenoid-rich microbenthos clusters are particularly abundant in maricultural reservoirs with growing bivalve mollusks: scallops, mussels and oysters.

In connection with the development of mariculture, patyrías are massively accumulated near marine gardens. The need to collect and destroy these predators allows you to simultaneously provide sufficient resources for the production of carotenoid preparations. Using traditional approaches to pretreatment of moisture-containing raw materials, which must be dehydrated before the process of extraction of lipid materials, we have developed a universal technology for the integrated processing of starfish (Artyukov et al., 2012). The essence of the method lies in the successive operations of dehydration, extraction, chromatographic purification, demineralization of waste, deproteinization, enzymolysis and the production of marine collagen peptides. After chromatographic purification of the extract concentrate, a complex of carotenoids enriched with astaxanthin, lutein and zeaxanthin is obtained. The developed technology of complex processing of *Asterina pectinifera* sea stars allows to obtain biologically active collagen peptides and carotenoid preparations enriched with astaxanthin, exhibiting immunomodulatory, anti-inflammatory and antioxidant activities. They can be used as a raw material for obtaining new medicinal, cosmetic and food products.
IMPLICATION OF RANGE OVERLAP ALONG THE PACIFIC TROPICAL-TEMPERATE TRANSITION ZONE – GENOMIC LESSONS FROM THE GENUS TRIPNEUSTES [talk]

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Sea urchins of the genus Tripneustes are among the most abundant and ecologically important pan-tropical marine invertebrates. Recognised as potent ecosystem engineers due to their intense grazing of macro-algae and sea grass and highly valued for their gonads, wild populations of Tripneustes are commercially exploited for fisheries and aquaculture. Recently, a new species, Tripneustes kermadecensis, was described from the southern Pacific Ocean, off the Kermadec Islands, near the tropical/sub-tropical transition zone. Here, we explore the range of Tripneustes combining morphological and genetic tools. We report, for the first time, the presence of a second Tripneustes species, T. kermadecensis, from Australia and show that this species is in fact highly abundant throughout most of the sub-tropical eastern Pacific, where it occurs in association with coral and temperate reefs and has long been miss-identified as the ‘lamington sea urchin’. As commercial exploitation and stock-release programs of Tripneustes are rapidly expanding, and as global warming causes tropicalization of eastern Australia, driving the southern expansion of its congener T. gratilla, we call for re-evaluation of the conservation vulnerability of T. kermadecensis along the Australian continent and action by the aquaculture industry to genetically confirm the species identity of stocks in their facilities.
FOSSIL ECHINODERM COLLECTIONS
AT THE YALE PEABODY MUSEUM [poster]

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The echinoderm collections in the Yale Peabody Museum Division of Invertebrate Paleontology (YPM-IP) consist of nearly three hundred drawers of echinoderm specimens – an estimated 20,000 specimens, including over 650 published specimens, and 33 holotypes. Many of these are historically significant specimens collected or acquired in the late 1800s and early 1900s by YPM curators O. C. Marsh, Charles E. Beecher, Charles Schuchert and Benjamin Silliman (the nucleus of the YPM-IP collections), and collectors Frank Howe Bradley and Darling K. Greger. Approximately 40% of the collection is Paleozoic crinoids (notably Crawfordsville material) and the remainder has broad taxonomic, stratigraphic, and geographic representation. Recently we acquired hundreds of cystoids, edrioasteroids, eocrinoids, holothuroids, stelleroids, and stylophorans from the Ordovician Fezouata Lagerstätten of Morocco.

YPM-IP has had a decade-long collaboration with the Marine and Paleobiological Research Institute (MPRI). This collaboration has expanded and complimented the YPM-IP collections by adding nearly 500 fossil echinoderms to our collections – many recently published, in preparation, or available for study. The MPRI specimens include rare and poorly described taxa, noteworthy morphological features, and exceptionally preserved fossil echinoderms from western US Cambrian shales and the Hunsrück Slate.

The Yale Peabody Museum is actively engaged with the digitization (cataloging, imaging, and georeferencing) of our invertebrate fossil collections for the benefit of researchers worldwide. Researchers can search our online collections database (both fossil and recent echinoderms) on the Peabody collections portal http://collections.peabody.yale.edu/search/.
THE GENUS *PACHYTHYONE* DEICHMANN, 1941 (HOLOTHUROIDEA: SCLERODACTYLIDAE) FROM THE TROPICAL EAST PACIFIC OCEAN (MEXICO): TAXONOMY AND DISTRIBUTION [talk]

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The Sclerodactylidae family is characterized by being elongated sea cucumbers, having U-shaped bodies and thin, rigid skin. Up to now, 21 genera of this family are known. The genus *Pachythyone* is exclusive to rocky areas in shallow waters (<40 m) of the Tropical Eastern Pacific ocean, and is represented by three species: *P. lugubris*, *P. pseudolugubris* and *P. rubra*; it is considered endemic to the Americas. Type material of all species, as well as individuals that do not belong to the type series, were located and reviewed, the material coming from different scientific collections. A detailed morphological revision is presented together with Scanning Electron Microscopy (SEM) photographs of the ossicles from different parts of the body. The results confirm a new species of *Pachythyone*, collected in Cocinas Island, Chamela Bay, Jalisco, Mexico on rocky substrate at 6 m depth. What differentiates this species from the others within the genus is that there are numerous wide, robust and very ornate tables ending in spiky spiers.
A LITERATURE REVISION OF THE GENUS *NEOTHYONIDIUM* DEICHMANN, 1938 (HOLOTHUROIDEA: PHYLLOPHORIDAE) WITH DESCRIPTION OF A NEW SPECIES FROM THE NORTH EAST PACIFIC (MEXICO) [poster]

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The genus *Neothyonidium* comprises eleven species (*N. armatum*, *N. dearmatum*, *N. hawaiense*, *N. inflatum*, *N. insolitum*, *N. intermedium*, *N. minutum*, *N. parvipedum*, *N. parvum*, *N. spiniferum* and *N. vultur*) that are distributed in the west Atlantic, Indo Pacific, Australia, China and the Hawaiian islands, mainly in shallow waters. Deichmann (1938) described this genus as including species with 20 tentacles arranged in two circles of ten tentacles each, calcareous tubular rings with long, deeply divided posterior extensions and long, narrow interradios. Ossicles of the body wall are tables with two pillars. A new species of sea cucumber of this genus is described. *Neothyonidium diabulum* sp. nov. was found in the Tropical Pacific Ocean of México, at 1–5 m depth living buried on rocky reefs. This is the first species that has been recorded in the Tropical Eastern Pacific Ocean, expanding the geographic range of the genus. The literature revision is presented together with Scanning Electron Microscopy (SEM) photographs of the ossicles from the new species.
CRINOIDs FROM THE CHARLIE GIBBS FRACTURE ZONE, NORTH ATLANTIC [talk]

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The CE18008 expedition (TOSCA: Tectonic Ocean Spreading at the Charlie Gibbs Fracture Zone, North Atlantic; Chief Scientist Dr Aggie Georgiopolou) took place in the summer of 2018 on board the RV Celtic Explorer. Its aims were to survey aspects of the geology and the benthic biology of the Charlie Gibbs Fracture Zone, a complex transform fault system which separates the Reykanae Ridge and the Mid Atlantic Ridge between approximately 50° and 52° North. Earlier hydrographic surveys had revealed a spectacular submarine landscape with vertical relief of over 4000m, rising to c. 600m depth.

The ROV Holland I was deployed during the expedition. The distribution of crinoids and the environments in which they occurred, from c. 3000 m to c. 600 m water depth, was analysed using high definition video footage acquired during five transects totalling approximately 30 km, together with ‘ground truthing’ of the identification of some taxa through limited biological sampling.

The environments encountered during the dives were very varied, ranging from pale coloured, soft sediment, commonly showing ripple marks, through admixtures of pebbles, cobbles and boulders of dark igneous rocks, in varying proportions, with pale sediment, to rock faces, many very steep, with only a patchy veneer of sediment.

The stalked crinoid fauna comprises at least three taxa, Anachalypsicrinus nefertitii, Democrinus parfaiti and a ten-armed, red form. Comatulids include Pentametrocrinus atlanticus and at least three, as yet unidentified taxa. The three stalked taxa have overlapping distributions but are each most common in certain parts of the transects. Both A. nefertitii and the ten-armed stalked form are attached by an attachment disc to hard substrates, ranging from cobbles to large rock surfaces. D. parfaiti occurs both on rock surfaces and in pebbly sediment. Even though its holdfast is a radix, one of the specimens recovered shows the radicles cemented to small pebbles. P. atlanticus occurs almost exclusively on soft substrates, but a few examples were attached by their cirri to isolated rocks in soft sediment. The other comatulids are associated with hard substrates and several utilize elevated positions on sponges and other erect benthos. With the exception of P. atlanticus, which typically extends its arms horizontally to form an upward facing feeding array, the other taxa form vertical filtration fans with the oral side of the arms down current.

The survey was carried out with the support of the Marine Institute, funded under the Marine Research Programme 2014-2020 by the Irish Government to support and promote the Atlantic Ocean Research Alliance (2018-2021). Seabed mapping data and expertise, software and hardware were provided by INFOMAR, funded by the Department of Communications, Climate Action and Environment. Financial aid for the transportations and operation of the seismic equipment for this research survey was provided by the German Science Foundation (DFG).
A REVISION OF *LYTECHINUS PICTUS* (VERRILL, 1867) AND THE REVIVAL OF *LYTECHINUS ANAMESUS* H. L. CLARK, 1912 FROM MATERIAL COLLECTED IN THE NORTH EAST PACIFIC (MEXICO) [talk]

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The genus *Lytechinus* A. Agassiz, 1863 worldwide, contains 12 valid species, five of which are included in the fossil record (*L. baldwini*, *L. coreyi*, *L. crasus*, *L. milleri* and *L. okinawa*) and 7 of which are recent species (*L. callipeplus*, *L. euerces*, *L. panamensis*, *L. pictus*, *L. semituberculatus*, *L. variegatus* and *L. williamsi*). Among the 153 species of sea urchins reported for Mexican waters, the genus *Lytechinus* is currently represented by five species distributed in the coastal strip of the Mexican Republic; 4 within the Gulf of Mexico and the Caribbean Sea (*L. callipeplus*, *L. euerces*, *L. variegatus* and *L. williamsi*) and only the *L. pictus* record for the Mexican Pacific limits. These 2 species were studied and formally synonymized by Kirk and Lessios (2004) using molecular tools (mitochondrial DNA). The aim of the present work is to propose the reanimation of *Lytechinus anamesus* as a valid species using morphological tools (macro and micro structures). Specimens of the type series of *L. anamesus*, and *L. pictus* housed in the scientific collections of the Natural History Museum of the Smithsonian Institution, Washington, DC., USA; Museum of Comparative Zoology of Harvard, Massachusetts, USA and of the National Collection of Echinoderms “Dra. Ma. E. Caso Muñoz”, from the Institute of Marine Sciences and Limnology (ICML), National Autonomous University of Mexico (UNAM). The shape of the test, number and size of primary spines, shape of the pedicellariae and type of ossicles present in the ambulatory feet of both species, support the separation of these two sympatric taxa.
A NEW FINDING ON THE ECHINODERM REMAINS IN THE BURIED OFFERINGS OF THE TEMPLO MAYOR OF TENOCHTITLAN, MEXICO CITY [poster]

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Within the rich faunistic archaeological remains recovered in the Great Temple of Tenochtitlan, the Aztec imperial capital located beneath modern Mexico City, it has been possible to determine fragments of tests or endoskeletons of calcium carbonate and microstructures (pedicels and spines) identified as evidence of sea urchins. All these organisms belong to the Echinoidea class. So far, there are 14 species reported for three classes. The Echinoidea class is the best represented with seven species, followed by the Asteroidea class with six, and finally the Ophiuroidea class with only one. The 15th and 16th century remains found in the main pyramid of Tenochtitlan were detected inside 18 offering boxes (1, 3, 5, 7, 11, 17, 57, 84, 88, 102, 120, 124, 125, 126, 137, 141, 172 and 174). Eight of them correspond to the 4th building stage of the Great Temple (AD 1440-1469), nine to stage VI (AD 1486-1502), and one to stage VII (AD 1502-1520). The taxonomic morphological analysis of the species associated with the offerings was made through direct observation with conventional stereoscope (macro characters) and the help of scanning electron microscopy (micro characters). At the moment eight species have been identified: *Eucidaris thouarsii*, *Echinometra vanbrunti*, *Clypeaster speciosus*, *Encope laevis*, *Mellita notabilis*, *Meoma ventricosa grandis*, and *Toxopneustes roseus* (all with current distribution in shallow areas of the American Pacific), in addition to *Mellita quinquiesperforata*, a sand dollar from the intertidal Gulf of Mexico. In the present work, the registration of *T. roseus* is included for the first time, increasing the total number of species of echinoderms offered to 15.
FIRST REPORT OF AN HOLASTEROID (ECHINOIDEA: HOLASTEROIDA) IN THE GULF OF MEXICO [poster]

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The order Holasteridae Durham & Melville, 1957 is one of the groups of echinoids that characterize the deep sea environments. In Mexico, there are currently 8 species already reported (Plexechinus cinctus A. Agassiz, 1898, Cystocrepis setigera (A. Agassiz, 1898), Echinocrepis rostrata Mironov, 1973, Pouttalesia tanneri A. Agassiz, 1898, P. thomsoni Mironov, 1976, Cystechinus giganteus (A. Agassiz, 1898), C. loveni A. Agassiz, 1898 and Urechinus reticulatus HL Clark, 1913), all of them with a distribution within the geographic limits of the Mexican Pacific, included in 6 genera and 3 families. When analyzing material from various oceanographic cruises that is deposited in the National Collection of Echinoderms “Dra. Ma. E. Caso Muñoz”, ICML, UNAM, a fragmented specimen of an irregular sea urchin was identified, which was collected off the coasts of the state of Tamaulipas (Gulf of Mexico) at 3,355 m depth, during the Oceanographic Campaign DGoMB-JSSD5 was identified. In the present work, we present the morphological description of calcareous micro-structures and fragments of the test of this holasteroid, identified here as a species of the genus Calymne Thomson, 1877. This is the first record of a species belonging to the order Holasteroida within the limits of the Gulf of Mexico.
LAST GLACIAL MAXIMUM AND ITS EFFECTS ON THE MARINE FAUNA OF SOUTHERN SOUTH AMERICA: THE CASE OF ARBACIA DUFRESNII
[talk]

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The Magellan biogeographic Province is an extensive zone of South America that comprise from ~42°S in the Pacific to ~41°S in the Atlantic. Both sectors are united by the Cape Horn Current, originated in the Southeast Pacific coast around 42°S, flows southward and then eastward to join with the Falkland/Malvinas Current at the Atlantic. Nevertheless, both coast present differences in their geomorphology, such as a segregated coastline with a complex landscape of gulfes, fjords, and channels in the Pacific, while the Atlantic sector has a coastline formed by huge plains in almost all its extension. Moreover, the continental shelf of the Southeast Pacific is narrower (~6.24 km), than the continental shelf of the Atlantic, which is the widest in the world (~440 km). The marine benthic fauna of this extensive province has been described as adapted to cold temperate and subantarctic zones due to the effects of the tectonic and climatic processes, such as the Quaternary glacial cycles and principally the Last Glacial Maximum (LGM). Which promote a global decrease in sea level (~130 m) and the formation of an ice layer in the southern tip of South America that advanced up to 43°S by the Pacific coast. This background allows proposing that the effect of the LGM should be greater for the Pacific marine benthic fauna than the Atlantic. Under the Quaternary biogeographic model of contraction and expansion, using molecular tools (mtDNA COI), we investigate the effect of the LGM on the genetic diversity of the benthic marine fauna on both sides of the Magellan Province. We study the echinoid Arbacia dufresnii, a shallow subtidal species of this great Province that also has a population further north in the southeast Pacific coast, at ~39ºS (Los Molinos), we assessed the diversity/structure genetic and gene flow pattern. Our analyses indicate that A. dufresnii presents a population expansion signal and low levels of genetic diversity on both sides of the Magellan Province. However, Los Molinos locality has a greater genetic diversity and environmental stability inferred that allow us to propose that could act as a source of diversity for A. dufresnii during the LGM. Moreover, we detect an incipient structure between Los Molinos and the Pacific Magellan Province, probably due to the biogeographic break described at the 42°S and an asymmetric pattern of gene flow. We propose that the synergy of the effects of the LGM in the Pacific was similar to the Atlantic sector, due to its extensive exposed continental shelf and, that the presence of a larval stage allows connectivity and generates genetic homogeneity among the different localities.

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**FOOD INTERACTIONS BETWEEN SYMBIOTIC GASTROPODS AND ECHINODERMS** [poster]

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Symbiotic associations represent a convenient model for studying intra- and interspecific relations. In the specialized family of gastropods (Gastropoda, Eulimidae), a transition from ectoparasitic to endoparasitic forms that have lost the classic gastropods structures can be detected. Morphology and anatomy features of many species of this family are well investigated, but the spectrum of their nutrition is practically not studied (in particular, it remained unclear whether the symbionts feed on echinoderms tissues or they are kleptoparasites).

Using a complex of modern biological methods (histology, isotopic method and biochemical analysis of fatty acids) the trophic structure of symbiotic associations between several species of echinoderms (starfishes, crinoids, holothurians and sea urchins) and molluscs-symbionts from the family Eulimidae family was studied for the first time.

According to the results obtained by isotopic analysis, a group of free moving symbionts from the genera *Annulobalcis* and *Melanella* (symbionts of crinoids and holothurians) has a structure typical for gastropods and is clearly used as the main source of food not for the tissues of their hosts, but for their filtrate. Tightly attached and gall-forming symbiotes of sea stars *Linckia laevigata* and sea urchins *Diadema setosum* (molluscs of species *Thyca crystallina*, *Stilifer variabilis*, *Stilifer utinomi* and *Echineulima mittrei*) show a clear preference for the fattiest tissues of their hosts.

In addition, using modern histological methods, the structure of the anterior part of the digestive system was analyzed in the same species (free moving species of the genus *Melanella*, attached *Thyca crystallina* and gall-forming *Stilifer variabilis*). As a result, we found that the digestive system of the *Melanella* genus has a structure typical of gastropods. For the species *Thyca crystallina*, the predominance of protein secretion in the glands around the proboscis and esophagus was found, confirming the hypothesis of intracellular digestion in connection with the transition to a parasitic lifestyle. Examining the structure of the anterior part of the species *Stilifer variabilis*, it was found that the proboscis is a classic variant of the structure of the digestive system of the parasitic gastropod.

Thus, using a set of different biological methods in a series of “free moving ectosymbionts – attached ectosymbionts – endosymbionts (gall-forming species)” we analyzed the effect of the symbiont on the host: with the transition to a tight attachment to the surface of the host’s body symbiont-host relations move from klepto- to truly parasitic.
FIRST RECORD OF CAYMANOSTELLA (ASTEROIDEA:
CAYMANOSTELLIDAE) FROM THE NORTH PACIFIC [poster]

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The family Caymanostellidae was established by Belyaev (1974) based on 13 specimens found on sunken wood collected from the Cayman Trench, Caribbean Sea at the depths 6740-6780 m. All specimens were referred to a new species Caymanostella spinimarginata Belyaev, 1974. The genus Caymanostella currently comprises four species. Among them only C. spini-
marginata is known from the Atlantic Ocean, the others are recorded from the Indian Ocean and South Pacific.

Three specimens of Caymanostella were recently sampled during the joint German–Rus-
sian expedition KuramBio II from the abyssal plain adjacent to the Kuril-Kamchatka Trench at the depths 5101–5134 m. The sea stars were found on sunken wood along with other taxa associated with this special habitat. Surprisingly, these new specimens were very similar to the C. spinimarginata, the most geographically distant species.

Comparison of the KuramBio II specimens and the type material of C. spinimarginata showed that they share the main morphological characters of this species: gonopore posi-
tion, abactinal plate arrangement and the shape of the inferomarginal spines. However, the new specimens had more elongated abactinal spinelets and more thorny adambulacral spines. Larger size of these spines and spinelets in the KuramBio II specimens possibly reflects the size difference between them and examined specimens of C. spinimarginata. All these dif-
ferences are rather point at intraspecific than interspecific variability.

Multi-gene molecular data was obtained for the enigmatic family Caymanostellidae for the first time due to a good preservation of the KuramBio II specimens (only single 595 bp fragment of 16S rRNA gene was known for Caymanostella sp. up to date). Preliminary phylo-
genetic analyses of ribosomal COI and 16S rRNA, and nuclear 18S rRNA gene sequences (total length ~3123 bp) place caymanostellids into a basal polytomy among representatives of six orders of the class Asteroidea. Additional data from other genetic markers is needed to clarify the phylogenetic position of the family Caymanostellidae.
Abstracts

MOLECULAR DIFFERENTIATION BETWEEN FOUR SPECIES OF SEA CUCUMBERS OF THE GENUS LABIDODEMAS FROM DIFFERENT LOCATIONS IN THE PACIFIC OCEAN AND THE INDO PACIFIC BY MEANS OF DNA SEQUENCING

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The sequencing of DNA in living organisms on a large scale reveals great promise in the systematics mainly among marine species, which frequently manifest controversies regarding their taxonomy.

Finding in recent studies in marine animals is that variation in mitochondrial DNA (mtDNA) is divided into nearby groups of closely related genotypes, according to the boundaries between traditionally recognized species, and congruent to nuclear markers; providing confidence to use DNA sequence variation as an overriding information in the demarcation between populations.

Large-scale molecular studies support the capacity of mitochondrial DNA mainly in the recognition between nearby species and the previous application of molecular techniques for taxonomically complicated cases; this probably has led to an overestimation in the proportion of species with mitochondrial DNA haplotypes poly-phyletic (presence of polyploidy).

In this work, we consider recent advances that follow the increase in the generation of data directed towards a modern systematics, in order to distinguish the taxonomy of DNA directly to the demarcation and delineation between four different populations of the genus Labidodemas, as a means to identify entities by DNA sequence similarity; as well as certain nuclear regions.
FUNCTIONAL AND PHENOTYPICAL TRAITS OF TWO TYPES OF PHAGOCYTES IN THE HOLOTHURIAN EUPENCTATA FRAUDATRIX [talk]

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Phagocytes of some echinoderms, including holothurians (sea cucumbers), can be separated into two fractions after a gradient centrifugation. Currently, the roles of separate fractions during the immune response remain poorly investigated. Recent studies of the authors on the holothurian Eupentacta fraudatrix have demonstrated that a high level of nitric oxide was a marker of one cell fraction referred to as P1 phagocytes, while the high activity of arginase was a marker of another cell type, referred to as P2 phagocytes. Yersinia pseudotuberculosis bacteria were shown to cause the death of holothurians, and its thermostable toxin (TcTYp) promoted the shift in the cell markers ratio.

In the present study, the concentration of reduced glutathione (GSH), the extent of apoptosis, and binding some plant lectins to the cell surface receptors were investigated in P1 and P2 phagocytes of E. fraudatrix exposed to TcTYp in vitro.

The GSH concentration in control P1 phagocytes was about 2-fold higher than in P2 cells after 24 h of incubation. TcTYp (0.15 μg/ml) induced both decrease in GSH content and cell viability in P1 but not P2 phagocytes, indicating that the cell viability depends on GSH concentration.

DNA-fragmentation assay by agarose gel electrophoresis showed that apoptosis in intact P2 phagocytes was more intensive compared to that in P1 cells. Hoechst 33342 staining revealed that chromatin condensation (apoptotic hallmark) was 6-fold higher in P2 compared to that in P1. Studies on time- and dose-dependence effects of TcTYp demonstrated that there were divergent changes in chromatin condensation (significant decrease in P1 while no effect in P2 phagocytes) after 1 h at 0.2, but nor 0.5 μg/ml TcTYp. In contrast, 0.5, but not 0.2 μg/ml TcTYp differently affected chromatin condensation in two types of phagocytes after 24 h: there was its elevation in the P1 phagocytes but no changes in P2 phagocytes.

Studies on the phenotypes of P1 and P2 phagocytes using FITC-conjugated plant lectins showed that lectins from Canavalia ensiformis (con A) and from Arachis hypogaea (PNA) bound to the surface receptors of P1 and P2 phagocytes with similar intensity. However, lectin from Dolichos biflorus (DBA) labeled P1 phagocytes with significantly higher intensity compared to P2 phagocytes. In contrast, lectin from Glycin max (SBA) labeled P2 phagocytes to a greater extent than P1 cells. Also, P1 and P2 phagocytes exposed to TcTYp were labeled by DBA and SBA mainly in different manner. Thus, both TcTYp concentrations induced divergent variations in DBA binding to P1 and P2 phagocytes after 1 h as well as after 24 h of incubation, and in SBA binding after 24 h of incubation. The variations in DBA binding to the surface cell receptors were consistent with changes in chromatin condensation.

In conclusion, the results obtained indicate that TcTYp differently affected P1 and P2 phagocytes, decreasing first of all apoptosis in the P1 phagocytes (apparently as result of decrease in their functional activity) during 1h, and increasing apoptosis mainly in this phagocyte type after 24 h. The data presented in this work suggest also the idea of the functional and phenotypical heterogeneity of phagocytes of E. fraudatrix.
STUDYING WITH NMR-SPECTROSCOPY METHOD OF CHANGING OF THE METABOLITE COMPOSITION OF *MESOCENTROTUS NUDUS* AND *ASTERINA PECTINIFERA* UNDER CONDITIONS BY HYPOXY STRESS [talk]

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The detection of lactic acid accumulation under hypoxia in sea urchins *Mesocentrotus nudus* indicates that the mechanisms for overcoming the stress caused by oxygen deficiency are similar in both echinoderms and in mammals. The method of NMR is successfully used to study the metabolic profile, since it is not so much a quantitative change of any elements that is important, the changes may be minor, and the relative difference between the metabolites from each other is important.

The composition of the metabolites of the coelomic asteric fluid of (*Asterina (= Patiria) pectinifera*) and sea urchin (*Mesocentrotus nudus*) was studied by NMR. A coelom liquid was obtained from control animals both immediately after being caught from their natural habitat, and 24 hours after keeping the animals in conditions of lack of oxygen.

Animals responded differently to hypoxia conditions. Sea urchins relatively well endured a lack of oxygen and after 4 days of keeping under conditions of hypoxia in sea urchins, no death was recorded. Starfish *Asterina* are more sensitive to stress caused by hypoxia: the dead individuals were found already on the second day.

The composition of metabolites varied significantly, both in starfish and in sea urchins, but the changes were different. In the coelomic fluid of sea urchins, the content of lactate significantly increased, and it was not possible to identify such changes in sea stars. The starfish’s lactate concentration remained unchanged, but an increase in the content of pyruvate and propionic acid was found.

It is known that the composition of metabolites in animals strongly depends on the nature of food. Herbivorous and carnivorous representatives of one insect order demonstrate significant differences in the composition of metabolites. Even though sea urchins and sea stars belong to the same type and are close relatives, they have a different type of food: sea stars belong to predators, and sea urchins feed on algae.

Of particular interest is the fact that under conditions of hypoxia in the composition of the coelomic liquid of sea stars no significant growth of lactate is detected, which is observed both in sea urchins and in rodents, in humans. A similar pattern in starfish may be due to the fact that starfish do not have a mechanism to adapt to the absence of oxygen, and changes in the composition of metabolites are caused by tissue necrosis. It is also possible that starfish have a fundamentally different mechanism for maintaining vital activity under stress caused by lack of oxygen. A significant difference in the biochemistry of starfish and sea urchins is the presence in sea urchins of naphthoquinone pigments – spinochromes – the biochemical synapomorphy of sea urchins.

The presence of naphthoquinone pigments is one of the characteristic biochemical synapomorphies of sea urchins caused by the genes encoding polyketide synthase enzymes, which are required for the spinochrome biosynthesis. In regular globular sea urchins, for example, *Strongylocentrotus purpuratus*, naphtho-quinone pigments appear at the stage of blastula.
THE MAIN DIRECTIONS OF STUDYING ECHINODERMS IN THE SCIENTIFIC INSTITUTIONS OF VLADIVOSTOK [talk]

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Vladivostok, the only city of \textit{porto franco} in Russia, is the southernmost Russian city, located on the shores of the warmest and richest Sea of Japan in the Ussuri taiga. This is a unique natural biotope in which many endemic species of flora and fauna inhabit – the only biosphere ecosystem in which 9 large predators live: four species of feline (Ussurian tiger, Far Eastern leopard, lynx and Amur forest cat), two species of bears (Himalayan and Brown), two species of canine (wolf and fox) and wolverine from the Mustelidae family, of which 11 species. The biota of the Sea of Japan is very diverse: it includes subtropical, subboreal and boreal species belonging to almost all types of animals and algae. There are numerous representatives of all five classes of Echinodermata. Naturally, they are actively studied by Vladivostok scientists who work in scientific institutions belonging to different departments. Institutes of the Russian Academy of Sciences: National Scientific Center of Marine Biology (NSCMB), V.I. Ilichev Pacific Oceanological Institute (TOI), G.B. Elyakov Pacific Institute of Bioorganic Chemistry (PIBOC), Pacific Institute of Geography (PIG), Scientific Center of the East Asia Terrestrial Biodiversity, et al. At Far Eastern Federal University Far Eastern Federal University specialists from several departments are engaged in echinoderm biology. Pacific Fisheries Research Center (TINRO-CENTER) investigate the reserves and reproduction of biological resources of the Far Eastern seas, primarily several species of commercial sea urchins and holothurians, whose reserves are large. Echinologists of Far Eastern State Technical Fisheries University focused their efforts on the development of technologies for mariculture of sea cucumbers and sea urchins. In total, Vladivostok echinologists are more than hundreds. At NSCMB and at biological stations there are modern marine aquariums with artificial regulation of environmental conditions that allow keeping animals adapted for life in various biotopes from boreal to tropical, including artificial reefs of tropical madreporian corals. This allows experimental hydrobiological studies. The biology of animal reproduction and development is studied first. To study the mechanisms of embryogenesis, sea urchins were chosen as model species, and the study of the mechanisms of regeneration focused on model types of holothurians, ophiuroids, sea urchins and crinoids. In PIBOC great success was achieved in the study of the biologically active substances of holothurians, sea urchins, and sea stars. The staff of the institute launched the production of several pharmacological preparations based on extracts from sea urchins and holothurians. In a number of institutions (NTSMB, POI, TIG, TINRO-CENTER) environmental studies of the waters of the Sea of Japan are conducted. As test objects for monitoring biotopes, both adult individuals and embryos and larvae of sea urchins are used.
CYTOLOGICAL BASES OF REGULATORY DEVELOPMENT IN ECHINODERMS AND DETERMINED IN MOLLUSCS [talk]

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Coelomic animals belong to two evolutionary lineages: Protostomia and Deuterostomia. They were divided around 700 million years ago and have determinative (mosaic) and regulative development. These types of development are distinguished by five main features: the nature of eggs cleaving, the way of mesoderm forming, the fate of the blastopore, the type of larva, and the organization of the nervous system. In addition, the skeleton of the Deuterostomes is mesodermal and Protostomes skeleton is ectodermic. The deuterostome skin is bilayer (ectodermal epithelium and mesodermal connective tissue cutis). Embryogenesis of Protostomes has no tendency towards regulation, which is well developed in Deuterostomes. This was demonstrated by many experimental embryological experiments: surgical and others. In our works, the ability to regulate development in echinoderms has been investigated, including the effect of gravitational fields on embryos. After centrifuging the sea urchin zygotes, in some cases the blastula is split in half and identical twins develop. The frequency of occurrence of twins correlates with the rigidity of the cortex, which is determined by the organization of the cortical cytoskeleton of eggs and embryos. In mollusks, there is no tendency to regulate embryogenesis. After centrifugation of zygotes of chitons and bivalve mollusks, twins are not formed, but in some cases polyembryonic elements are formed. The frequency of their appearance does not depend on the time of centrifugation of the zygotes.

We examined the cytoskeleton morphology of unfertilized eggs and blastomeres of mollusks and sea urchins to find out the cytological differences of embryos with determinative and regulative development. We discovered significant differences in their functional organization. Unlike sea urchins, the cortical cytoskeleton in mollusks is not rearranged during fertilization. The morphogenetic role of the cortex in the regulatory development of Deuterostomia and deterministic (mosaic) development of Protostomia is discussed.

In embryology, the hypothesis of positional information is popular – a system of morphogens distributed in space, which determine the differentiation of the embryo. Their distribution is determined by the organization of the cytoskeleton: it is dynamic in Deuterostomia embryo and is capable of rearrangement, while the Protostomia cytoskeleton is rigid and practically does not change during fertilization and morphogenesis. As a consequence, morphogens occupy a stable position in the egg, zygote and embryo, strictly determining the course of embryogenesis.
ASSOCIATED OPHIUROID FAUNA ON COLD WATER CORALS
OF THE REYKJANES RIDGE – AN INTEGRATIVE TAXONOMIC APPROACH [poster]

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Coldwater corals are a unique environment and provide a diverse biotope capable of supporting a wide variety of species. During the recent expedition IceAGE\_RR (Icelandic marine Animals: Genetics and Ecology _ Reykjanes Ridge hydrothermal vent activity) we came across two cold-water coral locations along the Reykjanes Ridge using a Remoted Operated Vehicle (ROV Phoca, GEOMAR). Ophiuroids are common benthic animals and live on and between the cold-water corals. In this study we want to focus on the species living on the corals picked by the ROV. The association off other organisms with specific corals are already well known, however this is lacking for the occurring ophiuroid species. Our integrative taxonomic approach of the collected ophiuroids leads to six species that live on the corals. We catalogue each ophiuroid species in a short identification guide. There, we can already see a variability in species occurrence on the corals. The species \textit{Ophiomitrella cf. clavigera} appears on two families of corals, Plexauridae Gray, 1859 and Acanthogorgiidae Gray, 1859. Our poster highlights the characteristics of each species including a molecular approach for \textit{Ophiomitrella cf. clavigera}. 
PERFOROCYcloides nathalieae new genus and species, an unusual Silurian cyclocystoid (Echinodermata) from Anticosti Island, Québec, Canada and a review of Silurian cyclocystoid distribution [talk]

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Cyclocystoids are a poorly known, rare, extinct class of bi-facially flattened disc shaped echinoderms, ranging from the Middle Ordovician to the Early Carboniferous. Articulated cyclocystoids are relatively common in the Ordovician but are rarer in younger strata. We here describe Perforocycloides nathalieae new genus and species, from the early Silurian of Anticosti Island, Québec, Canada, the first articulated cyclocystoid from the Silurian of North America. This taxon is distinguished from other cyclocystoids by the number of variably sized marginal ossicles, the lack of interseptal plates, and the novelty of pores located in the distal part of the sutures between adjacent marginals on the dorsal surface. These dorsal intermarginal sutural pores led to canals which penetrated the contiguous area of the lateral surface of the marginals and emerge on the ventral surface between the cupules of adjacent marginals. These dorsal intermarginal sutural pores/canals appear to be unique to Perforocycloides and whilst their function is speculative, they provided some form of communication between the dorsal disc and the distal side of the ventral marginals/cupules. Perforocycloides most closely resembles the Ordovician–Silurian genus Zygocycloides suggesting that this genus may have diversified more widely than previously reported during the Silurian.

A review of Silurian cyclocystoid distribution suggests taxa were geographically confined and that greatest diversity appears to have been located within Baltica. However, it also demonstrates our limited knowledge with no specimens recorded from Gondwana (e.g. Africa, Australia, South America), Siberia, and North- and South China, nor are any specimens known from Přidolí strata. Filling these gaps is therefore highly desirable.
ORIGIN AND MAIN DIRECTIONS OF EVOLUTION OF ECHINODERMATA [talk]

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The probable ancestor of Ambulacraria was a bilaterally symmetric coelomic organism. It has a preoral region of the body, a perioral region with hunting ciliated tentacles, and a metameric trunk region with metameric gill slits and gill pores. The coelomic cavity of this organism was divided into metameric sacs: paired protocoels, paired mesocoels, and paired trunk coeloms (metacoels). As in other Bilateria, the preoral and tentacle (perioral) regions of the body were free from the expression of Hox genes. Expression of the Hox genes began in the area of the first pair of gill slits in compliance with the principle of colinearity as in modern Enteropneusta. Development of the axial complex of organs is a synapomorphy of the clade Ambulacraria. The common ancestor of Ambulacraria lived in bottom soils and used the developed preoral body region for locomotion. The ancestors of Ambulacraria had the pelagicobenthic life cycle with the planktotrophic larva, which possessed the preoral and postoral ciliary bands (surrounding the adoral ciliary zone), neurotroch, and telotroch.

The ancestors of echinoderms buried themselves into the soft soils by the posterior body end. This led to the displacement of the anus to the ventral side. This evolutionary stage is reflected in the structure of echinoderm larvae, whose anus is shifted on the ventral side and it caused the reduction of neurotroch and telotroch. On the second stage, the ancestors of echinoderms began to lie on the right side of the body on the soft soils. It caused the complete reduction and disappearance of the right half of tentacle apparatus and right mesocoel. Herewith, the anus shifted on the dorsal side and the loop of intestine was formed. The fossil ancestors of echinoderms, which lied on the right side, are represented by the subphylum Carpozoa, who gave a wide diversity of forms in early Paleozoic. On the third evolutionary stage, the ancestors of modern echinoderms became the sedentary organisms, who attached to the solid substrate by the posterior body end. The attached mode of life caused the development of secondary radial symmetry. This caused the contravention of colinearity and order of the Hox genes expression. The left mesocoel formed the circumoral ring. The metameric coeloms of metacoel formed the metacoelomic rings, which are the remnants of metamermism of common ancestor of Deuterostomia. Radial water-vascular canals appeared between the primary perioral tentacles. The metameric coeloms of metacoel formed the metacoelomic rings, which are the remnants of metamermism of common ancestor of Deuterostomia. Radial water-vascular canals appeared between the primary perioral tentacles. As in many sedentary animals, the preoral lobe reduced, but the preoral coeloms (protoceols) together with the axial organ immersed deep into the body. Only Holothuroidea retained the primary perioral tentacles (homologues of the tentacles of Deuterostomia and, perhaps, of all Bilateria) along with the radial water-vascular canals. Possibly, the labial podia of Crinoidea are also the homologues of the primary perioral tentacles. Holothuroids began to crawl on the primary ventral side, trivium. The ancestors of Asteroidea, Ophiuroidea, and Echinoidea began to crawl on the oral face and this led to the shifting of the anus to the aboral side. The loop of intestine was retained only in Echinoida.

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ON THE EVOLUTION OF THE LARVAL DEVELOPMENT IN AMBULACRARIA [talk]

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1. The most plesiomorphic type of development among the echinoderms is characteristic for Holothuroidea: free-swimming ciliated blastula, free-swimming ciliated gastrula, dipleurula with simple ciliary band (starts feeding), auricularia with intricately arranged ciliary band (actively feeding), larva with simplified ciliary band – doliolaria (non-feeding), metamorphosis.

2. Most of Eleutherozoa (sea stars, sea urchins, and brittle stars) have the following stages in their life cycle: free-swimming ciliated blastula, free-swimming ciliated gastrula, dipleurula with simple ciliary band (starts feeding), feeding larva with intricately arranged ciliary band (bipinnaria, echinopluteus, ophiopluteus), metamorphosis. However, in some sea urchins and brittle stars, the rudimentary doliolaria remained in the development.

3. In the life cycle of modern sea lilies, only the following stages remained: doliolaria (non-feeding), metamorphosis. All stages, which precede doliolaria, are embryonized.

4. The plesiomorphic variant of the life cycle of Enteropneusta includes the following stages: blastula (embryonized), gastrula (embryonized), free-swimming dipleurula (starts feeding), free-living tornaria with intricately arranged ciliary band from Heider’s stage to Krohn’s stage (actively feeding), free-swimming Spengel’s stage with simplified ciliary band (non-feeding), metamorphosis.

5. Thus, there is reason to believe that the life cycle of the common ancestor of Ambulacraria included the following larval stages: free-swimming ciliated blastula, free-swimming ciliated gastrula, dipleurula with simple ciliary band (starts feeding), larva with intricately arranged ciliary band (actively feeding), larva with simplified ciliary band (non-feeding), metamorphosis. In different groups of Ambulacraria, the stages of life cycle were embryonized right up to achieving the direct development. In Asteroidea, Echinoidea, and Ophiuroidea, the stage of non-feeding larva with simplified ciliary band, i.e. doliolaria, is lost.

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AXIAL COMPLEX OF ORGANS: THE ECHINODERM KIDNEY IS HOMOLOGOUS TO THE HEMICHORDATE HEART-KIDNEY [talk]

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The question of the presence of the kidneys in echinoderms, comparable to kidneys of other invertebrates, is the subject of discussion. The kidney must to contain some morphological components: firstly, the net of haemal vessels, secondly, the coelomic cavities, where the liquid from the haemal vessels gets during the ultrafiltration, and thirdly, the excretory canal, which connects the excretory region of the coelom with the environment. In Echinodermata, the kidney’s functions are performed by the axial complex of organs (ACO). The blood net of ACO is represented by the system of haemocoelic spaces, which lie between the folds of the coelothelium of axial coelom. Contractions of the heart, which is enclosed into the pericardial coelom on the aboral side of the body, provide the directional movement of the blood. The heart accepts the blood from two aboral haemal rings: the gastric ring and the genital ring. Haemocoelic spaces of ACO are separated from the axial coelom by the basal lamina. The surface of this basal lamina from the side of coelom is covered by the coelomic lining, which contains the podocytes and epithelial-muscle cells. Contractions of the epithelial-muscle cells create the pressure, which provides the ultrafiltration of liquid from the haemocoel to the axial coelom. The liquid passes through the filter, which is formed by the basal lamina and is modified during the passing through the narrow spaces between the processes of the podocytes. The coelomic liquid with the products of excretion is removed from the axial coelom to the environment via the pores of madreporic plate.

The echinoderm kidney is homologous to the heart-kidney complex of another deuterostome phylum, Hemichordata. The hemichordate’s heart-kidney consists of the proboscis coelom, which is developed from the left axocoel of tornaria larva, the pericardial coelom, which is formed from the right axocoel, the heart, and so-called glomerulus, i.e. the net of haemocoelic spaces between the folds of the proboscis coelom. The liquid is filtered from the haemocoelic spaces of the glomerulus through the basal lamina, passes between the finger-like processes of the podocytes, and gets to the proboscis coelom. From there the liquid is excreted to the environment via the coelomoduct.

The heart-kidney of Hemichordata is undoubted homologue of the ACO of Echinodermata. It is formed from the homologous larval coeloms, has a significant similarity in the structure, and in addition is analogous in function. Probably, the predecessor of the heart-kidney has appeared in common ancestors of echinoderms and hemichordates. We can assume that the heart-kidney = ACO represents one of the most important synapomorphies of Ambulacraria.

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AXIAL COMPLEX OF CRINOIDEA: PLESIOMORPHIC OR DERIVED?
[talk]

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Axial complex of organs (ACO) of Crinoidea significantly differs from the ACO of other modern echinoderms. We have to decide, are these peculiarities plesiomorphic or derived? We studied the structure of ACO of Himerometra robustipinna (Carpenter, 1881) (Himerometridae, Comatulida).

Axial organ is located within the cavity of axial coelom. Axial organ extends along the oral-aboral body axis, and only in the most oral part it deviates from the central axis to the interradius AB. In the axial organ, we identify the lacunar region and the tubular region. The tubular canals of the axial organ have the cuboidal epithelial lining, and end blindly both on the oral and aboral sides. Axial coelom, perihaemal coelom, and genital coelom are separated from the general perivisceral coelom, but they connect with it and with each other via numerous openings. The oral haemal ring lies within the cavity of the perihaemal coelom, and communicates with the axial organ. In addition, the axial organ communicates with the haemal vessels of the intestine and with the genital haemal lacuna. Numerous thin stone canals pierce the spongy tissue of the oral haemal ring and at the same time they serve as a support for it. On the oral side, each stone canal opens into the water ring. Stone canals do not communicate with the environment. Instead of them, the numerous slender tegmenal pores, which pierce the epidermis of the oral side of the calyx, open to the environment. Pore canaliculi of the tegmenal pores lead into the bubbles of the perivisceral coelom.

For the crinoid’s ACO, it is characteristic the polymerized condition of some structures, which are oligomerized in other echinoderms, for example, numerous tegmenal pores and numerous stone canals. Numerous tegmenal pores of Crinoidea are the mere openings, which are scattered over the oral surface of the calyx. They are not gathered into the specialized madreporic plate as in Echinoidea, Asteroidea, and Ophiuroidea. We can consider this feature as a plesiomorphic state. At the same time, the perihaemal coelom of Crinoidea, which surrounds the oral haemal ring, is, possible, the result of fusing left axocoel and both somatocoels, which remain separate in other modern echinoderms. Herewith, the histological structure of the axial organ of Crinoidea is more similar to the axial organ (glomerulus) of Hemichordata. There are numerous coelomic tubular canals, between which the haemocoelic lacunae lie, in the axial organ of Crinoidea and Hemichordata.

Thus, ACO of Crinoidea has a plesiomorphic state and possesses a similarity to the ACO of hemichordates. It corresponds to the basal position of Crinoidea among the modern echinoderms.

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DIVERSITY OF ANTARCTIC ECHINOIDS AND ECOREGIONS
OF THE SOUTHERN OCEAN [talk]

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The Southern Ocean is currently facing significant environmental changes that might have deep and manifold impacts on the structure and functioning of marine ecosystems. In this context, understanding and forecasting marine species distribution is a pregnant scientific issue. Echinoids are common and diversified in benthic communities of the Southern Ocean. They are widely distributed, from the continental shelf to deep waters (below 5000 m), display contrasting ecological niches and habitats, and most species are endemic to the Southern Ocean (68%). Despite recent sampling efforts, our knowledge of echinoid distribution in the Southern Ocean is still incomplete. Several statistical and model approaches have been developed to address this issue and understand the factors that determine echinoid distribution. Species distribution modeling is one of them. It is based on georeferenced occurrence data and environmental parameters to estimate species total distribution over their entire distribution range and at broad spatial scale. Individual species distribution models can then be merged into ecoregions, a convenient approach to address conservation issues. These individual species models and ecoregions can be used to predict species and community distribution shifts for the different IPCC scenarios of climate change.
DIVERSITY OF EARLY FORCIPULATAE (ASTEROIDEA) [talk]

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The clade Forcipulatae, comprised of about 400 extant species, is well-defined morphologically. A reliable identification of a fossil form requires the preservation of complete body, which is exceptional in a fossil record that remains relatively sparse. We here reappraise four fossil forms from the Jurassic of England that belongs to Forcipulatae, but has not always been recognized as such: Asterias gaveyi Forbes 1850, Compsaster spiniger Wright 1880, Ophiidiaster davidsoni de Loriol and Pellat 1874 and Terminaster cancriformis Quenstedt 1876.

Extensive observation of these four fossils, including key details of the abactinal skeleton, ossicle spination and, where present, pedicellariae, combined with detailed comparative anatomical studies of extant taxa suggest that they need re-assignment. A phylogenetic analysis comprising 29 extant forcipulataceans and the 4 fossil forms was performed. 115 characters were derived from the skeleton with emphasis on the organisation of the abactinal skeleton, as most of the synapomorphies of the extant clades (i.e., for the Asteriidae, the Stichasteridae) address the abactinal skeleton structure.

The results of the phylogenetic analysis place A. gaveyi and T. cancriformis along the stem of crown Zoroasteridae, supported at this position by their compact abactinal skeleton and the lack of crossed pedicellariae. These two fossils challenge previous hypotheses regarding the homology of the unique row of marginals in zoroasterids, as two rows of marginals can be identified in T. cancriformis. Ophiidiaster davidsoni is retrieve within the Stichasteridae, and C. spiniger within the Asteriidae. Although the latter possesses crossed pedicellariae, there is no trace of a wreath organ, which is the most distinct synapomorphy of Asteriidae.

The position of the fossils in the tree suggests an early diversification of Forcipulatae during the Jurassic. The reanalysis of these taxa demonstrates that the early diversity of the Forcipulatae was greater than previously thought and challenges existing perceptions of the evolutionary history of this major clade.
PRELIMINARY INTERACTIVE IDENTIFICATION KEY TO IDENTIFY BRITTLE STAR FAMILIES (ECHINODERMATA; OPHIUROIDEA) [talk]

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The class Ophiuroidea is the largest taxon among extant echinoderms, with over 2000 described species. In this study, the first interactive identification key for type species of 33 families of Ophiuroidea was developed and revised taxonomic diagnoses are provided. The key was built by internal and external characters including at least two mutually exclusive attributes per family. Moreover, different numeric and multistate characters were used to make a traditional as well as an interactive key using the DELTA software. Illustrations (SEM and digital photos) will be included to facilitate the assessment of character states. Not only is it the first identification key for the families according to the recently proposed new classification, but this interactive key also helps users in family level taxonomy of brittle stars as easily as possible. As the interactive key allows new characters to be added, a more precise identification will become possible as the project progresses and more morphological traits are included.
Echinocyamus, A Boring Story Through Time [talk]

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The dwarf pea-urchin genus Echinocyamus is ubiquitous in the fossil record and modern ecosystems worldwide. Today, this minute burrowing echinoid lives in shallow-water and deep-sea sediments from the polar regions to the tropics. When present, both in recent environments and in the fossil record, tests of this clypeasteroid are typically abundant. Structural analysis reveals that Echinocyamus tests are highly reinforced and performative structures capable of surviving heavy load conditions that can allow preservation in numerous paleoenvironments. Although one of the most diminutive echinoids, Echinocyamus represents a major food-source for predatory (drilling) cassid gastropods. Due to the high preservation potential of Echinocyamus tests, predatory drill holes are often well preserved in both modern and fossil tests, where drill-hole morphology still exhibits features that can be confidently attributed to the predatory cassids.

The high preservation potential of tests and the holes found therein, as well as the abundance of Echinocyamus tests throughout the Cenozoic, make them particularly suitable for assessing evolutionary history of cassid-echinoid predator-prey interactions. Here, modern Echinocyamus populations from Italy and Egypt were compared to fossil occurrences from Germany, Italy, Malta, Poland, and the US. The fossil tests were examined for presence of drill holes and microstructures that may be indicative of predatory origin of drilling trace. Furthermore, test dimensions, drilling frequencies, predatory site and size selectivity were used for comparative analyses.

Results show that drilling predation traces are common and often nearly pristinely preserved. Drill hole microstructures such as profile, circularity, outline, and dimensions indicate that these trace fossils are of biotic origin, most likely produced by predatory snails, which are only represented by cassid gastropods today. The interpreted drill holes account for drilling frequencies between 0 and 71%. Predatory patterns such as dominance of single, unhealed holes and spatial drilling preferences for the aboral test side and the petalodium are consistent through time and across the sampled geographic range. Other parameters such as test size selectivity by the predator and drilling frequencies vary through time and space.
DRILLING PREDATION ANALYSIS: THE RELIABILITY OF MEASUREMENTS [poster]

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Drilling predation upon shelled marine invertebrates is a common and well-known biotic interaction in benthic communities. Predatory signals such as stereotypic drilling patterns, predatory etching or grasping marks and the drill hole morphology can provide insight into the predator-prey system. Drill holes in echinoids are often found well-preserved in modern ecosystems and the fossil sedimentary record. The drill hole morphology, however, vary among species and produce numerous shapes which can make comparable and reliable measurements difficult.

In this research, drill hole shapes ranging from perfect circles to irregular polygons are compared using different measurement methods. The length, width and area of the shapes were digitally determined by image based analysis and statistically compared for the accuracy and precision of measurements. Results of this evaluation are compared to measurements obtained from an analogue caliper and are discussed with respect to their significance in result interpretation. Advantages and limitations of image based and analogue measurements are additionally discussed on a dataset from the field.

Results indicate that image-based measurements of length and area provide a high accuracy and precision, where the precision of the measurement correlates with the drill hole outline. For a perfect circle, length measurements are most precise, whereas area measurements deviate slightly. The more irregular a drill hole is, the higher is the deviation from central tendency. In average, length measurements possess the highest deviation from central tendency, whereas area measurements show more accurate results. Statistical analysis thus show that area measurements should be preferred over length measurements when drill holes are irregular. In addition, digital measurements should be chosen over manual caliper measurements as the latter has been shown to alter drill hole outlines.
RECENT DISCOVERIES SHED LIGHT ON THE ORIGIN OF CRINOIDS [talk]

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Crinoid origins are currently debated in sharply divergent ways, with radically different conclusions ultimately arising from differing interpretations of basic anatomy. The only way to end this impasse requires additional evidence, and that is the focus here. One hypothesis suggests a blastozoan as the nearest crinoid ancestor, this through identification of purported homologous plate systems linking these two groups. Two primary lines of evidence have been relied upon to support this interpretation. First, there is the question of “oral” plate homology. “Orals” occur sporadically among crinoids, and strong phylogenetic evidence indicates they originated independently and asynchronously among different groups. For example, “oral” plates of the cladid Hybocrinus have been declared homologous with those of many derived blastozoans, overlooking recent works demonstrating that the two earliest-known hybocrinids express many tiny tegmen plates and no “orals” at all. Second, a Late Ordovician blastozoan, Eumorphocystis, has been interpreted to possess brachial and radial plates homologous to those of crinoids. This claim for Eumorphocystis is founded primarily on the supposed presence of what is interpreted as the most diagnostic character of crinoid arms in this blastozoan, coelomic cavities extending from and in continuity with the thecal cavity. In fact, Eumorphocystis arm cavities do not extend to the thecal interior. In keeping with the derived nature of this stratigraphically late taxon, the arm cavities of Eumorphocystis have no homology with the crinoid configuration, undermining attempts to interpret a sister taxon relationship with crinoids.

The record of earliest crinoids has greatly expanded from just one 20 years ago to seven now. These taxa include camerate-like, cladid-like, and disparid-like forms. This overall taxonomic framework fails to underscore the phylogenetic significance of this earliest assemblage, all members of which share a trait mosaic unlike their later Ordovician counterparts: 1) a pentameric stalk whose proximal-most meres interlock with the cup-base circlet plates, 2) irregular cup plating, 3) interradial plate fields, 4) internal floor plates expressing podial basins, and 5) cover plates arranged in lateral and medial tiers. These synapomorphies lead to a previously unavailable database early in crinoid history. A diversity of blastozoans, edrioasteroids, a stylacidian, and all Tremadocian crinoids, were, for the first time, incorporated into a phylogenetic analysis with these data rooted on the early radiate echinoderm Stromatocystites. Camptostroma, a Cambrian radiate echinoderm with short arm-like extensions of the ambulacral tips and associated thecal wall was included, as were new data from Hybocrinus, Carabocrinus, another early cladid with supposed “orals”, and Eumorphocystis. The recovered trees produced no phylogenetic signal deriving crinoids from among blastozoans. Crinoids branch directly from edrioasteroid-like radiate echinoderms with Camptostroma as a pre-crinoid intermediary.
Ophiocnemis marmorata (Lamarck, 1816) is a shallow-water brittle star, widely distributed around the Indian Ocean to the western Pacific Ocean. This species is not only found from sandy sea bottom but also recorded riding on some jellyfish species. We found abundant brittle stars from the jellyfish, Lobonemoides robustus, Rhopilema hispidum, and Versuriga anadyomene. The brittle stars on the jellyfish were from 1 to 11 mm in disc diameter while those found on the sea bottom were about 10–24 mm in disc diameter. The post larvae of O. marmorata may settle on the jellyfish and leave them for the sea bottom when they grow to be about 10 mm in disc diameter. The brittle stars can be dispersed using jellyfish when young but live on the bottom when adult.

In this study, to estimate the population genetic structure, we performed multiplexed inter simple sequence repeat genotyping by sequencing (MIG-seq) using a total of 253 individuals of the brittle star associated with jellyfish collected from Thailand, Malaysia, Philippine, Australia, and Japan, and living on the sea bottom in Singapore and Thailand. Obtained large SNP datasets were assessed using STRUCTURE 2.3.4.

The result indicated that each of the brittle star populations was rather homogeneous; however, even at the same sampling locality, individuals collected in a different period belong to a different cluster. The genetic structure indicated that O. marmorata has high dispersal ability, and its population structure strongly depends on the life history of jellyfish.
EXCEPTIONALLY PRESERVED LATE ORDOVICIAN ‘STARFISH BEDS FROM THE TAFILALT AREA, MOROCCO, IMPLICATIONS FOR THE GREAT ORDOVICIAN BIODIVERSIFICATION EVENT
[poster]

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The Upper Ordovician series of the Tafilalt area (eastern Anti-Atlas, Morocco) have yielded several echinoderm Lagerstätten (or ‘starfish beds’) providing a relatively continuous record of successive, nearshore, cool water, echinoderm-dominated assemblages from the early Sandbian to the Hirnantian. During this time interval, the composition of the majority of the Tafilalt echinoderm assemblages shows relatively little change, with the persistence of the same dominating groups such as crinoids coronates diploporitans edrioasteroids, eocrinoids, glyptocystitid rhombiferans, solutans and stylophorans. However, these assemblages represent one of the earliest episodes where ophiuroids and asteroids have become a significant, and in some cases dominant part of the some of the assemblages. This includes some of the earliest preserved examples of dense aggregations of brittle stars or echinoderm meadows often observed today in deep water/cool water habits. Unlike assemblages of comparable age such as Ladyburn Starfish Beds, Scotland, these examples are likely to be in-situ. Closer examination of the generic and specific content of the three main asterozoan assemblages reveal that distinct assemblages first dominated by protasterid ophiuroids that appeared in the early Ordovician while other assemblages contain entirely new taxa of both ophiuroids and asteroid and represent the rapid diversification of the these groups during the GOBE.
A NEW SOMASTEROID FROM THE FEZOUATA LAGERSTÄTTE IN MOROCCO AND THE EARLY ORDOVICIAN ORIGIN OF ASTEROZOA [talk]

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Somasteroids are widely regarded as ancestors of Asterozoa, the group of echinoderms that includes brittle stars and starfish. The phylogenetic position of somasteroids makes them critical for understanding the early evolution of crown group Echinodermata. However, the origin of asterozoans, the assembly of their distinctive body organization and their relationships with other Cambrian and Ordovician echinoderms remain problematic due to the difficulties of comparing the calcitic endoskeleton of the disparate groups. Here we describe the new somasteroid \textit{Cantabrigiaster fezouataensis}. A primitive asterozoan from the Fezouata Lagerstätte, Morocco with a unique endoskeletal arm organization that reveals the ancestral morphology of this major clade. \textit{Cantabrigiaster} differs from all other known asterozoans in the absence of adambulacral ossicles defining the arm margins, evoking parallels with non-asterozoan echinoderms. Developmentally informed bayesian and parsimony based phylogenetic analyses, which reflect the homology of the biserial ambulacral ossicles in Palaeozoic echinoderms indicate that it is the earliest diverging stem-group asterozoan revealing the ancestral morphology of this major clade. Our results clarify the affinities of problematic asterozoans. Somasteroids are resolved as a paraphyletic grade within stem and crown group Asterozoa, whereas stenuroids are paraphyletic within stem-group Ophiuroidea. \textit{Cantabrigiaster} illuminates the relationship between Ordovician crown group Echinodermata and its Cambrian stem lineage.
A NEW FOSSIL SPECIES OF THE GENUS OPHIURA (ECHINODERMATA, OPHIUROIDEA) FROM THE MIOCENE DUHO FORMATION, KOREA [poster]

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A series of articulated ophiuroid specimens preserved as external moulds and assignable to a new species of the genus Ophiura were found in the Miocene Duho Formation (Yeonil Group) in Pohang City, Korea. The genus Ophiura is among the most speciose, currently including more than 300 species, both extant and fossil. In order to identify the new Korean fossil specimens, we compared them with 19 living congeners occurring around Korea and Japan, as well as 24 fossil species of Jurassic to Pleistocene age from Greenland, Europe, USA, Korea and Japan, all placed in the genus Ophiura.

The present specimens expose both dorsal and ventral sides and have a thin disc covered by imbricating or abutting scales with large central disc plates, separated radial shields, slender, gradually tapering arms, contiguous and trapezoidal dorsal arm plates, contiguous tiny genital plate papillae at the arm base, large superficial second oral tentacle pores adjacent to the mouth slit and covered by papillae, contiguous tiny genital scales, adpressed tapering arm spines, lateral arm plates separating the ventral arm plates and having a pair of rounded arm spine articulations at the distal end of the lateral arm plates. Although the new species is similar to extant Ophiura sarsii sarsii in the over all appearance, it belongs to an undescribed species, judging from the long and spiniform apical and oral papillae, and tiny, squarish and contiguous arm comb papilla.

In previous reports, fossil ophiuroids from the Duho Formation, Korea, were tentatively assigned to extant species of Ophiura. However, these identifications were inappropriate because of insufficient morphological observations. Thus, the new species is the first specifically identified fossil record of the ophiuroids in Korea.

The 23 specimens of the new species occur in dense aggregations on four slabs, almost all exposing the ventral side on the bedding plane; the arms were extended and only slightly bent; most of individuals were not in contact or overlapping, suggesting an autochthonous occurrence. Aggregation density (506 inds./m², calculated from 23 inds./644 cm²) of the present specimens is similar to those of the extant and fossil Ophiura sarsii sarsii occurring around Japan.

The new species is inferred to have lived in a deep water setting, judging from sedimentary structure analysis of the Duho Formation and co-occurring benthic foraminifers (e.g. Uvigerina proboscidea), mollusks (e.g. Yoldia sagittaria) and a trace fossil (Chondrites isp.).
CRINOID STEMS DISTRIBUTION IN THE ORDOVICIAN
OF ST. PETERSBURG REGION, RUSSIA: PRELIMINARY DATA [poster]

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In the carbonate Ordovician of the Eastern Baltic the crinoid stem fragments are the significant part of the bioclasts in normal-marine sediments. The abundance and relatively high rates of evolution make crinoid stems a perspective tool for intrabasin correlation. The crinoid stratigraphy was developed by some researchers (Yeltyscheva, 1964, 1966; Hynda, 1986) but it is still far from practical application due to insufficient taxonomic, stratigraphic and facial knowledge of the crinoid stem complexes. The preliminary stratigraphic distribution of the crinoid stems at 17 sections of the Middle and Upper Ordovician (Volkhov-Keila Stages) is studied at Russian part of the Baltic-Ladoga Klint. The bulk samples of 2–5 kg were taken at 30 levels. The following results are obtained.

1) About 50 «species», established by previous researchers (Eichwald, 1860; Öpik, 1934; Eltysheva, 1964, 1966; Hynda, 1986; Rozhnov, 1988, 1990), make up less than 30–50% of the real composition of the complexes. *Grammocrinus* Eichwald, *Sphenocrinus rarisulcatus* Yeltyscheva, *Tetragonocrinus pigmeus* Eichwald, *Baltocrinus balticus* Yelt., *B. hrevikensis* (Yelt.) indicated as typical (Eltysheva, 1964, 1966) are rare/absent in bulk samples. Most taxones have another stratigraphic range. For example, *Sphenocrinus* Eichwald was believed to have existed from Volkhov to Kunda Stages, but it reaches to Lasnamägi Stages at least.

2) The complexes are strongly endemic. Rare «species» are similar to *Ranuncucolumnus* Donovan (Avalonia), *Bystrovicrinus* Stukalina, *Dentiferocrinus* Yelt. and *Fascicrinus* Stukalina (Kaakhstan, Siberian platform). These similarities are most likely are convergence.

3) Two groups of «genera» can be distinguished: a) the basic ones, having a wide stratigraphic range, b) the local ones which occur at narrow intervals. The basic «genera» show continuous speciation throughout Dapingian-Darrivilian (*Sphenocrinus*, *Crenatocrinus* Hynda), Darrivilian-Sandbian (*Baltocrinus* Stukalina, *Equitanicrinus* Stukalina, *Ristnacrinus* Oepik, *Schizocrinus*, *Teicherticrinus* Stukalina).

4) Significant changes in the crinoid complexes are observed at the boundaries of Volkhov/Kunda, Kunda/Aseri and Kukruse/Idavere Regional Stages. The Kunda Stage are characterized by the species of «Babanicrinus assemblage» – *Babanicrinus pentaporus* (Eichwald), *Crenatocrinus* sp., *Variabilicrinus variabilis* (Yelt.), and, in upper part, *Sphenocrinus irenensis* Yelt., *S. quinquevalatus* Yelt., *Decacrinus* antiquus (Yelt.), *Squameocrinus privus* (Yelt.). They all together with *Sphenocrinus obtusus* Eichwald (occurs from Volkhov Stage) disappear near the Kunda Stage top. From the base of upper Kunda Substage, the first «species» of typical Darrivilian-Sandbian «genera» appear, such as *Ristnacrinus* sp., *Baltocrinus balticus*, *Schizocrinus* stellatus Yelt. and *Teicherticrinus* sp. The Aseri and Lasnamägi Stages consisting *Asericrinus* cf. *aseriensis* (Yelt.) and undescribed crinoid stem «species» belonging to «genera» *Sphenocrinus*, *Squameocrinus*, *Crenatocrinus*, *Schizocrinus* (sp.1, sp. A). The Kukruse Stage consisting *Ristnacrinus marinus* Oepik, «Schizocrinus» sp. B-F and *Squameocrinus* sp.2, but the appearance level of this fauna is not found. The basal Idavere strata show the appearance of undescribed five «species» of *Schizocrinus* (sp. G-L restricted by Idavere and lower Jõhvi strata), such as typical *Teicherticrinus angulatus* (Yelt.) and *Virucrinus kegelensis* (Yelt.). Throughout the Jõhvi and Keila Stages taxonomic diversity and the number of crinoids is reduced, which partly due to transition to coastal environments with high salinity (upper part of the Keila Stage).
FOREIGN COMPONENTS AMONGST CRETACEOUS ECHINOIDS FROM Plio-Pleistocene Gravel Deposits in the Netherlands [poster]

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In the Netherlands erratic macrofaunal assemblages of a northerly, (north)easterly and south/southeasterly origin are common, as a result of Pleistocene glaciations, the Eridanos Stream and rivers such as the Maas (Meuse) and Rhine and their tributaries. A typical element in Pliocene and Pleistocene sand/gravel deposits in the Belgian and Dutch provinces of Limburg are flint nodules and cobbles, mostly cavernous and/or angular and with patina. These are undoubtedly of a local/regional origin, having been known for a long time and familiar faunal elements such as echinoids, e.g., cassiduloids (Oolopygus gr. pyriformis), holasteroids (Echinocorys spp., Hemipneustes striatoradiatus), microasterids (Diplodetus spp.) and hemiasterids such as Bolbaster koninckanus and B. prunella, as well as asteroids (Nymphaster studlandensis). Amongst regular echinoids, Gauthieria is common. In general, these flints are of late Maastrichtian age, having been derived from the Gulpen Formation (mostly Lixhe 1-3 and Lanaye members) and overlying Maastricht Formation.

The other flint component is invariably well rounded, abraded and more or less polished, being of elongate, oval or near-circular shape, of variable dimensions (20-100 mm) and colour: light grey to dark blue and black, with all intermediates. These are the so-called ‘Maaseieren’ (Dutch for ‘Meuse eggs’) that occur across southern Limburg (the Netherlands), the Lower Rhine Embayment north of Aachen (Germany) and the Campine area in northeast Belgium. These have a chequered history of repeated erosional and depositional events and, as a consequence, can only be dated if containing age-diagnostic macrofossils. In addition to an earlier record of a saleniid, Bathysalenia sp. and cidarid primary spines, we here add Tylocidaris clavigera and Plesiocorys (Sternotaxis) plana. In the Anglo-Paris Basin, the former ranges from the upper Turonian to lower Santonian, while the latter is common in the upper Turonian. Other, non-echinoderm macrofaunal elements in such flint eggs include siliceous sponges and inoceramid and limid bivalves that are not known in situ in the Upper Cretaceous (middle Santonian to upper Maastrichtian) strata in the study area. From recent reconstructions of the courses of late Cenozoic and Pleistocene rivers in northwest France and across southern and central Belgium, it would appear quite possible for such flint eggs to have originated from those areas and made their way, after progressive uplift of the source area and following the uniform parallel drainage system across central Belgium towards the Roerdal Valley Graben in the northeast. This hypothesis needs to be tested in the near future on the basis of additional material from a variety of localities and lithostratigraphical units.

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EFFECT OF DOPAMINE ON PHENOTYPIC PLASTICITY IN LARVAE OF SEA URCHINS [poster]

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It is well known that pre-feeding larvae of many echinoids are able to differentially grow their post-oral arms depending on microalgae concentration. Often this phenomenon considered as an offensive response which allows larvae to improve food acquisition when food is scarce. Although the effect of algae concentration on post-oral arms growth is documented well, little is known to date on the mechanism underlying this phenomenon. Existing data suggest that developing larvae use chemosensation to detect algae in their environment and “adjust” the growth rate of post-oral arms through dopamine signaling. Here we tested the effect of dopamine on developing larvae of the sea urchin Strongylocentrotus intermedius. Our results show that dopamine significantly affects the post-oral arms growth in a concentration-dependent manner: the higher the concentration of dopamine, the shorter the post-oral arms. In absolute values, the difference in mean length of post-oral arms in 4-day-old plutei was 4.2% for no dopamine vs. low dopamine (0.5 μM) conditions and 12.7% for no dopamine vs. high dopamine (1.5 μM) conditions. The difference in mean length of body rods and length of body midline between different experimental conditions did not exceed 2%. A cLSM study of formaldehyde-glutaraldehyde-induced fluorescence of catecholamines showed that 2-day-old plutei of S. intermedius already have two well-developed groups of 2 to 4 catecholamine positive cells at the base of each post-oral arm. Our results support the already published data that dopamine plays an important role in regulation of the post-oral arm growth in pre-feeding larvae of sea urchins.
CELLULAR SOURCE OF DIGESTIVE SYSTEM REGENERATION IN LAMPROMETRA PALMATA AND ANNEXIA BENNETTI [poster]

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The aim of this study was to identify the cellular source of digestive system regeneration in two feather stars, Lamprometra palmata (Müller, 1841) and Annexia bennetti (Müller, 1841). These species belong to different families and vary in the ability to autotomize the visceral mass, the complex of internal organs comprising the digestive system. *L. palmata* is able to autotomize the whole visceral mass and regenerate it extremely fast. It takes only four days to regenerate a small digestive system. In contrast, *A. bennetti* cannot autotomize its digestive system. After excising the visceral mass, the animal regenerates it within approximately 25 days.

A transmission electron microscopic (TEM) study showed that in *L. palmata* the digestive system regenerates from juxtaligamental cells, which transdifferentiate directly into enterocytes. After autotomy, a pool of these cells was observed on the calyx surface in the damaged septa of the aboral coelom and in the upper third of the skeletal element. The transdifferentiated juxtaligamental cells migrate to the surface of regeneration, where they form a new digestive system. On day four post-autotomy, vesicular and granular enterocytes were observed in regenerating digestive epithelium. In *A. bennetti*, an open wound appeared on the surface of the calyx after excising the visceral mass within at least 14 days. The wound disappeared only on day 25 post-autotomy, when a fully formed visceral mass was observed on the surface of the calyx. A TEM study of regeneration in *A. bennetti* showed that enterocytes of the digestive system regenerate from the remaining cell of coelomic epithelium of the damaged septa on the calyx surface. These cells transdifferentiate and migrate to the surface of regeneration where they form the anlage of digestive system. Digestive epithelium was observed on the calyx surface on days 10 to 14 post-autotomy. Subsequently, the wound was covered by epidermis, growing from the edges of the wound.

Our results indicate that feather stars, differing in the ability to autotomize their visceral mass, also differ in rate and cellular sources of digestive system regeneration.
TRACES OF THE ANTEMORTEM INJURIES IN THE TESTS OF THE LATE CRETACEOUS ECHINOIDS [poster]

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Large numbers of papers on paleoecology and taphonomy of fossil echinoids, inclusive of the Late Cretaceous ones, have been published recently. Numerous examples of epibiotic connections have been cited: traces of drilling and various organism attachments to the tests, bite marks, both antemortem and postmortem. There is, however, very little information on the antemortem injuries in the Late Cretaceous echinoids that are unrelated to commensalism, predation, parasitism or other actions of other animals, and have left the organism to survive and to go on developing. We believe this may be exemplified by means of three echinoid specimens from the Turonian and the Campanian of the Bolshevik section (the town of Volsk).

Fragments of inoceramid shells are ingrown in the tests of *Echinocorys ovata* (Leske), *Conulus matesovi* Moskvin from the Lower Campanian and in *Micraster corbovis* Forbes from the Middle–Upper Turonian. The *E. ovata* (Leske) test bears the largest number of injuries: fragments of the mollusk shell, ingrown at various angles, occur in seven places of the oral surface, inclusive of the peristome area. The *C. matesovi* Moskvin also has a foreign fragment on its oral surface, and *M. corbovis* (Forbes) – on the aboral surface, ingrown practically at right angle. The fragments vary in sizes, they are mostly sharp and non-rounded, from a few millimeters to a centimeter long and up to one millimeter thick; the depths of their penetration into the test are also different, some of them go all the way through. The injury edges are even, non-ragged or broken, mostly adherent to the foreign objects and occasionally slightly running over them due to accretion of secondary calcite.

Certain conclusions on the mechanisms of damaging may be made on the basis of studying some previously described aspects of the location geology and taphonomy. The foreign objects could have been introduced into the tests of still juvenile specimens during some storm that could have provoked the test collision with a freshly broken inoceramid shell lying on the sea bottom. Similar pattern accounts for the injuries on the oral surfaces of *E. ovata* (Leske) and *C. matesovi* Moskvin – the forms that move freely over the substrate. The mechanism may be slightly different in case of *M. corbovis* (Forbes), peculiar for burrowing way of living. Since the injury is recorded only in the aboral surface, one may suggest that the thin test insufficiently immersed in the sediment was crushed down by an inoceramid shell fragment during a storm, and a part of that fragment happened to find its way inside. All the injuries proved to be nonlethal and the organism managed to heal them and to survive, while the fragments of the mollusk shell stayed stuck in the developing test.
TURONIAN – CONIACIAN ECHINODERMS FROM THE SOUTH OF THE RUSSIAN PLATFORM [poster]

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At present, our knowledge on the taxonomic composition and the stratigraphic distribution of most groups of the Late Cretaceous echinoderms from the Russian Platform are fragmentary. In this regard, new finds of echinoderms from two poorly studied Turonian – Coniacian sections “Chukhonastovka” and “Kamenny Brod” are of great interest. These sections are located in the Lower Volga Region, within the Olkhovsky District of the Volgograd Oblast and are confined to the southern part of the Ulyanovsk-Saratov Basin. Crinoids, specially Bourgueticrinus (columnals, holdfasts, as well as incomplete cups) are one of the most numerous echinoderm fossils collected from the Turonian of the “Chukhonastovka” section. Two different species were identified on the basis of cup fragments: B. fischeri and B. ellipticus. Pentacrinids are more rare. Studied pentacrinid columnals are rounded-pentagonal in cross-section and bear a characteristic spinous sculpture. According to the morphology of the sculpture, they can be attributed to Nielsenicrinus carinatus. The studied specimens are the earliest records of this species from the Turonian. An isolated centrodorsal of the comatulid crinoid Glenotremites paradoxus is found in the Turonian section of “Chukhonastovka”. Echinoids are represented by numerous spines and test fragments of Echinocorys sp., a single specimen of Gauthieria radiata and isolated plates of indeterminate cidarids. Asteroids are represented by numerous marginal plates of indeterminate goniasterids, and ophiuroids are represented by isolated arm segments of Ophiotitanos serrata and Ophioderma ? radiatum. This first species had the widespread distribution in the Late Cretaceous – Paleogene sediments, while the second species is previously known only in Campanian–Maastrichtian. Similar but more depleted echinoderm assemblage was determined from “Kamenny Brod” section. Echinoids (spines and test fragments of Echinocorys sp.), crinoids (Bourgueticrinus sp., ?Nielsenicrinus carinatus) and gonasterid plates were collected in this section. These taxa were found here in both the Turonian and the Coniacian sediments. The level of echinoderms concentrations established in the microfossil samples in the lower part of the “Kamenny Brod” section, as well as in the sections “Chukhonastovka-1-3”, can be traced in more northern areas of the right-bank of the Volga Region. The obtained results allowed to significantly expand the data on the taxonomic diversity of the Late Cretaceous echinoderms, and also to confirm the previously proposed hypothesis about the time and pathways of their migration and distribution in the Late Cretaceous. The described echinoderm assemblage is also interesting because it is one of the richest and most diverse Turonian echinoderm assemblages from the Russian Platform.
Two species of elpidiid holothurians, *Elpidia heckeri* and *Kolga hyalina*, are common in many deep-sea benthic communities of the Arctic Ocean. In the present study we examined population density, size structure and reproductive stage of *E. heckeri* and *K. hyalina* aiming to understand their ecological preferences and possible competition. The material was obtained in the abyssal of the Nansen and Amundsen Basins during the *Polarstern* cruise IceArc in 2012 (02.08–29.09), and also in the 72 cruise of RV *Akademik M. Keldysh* in 2018. The seafloor was photographed at nine stations using a towed camera platform OFOS. At seven of these stations Agassiz trawls were taken.

The ice thickness at the stations varied affecting the growth of ice algae. OFOS observations revealed algal patches covering from 0 to 10% of the seafloor suggesting notable difference in organic matter supply between stations. More stable populations of both species occurred closer to the ice margin east of 75°E.

Populations with low to average density and larger body were found in the areas under the thinner ice. Food supply in this area is suggested to be more regular. Under the thicker ice, and also in the western part of the Nansen Basin, two types of populations was found. The first type was characterized by low population density and relatively small size of individuals. In the second type, density was high, especially of *K. hyalina* reaching 1.7 ind.·m$^{-2}$, with right-skewed size distribution curve and absence of age cohorts. In this area with generally lower carbon flux massive algal falls apparently occur occasionally.

Boetius et al. (2013) showed that *E. heckeri* and *K. hyalina* selectively utilize freshly sunken ice diatom *Melosira arctica*. Chl *a* measurements of the gut content in both species showed that its concentration was up to 300 times higher than in surrounding sediment.

Seasonal reproduction was suggested for both species. Smaller eggs in *K. hyalina* suggest its higher fecundity.

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COLLECTION OF ECHINODERMATA IN THE P.P. SHIRSHOV INSTITUTE OF OCEANOLOGY, RUSSIAN ACADEMY OF SCIENCES [poster]


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Collection of Echinodermata has been in existence since the establishment of Shirshov Institute of Oceanology in 1946. It comprises species of all recent classes of Echinodermata collected by numerous Soviet and Russian expeditions onboard RV Vityaz, Akademik Kurchatov, Dmitry Mendeleev, Akademik Mstislav Keldysh and others. The collection comes from across the globe from shallow to hadal depths. It contains ~10000 lots including type specimens of mainly deep-sea species. Many known echinoderm taxonomists worked with echinoderms here: G.M. Belyaev, Z.I. Baranova, N.M. Litvinova, A.V. Smirnov and others. Since 2018 an electronic database has been established on the basis of Specify Software platform; to date it comprises ~1000 lots.
268 MILLION YEARS OF ECHINOID MITOCHONDRIAL STABILITY
[talk]

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Extant echinoids are subdivided into two major groups, the cidaroids, with a single, often massive primary spine per plate, and the euechinoids, with numerous primary spines per plate. Based on their fossil record our understanding of the phylogeny of the Echinoidea suggests that the two groups diverged in Late Palaeozoic. The oldest known cidaroid is Permian (Roadian–Capitanian) in age, placing the divergence of the two groups at at least 268.8 million years before present. Recent research suggests that a large-scale reorganization of echinoid gene regulatory networks occurred prior to the divergence of cidaroids and euechinoids.

Here we present 12 new complete echinoid mitochondrial genomes including, for the first time, four complete and fully annotated genomes of the order Cidaroida assembled from next-generation sequence data. Additionally, we provide eight corrected and newly annotated mitochondrial genomes from the family Strongylocentrotidae. Results of our phylogenetic analysis provide strong support for the basal placement of cidaroids among the Echinoidea. The eight corrected strongylocentrotid mitogenomes are similarly well supported, and this family now holds 20 complete mitogenomes (the highest number of all echinoid families). Deviations from the standard echinoid mitochondrial genome order observed in some Strongylocentrotids before could be shown to be based on misassemblies.

Despite the long divergence time of cidaroids, echinoid mitochondrial genomes are surprisingly conservative. This observed stability of echinoid mitochondrial genome is in stark contrast to the situation observed in other echinoderm groups, particularly ophiuroids, which show multiple mitochondrial genome rearrangements in different subclades.
MORPHOLOGY, CLASSIFICATION AND LINEAGE OF SEA URCHINS OF THE SUBORDER URECHININA (ECHINOIDEA: HOLASTEROIDA) OF THE MESOZOIC AND CENOZOIC BOUNDARY OF THE MANGYSHLAK PENINSULA [poster]

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Three species of sea urchin from the Upper Paleocene of the Mangyshlak Peninsula were studied: \textit{Garumnaster michaleti} (Lambert, 1907), \textit{G. luppovi} (Weber, 1949) and \textit{Basseaster rostratus} (Lambert, 1936). These species in a number of published works are presented only in short diagnoses. The systematic position of these species was also not entirely clear. In the Foundations of Paleontology, \textit{G. luppovi} was assigned to the genus \textit{Duncaniaster} (Poslavskaya, Solovjev, 1966).

A detailed study of the morphology of these species was conducted. Comparison of the structure of the apical disc, the paired interambulacral zones, the plastron and some other parameters made it possible to reconsider the position of these species in the system. \textit{G. michaleti} and \textit{G. luppovi} have features characteristic of Urechinina: subanal fasciole, absence of genital pores in the madrepores, orthosternous plastron without rostral plate, meridoplacoid posterior pair of interambulacrum. Also when comparing with other genera of this suborder, between \textit{G. luppovi} and \textit{G. parvus}, the greatest similarity was found in the location of the plates of the apical system and the plastron and in the location of the periproct. It was concluded that they should be attributed to the same genus. However these are significantly different species, since there are differences in the shape of the shell, in the location of the peristom, and in the proportions of the plates of paired interambulacrum and plastron.

In addition, in these species, variability was found in the structure of the anterior pair of interambulacrum. The prevailing number of specimens was observed in the meridoplacoid interambulacrum paired. But a small number of specimens had an amphiblacoid anterior pair of interambulacrum. Such cases were observed in both species.

The modern Urechinida is widely represented in the bathyals and abyssals of modern oceans. The main apomorphies characteristic of this family are: subanal fasciola, absence of genital pores in the madrepore, meridoplacoid (2nd and 3rd) interambulacrum. Early Urechinina (the end of the Cretaceous, Paleocene) is not always a complete combination of these signs. This was shown, in particular, on the changeable structure of the second and third interambulacrum of the \textit{Garumnaster} genus. The genus \textit{Basseaster} from the Danish stage has four genital pores, not three, like other members of the family.
BOLBOPORITES: THE INTERPRETATIONS GETTING BACK ON TRACK [poster]

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Bolboporites are small (up to 15 mm) calcite body cone-shaped with a smooth base, on which there are always two paired pits and a coarsely cellular lateral surface. A thin longitudinal canal passes inside the body from sharp end to the smooth surface where it opens near paired pits. Bolboporites are often found in the Ordovician deposits of Balto-Scandia and North America and for 190 years attracted the attention of various researchers.

The body shape characteristic of Bolboporites is found in many marine invertebrates, and as a result, for a long time, they have been assigned to different types of animals. Bolboporites were first described in 1830 by H.I. Pander from the Ordovician deposits of the vicinities of St. Petersburg (Pander, 1830). Pander considered them as corals. Subsequently, various researchers attributed them to bryozoans, corals, calcareous algae and Hydrozoa. Already in the 50s of the last century, there were no doubts about the echinoderm nature of Bolboporites, since their calcite body has a stereom structure. Some researchers considered them the remains of some unknown echinoderms, others attributed to the classes Cystoidea, Asteroidea and Echinoidea – mainly, like spikes on the surface of representatives of these echinoderms. The interpretation of Bolboporites as spines of a starfish was developed in detail by Yeltysheva (1955).

The findings in the Leningrad region of some Bolboporites specimens with the paired segments joined with the paired pits on the smooth surface have changed the reconstruction of Bolboporites. The segments were interpreted as a proximal part of a biserial brachiole. In this case, the longitudinal canal in the Bolboporites body is homological to the stem axial canal of Blastozoa and Crinozoa. In result, Bolboporites was reconstructed as individual very specialized representatives of eocrinoids with fused stem and theca (Rozhnov, Kushlina, 1994). According to this reconstruction, they lived with the sharp end of a cone-shaped body immersed in sediment, and the only wide smooth surface of the cone with the brachiole stuck up above ground. Because the absence of an internal cavity in the Bolboporites body, with the exception of the thin longitudinal channel, it is assumed that the internal organs were placed on the upper smooth surface and were covered with a skletonless leathery film. Similar life forms with fused stem and theca plates in the solid calcite body are known among the Permian crinoids. This interpretation of Bolboporites was accepted by most researchers and was included in the Russian textbook on paleontology.

However, in recent years, B. Lefebvre first proposed the interpretation of Bolboporites as calcareous algae (2014), then, making sure that there is a stereom, he suggested that these are the spines of a starfish (2018). These interpretations have already been convincingly rejected in the history of the Bolboporites study. It seems to us that the reconstruction of Bolboporites as an individual organism, having a merged skeleton of the stem and theca with the only brachiole extending from it, based on a large number of the studied material, including several specimens with the preserved proximal brachiole, is most convincing.

The study is supported by the Russian Foundation for Basic Research, project 18-04-01046A. It is a contribution to the International Geoscience Programme (IGCP) Project 653 – The onset of the Great Ordovician Biodiversification Event.
As the majority of marine invertebrate groups, stylophoran echinoderms were severely affected by the Hirnantian mass extinction. All cornute groups went extinct and only four clades of mitrates survived the crisis: Allanicytiidinae, Anomalocystitinae, Paranacystidae, and Peltocystida. However, the mitrate Silurian fossil record is extremely scarce and restricted to shallow, low-latitude settings. Only two Silurian allanicytiidines were described: \textit{Placocystella burretti} (Llandovery, Tasmania) and \textit{P. garratti} (Ludlow, Victoria). The Silurian fossil record of anomalocystitines includes \textit{Mongolocarpos minzhini} (Ludlow, Mongolia), \textit{Placocystites forbesianus} (Wenlock, England), \textit{Victoriacystis wilkinsi} (Ludlow, Victoria), and one undescribed form from the Wenlock of Gotland, Sweden. Silurian paranacystids were recorded in the Wenlock of Gotland (isolated plates) and the Ludlow of Victoria, Australia (\textit{Adoketocarpus acheronticus}). No Silurian peltocystids have been described so far, but they reoccur as ‘Lazarus taxa’ in the Devonian and the Carboniferous. Stylophoran recovery did not take place before the Lower Devonian, with high diversity values approaching those of the Ordovician, and a palaeobiogeographic expansion into the cooler settings of the Malvinocaffric Realm.

In this context, the discovery of a complete, fully articulated specimen of mitrate stylophoran in the late Llandovery (early Telychian) Cybele Member (Jupiter Formation) of Anticosti Island, Canada is particularly significant. Its exposed lower thecal surface, with sockets for the articulation of two posterior spines, clearly supports anomalocystitid affinities. Tomographic investigations (in progress) should provide additional information on the (unexposed) upper thecal surface and, thus, help decipher whether this new mitrate should be assigned to the Allanicytiidinae or to the Anomalocystitinae. Along with \textit{Placocystella garratti} (see above), this new anomalocystitid represents the earliest record of stylophorans in the Llandovery, i.e. immediately after the Late Ordovician mass extinction. The Anticosti mitrate is also the first known occurrence of stylophorans in the Silurian of North America, thus greatly expanding their palaeobiogeographic distribution, and confirming their restriction to warm-water, shallow settings.
TAXONOMIC REVISION OF THE CORNUTE FAMILY COThURNOCYSTIDAE BATHER, 1913 (ECHINOdermata, styLOPHORA) BASED ON NEW AND REVISED OCCURRENCES FROM THE ANTI-ATLAS (MOROCCO), MONTAGNE NOIRE (FRANCE) AND NEVADA (USA) [poster]

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The family Cothurnocystidae Bather, 1913 forms a relatively well-defined clade of cornute stylophorans characterized by a marginal frame posteriorly closed by a bridge formed by $M_5$ and $M'_5$, two polyplated infracentral areas, strong protuberances on the lower surface of anterior marginals, a cothurnocystid marginal $M_c$ inserted between $M_5$ and $M_6$, a blade-bearing $M_3$ (spinal) in contact with the zygal plate, a marginal $M_4$ -when present- restricted to the upper surface, two moveable posterior spines (glossal and digital) articulated to the theca, and respiratory structures (cothurnopores) in the right anterior corner of the supracentral area.

Cothurnocystids diversified in the Furongian–Early Ordovician time interval, possibly from middle Cambrian $Archaeocothurnus$-like taxa, and thrived during most of the Ordovician, with $Cothurnocystis elizae$ (Katian, Scotland) as their youngest known representative.

New middle Tremadocian cornute material recently collected in the lowermost Fillmore Formation of eastern Nevada extends the stratigraphic range of ‘Cardiocystella’ prolixora described lower in the same section, in Furongian deposits of the Whipple Cave Formation. This material adds morphological data for this taxon and, in particular, confirms the posterior closure of its marginal frame by a $M_5$–$M'_5$ bridge. This more complete characterization indicates ‘Cardiocystella’ is a junior synonym of $Procothurnocystis$ and the earliest-known cothurnocystid. These Laurentian fossils occur in limetones that were deposited in shallow, agitated, warm-water carbonate environments, in contrast with Gondwanan deeper, quieter, cool-water siliciclastic occurrences.

The genus $Procothurnocystis$ was defined for cothurnocystids with a $M_4$ marginal, but only two adorals ($A_0$ lost). Two taxa were originally assigned to this genus: $P. courtessolei$ (late Tremadocian, Montagne Noire), and the type-species, $P. owensi$ (Dapingian, Wales). The occurrences reported here considerably extend the range of this taxon downward, into Furongian–middle Tremadocian of Nevada (see above). Locally extremely abundant material very close to $P. prolixora$ occurs in the late Tremadocian of the Anti-Atlas, Morocco. Two younger occurrences of $Procothurnocystis$ have been also reported in the late Darriwilian of Bohemia (Dobrotiva Formation) and the early Sandbian of the Anti-Atlas (Izegguirene Formation).

Two other cothurnocystid genera were described: $Arauricystis$ and $Cothurnocystis$. $Arauricystis$ (late Tremadocian, Montagne Noire) differs from $Cothurnocystis$ by the loss of $Mc$. $Cothurnocystis$ differs from $Procothurnocystis$ by the loss of $M_4$. Finally, ‘$Cothurnocystis$’ fellinensis (late Tremadocian, Montagne Noire) probably represents the most basal member of the family Cothurnocystidae, as its upper surface retains the plesiomorphic condition with three adorals ($A_0$ is lost in $Arauricystis$, $Cothurnocystis$ and $Procothurnocystis$). This cornute should be assigned to a new genus.
UTILIZING COMBINED MORPHOLOGIC DISPARITY AND PHYLOGENETICS TO ELUCIDATE SPECIES RELATIONSHIPS IN PARACRINOIDEA [talk]

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Great strides have been made in understanding the phylogeny of the five extant echinoderm classes, but from the Paleozoic perspective these only represent two clades, among some 20 others at the class-level. Many early Paleozoic echinoderm groups have never been rigorously examined using a common homology scheme and phylogenetic methods; consequently, we cannot discern evolutionary patterns such as the evolution of complex morphologies and timing of clade origins. Paracrinoidea is a temporally and geographically limited clade known only from the Middle to Late Ordovician of Laurentia and Baltica.

The aberrant nature of paracrinoids has long hindered our understanding of the clade and has further prevented their inclusion in phylogenetic analyses of blastozoan echinoderms as a whole. Paracrinoidea is a well-constrained clade with a set of several easily identifiable synapomorphies that characterize members of the group including asymmetry at the thecal poles, asymmetrical ambulacral organization, uniserial brachioles, and atypical placement of the anal opening in the BC interray. These unusual features make for a plethora of character data that make this clade an excellent case study. However, their unusual nature has hindered our understanding of species relationships within the clade and resulted in competing classification systems based on either the presence or absence of erect ambulacra or respiratory structures. This study uses the novel approach of combining morphological disparity with phylogenetic analysis to elucidate relationships within Paracrinoidea to understand species relationships within the clade.

This analysis suggests that respiratory structures, oral plate arrangement, and ambulacral morphology are important in defining subclades within Paracrinoidea, as has been suggested by phylogenetic hypotheses of other blastozoan groups. However, several within clade relationships remain unclear, as description of homologous characters proved difficult with the high level of disparity among members of Paracrinoidea. Across the relationships suggested by this analysis ambulacral reduction is apparent, with a couple clades partially diagnosed by the reduced number of ambulacra present, to either four or two. Respiratory structures evolved multiple times within Paracrinoidea and are not the sole clade defining feature as previously thought.

Results of this study confirm several species relationships that were determined based on gross morphology and refute several features that were suggested to be clade defining. The use of morphological disparity and phylogenetic analysis provided some insight to the relationships within Paracrinoidea that have been complicated by unusual morphologies. Continued understanding of universal elemental homology and homologous thecal features, in addition to taxonomic revision, will allow future analyses to further elucidate relationships within Paracrinoidea and will allow paracrinoids to be included in larger echinoderm phylogenies.

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FILLING GAPS: DEVONIAN ECHINOIDEA, HOLOTHUROIDEA, AND CYCLOCYSTOIDEA FROM CHINA (ECHINODERMATA) [poster]

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Articulated echinoids from Palaeozoic strata are notably rare worldwide, even in China. Previously, only a handful of specimens and species were reported from the Carboniferous of southern China. However, the extensive Devonian marine deposits of southern China yielded diverse invertebrate faunas, including echinoderms. The Late Devonian Heyuanzhai Formation (late Givetian to Frasnian) of western Yunnan has delivered so far diverse and abundant crinoid faunas as well as one blastoid species. New collections and combined macro- and micropalaeontological methods result in the recognition of articulated and/or disarticulated echinoid, holothurian and cyclocystoid material, which increases the known echinoderm diversity from China.

Besides isolated ambulacral/interambulacral plates and spines, we are reporting one complete echinoid specimen of a new genus and species (Echinocystitidae), which is characterised by distinct imbricate plating of the test, very large pedicellariae, a conspicuous madreporite and Aristotle’s lantern. We are also newly reporting radial/interradial calcareous ring elements of stem group apodid sea cucumbers. Additionally, a broken cyclocystoid marginal ossicle have also been found.

Those echinoderms collected from a coral biostrome unit of the upper Heyuanzhai Formation at Shidian sections have been found in association with rugose corals, stromatoporoids and bryozoans, suggesting a shallow-water depositional environment. Further microfossil findings provide evidence for the presence of ostracods, tentaculites, machaeridians, and asterozoan echinoderms. Based on conodonts, the upper part of the Heyuanzhai Formation in western Yunnan is Frasnian (~380 myr) in age.

Finally, this is the first record of Chinese Devonian echinoids and the first report of holothurian calcareous ring elements and cyclocystoid ossicles in China. These occurrences greatly expand the distribution of echinoid, holothurian and cyclocystoid echinoderm fossils from Laurussia to Gondwana.
DIVERSITY AND DISTRIBUTION OF ECHINODERMS AT THE SOUTH EASTERN PACIFIC [poster]

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Marine biodiversity comprises an intricate mosaic of historical and contemporary factors that must necessarily be studied through the integration of different approaches. Biogeography is a holistic discipline that helps us to understand historical and contemporary processes that can explain patterns of distribution, abundance and diversity of species.

Echinoderm species have been insufficiently studied in the south eastern Pacific (SEP), mainly because there are still some problems with the identity of many species. In addition, their distribution and diversity are only partially known. In biogeographical studies, echinoderms practically have not been included as study models despite their high local diversity. Probably more than 360 species of the approximately 7000 species known throughout the world inhabit the SEP. The objective of the present study is to analyse the diversity and distribution of echinoderms along the SEP, assessing the existence of biogeographic structuring and the role of physical variables in generating geographical patterns. We hypothesize that the control by environmental factors, and the effect of geometric constraints, determine the range size and distribution limits of echinoderms along the SEP, generating a latitudinal gradient in species richness. Based on a literature review and >7,000 records obtained from collections, we constructed a presence–absence matrix along the south eastern Pacific (from Peru to southern Chile) including oceanic islands (Juan Fernandez and Desventuradas archipelagos and Easter Island), to estimate species richness and geographic ranges. Biogeographic units were determined by means of multivariate analyses. The effects on species richness of environmental variables (temperature, salinity and oxygen) were evaluated by means of ordinary least squares regression and simultaneous autoregressive models.

Species richness was low across the temperate ecoregions (5 to 10 species) and increased towards the pole (from 15 to 30 species). We identified five biogeographic units, highlighting two major distribution breaks at 30°S and 42°S. Species richness was strongly related with environmental variables, being temperature the best single predictor.

Along the SEP echinoderms exhibit both a clear biogeographic pattern and an inverse diversity gradient, which appear strongly related with physical factors consequence of the naturally bounded domain of the Eastern Pacific.
MIOCENE ECHINOIDS FROM PALENQUE, CHIAPAS [talk]

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Recent collecting in the Miocene Tulijá Formation near Palenque, Chiapas State of Mexico, has provided five species of echinoids: Stomopneustes pristinus, Echinolampas aldrichi, Clypeaster chiapanensis, Agassizia regia, and Schizaster dumblei; their reports are illustrated, measured and described. These new reports are a significant expansion of the known distribution of Stomopneustes pristinus and Agassizia regia, which were previously documented merely from their type localities; also, this is the first confirmed report of Schizaster dumblei in the Miocene. Neotype material is established for C. chiapanensis and discrepancies between previous descriptions have been resolved. The echinoid fauna of the Tulijá Formation shares species with the Meson and Tuxpan formations on the Gulf of Mexico and supports the description of the Tulijá Formation as a shallow marine paleoenvironment with high energy.
EXTENDING THE LIMITS OF ABERTELLA (ECHINOIDEA: CLYPEASTEROIDA) [talk]

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Family Abertellidae has been reported for the Atlantic coast of America, from Maryland, USA to the Argentinian Patagonia. This taxon is characterized by the lack of lunules and the presence of strongly discontinuous interambulacra. The objective of this work is to present the new report of one non-lunulated clypeasteroid. The specimens were collected prepared by physical and chemical methods in order to observe the interambulacra. Plate diagrams were made for the oral and aboral sides and specimens were identified. 15 specimens were identified as Abertella (Clypeasteroida: Abertellidae), collected in Formation El Refugio (Miocene–Pliocene) and y Formation San Ignacio (Miocene), Baja California Sur, Mexico. This is the first report of Abertella for the Pacific coast of America and the second report for the genus in Mexico, this after the report of A. cazonensis from Cazones River, Papantla, Veracruz (Late Oligocene – Early Miocene).
THE ECHINOIDS FROM THE NATIONAL COLLECTION OF PALEONTOLOGY, INSTITUTE OF GEOLOGY, UNAM, MEXICO
[poster]

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Class Echinoidea includes organisms with a flexible test formed by flat and imbricated calcareous plates, set in ten double columns: five ambulacral (I–V) and five interambulacral (1–5); due to the calcareous skeleton, its fossil record is abundant. The echinoids are found since the Ordovician (Perischoechinoidea) to present, being the most abundant post-Paleozoic echinoderms. Since 1978 the National Collection of Paleontology (CNP), National Autonomous University of Mexico has formally catalogued and curated the national fossil record. Nowadays it houses more than 10,000 type and voucher specimens. The objective of this work is to present the diversity of echinoids housed in the Type Collection of the CNP and the principal localities where it has been collected. To date, 201 specimens of echinoids have been catalogued, classified in 10 orders, being Spatangoida the most diverse, with 20 species; the fossil record dates from the Oxfordian (Jurassic) to the Quaternary (Pleistocene). San Juan Raya Formation (Early Cretaceous), Puebla, is the formation with the most specimens from the country, with 124 specimens.
NEW SYSTEM OF THE ECHINODERM CLASS OPHIUROIDEA (BRITTLE-STARS): A REMARKABLE EXAMPLE OF AGREEMENT BETWEEN MOLECULES AND MORPHOLOGY [talk]

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After applying molecular phylogenetic methods since the 1990s, higher-level classification of various organismal groups has undergone dramatic change. Previous common morphology-based systems were profoundly challenged by the results of molecular data. Notable examples are the Ecdysozoa and Lophotrochoza concepts, when non-segmented nematodes turned out to be related to segmented Arthropoda, whereas segmented annelids were found instead to be unrelated to arthropods. In that situation, traditional zoologists sometimes attempted to suggest new morphological definitions for the molecular groups a posteriori. Furthermore, the concept of so-called integrative taxonomy has become popular and implies that molecular, morphological and other data should be combined in the resulting classifications. In practice, however, taxonomy commonly just follows the results of molecular phylogeny, and morphological data are considered incidental.

Here we will focus on a remarkable example when major features of the novel classification of a high-ranked group (echinoderm class Ophiuroidea) were originally suggested using detailed morphological data (Martynov, 2010) and only four years later were confirmed by phylogenetic analysis using transcriptomic data (O’Hara et al., 2014). Similar to the molecular-driven challenges in classifications of Bilateria, but based instead on the scanning electron morphological data of the microstructural characters, a groundbreaking relationship was suggested for traditional ophiuroid classification between an externally highly dissimilar group, Euryalida (basket-stars, e.g. Gorgonocephalidae family), and a traditionally ‘central’ ophiuroid family, Ophiuridae. The majority of other ophiuroid families, according to microstructural morphological data, were considered to form a large assemblage. Such groupings were never suggested in the history of ophiuroid classification, yet have turned out to be highly consistent with the subsequent molecular data. By further joint efforts of an international group of ophiuroid experts, and using such remarkable consistency between morphology and molecules, a novel classification of the Ophiuroidea has been recently developed (O’Hara, Hugall, Thuy, Stöhr, Martynov, 2017, 2018). Recent ophiuroids are thus grouped into two major superorders – Euryophiurida (i.e. Euryalida + Ophiuridae s.l.) and Ophintegrida (which encompasses the majority of ophiuroid families). At the family level, the new system provides considerably more detailed taxonomy since it suggests 33 families instead of 18 families in the Smith, Patterson, Lafay (1995) classification or 13 families in the pioneering Matsumoto (1915) system. Further development of the new classification will require separation of more new families, since even in the current most differentiated system morphological diagnoses in some cases need to be refined. Another important perspective is the necessity of broad inclusion of ontogenetic principles, including the consideration of paedomorphosis, into taxonomy.

This remarkable case of the class Ophiuroidea has general implications for any metazoan group: 1) Morphological data can be used with some caution as primary instead of merely secondary phylogenetic information. 2) The congruence between morphology and molecules is possible, particularly when morphological and molecular data are detailed and based on a large selection of taxa. 3) Morphological studies are imperative also because this is the only way to evaluate paleontological data. 4) Consistent application of morphological, molecular, ecological, etc. data that in total form a broad ontogenetic approach must be practical, and not just theoretical for the future of taxonomy and phylogenetics. This study was supported by a research project of the MSU Zoological Museum (AAAA-A16-116021660077-3).
MORPHOLOGICAL CHANGES IN SKELETAL ELEMENTS OF FEATHERSTAR CAUSING BY *MYZOSTOMA KHANHKHOAENSIS* SP. NOV. (MYZOSTOMIDA, ANNELIDA) [poster]

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Biodiversity of communities associated with Crinoidea is very high and present by both vertebrate and invertebrate symbionts, which may live not only on surface or in body cavity of the host, but cause the deformation of skeletal elements of the host. One of the most known symbionts of crinoids are Myzostomida, a specialized group of marine annelids. Fossil evidence of myzostomids has been reported from the Lower Jurassic and now about 200 of recent myzostomid species are described. In the aspect of host interactions, myzostomids can be divided into four ecological groups: 1) free-living forms which can move easily over the entire body of the host as adults, 2) cyst-forming, living in soft tissues of the host as adults, 3) gallicolous forms forming excrescences in skeletal structures of the host and 4) endosymbionts, living in the digestive tract or other organs of the host. Nevertheless, a new myzostomid species which cannot be attributed to the abovementioned ecological forms was found in the Nhatrang Bay (Central Vietnam). This species is associated with *Clarkcomanthus albinotus* Rowe, Hoggett, Birtles & Vail, 1986 and stimulates deformation of the skeletal elements of host’s arm, without the formation of full galls or cysts.

*Myzostoma khanhkhoaensis* sp. nov lives in groups up to 40 specimens per host on distal part of the arm, and change the shape and size of the main skeletal elements, lead to it’s deformation. Morphological analysis of infected arms shows that *Myzostoma khanhkhoaensis* sp. nov. does not case formation of new skeletal elements, as the gallicolous species and only changes shape of present skeletal elements, make them larger, shorter and broader; the surface of skeletal elements covers by additional spines and spicules. Movability of infected arm decreases, as a result, it twists to the oral side and form a bucket-like structure inhabited by myzostomids, possible, protecting worms from predation.
INTERSPECIFIC COMPETITION AND INVASIVE ABILITY OF HOLOTHURIA (ROWEOOTHURIA) ARGUINENSI S: IS ITS DIET A THREAT TO NATIVE SPECIES? [poster]

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This work focuses on the diet of five holothurians species of the Holothuriida order. Four species are native to Mediterranean Sea (Holothuria poli, Holothuria tubulosa, Holothuria forskali and Holothuria sanctori); while the fifth species (Holothuria arguinensis) is an invasive species originating from the Atlantic Ocean. The sampling was carried out during fall 2016 in a shallow water area (Salamandre, Mostaganem) and aims to (1) have insight on H. arguinensis dietary components and (2) to test for competition in the acquisition of food sources between the invasive species and the native species.

The Foraminifera are the most consumed food by H. poli and H. tubulosa (with 17.33% and 29.33% respectively); In contrast, the plant fractions are most, appreciated by H. forskali (diatoms with 28.66% and algae with 20.66%) and H. sanctori (algae with 31.33% and diatoms with 21.33%). We highlight that crustaceans are highly consumed by the four native species (21.33%, 16%, 10% and 9.06%, for H. forskali, H. sanctori, H. tubulosa and H. poli respectively). Holothuria arguinensis feed especially on the animal food sources (mollusk shells, sponge ossicles and nematodes, with 24.80%, 11.6% and 6.80% respectively). Statistical analysis (Permanova) showed difference (P < 0.001) between the invasive and the native species. The Non-metric multidimensional scaling (NMDS) analysis shows that H. arguinensis could be qualified as a “specialist” species (having a narrow trophic niche). We conclude that the invasive species H. arguinensis does not compete with the four native species as long as it prefers food sources that the other holothurian species slightly consume.
SYSTEMATIC, MICRO-DISTRIBUTION AND TROPHIC PLASTICITY OF HOLOTHURIANS INHABITING THE POSIDONIA OCEANICA SEAGRASS BED OF THE SOUTHWESTERN MEDITERRANEAN SEA (ALGERIA) [talk]

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Sea cucumbers are major representatives of the benthic compartment of the Mediterranean P. oceanica ecosystem. In this study we describe and discuss some aspects of the systematic position of four sympatric holothurians species (Holothuria poli, Holothuria tubulosa, H. sanctori and H. forskali). The phenotypic plasticity between species is discussed using morphological characters. According to the ecological classification, the studied holothurians species show a high niche overlap, which suggests that these benthic invertebrates used the same food sources and therefore exhibited similar trophic niches. The coexistence of these holothurians species could be explained by spatial and behavioral segregation. Indeed, H. poli and H. tubulosa mainly prefer detrital and rocky beds, near P. oceanica meadows, while H. forskali and H. sanctori are located under the boulders and can even be found on rocky bottoms rich in plant species.
GENETIC DIVERSITY AND DEMOGRAPHIC HISTORY
OF THE ENDEMIC SOUTHEASTERN PACIFIC SEA URCHIN
*ARBCIA SPATULIGERA* (VALENCIENNES, 1846) [poster]

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The structure genetic pattern of species is the result of the relationship between homogenizing and structuring factors and the effects of interaction within historical and contemporary processes. Potential dispersal has been defined as a major homogenizing factor, corroborate by connectivity paradigm, which describes that high dispersers will show low or no genetic differentiation. In contrast, biogeographic breaks and oceanic currents have an important role in enhancing or limiting connectivity being potential structuring factors.

We studied this relationship in *Arbacia spatuligera*, a subtidal echinoid with a planktonic larval stage and widely distributed along the Southeastern Pacific (SEP). SEP is biogeographically divided in two provinces: Peruvian Province (4°–30°S) and Magellanic Province (42°–56°S) and an Intermediate Area (30°–42°S), marked by two biogeographic breaks (~30°S and 42°S) and it is influenced by a complex system of marine currents known as Humboldt Current System (HCS) which moves from ~42°S to 6°S.

Using molecular tools (mtDNA COI) we assessed the genetic diversity and genetic structure pattern also inferred the demographic history of this species. Analyses showed that along ca 3.200 km, *A. spatuligera* has no genetic structure signals, an unexpectedly low genetic diversity and showed evidence of a recent demographic expansion dated ~33000 – 47000 years ago, probably related to the MIS3 climatic events. We propose that *A. spatuligera* is a high disperser and our findings support the hypothesis that dispersal potential is a determining factor of the phylogeographic patterns in the SEP influenced by HCS. To explain unexpected genetic diversity further analysis are needed.
PENNSYLVANIAN CRINOID ASSEMBLAGES FROM THE MOSCOW BASIN [talk]

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Well preserved Pennsylvanian crinoids from the Moscow Region are known already for more than 150 years (crinoids from the famous Myachkovo quarries described by H. Trautschold). Currently, several crinoid faunas originating from different Pennsylvanian Formations from the Moscow Region are known (Mirantsev, Rozhnov, 2012). The most numerous finds have been made in the Suvorovo and the Neverovo formations (both Kasimovian). Nearly all previously described crinoids from the Myachkovo quarries occurred from the Suvorovo Formation. Currently, these quarries are no longer available for study, but there are similar sections with a rich echinoderm fauna in the Oka-Tsna Swell. The younger Neverovo Formation is characterized by the appearance of new crinoid taxa and the extinction of some dominant crinoids of Suvorovo Formation (e.g. Moscovicrinus). Crinoids in the localities of these Formations are well preserved; frequently preserved with an intact crowns and stems. More than 1,000 crows have already been collected. Among the crinoids in the collection there are representatives of new genera and species. The analysis of new undescribed taxa allows us to obtain new data on the taxonomy of the Upper Paleozoic crinoids, which will be useful for the upcoming crinoid volume of the “Treatise...”. Crinoids are represented by both endemic forms and identical or sibling taxa with the North American forms. The biserial arms, typical for the Pennsylvanian crinoids (Catacrinidae, Erisocrinidae, Cromycrinidae, Stellarcrinidae) are not common among the Moscow region crinoids. These families either represented by rare uncommon finds, or represented by forms with uniserial arms.
NEW CYCLOCYSTOIDS (ECHINODERMATA) FROM THE MIDDLE-UPPER ORDOVICIAN OF THE LENINGRAD REGION [poster]

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Cyclocystoids is a small class of Paleozoic echinoderms. The skeleton of the cyclocystoid is disc-shaped, flattened, up to 50 mm in diameter. It consists of a complex central disk with a ring of massive marginal ossicles around, and a peripheral ring composed of small plates. Functional morphology and relationships of cyclocystoids within other echinoderms are the subject of discussion among researchers.

Complete cyclocystoids are rare. The most common are marginal ossicles, that can be well identified. Currently, about 40 species of cyclocystoids are known, most of them – from the Ordovician deposits of Central and Northeastern Laurentia. Isolated cyclocystoid marginals were previously noted from the Ordovician of Baltoscandia (Sweden, Estonia).

Authors have collected more than 200 marginals of cyclocystoids. The plates were found in four localities: on the river Mga near the Sologubovka village (lower part of the Azeri Regional Stage) and in three localities in the west of the Leningrad Region (Haljala stage). About 99% of the material were from clays of the Gryazno Formation, near the Klyasino village.

Nine morphotypes of marginal ossicles, which can be attributed to 3 genera of cyclocystoids were identified. Morphotypes 1–4 (\textit{Cyclocystoides} sp.) include ossicles with a convex dorsal side and smooth cupules without tubercles. The number of cupules on one marginal can vary from one to four, but most of the specimens have three cupules. Morphotypes 5–7 (\textit{Apycnodiscus} sp.) include similar marginals, but with tubercles in cupules. There are specimens with one to three cupules on the plate. Ossicles assigned to morphotypes 8 and 9 are differ considerably from previously described ossicles, and apparently represent a new genus. These plates are characterized by a protrusion, a spiky ornament on the flattened dorsal side, and the presence of a depression on the crest of marginal ossicle. Plates with one cupule are common; plates with two cupules are rare.

Thus, a new data on the taxonomic composition of the Ordovician cyclocystoids in Baltoscandia as well as new information on cyclocystoid paleobiogeography were obtained.

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FIRST MIDDLE JURASSIC OPHIUROIDS FROM THE CENTRAL RUSSIA
[poster]

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Jurassic marine sediments are widespread in the central part of the Russian Platform. Nevertheless, many groups of echinoderms are still poorly studied in comparison with the coeval Western European deposits. It concerns ophiuroids, whose fossils from the Jurassic of the Central Russia are still unknown in literature. Recently, several complete articulated ophiuroid specimens from the Jurassic of different parts of Central Russia have been collected. Significant but fragmentary material obtained through the study and selection of microfossil samples. A rich locality for ophiuroid microfossils is located in Nizhny Novgorod Region in “Pochinki” section, near the well known section “Uzhovka”. All fossil were collected in the Lower Callovian part of the section (upper part of the Cadoceras elatmae ammonite zone, Cadochamoussetia subpatruus subzone). In addition to isolated skeletal elements collected from the microfossil samples, a nearly complete specimen was found. The analysis of the LAP morphology indicates the presence of at least three ophiuroid genera. The preliminary study allows attributing these ophiuroids to Ophiolepididae and Ophiacanthidae.
NEW SPECIES OF THE GENUS *BATHYCRINUS* (CRINOIDEA, BATHYCRINIDAE) FROM THE YAP AND PALAU TRENCHES [poster]

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A new species of the genus *Bathycrinus* was found in the Yap Trench at a depth of 6445 m (RV *Xiangyanghong 9*, cruise DY38, St DV152, type locality) and in the Palau Trench at depths of 7000-7170 m of (RV *Vityaz*, cruise 57, St. 7291, paratype locality). Two specimens with upper diameter of aboral cup 3.4 mm (holotype) and 2.4 mm (paratype) were collected. Aboral cup is moderately high; ratio of its height to width is 0.70 and 0.75. Radial ring is slightly funnel-shaped, forming with basal ring evenly sloping line; basal plates are fused. First and second primibrachs are with smooth surface and longitudinal median convexity. Their sides flattened into wide lateral flanges, which are bend outwards. Knobby processes are located on both primibrachials. Profile of arm (viewed from side) is smooth. Most frequent proximal patterns are 1+2 4+5 7+8 10+11 13+14 15+16 17; most frequent position of the first pinnule is on brachial 13. The stalks are with 20 and 18 short columnals and elongate mesistele columnals. Ratio of length to diameter in the most elongate columnal is 5.1 and 6.3. Articulate facets are round in proxistele and elliptical in mesistele with fulcral ridge along the small facet diameter. Dististele is lost. The new species differs from other *Bathycrinus* species in having outwardly bended flanges of the primibrachials and very elongate mesistele columnals. Among 12 previously known species of *Bathycrinus*, 6 species were found at the depths greater than 6000 m in Aleutian, Atakama, Izu-Bonin, Japan, Kermadec and Kuril-Kamchatka trenches.
ASTEROID DIVERSITY: A VIEW FROM THE SOUTHERN OCEAN [talk]

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The origin and evolution of the benthic marine fauna of the Southern Ocean (SO) have long been debated and it is commonly believed that extant communities display some ecological features present in paleozoic-like assemblages, such as the lack of durophagous predators (most fish and decapod taxa) and the dominance of sessile suspension feeders, although they likely originated from recent in-situ diversification. Evidences tend to show that Antarctic asteroids follow this general evolutionary pattern. The overall fossil record of Antarctic asteroids is poor indicate the presence of an extinct fauna on Seymour Island during the Eocene. It is however interesting to note that the taxa found during the Eocene are still represented by congeneric relatives outside of the SO.

All recent asteroids belong to the monophyletic sub-class Neoasteroidea, which diversified after the Permian-Triassic transition and the near complete extinction of the entire class. It is estimated that nowadays, it is the most diverse class in echinoderms, after the Ophiuroidea, with around 1,900 described species but asteroid global diversity is suspected to be highly underestimated and overlooked.

Apart from the very rarely encountered and still taxonomically puzzling genus Xyloplax, not discussed in the present work, all seven orders of the class Asteroidea have representatives in the SO as well as 75% of extant families. Such a wide taxonomic richness is not that typical for SO taxa. The ichthyofauna is for example described as “a taxonomically restricted and endemic modern fauna” and only a fifth of crinoid families are present in the SO. The wide taxonomic richness of SO sea stars, however, does not preclude their singularity as 59% of species are endemic to the SO and 29% to the Antarctic (south of the Polar Front).

Benthic studies carried out on other SO taxa highlighted the variety of possible scenarios explaining the origin of Antarctic fauna. The polar emergence, Gondwanan origin of relic fauna or colonization along the Scotia Arc from South America have been proposed as possible scenarios. There are no fossil evidence of autochthonous sea star surviving the cooling of Antarctica and current phylogenetic evidences argue for a recent diversification of the class in the SO. They also suggest a possible ancestry from adjacent sub-Antarctic regions and colonization from the deep sea following an ‘emergence’ scenario.

The different pathways for sea stars to colonize, diversify and evolve in the SO remain unclear and are presumably of a great variety. In the light of recent phylogeographic works we explored an extensive phylogeny reconstruction based on over 4,000 sea star barcode sequences and analyzed species and genus richness patterns. Results confirm that sea star richness has been overlooked and misunderstood in the SO and suggest that the extant SO sea star fauna is mostly the result of recent diversification.
DIVERSITY IN KERGUELEN ASTEROIDS: A CROSSROADS OF FAUNAL INFLUENCES IN THE SOUTHERN OCEAN [poster]

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The marine fauna of the isolated archipelago of the Kerguelen Islands have been studied for decades as they represent key elements for understanding the biogeography of benthic taxa in the Southern Ocean. The pivotal position of the Kerguelen Islands among the sub-Antarctic islands (from South America to the Scotia Arc and the Macquaries) and the possible connections with the high Antarctic make this archipelago an essential link between biogeographic regions of the Southern Ocean.

Compiling data from three research projects (POKER, Proteker and ACE – ASCCC) we conducted diversity, phylogeographic as well as multivariate analyses to characterize asteroid assemblages of the Kerguelen Plateau.

Mitochondrial gene COI sequences of 320 specimens were used to analyze biogeographic relationships between the Kerguelen Islands and other regions of the Southern Ocean. Gene sequences from specimens of the Kerguelen were compared with thousand other sequences from the entire Southern Ocean to better assess the weight of the Kerguelen Islands in the biogeography of the Southern Ocean.

This work brings new insight into our knowledge of the origin of the asteroid fauna of the Kerguelen Plateau and the role of this sub-Antarctic archipelago as a potential species source for post-glacial recolonization of sub-Antarctic islands and of the Antarctic shelf during the Holocene.
NEW ECHINODERM LAGERSTÄTTE FROM THE LETNÁ FORMATION (SANDBIAN, UPPER ORDOVICIAN) OF BOHEMIA [talk]

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The Upper Ordovician (Sandbian) Letná Formation of Bohemia (Czech Republic) provides an important insight into the Early Palaeozoic diversification of marine ecosystems. In this formation, several levels can be interpreted as Konservat-Lagerstätten: they yielded abundant fossil remains, including exceptionally preserved, non-mineralized and poorly mineralized organisms. Non-trilobite arthropods (e.g. Duslia, Furca, Zonozoe) occur together with well-preserved trilobites, echinoderms, brachiopods and bivalves.

Last year, a new locality (Chrustenice) was discovered in the Letná Formation. It is characterized by mass occurrences of articulated echinoderms, which can be interpreted as storm-induced levels of accumulations (Konzentrat-Lagerstätten) of living or freshly killed individuals. The Chrustenice echinoderm assemblages are particularly diverse and dominated by solutans, associated with various asterozoans, blastozoans, crinoids, edrioasteroids, and stylodermans. The forthcoming description of these new assemblages will bring a wealth of new data on their systematics, functional morphology, taphonomy, palaeoecology, palaeobiogeography, and evolutionary implications. Preliminary investigations of the Chrustenice faunas show the occurrence of several ontogenetic stages in ophiuroids, as well as examples of ecological interaction, e.g. between solutans and edrioasteroids.

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STATUS OF ECHINODERM POPULATION IN LAKSHADWEEP ARCHIPELAGO WESTERN INDIAN OCEAN [talk]

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Echinoderms, one of the most important groups of marine living beings, particularly in the coral reefs, play an important functional role in the marine environment. Lakshadweep constitutes the only atoll formation in India and forms the northernmost segment of the Chagos – Maldives - Laccadive oceanic ridge. The present article provides the status of echinoderm population in different biogeographic zones, of various atolls of Lakshadweep archipelago. The study was carried out from October 2016 to March 2019. A total of 296 transects were surveyed in 10 inhabited and two uninhabited atolls of Lakshadweep. A systematic survey was conducted adopting the belt transect method from reef top to 30m depth. Echinoderms belonging to 104 species have been reported from the Lakshadweep waters. During the survey in the waters of Lakshadweep atolls, 68 species of echinoderms belongs to 20 families, and 42 genera were recorded. The 68 species include three new records to the Indian subcontinent and eight new records to the Lakshadweep archipelago. The present work consolidates information on Echinoderms diversity from these atolls. The Echinoderms diversity was highest in the Kavaratti atoll (58 species) and lowest in Androth island (25 species). The paper discusses the geomorphologic factors influencing the observed distribution pattern of echinoderm. The detailed investigation carried out gathered comprehensive baseline data on the occurrence and quantitative abundance of the Echinoderms resources of Lakshadweep for framing conservation strategies for these invaluable resources. Considering the threat of biodiversity loss through climate change, global warming and ocean acidification, there is an urgent need for developing long term documentation of the variability in echinoderm biodiversity, particularly in regions like Lakshadweep atolls that have been poorly studied.
Abstracts

MOLECULAR PHYLOGENETIC ANALYSIS OF DEEP-SEA HOLOTHURIAN GENUS PANNYCHIA USING BY MIG-SEQ [talk]

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The sea cucumber genus Pannychia is one of the dominant megafauna on bathyal seabed in the Pacific Ocean. The genus is distinguished easily from the other laetmogonids by mid-ventral tube feet, dorsal lateral papillae, and large wheel ossicles with brim teeth. In the North Pacific Ocean, six species or subspecies, P. moseleyi, P. moseleyi henrici, P. moseleyi virgulifera, P. moseleyi mollis, P. pallida and Laetmophasma fecundum, have been described in this genus and have been reported in the North Pacific Ocean. Hansen (1975) synonymized these taxa with P. moseleyi. However, only a few taxonomic characters were verified based on limited number of materials in his study, and the status of P. moseleyi is still confused. To revise the taxonomy of the genus Pannychia, the molecular approach is required, but the conventional DNA markers, like COI, are sometimes difficult to obtain sequences from long term preserved museum specimens.

In this study, we performed multiplexed inter simple sequence repeat (ISSR) genotyping by sequencing (MIG-seq). This method is the availability for specimens whose DNA is degenerated by long time in preserved condition because deep-sea species, like Pannychia, are limited opportunity for sampling. We used 45 individuals of Pannychia holothurians collected from the North Pacific area, the East China Sea, the Pacific coast of Japan, the Okhotsk Sea, the Bering Sea and the western coast of North America, from 1994 to 2018. The obtained sequences were trimmed their adapter sequence by FASTX-Toolkit and processed by PyRAD. From the aligned dataset, a maximum likelihood tree was constructed by RAxML Next Generation.

Our study showed high species diversity of the genus Pannychia in Northwest Pacific Ocean. Six distinct clades were detected in the ML tree with high-resolution and identified by morphological observations to P. fecundum, P. m. henrici, P. m. virgulifera, P. taylorae and two undescribed species, respectively. P. m. henrici and P. m. virgulifera have clearly distinct morphological features and sympatric distribution, so these subspecies should be regarded as species. L. fecundum should be transferred to the genus Pannychia because this species made a monophyletic clade with an undescribed species in the genus.
BIOGEOGRAPHY OF DEEP-WATER STALKED CRINOIDS REVISTED: EXAMPLE FROM WESTERN PACIFIC AND INDIAN ISOCRININE FAUNAS [talk]

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Tropical, shallow-water fauna in the western Pacific is known for its high diversity. Many shallow-water faunas have their centers of the highest diversity in the tropical western Pacific, with decreasing diversity toward north and west. Previous studies on many marine invertebrates showed that shallow-water faunas of the Indian Ocean are similar to those of the western pacific in their compositions.

In contrast to such shallow-water faunas, deep-marine faunas show different pattern of distribution. Recent species of the suborder Isocrinina are distributed in the western Pacific and in the Indian Ocean (as well as in the Atlantic), but their compositions in these two oceans are very different. In the western Pacific, species of Metacrinus, Saracrinus, Hypalocrinus, Endoxocrinus and Proisocrinus are widely distributed from the southern sea off Japan to the sea around New Zealand, and Endoxocrinus and Proisocrinus also extend to New Caledonia and Tahiti. On the contrary, in the Indian Ocean, only one genus consisting of one species of isocrinines, Teliocrinus springeri is reported. Therefore, there is almost no common species in these two oceans, except for a station in the southern Malay Peninsula where species of Metacrinus is once reported to be collected. Between the distribution of isocrinines of the two oceans, clear boundary, or a barrier is confirmed, along the Malayan Peninsula, Java and Sunda archipelagos. Therefore, for deep-water fauna such as stalked crinoids, shallow seas in Indonesian archipelago forms a barrier for isocrinines, where deep-water fauna cannot migrate to the other oceans.

From the historical viewpoint, southeastern Asia is an area where elements of Gondwana (such as western Sulawesi and New Guinea) migrated north and collided with Eurasia in the Neogene, forming a famous biogeographic line known as Wallace Line. At the same time, marine faunas should be affected by the collision. In Miocene, isocrinines in the western Pacific area consisted of Isselicrinus, Isocrinus and Teliocrinus, none of which are common to the modern western Pacific fauns. Therefore, a large turnover of isocrinine genera and species has occurred since the Miocene prior to the present.
SEA CUCUMBERS FIBRILLAR COLLAGEN: STRUCTURAL AND PHYSICAL-CHEMICAL CHARACTERIZATION [poster]

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The holothuroid dermis in general is characterized by its abundant fibrillar and by being a dynamic tissue able to modify its mechanical properties in short time spans (mutable collagenic tissue). This work focused on the isolation and physicochemical and structural characterization of fibrillar collagen type I solubilized with pepsin from the species \textit{Holothuria inornata} and \textit{Holothuria lubrica}. Fibrillar collagen was purified by FPLC using a Superdex HiLoad 16/60 column and positive identification was achieved as a precursor of the α I chain of marine type I collagen by LC-MS / MS. The molecular weight was estimated at 133 KDa by densitometry on SDS-PAGE gels. The analysis of gel permeation and cation exchange chromatography’s revealed the existence of aggregates; which were also confirmed by dynamic light dispersion presenting hydrodynamic radii that correspond to the reported for collagen fibrils. The analysis of the secondary structure by Fourier transformed infrared spectroscopy of amide I (1600 - 1700 cm\textsuperscript{-1}) and amide III (1250 - 1400 cm\textsuperscript{-1}) revealed a strong contribution of β-sheet structures. The prediction of the secondary structure by means of the software secondary structure estimation of the Spectra ™ Manager suite and the CAPITO server denoted the very high contribution of the “other” and “irregular” structural categories, respectively. An informatic analysis was carried out with collagen peptides from the PDB and protein secondary structure prediction servers 2STRUC and POLYPRONLINE, and an extended presence of polyproline II type helices (PPII's) was found. The PCDDB DICROMATCH tool matched the isolated collagen with type II fibrillar collagen from bovine origin, suggesting the positive identification of fibrillar collagen with the characteristic spectroscopic marks of PPII’s in their respective circular dichroism (CD) spectra. The examination of the isolated collagen by CD at different temperatures revealed spectral marks possibly associated with the formation and loss of structure of collagenic fibrils.
RECORD ABOUT HOLOTHURIANS OF THE MATUA ISLAND (KURIL ISLANDS) [poster]

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20-th Kamchatka-Kuril expedition to Matua Island (middle group of Kuril Islands) organized by Russian Geographic Society and held with the support of Russian Ministry of Defense took place in 2016. The specimens for the scientific research were collected during SCUBA diving. Seven species of holothurians were collected during the expeditions. Four species of holothurians, including Havelockia obunca, Pseudocnus pusillus, Scoliorhapis stepanovi and Taeniogyrus inexpectatus were discovered in shallow-water of Matua Island for the first time. Echinopsolus sp. was marked for holothurians fauna of Russian Far Eastern seas for the first time. The check-list of holothurians is given below.

Scoliorhapis stepanovi Al. Smirnov & Panina 2017
Material examined. 20 August 2016, Kuril Islands, Matua Island, Crocodile Cape, 48º03’244 N, 153º16’443 E, depth 15 m, t=3 ºC, collector N.P. Sanamyan (2 ind.).

Taeniogyrus inexpectatus (Smirnov, 1989)
Material examined. 23 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’486 N, 153º15’660 E, depth 16 m, t=4 ºC, soil – sand, boulder, collector N.P. Sanamyan (1 ind.).

Synallactes nozawai Mitsukuri 1912
Material examined. 24 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’474 N, 153º15’691 E, depth 13 m, t=2ºC, collector N.P. Sanamyan (1 ind.).

Havelockia obunca (Lampert, 1885)
Material examined. 19 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’490 N, 153º15’661 E, depth 15 m, t=2 ºC, collector N.P. Sanamyan (4 ind.); 26 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’477 N, 153º15’659 E, depth 15 m, t=4 ºC, collector N.P. Sanamyan (1 ind.).

Echinopsolus sp.
Material examined. 28 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’471 N, 153º15’692 E, depth 14 m, soil – sand, boulder, t=7 ºC, collector N.P. Sanamyan (1 ind.).

Cucumaria vegae Théel, 1886
Material examined. 20 August 2016, Kuril Islands, Matua Island, Crocodile Cape, 48º03’244 N, 153º16’443 E, depth 15 m, t=3 ºC, collector N.P. Sanamyan (8 ind.); 22 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’490 N, 153º15’661 E, depth 15 m, t=3 ºC, collector N.P. Sanamyan (95 ind.); 23 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’486 N, 153º15’660 E, depth 16 m, t=4 ºC, collector N.P. Sanamyan (1 ind.); 28 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’471 N, 153º15’692 E, depth 13 m, t=7 ºC, collector N.P. Sanamyan (1 ind.).

Pseudocnus pusillus (Ludwig, 1886)
Material examined. 23 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’486 N, 153º15’660 E, depth 16 m, collector N.P. Sanamyan (49 ind.); 24 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’474 N, 153º15’691 E, depth 13 m, t=2 ºC, collector N.P. Sanamyan (6 ind.); 25 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’485 N, 153º15’669 E, depth 17 m, t=2 ºC, collector N.P. Sanamyan (1 ind.); 25 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’485 N, 153º15’669 E, depth 15 m, t=2 ºC, collector E.V. Drashev (26 ind.); 25 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’486 N, 153º15’656 E, depth 17 m, t=4 ºC, collector N.P. Sanamyan (1 ind.); 28 August 2016, Kuril Islands, Matua Island, Rublenaya Bay, Beak Cape, 48º05’494 N, 153º15’658 E, depth 16 m, t=4 ºC, collector N.P. Sanamyan (1 ind.).
EVOLUTION, FUNCTIONAL MORPHOLOGY AND PAEDOMORPHISM IN THE GOGIID-ASCOCYSTSTITID LINEAGE (EOCRINOIDEA; CAM-ORD) [talk]

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Gogiids (Lower and Middle Cambrian; especially South China [Yangtze] and western Laurasia plates) and the ascocystitids (Lower to Upper Ordovician; Prague Basin and Morocco [western Gondwana]) form a disjunct lineage with no known representation in the Upper Cambrian and somewhat rare representation in the lower Ordovician. Gogiids have thick polyplated stalks, that through various taxa are gradationally reduced through time to thin irregularly plated stems, or in some younger genera, and in all ascocystitids, into a thin holomorous stem. Nubben-like distal ends are common in both groups and suggest attachment by substrate penetration and “bio gluing”. Thecae in both groups are composed of poorly organized hexagonal plates. Gogiid thecae are disordered by insertion of intercalates, especially in older parts of the theca and differ significantly from ascocystitids in that the latter maintain a juvenile-like gogiid plate pattern, with little intercalation, well into early maturity. Thecal respiratory structures in gogiids are epispires (sutural pores) and vary in position, shape and number along a plate facet. Epispires first appear in early juveniles between plates directly under the recumbent ambulacra; this stage is followed in early juveniles by epispires appearing between plates directly above the stem/theca intersection. Development of epispires over the rest of the theca (final stage) occurs in mid to late juvenile stage(s). Epispires begin as circular openings and with plate growth elongate and become broadly to elongately oval during ontogeny. The Lower Ordovician ascocystitid genus Rhopalocystis (Morocco) peda-morphically maintains small circular (juvenile-like) epispires throughout ontogeny. By the Upper Ordovician ascocystitids have lost their epispires and there are no trans sutural respiratory openings. Large Ascocystites have raised ridges on thin thecal plates that continue from one plate to the next. These ridges are also thin walled and internally form channels. The sutures appear to have been flexible and the thecal walls probably flexed easily. Large thecal volume would argue for internal circulation of body fluids in ascocystitids probably past the theca’s internal surface for oxygen exchange, mimicking juvenile gogiids. Currents circulating body fluids were probably generated by peristalsis of the gut and spasmodic flexing of interplate muscles. The largest specimen studied for an example, has a theca 184 mm high and 45 mm in maximum width. Allowing for plate thickness the internal volume is approximately 67 cc. The internal surface area of the theca in mature Ascocystites is not sufficient to effect viable respiration simply by diffusion, so a mechanism for internal body fluid circulation is a necessity. Ambulacral areas in both gogiids and ascocystitids are similar especially when comparing ascocystitids to some laurentian Middle Cambrian gogiids where in both ambulacral rays have branches that end in brachiole bases. The gogiid/ascocystitid clade does not survive the upper Ordovician.
TOWARDS A TERMINOLOGY OF ANAL PLATES IN MODERN SEA CUCUMBERS (HOLOTHUROIDEA) [poster]

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Anal teeth or plates, usually five in number, are radially placed calcareous ossicles encircling the anus in several species of actinopodid (pneumonophoran) sea cucumbers. This structure, up to few millimetres long, is composed of elongate, perforated and either triangular or Y-shaped plates. First reported in the mid 18th century, anal teeth have been sporadically noted in systematic descriptions since then. In detail, the taxonomic distribution of those ossicles is variable and particularly well developed in Holothuriida (e.g. Actinopyga, Holothuria/Microthele), Molpadida (e.g. Cherbonniera, Eupyrgus, Hedingia, Molpadia), and Dendrochirotida (e.g. Actinocucumis, Cercodemas, Havelockia, Massinium, Pentamera, Placothuria, Pseudocolochirus, Pseudothyone, Psolidiella, Psolus, Sclerodactyla, Stereoderma, Thyone).

Accordingly, this structure is clearly another important gross morphological character in Holothuroidea besides the calcareous ring. However, heavily understudied, a compilation and discussion of the morphology and systematic distribution of anal teeth is missing so far. High-resolution x-ray computed tomographic (CT) analysis of anal teeth (“anal ring”) of several members of the Molpadida: (1) Cherbonniera utriculus (Molpadiidae), (2-3) Eupyrgus pacificus and E. scaber (both Eupyrgidae) and (4) Hedingia albicans (Caudinidae) reveals details previously not observed, overlooked or unstudied. Thus, the “anal ring” appears to be a complex structure too as formerly supposed by most echinodermologists. My present study is a first attempt to introduce a terminology for sea cucumber anal plates/anal rings.
NEW INSIGHTS INTO EARLY EVOLUTION OF MODERN MYRIOTROCHID SEA CUCUMBERS (HOLOTHUROIDEA: APODIDA) [talk]

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Myriotrochids are small, infaunal apodid sea cucumbers that occur in bathyal, abyssal and hadal depths of modern seas but have been also found in artic and sub-arctic shallow waters. The presence of myriotrochids, stem-group myriotrochids and apodid relatives in the fossil record is mostly indicated by isolated distinctive body-wall ossicles and calcareous ring elements since the Silurian. However, their record is sporadic and the evolutionary information is largely based on isolated ossicles only. Fortunately, in a handful of cases articulated/partly articulated calcareous ring material or whole body fossils were found recently in several Palaeozoic strata and fossil lagerstätten, facilitating much more significant insights in the evolution and phylogeny of this class.

The Late Triassic Cassian Fm. of Italy (~235 myr) is regarded as one of the most important strata of early Mesozoic invertebrates worldwide, including all groups of extant echinoderms (Crinoidea, Asteroidea, Ophiuroidea, Echinoidea, Holothuroidea) as well as the youngest representatives of the extinct (‘Palaeozoic’) ophiocistioids. Here we present well-preserved holothurian calcareous ring material from a fossil assemblage sampled near Misurina, Dolomites, Italy, yielding apparently a new member of ‘modern’ myriotrochids (Apodida). Based on several partly articulated calcareous rings, which are showing the typical morphology concerning the anterior processes and arrangement for the passages of nerves in dorsolateral and ventral radial elements, we can assume a crown group member of the Myriotrochidae, as all Palaeozoic representatives have a clearly different entire calcareous ring structure.

Our new record from the Late Triassic Cassian Fm. has novel implications for understanding the evolution of apodids and the timing of distinction between stem and crown group myriotrochids in the course of the Mesozoic Marine Revolution.
MORPHOLOGY OF MYELODACTYLIDS (DISPARIDA) AS A REFLECTION OF THE “DEEP” ONTOGENESIS OF CRINOID [talk]

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Many changes in the morphology of animals are caused by paedomorphosis – a delay in the development of one of the modular systems of the body and thereby the manifestation of its underdeveloped stage in the morphology of an adult organism. The opposite conclusion is also true: the study of paedomorphic organisms allows some features of the “deep”, that is, not expressed in the age-related variability of ordinary forms, ontogenesis. This approach allows us to reconstruct the morphogenesis of unusual aberrant taxa and thereby reveal their possible phylogenetic relationships. Using this method to analyze the morphology of the small family of disparid crinoids Myelodactylidae allows us to identify the morphogenetic basis of these unusual crinoids.

Myelodactylidae unite 5 described genera and two (three) new ones in the collection of the Borissiak Paleontological Institute, some of which are known only by stem fragments. The family is found in Baltica, Lawrentia, Siberia and Gondwana, mainly in Silurian, but some columnals are known from the Late Ordovician and Early Devonian. The calyx, judging by its plating in the genus Myelodactylus, has a typical icriniid structure: five basals and five radials, of which only one C is composed of the lower and upper radials. The anal tube extends from the left edge of the upper radial C. A characteristic feature of this family is a stem with spirally twisted or at least much curved mesistele and proxistele with the crown located at an acute angle to this spiral and directed in the opposite direction. The columnals of the mesistele are bilaterally symmetrical, with a plane of symmetry coinciding with the plane in which the spiral is twisted. The outer part of the spiral of the mesistele and each of the columnals is usually convex, and the inner is often flat or even concave. The shape of the mesistele columnals and the facets for cirrus attachment located on the edges of the inner side of the segment joint emphasize the bilaterality of the mesistele and each of the columnals. Some representatives have no cirri. Mesistele columnals can be holomeric, or consist of several segments and be, respectively, bimeric, trimeric and pentameric. In some representatives, two depressions, sometimes rather deep, are symmetrically located near the lumen. Apparently, they served as a support for the ligament or for muscles. The stem twisting of the myelodactylids into the spiral was posthumous in some species, as is observed in some icriniids (Ristnacrinus and Baltocrinus). Twisting and untwisting of the spiral mesistele during the life of the animal in species with a strong ligamentous (muscular?) articulation between columnals could be an adaptation to adverse conditions or predators. Judging by the location of the cirri on the mesistele, the spiral twisted towards the ground in the same homocrinid plane (BC-E), in which the proxistele was bent, but in the opposite direction. The bending of the proxistele with the crown was probably resulted from a pedomorphic delay in the torsion process (el- evation). The location of the anal tube in radius C and the use of the virtually left branch of the skeleton of the arm C for support, as in most disparids, are resulted of the displacement of the anus from the larval plane towards the primary hydropore. Such a process reflects the ontogenetic movement of the primary hydropore and anus, the rudiment of which marks the initial larval plane, into a single plane. This process is observed in the ontogenesis of modern crinoids. Such paedomorphic processes determine the uniqueness of the life form not only of myelodactylyids, but also of many other crinoids, such as, for example, disparid Calceocrinacea, camerate Camptocrinus, many ctyrtoicrinids and many others crinoids and blastozoans.

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EDIKAARAN ARKARUA IS NOT AN ECHINODERM, BUT A BURSTING BUBBLE IN A CYANOBACTERIAL MAT: CONCLUSION FROM A CAMBRIAN FIND IN SIBERIA [poster]

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Ediacaran fossil from the Pound Subgroup of South Australia Arkarua adami was assigned to echinoderms and among them conditionally to edrioasteroids because it has five-ray symmetry in the arrangement of the structure, extending from the center of the disk to the periphery. In addition to the five-ray structure resembling echinoderm ambulacra, other important features of this type, such as the calcite stereom skeleton and hydropore, are unknown in these fossils. This cast doubt on the echinoderm nature of Arkarua and similar forms from the Vendian of the White Sea area. The absence of these features could be explained by the safety and/or preskeletal stage of the phylogenetic development of the type. Such uncertainty in the interpretation of this hypothetical echinoderm also creates uncertainty in the interpretation of the origin of the whole type.

Findings of arkaura-like forms in the lower Middle Cambrian (Elanka Formation, lower part of the Amgian stage; according to the international system, the upper stage 4 of Division 2) of Siberia (Yakutia, the Middle Lena River, the left bank, Elanka village) shows that they are bursting bubbles filled with oxygen in thin cyanobacterial mats.

Here, in thin layered brown and dark brown dolomitic limestones, numerous disk-shaped formations with a diameter of 0.5 to 2 cm with cracks radially diverging from the center and filled with rocks of different colors were found on the surface of the layers. The symmetry of these radial structures is from biradial to seven-radial. Five-radial forms are common among them, very similar to the Ediacaran Arkarua. Like the ediacarian forms, the Cambrian five-rayed specimens also resemble attached edrioasteroids in their outlines. But the details of their macro- and microstructure indicate their microbial origin. A study of Cambrian specimens under a scanning electron microscope showed the presence of a large number of mineralized extracellular polymeric substance (EPS) binding carbonate grains. This indicates that the discoid formations first emerged as round, convex structures on the surface of a thin cyanobacterial mat, that is, they were bubbles filled with gas. This gas was probably oxygen released by cyanobacteria during photosynthesis. The EPS above these bubbles was apparently already slightly mineralized. Unable to withstand the pressure of the incoming gas, the film burst above the bubbles, forming radial cracks that divide the disk into almost identical sectors. The number of cracks was random, but often equal to five. The resulting disc-shaped forms with five sutures resembled echinoderms in symmetry type. But the wide variability of symmetry, together with clear signs of a cyanobacterial mat, proves the origin of these structures as a result of the bursting of bubbles due to the pressure of the gas filling them. The convincing picture of the formation of the Cambrian five-rayed disks indicates, in our opinion, a very likely similar origin of the Ediacaran Arkarua.

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DIFFERENT FOOD PREFERENCE RELATED TO ARM MORPHOLOGY IN TWO ASTEROID SPECIES [poster]

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Two starfish species, Coscinasterias acutispina and Patiria pectinifera, were examined for their feeding habits. Both species are found sympatrically in the rocky shore of the intertidal zone and known as predators feeding on molluscs. In field investigation, 20% of 576 observed individuals of C. acutispina were found eating molluscs in contrast to 2% of 484 observed individuals for P. pectinifera. In P. pectinifera approximately 60% of observed individuals were projecting the stomach outside from the mouth, though no prey animal was found below the stomach, but the underlying substrates were covered with algae. In aquarium experiments where a starfish individual and 2-3 individuals of limpets or snails collected from the asteroid habitat were put together in an aquarium, C. acutispina ate approximately 90% of prey animals used in the experiments whereas P. pectinifera fed 15% of the prey molluscs used in the experiments. In many cases the prey animals could easily run away from the attack of P. pectinifera, while C. acutispina manipulated the long, flexible, separated arms to cover the prey and grasped it with the sucker-tipped tube feet. The length and flexibility of arms, the distribution of sucker-tipped tube feet on arms play important roles to catch the molluscs. In aquarium, P. pectinifera did not frequently attack prey molluscs but stayed for a long time on a stone covered with algae. P. pectinifera are presumably not active predator on molluscs like snails and limpets that can move quickly. The blue bat star has a broad body with short wide arms, which facilitates the animal to cover food widely and safely with the stomach under the body. The morphology are adapted for feeding on less-moving, sessile or dead organisms as well as detritus or algae. The two starfish species are not competitive in their sympatric habitat because of the different feeding modes related to their morphology.
MYCOSPORINE-LIKE AMINOACIDS AS PHOTOPROTECTIVE COMPOUNDS ON SEA CUCUMBER COLLAGEN [poster]

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Organisms exposure to ultra violet radiation (UVR) compromises the stability of macromolecules such as DNA, lipids, and proteins. Compounds that mitigate the damages caused by UVR, for example mycosporins-like amino acids (MAAs), are capable of absorbing UVR (UV-A and UV-B), acting as photo-protective compounds. Further MAAs show strong photo stability, and absence of cytotoxicity. Marine organisms like sea cucumber Holoturia lubrica inhabits clear and shallow waters, so it is regularly exposed to direct sun irradiation in nature. Thus, the accumulation of MAAs in the epidermis of H. lubrica might be associated to photo-protection and could prevent UVR damage. On the other hand, collagen is one of the main components of the body wall of sea cucumbers, which represents up to 70% of total protein. Therefore, this work focuses on the physicochemical characterization of body wall collagen and epidermal MAAs mixture in order to assess the photo-protective activity of MAAs on collagen structure. Methanolic extracts of the epidermis showed absorbances in the UV-wavelength range of MAAs and the collagen isolated of the body wall was identified as type I collagen. In addition, these two compounds have the potential to be used in biotechnology industry, due to their low allergenicity and toxicity.
MODELING THE DISTRIBUTION OF ECHINOID FAUNA IN THE SOUTHERN OCEAN [poster]

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Significant environmental changes have already been documented in the Southern Ocean (e.g. sea water temperature increase and salinity drop) but its marine life is still incompletely known given the heterogeneous nature of biogeographic data. However, to establish sustainable conservation areas, understanding species and communities distribution patterns is critical. For this purpose, the ecoregionalization approach can prove useful by identifying spatially explicit and well-delimited regions of common species composition and environmental settings. Such regions are expected to have similar biotic responses to environmental changes and can be used to define priorities for the designation of marine protected areas.

In the present work, a benthic ecoregionalization of the Southern Ocean is proposed for the first time based on echinoid distribution data and abiotic environmental parameters. Echinoids are widely distributed in the Southern Ocean, they are taxonomically and ecologically well diversified and documented. Given the heterogeneity of the sampling effort, predictive spatial models were produced to fill the gaps in between species distribution data. Then a first procedure was developed using Gaussian Mixture Models (GMMs) to combine individual species models into ecoregions. A second, integrative procedure was implemented using the Generalized Dissimilarity Models (GDM) to model and assemble species distributions. Both procedures were compared to propose benthic ecoregions at the scale of the entire Southern Ocean.
TAXONOMIC REVIEW OF THE GENUS *PSEUDOCNUS* PANNING, 1949 (HOLOTHUROIDEA: DENDROCHIROTIDA) REPORTED FOR MEXICO [talk]

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*Pseudocnus* Panning, 1949 is a genus belonging to the family Cucumariidae Ludwig, 1894, currently conformed of 15 species distributed on the world. For the coast of Mexico only one species have been reported: *Pseudocnus californicus* (Semper, 1868). The aim of this work was to morphologically compared the specimens that were collected during the field work in the Upper Gulf of California (Bahia de los Angeles, La Paz, Baja California Sur, september, 2016) with the material previously deposited in the Colección Nacional de Equinodermos "Dra. Ma. E. Caso Muñoz ", from ICML, UNAM, of the species belonging to the genus *Pseudocnus*. In this work identification of the specimens in comparison with the other species of this genus was made, external and internal morphological characters were use to propose a new species in the genus *Pseudocnus* distrubted within the eastern Pacific; this new species have been recognized by the presence of perforated plates with spruce-like extension and trirradiate spinosus bars ossicles in the body wall, and in the tentacles are perforated plates and rosettes ossicles are present. This new species is very similar to *Pseudocnus dubiosus* (Semper, 1868) because have body wall ossicles perforated plates with spruce-like extension and perforated plates in the tentacles.
NEW RECORD OF THE GENUS LEPTOPENTACTA H.L. CLARK, 1938 (HOLOTHUROIDEA: CUCUMARIIDAE) FOR THE MEXICAN PACIFIC [poster]

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Leptopentacta H.L. Clark, 1938 is a genus belonging to the family Cucumariidae Ludwig, 1894, currently conformed of 13 recognized species. Only two species have been reported for the Eastern Pacific: Leptopentacta nova Deichmann, 1941 and Leptopentacta panamica Deichmann, 1941. The aim of this work is to show new geographic records of Leptopentacta nina Deichmann, 1941 for the Mexican Pacific based on material deposited at the Colección Nacional de Equinodermos “Dra. Ma. E. Caso M.”, at the ICML, UNAM. The external and internal morphological characters were reviewed using a compound microscope; the analysis of body wall and tube feet ossicles (body wall ossicles with concave plates, knobbed, irregular buttons and larger plates with knobbed surface, in the tube feet have end plate), was made with the help of a light microscope and Scanning Electron Microscope (SEM). In the present work the number of species of the genus Leptopentacta reported for the Mexican Pacific is increased to three species.
NEW RECORDS OF THE FAMILY CUCUMARIIDAE LUDWIG, 1894
(HOLOTHUROIDEA: DENDROCHIROTIDA)
FOR THE MEXICAN PACIFIC [poster]

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The family Cucumariidae Ludwig, 1894 is one of the most diverse taxonomic groups in the order Dendrochirotida, containing 231 valid species (49 genera, two subfamilies). For Mexico 15 species of cucumariids have been reported so far. Particularly for the Mexican Pacific only four species of three genera have been reported: Cucumaria De Blainville, 1830; Pseudocnus Panning, 1949 and Trachythyone Studer, 1876. The aim of this work is to show the new records of species belonging to the family Cucumariidae from material held at the Colección Nacional de Equinodermos “Dra. Ma. E. Caso Muñoz “, from ICML, UNAM. Specialized literature of the group was reviewed in order to identify the material; the external and internal morphological characters were reviewed using a compound microscope; the analysis of ossicles was made with the help of a light microscope, later the ossicles were mounted for Scanning Electron Microscope (SEM) and photographed using a S-2460N Hitachi, in the Laboratorio de Microscopía y Fotografía de la Biodiversidad (I), del Instituto de Biología, UNAM. We report six new records of the family Cucumariidae for the Mexican Pacific: Cucumaria piperata Stimpson 1864, Cucumaria pallida Kirkendale & Lambert, 1995, Cucumaria salma Yingst, 1972, Pseudocnus curatus (Cowles, 1907), Pseudocnus dubiosus (Semper, 1868) and Pseudocnus lubricus (HL Clark, 1901). The number of species of the family Cucumariidae reported for the Mexican Pacific is increased to ten.
NEW DATA ON CRYPTOCRINIDAE (ECHINODERMATA, EOCRINOIDEA) FROM THE MIDDLE ORDOVICIAN OF LENINGRAD DISTRICT (RUSSIA) [poster]

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Cryptocrinidae includes two genera known from the Middle Ordovician of Baltoscandia: *Cryptocrinites* von Buch, 1840 from the Aseri regional stage (Darriwilian) and *Paracryptocrinites* Rozhnov et Fedorov, 2001, the more ancient genus from the Volkhow regional stage (upper Dapingian – lower Darriwilian).

Von Buch, erecting the genus *Cryptocrinites* in 1840, included in it, besides the widespread *C. laevis* (Pander, 1830), the second species, *C. cerasus*. The location of the specimen depicted by Buch is unknown; in his next work, under the name *C. cerasus*, Buch gave images of *C. laevis* of a completely normal appearance. In this regard, later authors found that *C. cerasus* is nomen dubium. A new find of a well-preserved theca allows us to return to the consideration of this species. This species should be attributed to the genus *Paracryptocrinites*. *Cryptocrinites (?) similis* Bockelie, 1981 is a junior synonym for *Paracryptocrinites cerasus* (von Buch, 1840).

*P. cerasus* has larger plates of the third (upper) lateral circlet and shorter ambulacra than *P. bockeliei*, a type species of the genus. The structure of the mouth and ambulacra is more similar to that of *C. laevis*.

The aberrations encountered among the studied specimens of *C. laevis*, namely, the presence of sculpture in the form of small granules and the appearance of additional plates, demonstrate ancestral features of *Cryptocrinites*. The appearance of additional plates enhances the irregularity of thecal structure and upsets the organization of plates in the circlets.

The greater number of thecal plates and the less rigid and constant organization into the circlets are just the signs that the more ancient cryptocrinid representatives (*Paracryptocrinites* spp.) show us. Apparently, the thecal structure of *Cryptocrinites* was settled simultaneously with the decrease in the number of tablets of the aboral theca.
New data on the distribution of Hemicosmita (Rhombifera, Echinodermata) in the Middle Ordovician (Darriwilian) of the Leningrad district (Russia) has been obtained. *Hemicosmites pyriformis* occurs in the upper part of the Kunda regional stage (*Asaphus sulivi* zone) - the middle part of the Aseri regional stage (*A. punctatus* zone); *H. malum* and *H. oblongus* in the upper part of the Aseri regional stage (*A. kowalewskii* zone). The detailed description of the mentioned species is given. Neotypes were chosen for *H. malum* and *H. oblongus*.

A new *Paracaryocrinites* species was found on the border of the Kunda and Aseri regional stages. This genus was previously known from the Ordovician of eastern Gondwana (southern China and Thailand). This genus is considered to belong to Caryocrinidae, but the absence of tegmen also brings it close to Hemicosmitidae. *Paracaryocrinites* has 8 lateral plates, ambulacral furrows and mouth covered with small plates, and a periproct located on an elevation on the border of the radial and lateral circket. The good preservation of the material studied reveals details showing the affinity of the new *Paracaryocrinites* species and *Hemicosmites* genus, namely the presence of a facet-like structures, one for each of the three ambulacral furrows. Each of these facet-like structures is associated with an additional plate included in the radial circket. *Hemicosmites* have similar facets-like structures and associated with them additional plates (Bockelie, 1979), although in *Hemicosmites* these plates have been greatly reduced. In *Hemicosmites*, the hydropore is located between the radial plate and the very small plate above it, which is also undoubtedly included in the radial rim. Thus, *Hemicosmites* and *Paracaryocrinites* both have 13 plates in the radial circket (5 in the anal interradius, 4 in the rest interradia). Two closely related species, *H. pyriformis* and *H. malum*, and new *Paracaryocrinites* species have a very small radial circket; the arm facets are located at the sutures of adjacent lateral and two radial plates; there are no pore rhoms on the radial plates. *H. oblongus*, like all later *Hemicosmites* species, has a radial circket of a larger size; the arm facets are located at the sutures of two adjacent radial plates. This species is very similar to the later *H. extraneus*, differing from the latter mainly in the absence of pore rhombs on the radial plates.

Judging by the revealed similarity of the details of the structure, it can be assumed that the *Paracaryocrinites* is close to the ancestral form of Hemicosmitidae. Later in Hemicosmitidae periproct moved further down to the side of the theca (to the border between LL and ILL circllets or between the two ILL plates) and at the same time on the opposite side of the theca a ninth plate appeared in the lateral circket. Hemicosmitid genus *Corylocrinus*, having 8 LL, periproct between LL, thus occupies an intermediate position between Caryocrinidae (8 LL, periproct above LL) and other Hemicosmitidae.
GROWTH AND DEVELOPMENT OF ALLOCATILLOCIRINUS CARPENTERI, A MISSISSIPPIAN (CARBONIFEROUS) MICROCRINOID [talk]

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Allocatillocrinus carpenteri (Wachsmuth 1882) is a multibrachiate, disparid microcrinoid assigned to the family Allagecrinidae. It occurs widely in Carboniferous (late Mississippian) rocks of the midwest and southern regions of the USA. Well preserved crowns with columns attached, together with complete thecae, disarticulated thecal plates, brachials and columnals washed from shale, provided material for the reconstruction of its growth and development.

The smallest specimens recovered have a cup height of approximately 450 μm and consist of basals, five radials without arm articular facets and five primary peristomial cover plates, the latter forming one quarter of the height of the theca. In specimens with aboral cups 1 mm high, the first five arm articular facets had developed on the radials in the set order described for other disparid crinoids (C ray first, followed closely by the E ray, and the B, D and A rays in sequence). After the first five articular facets were formed, a notch developed on the upper left margin of the C radial for the reception of the lowest plate of the anal tube, which was connected to the interior of the theca by an opening adaxial of the C radial. No further facets developed on the C and E radials. Additional facets developed on the other facets in the sequence B, D and A up to the twelve armed stage; thereafter the A radial came to bear the greatest number of arms. Large thecae bore a total of 20 or more arms. The architecture of the arm articular facets increased in complexity during growth, developing from a small shallow depression with an arcuate margin on the middle of the distal surface of the radial to a facet with a distinct outer ligament pit, an aboral nerve canal and well developed inner ligament areas.

Although the width and height of the aboral cup grew isometrically, the overall shape of the theca changed during growth, because the circlet of primary peristomial cover plates was proportionately lower in larger thecae and because the thecal outline in aboral view changed from elliptical in very small specimens to pentastellate in intermediate sized specimens to circular in the largest specimens. It is probable that the primary peristomial cover plates were resorbed in the larger specimens.

The arms, as well as increasing in number in concert with growth of the theca, also increased in length, principally by the addition of new ossicles at their distal ends. When estimates of the thecal volume of appropriately preserved individuals are plotted against the product of the number and length of their arms, the relationship is found to be allometric, with an exponent of approximately 0.7.

The column in large specimens consisted of a proxistele of wide, thin ossicles with distinctive architecture of the articular surfaces; a heteromorphic mesistele with columnals of differing width and height; and a less distinctly heteromorphic dististele with columnals of varying height but essentially the same width. During growth of the theca, the column increased in length, mainly by the growth of individual columnals and the insertion of new columnals in the mesistele. In the smaller specimens the mesistele and dististele are not differentiated. It appears that growth of the column was modular and that columnals of the proximal part of the mesistele in young individuals were not transformed later into proxistele columnals.
GELATINASE EXPRESSION: A FACTOR DETERMINING THE REGENERATIVE ABILITY IN HOLOTHURIANS [poster]

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Holothurians often used as a model for studying the mechanisms of regeneration. These animals have a unique ability to recover parts of the body as well as whole organs after various kinds of injury. Regeneration in holothurians occurs by migration and dedifferentiation of cells and their interaction with the connective tissue. One of the factors that alter the properties of connective tissue is specific proteolytic enzymes - matrix metalloproteinases (MMPs). They belong to the zinc metalloproteinase family, whose function is associated with the metabolism of connective tissue proteins in normal and pathological conditions. Studies were carried out on adult holothurians Eupentacta fraudatrix and Cucumaria japonica. The injury was done with scissors, dissecting the wall of the body and the right dorsal ambulacrum. Proteinase activity was assayed by quantitative zymography. Zymograms of tissue homogenates of intact specimens of E. fraudatrix showed two pools of proteins with lytic activity against gelatin. No proteins with proteolytic activity against gelatin were found in tissue homogenates of intact individuals of C. japonica. Gelatinase expression after injury differed between the studied species. In C. japonica, no gelatinase activity at the site of the incision was detected either by biochemical methods or by in situ zymography. At the same time, several proteases were revealed in E. fraudatrix and their activity changed during morphogenesis, suggesting their participation in regeneration. In early stages after injury, when wound healing and tissue preparation for regeneration occur, high molecular weight proteases were activated. Subsequently, MMP with lower molecular weight were expressed. The activity of all proteases was high throughout the regeneration process. Treatment with the MMP inhibitor GM6001 led to a decrease in the migratory activity of cells and to the cessation of regeneration. However, cell differentiation was not blocked. A comparative analysis of the dynamics of protease activity after different types of injury (evisceration and body wall transection) revealed shared features of expression of these enzymes during regeneration. In early stages of recovery, high molecular weight proteinases are activated, whereas the expression of MMP-like proteins with lower molecular weights is of crucial importance at later stages of regeneration during the differentiation and formation of the lost structures. The different time of expression and the results of in situ zymography, as well as the literature data on holothurian transcriptome analysis indicate the presence of several MMPs in holothurians, which regulate different stages of regeneration.

Thus, we identified 4 proteinases in the body wall and ambulacral organs of the sea cucumber E. fraudatrix, which are similar in their properties to vertebrate gelatinases. Their activity increased after injury. This contributes to the remodeling of the extracellular matrix at the site of injury and to cell migration, and ultimately leads to the restoration of the damaged structures. The lack of MMP expression in C. japonica in normal condition and during regeneration apparently results in the inability to repair damaged structures. In this regard, we suppose that metalloproteinases with gelatinase activity are one of the key factors of regeneration in holothurians.
THE ORIGIN OF THE SUBORDER SYNAPTINA (HOLOTHUROIDEA, SYNAPTIDA) AND ITS EVOLUTION DURING THE MESOZOIC – CENOZOIC [talk]

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The recent Synaptina are characterized by such synapomorphic characters as presence of special organs in their body cavity – ciliate funnels, and additionally, in larvae and juveniles, wheels sclerites with flat hub and numerous spokes. The subfamily Taeniogyrinae (fam. Chiridotidae) is characterized by the presence of an “ensemble” of chiridotid wheels with 6 spokes and a complex hub (known from the middle Triassic) and sigmoids with open-eye (unknown in fossils), or sigmoids only, and radial segments of calcareous ring not perforated for passage of radial nerves, The subfamily Chiridotinae (fam. Chiridotidae) has only chiridotid wheels and, sometimes, rods in the body wall; the radial segments of the calcareous ring have a perforation for passage of nerve. The presence of a complex of sclerites consisting of anchor and anchor plate is characteristic for the family Synaptidae. Most researchers believe that the ancestors of the Mesozoic Synaptina were holoturoids possessing sclerites sahped as sigmoids with a closed eye: the hooks (the formal family Achistridae). The hooks are known from middle Devonian to lower Cretaceous (there is one problematic record for Paleocene). Sclerites shaped as hooks and wheels similar to recent larval wheels were described in extinct species Rothamus multiradiatus (Carboniferous, Mississippian, Germany) (Haude, Thomas, 1994). Also from Carboniferous (Mississippian, UK) an ensemble of sclerites consisting of hooks (Achistrum nicholso- nii) and perforated plates has been described (Etheridge, 1881). Some years ago, in Scoliorhapis lindbergi (Taeniogyrinae) some teratological sigmoid sclerites resembling synaptids anchors were found among normal sigmoids (Inoue, Kajiharas, 2012). Recent SEM studies of sigmoids structure revealed that sometimes the sigmoid spear has small teeth, similar to the teeth on the anchor arms in the family Synaptidae. These data led me to a hypothesis that modern sigmoids could have originated from anchors. Anchors, in turn, may have originated by mirror duplication of hooks with a closed eye. With appearance of anchors in upper Jurassic the hook-shaped sclerites disappear from the paleontological record fairly quickly (the last unequivocal finding is from lower Cretaceous). Apparently, taxa with anchor-shaped sclerites outcompeted taxa with hook-shaped sclerites and the latter became extinct. Both hooks and anchors could perform a similar function, and perhaps the anchors gave a competitive advantage, thus contributing to spreading of taxa with anchors starting from the upper Jurassic and extinction of taxa with hooks. The hypothesis of anchor origin by mirror duplication of hooks suggests a novel view on evolution and classification of the suborder Synaptina. There are two possibilities for origin of sigmoids sclerites in subfamily Taeniogyrinae: 1) they could have originated by “secondary recapitulation” of hooks with a closed eye, with modification resulting in sigmoids with an open eye; 2) the sigmoids originated from anchors, which, in turn, are mirror duplicated hooks. The family Synaptidae can be divided into two groups. The first group includes subfamilies Rynkatorpinae (from upper Jurassic to recent) and Leptosynaptinae (from upper Cretaceous to recent) and corresponds to the group Heterournae of Heding (1928). The second group includes the subfamily Synaptinae (from Eocene to recent) and corresponds to the group Micrournae of Heding (1928). Based on the new data on morphology of sigmoids and anchors I propose to make a number of changes in classification of the suborder Synaptina.

This work is a contribution to the state research theme “Taxonomy, biodiversity and ecology of invertebrates of Russian and adjacent waters of the world ocean, continental reservoirs and wetlands” (№ AAA-A19-119020690072-9).
THE ORIGIN OF THE CLASS HOLOTHUROIDEA
(ELEUTHEROZOA: ECHINOZOA) [talk]

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Holothurians possess a number of unique characters. The main characters distinguishing them are the presence of oral tentacles and the calcareous ring and the structure of their water-vascular (ambulacral) system. In all extant classes of Eleutherozoa, except holothurians, the five primary lobes of the hydrocoel initially develop as tentacles and subsequently transform into radial ambulacral canals. In holothurians, the five primary lobes of the hydrocoel give rise to the five primary tentacles positioned around the mouth, while the radial ambulacral canals develop from the hydrocoel between adjacent tentacles at a later stage and terminate aborally. In my opinion, it is plausible that this feature in development of the ambulacral system, like some other unique structural characters of holothurians, may be explained by the pedomorphic origin of Holothuroidea. I hypothesize that Echinodermata descended from ancestors, which had a tentacular apparatus derived from the mesocoel, like the tentacular apparatus of modern Pterobranchia. Previously, I proposed a hypothesis of a two-stage morphogenetic program in development of the ambulacral system of Eleutherozoa (Smirnov, 2014; 2015). The first stage is development of the hydrocoel outgrowths as tentacles. The second stage is transformation of the primary tentacles into radial ambulacral canals incorporated in the body wall. The development of echinoids illustrates the two stages perfectly. In Echinoidea, the primary outgrowth of the hydrocoel develops as tentacles, and then they change the direction of their development, bend backward and give rise to the radial ambulacral canals. In Holothuroidea the process of transformation of the five primary tentacles into radial ambulacral canals has been interrupted. The five primary radial outgrowths remained tentacles but the next stage of the program is modified. The radial canals of holothurians begin to develop into a hydrocoel between the five primary tentacles later. Development of the radial complex of organs consisting of the ambulacral canals, nerve cords, epineural, hyponeural and hemal canals was modified too. In contrast to echinoids and ophiuroids, in holothurians the radial epineural nerve develops not at the bottom of the closed epineural canals, but as outgrowths of the anlage of the epineural nerve ring, and the epineural canals develop by forming a cavity in the tissue lying outward from the radial nerves, and not by closing the epineural folds. This equifinal development results in the radial complex of Holothuroidea being very similar in structure to the radial complex of Echinoidea and, to a lesser extent, of other Eleutherozoa. In my opinion, this similarity indicates homology of the ambulaca of holothurians and other echinoderms. Thus, although topographically the radial complex in holothurians is shifted relative to the radial complex of the other Eleutherozoa by about 36° into the “interradial” position, it is homologous to the radial complex of the other Eleutherozoa and is isomorphic to them. It is very likely that all or some of the segments of the Holothuroidea calcareous ring represent modified first ambulacral plates and are homologous to some parts of the jaw apparatus of other Eleutherozoa. Published studies of holothurian development demonstrated that the bilateral symmetry plane of their larva is coincident with the bilateral symmetry plane of the adult animal. Apparently, holothurian ancestors switched to crawling on the side corresponding to the larval ventral side, and the bilateral symmetry of holothurians started to develop based on the bilateral symmetry (or more precisely, on bilaterally asymmetrical symmetry) of their larvae, or possibly even larvae of echinoderm ancestors.

This work is a contribution to the state research theme “Taxonomy, biodiversity and ecology of invertebrates of Russian and adjacent waters of the world ocean, continental reservoirs and wetlands” (№ AAA-A19-119020690072-9).
THE HISTORY OF THE COLLECTION OF ECHINODERMS OF THE ZOOLOGICAL INSTITUTE RAS [talk]

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The history of the echinoderm collection at the Zoological Institute (ZIN) is, in fact, the history of Russian expeditions to the seas around Russia and adjacent waters, and to Antarctica. During the XIX century acquisitions of echinoderms at the Zoological Museum were not numerous, but in the XX century the collections of the Department of echinoderms began to grow intensively. Currently, the Zoological Institute accommodates most of the material collected in the Russian seas and also the collections of animals by Russian expeditions to Antarctica. There are some collections from the tropics and other parts of the world ocean.

Currently, the collection of echinoderms includes 25250 lots identified to species and a large amount of material that is still unidentified. Among the collections of the Department of Echinodermata are those obtained by the following important expeditions: Expedition for scientific and industrial fishery explorations of Murman coasts (1898-1906); Russian-Swedish expedition to Spitsbergen (1899-1901); the Polar Expedition of the Academy of Sciences (1900-1903); the Arctic Ocean Hydrographic Expedition (1909-1915); collections of the Floating Marine Institute (scientific vessel “Perseus”) in the Barents and Kara Seas (1921-1929); numerous expeditions of the State Arctic Institute to the seas of the Soviet Arctic, the Greenland Sea and the Central Arctic Basin (1925-1960), including high-latitude expeditions on the icebreaker “Sadko” (1935-1938) and on drifting ice stations “North Pole 2–North Pole 8” (1950-1958); as well as the first three Complex Antarctic expeditions aboard the diesel-electric ship “Ob” to Antarctica (1955-58) (Smirnov, 1999). The ZIN received the invertebrate material, including echinoderms, collected by the Pacific Complex Expedition (1932-1933). This expedition was organized and carried out thanks to the efforts of professor Konstantin Derjugin (1878-1938) and made a tremendous contribution to the study of the fauna of the Far Eastern seas of Russia. In 1934, the ZIN launched an expedition to study the Sokolovskaya Bay, the Sea of Japan. In 1947-1949 ZIN and the Pacific Institute of Fisheries and Oceanography carried out a large Kuril-Sakhalin expedition, which studied the waters around the southern Sakhalin and the south Kurile Islands. Cooperation between the two institutions was continued in 1975 by an expedition aboard the ship “Raduga” to the shores of Kamchatka and in 1978 by an expedition aboard the ship “Poseidon” to the Sea of Okhotsk. A part of the echinoderm collections made in the Far Eastern seas by the famous research vessel Vityaz in 1949-1954 are also deposited at the ZIN. Identification of these collections resulted in a very complete inventory of the Russian echinoderm fauna and publication of keys to echinoderms of the Russian seas, as well as many papers on taxonomy and regional faunas of Echinodermata. Scuba-diving hydrobiological expeditions were carried out almost annually from 1962 till 1989 to study the fauna and ecosystems of the upper parts of the shelf in nearly all Russian seas. As a result of these expeditions, led by the head of the Marine Research Laboratory at ZIN, Alexander Golikov (1931-2010), the upper shelf fauna (including echinoderms) of the Russian seas was collected and investigated (Smirnov, 2010). Studies of the upper shelf were also carried out in Antarctica in 1964-65 under the leadership of Mikhail Propp (1937-2018) (11th Soviet Antarctic Expedition [SAE]), and in 1967-1968 (13th SAE) and in 1970-1972 (16th SAE) under the direction of Evgeniy Gruzov (1933-2010). As a result of these expeditions, echinoderm fauna of the Antarctic coast was inventoried at many localities (Smirnov, 2017). Scuba-diving explorations in Antarctica resumed in 2007 (52nd RAE) and continue to date, mainly in the Prydz Bay and also in the South Shetland Islands. During last two decades the Marine Research Laboratory collaborated in different expeditions to the Arctic seas, the Bering and Chukchi seas.
At the very beginning of the history of the Zoological Museum of the Russian Academy of Sciences, its founder and first Director Johann Friedrich von Brandt (1802-1879) published a paper entitled “Prodromus descriptionis animalium … Fasc. 1”. In this work he described echinoderms collected by Carl Heinrich Mertens (1796-1830) during the round the world expedition of Fedor Litke (1797-1882) on the sloop “Sinyavin” in 1826-1829, and proposed one of the first classifications of the class Holothuroidea. The history of the Department of Echinodermata, the “V Department of invertebrates” at the Zoological Museum, began on January 1, 1913, when Alexander Mikhailovich Djakonov (1886-1956) was invited to work at the Museum with its echinoderm collection. At the beginning of 1913 he was sent abroad to get acquainted with organization of storage of echinoderm collections in Europeans museums and to acquire skills in systematics of this group. Djakonov led the department since his return in 1914 until the end of his life. In the “Keys to the Fauna of the USSR” series he published “Echinodermata of the Northern Seas” (1933); “Sea Stars (Asteroidea) of the USSR Seas” (1950, English translation 1968); and “Ophiuroids of the USSR Seas” (1954, English translation 1967). In the “Fauna of Russia and adjacent countries” series Djakonov (1923, English translation 1969) described the regular Echiinoidea (except for the family Strongylocentrotidae): the monograph entitled “Echinodermata. Vol. I. Echiinoidea”. He is the author of monographic essays on sea stars of the genera Leptasterias (1931, 1938), Pedicellaster, Evasterias, Asterias, (1950) and Henricia (1961). Djakonov identified and described echinoderms collected by expeditions of the Zoological Institute on the Sokolovskaya Bay, Sea of Japan (1938) and the Kuril-Sakhalin expedition of 1947-49 in the areas of southern Sakhalin and the southern Kuril Islands (1958, three articles). He also wrote brief “Keys to Echinoderms of the Far Eastern Seas” (1949). In his zoogeographical papers, Djakonov substantiated a hypothesis about the origin of a significant part of the Arctic fauna due to immigration from the Pacific Ocean (1945), and a hypothesis about the Malayan archipelago as the center of origin of the Indo-West Pacific marine invertebrate fauna, and analyzed the amphipacific distribution pattern in echinoderms (1955). In total Djakonov published 39 papers on echinoderms. It should be emphasized that we are obliged to Djakonov not only for establishing a collection of echinoderms in the Zoological Museum/Institute, but also for designing a system of registration of collection lots and for implementing the collection storage methods that are still in use today. Djakonov is rightfully considered as the founder of the taxonomy of Echinodermata in Russia despite the fact that in his soul he was an entomologist and divided his “scientific” time between the study of echinoderms and lepidopterans (primarily geometrid moths). Tatyana Sergeevna Saveljeva (1902-1982), a dedicated assistant of Djakonov, worked at the Department from 1924 to 1960, and in addition to curating the collection and maintaining it in perfect order, published four articles on the taxonomy of Holothuroidea of the Russian seas. In 1960-1983, the Department of Echinodermata was led by the former apprentice of Djakonov, Zoya Ivanovna Baranova (1922-2010), who had been working at the Zoological Institute since 1948. She is the author of 35 publications on echinoderm, including a monograph on echinoderms of the Bering Sea (1957). Evgeniy Nikolaevich Gruzov (1933-2010) was a pioneer of Soviet scuba-diving hydrobiological research in Antarctica and was leading the Department from 1984 to 1998. He investigated the coastal benthic fauna and biocenoses of Antarctica. Gruzov is also the author of the concept on origin of the Antarctic shelf fauna, developed by him based on the vertical distribution of the Antarctic sea stars. Currently, the department’s employees are Dr. Alexey Vladimirovich Smirnov and Dr. Igor Sergeevich Smirnov.
DEVELOPMENT OF THE CONCEPT OF E.N. GRUZOV ON FORMATION OF THE ANTARCTIC SHELF FAUNA ON AN EXAMPLE OF OPHIUROIDS AND FISH [poster]

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Almost forty years ago, Evgeniy Nikolaevich Gruzov put forward the hypothesis of preservation (surviving) a shallow-water bottom shelf fauna of invertebrates at the bathyal depths of the continental slope of the continent during the maximum glaciation of Antarctica, and then later the subsequent secondary re-colonization of the free shelf released during the retreat of the shelf glacier by survived the “ice age” of the bathyal fauna. (Gruzov, 1980, 1983, 1983a; Smirnov A., 2017; Gruzov et al., 2018).

The concept was based on an analysis of the characteristics of the modern vertical distribution patterns on the shelf and slope of the Antarctic continental seas in one of the echinoderm groups - starfish (Asteroidea) (Gruzov, 1984, 2005). The essence of the Gruzov hypothesis consisted in the fact that the ever-increasing cooling and the development of powerful ice cover on the mainland of Antarctica after the formation of the Antarctic Circumpolar Current forced the invertebrates from the shoal, moving away from the ice shelf, to move beyond the edge of the shelf to great depths of the slope. The adaptive peculiarities of the overwhelming majority of the species of the Antarctic bottom biota — eurybathy and stenothermicity with the development of cold adaptation — were realized by its surviving representatives at the bathyal depths of the slope. After the reduced and retreat of the glaciers from the shelf area, these animals began to re-occupy the free spaces freed from the ice, but already on the recessed continental shelf with depths of up to 500-600 m on its edge.

The flip side of this secondary colonization of the continental shelf by bathyal fauna is the lesser species diversity of starfish (Gruzov, 2005). Further development of these dispositions on benthic invertebrates was carried out by Gruzov himself (1984, 1985) and on fishes by Andriashev (1979, 1986), and the fact of maximum species representation is the biodiversity of the Antarctic fauna at depths of about 600 m and a very small number of shallow-water fish species, for the first time marked by A.P. Andriashev, in the first review of Antarctic fish (1964, 1965), was called the “glacial submergence” (Andriashev, 1986).

In 1996, Tom Bray and colleagues published a paper in which they compared the vertical distribution ranges of invertebrates from the European seas and the Antarctic, and concluded that the extended ranges (eurybathy) of the Antarctic benthos can be interpreted as an adaptation to variations in the expansion of the ice shelf in the glacial-interglacial cycles (Brey et al., 1966).

Data on the vertical distribution of brittle fish and fish confirm the Gruzov's hypothesis about the re-colonization of the upper parts of the shelf — the upper sublittoral zone of the continental seas of Antarctica — after the retreat of the ice shelf of the bathyal fauna survived during the maximum glaciations.

The work is executed within the limits of researches on the state themes: AAAA-A19-119020690072-9 and AAAA-A19-119020790033-9, also it was partially carried out at support of the Subroutine «Studying and research of Antarctic» the Federal target program “World Ocean”, the state program of the Russian Federation “Environmental Protection” for 2012–2020, the subprogram “Organization and support of work and research in the Antarctic”, the project “Hydrobiological research (benthos and plankton) in the Southern Ocean” and the program of basic researches of Presidium of the Russian Academy of sciences « The Biodiversity of natural systems and biological resources of Russia » (the project: «Taxonomic and ecological-faunistic aspects of studying of a fauna diversity of Russia»).
The echinoderm collection of the Department totals more than 25000 units of storage and is divided into systematic and non-identified. The systematic part of the collection is stored in taxonomical order (according to family, genus and species), while non-identified part – according to expeditions.

Several specimens were obtained before 1899. The main collection originates from the materials of the famous first Russian research vessel «Andrey Pervozvanny» (1899). Since that time many regions of the World Ocean were sampled and lot of materials were collected by Zoological Institute researchers. For example, a total of 309 species and subspecies of brittle stars (Ophiuroidea) are available in the Marine Research Laboratory of the Zoological Institute RAS collection mainly from cold and temperate waters of the World Ocean (polar and middle latitude regions).

Great volume of data did not allow analyzing to the full the extracted and identified material and from 1988 was created information system of marine invertebrates.

The database includes information on sea stations where marine invertebrates have been collected and contains data on coordinates, depth, ground and other parameters. In combination with a systematic data base containing information about the structure of fauna of a particular region (classifier) and collection data base (information about a place and a way of storage of assembled material) the data bank “OCEAN” permits us to conduct search of information under numerous inquiries, among which it is possible to name, for example, the following, reception of information about stations on a given set of parameters; reception of lists of taxa on a given set of parameters or for a particular station; reception of lists of stations or collection numbers for a given taxon or group of taxa. Reception of answers on queries in textual and cartographic form is possible.

These data have not only scientific and historical aspects. Accumulation of monitoring collections over a broad period make it possible to track changes in marine ecosystems under climatic, hydrologic and anthropogenic influence.

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NUTRITIONAL COMPOSITION OF ISOSTICHOPUS FUSCUS, I. BADIONOTUS AND HOLOTHURIA GRISEA (COMMERCIALY VALUABLE SEA CUCUMBERS) [poster]

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Sea cucumbers have high value of nutrition and high potential economically for increasing trading of other fisheries productions; the knowledge of its chemical composition contributes to improving our understanding of these living organisms. This study compared the chemical composition of wild sea cucumbers species: Isostichopus fuscus, I. badionotus and Holothuria grisea. Sea cucumbers were captured by hand by artisanal fishermen in Mexican waters (Pacific and Atlantic oceans), where they were subsequently killed and dried (using commercially conventional methods), transported to the laboratory of the “Departamento de Análisis Bromatológicos del Laboratorio Central de la Administración General de Aduanas” (in Mexico City) to be analyzed. Thirty specimens of each species were used for the analysis. 9-47 g of body wall were used for each sample. Significant differences (p < 0.05) in the protein content, lipids and ash were found. The chemical composition ranged from 51.63% to 57.05% for protein; about 1.08% to 1.43% for lipids; 31.84% to 37.01% for ash; between 1.15% and 5.52% for moisture. Chemical composition of body wall was similar to that reported for sea cucumbers internationally traded, which indicates that these are species with a competitive commercial value for use in food. This work is a collaboration with the “Departamento de Análisis Bromatológicos del Laboratorio Central de la Administración General de Aduanas, Servicio de Administración Tributaria (SAT), Secretaría de Hacienda y Crédito Público, México".
REPRODUCTIVE BIOLOGY OF THE SEA URCHIN *ARBAcia LIXula*  
(Echinodermata, Echinoidea, Arbacioida)  
OF THE COASTAL ZONE OF MOSTAGANEM (ALGERIA) [talk]

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Data on the reproductive biology of the black sea urchin *Arbacia lixula* (Linnaeus, 1758) are lacking in Algeria. In order to fill this gap, a study was carried out in two contrasting shallow water areas in Mostaganem bay (the first located at Salamandre harbor, is characterized by a hard substratum and dominated by photophilic algae; the second located in Stidia is characterized by a sandy and rocky substratum and the presence of the *Posidonia oceanica* meadow). Sampling was carried out over one year (December 2013 – November 2014), at a depth of between 1 and 5 m. Analysis of the variability of the gonadal index (IG), the repletion index (IR) and the water temperature was carried out each month. At the same time, a microscopic study of gonads was established to determine the degree of gonad maturation. The results show a trophic richness and a better health of *A. lixula* at Stidia site, consequently the spines of individuals are longer and finer. The hydrodynamics and the soft substratum lead to a flattening of the sea urchin test allowing a better adhesion. The continuous and relatively high trophic activity leads to a good gonadal production (spawning from spring to early summer in both sites).
REPRODUCTIVE MODALITY AND SEASONAL VARIATION OF SAPONINS IN ECHINASTERS SEPOSITUS (ECHINODERMATA: ASTEROIDEA) GONADS OF WESTERN ALGERIA [poster]

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The sea star Echinaster sepositus (Retzius, 1783) was studied to analyze the properties of saponins and their relationship with the reproductive cycle of this species. The individuals were collected monthly from March 2014 to March 2015 at the Salamandre harbor (Mostaganem, Algeria) between 2–9 meters depth. The reproductive cycle of this species were studied using the gonadal index (GI). The obtained results indicate that the values of this index gradually increase in the autumn to reach high values in winter and spring with the presence of two spawning events, the first in the summer (July 2014) and the second at the beginning of autumn (October, 2014). The concentration of saponins is low in summer, increase in autumn and reach high values in winter. The evaluation of the antibacterial activity of saponins isolated from the different anatomical components (pyloric caeca, stomach, gonads, aboral tegument and oral tegument), show that only saponins from gonads exert moderate antimicrobial activity against Staphylococcus aureus, with an inhibition diameter of 1.54 cm and a survival rate of about 51%.
NEW RECORD ABOUT DISTRIBUTION OF SEA CUCUMBER
YPSILOTHURIA BITENTACULATA ATTENUATA FROM FAR-EASTERN SEAS OF RUSSIA [poster]

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The family Ypsilothuriidae Heding, 1942 previously was included in the order Dactylochirotida Pawson & Fell, 1965, then it was removed to the order Dendrochirotida Grube, 1840 (Smirnov, 2012) in 2012 year. The family Ypsilothuroidea includes three genera: Echinocucumis M. Sars, 1859, Ypsilocucumis Panning, 1949 and Ypsilothuria Perrier R., 1886. The genus Ypsi- lothuria contains only two species: Y. talismani R. Perrier, 1886, which is soft bodied, and Y. bitentaculata (Ludwig, 1893) which is ‘hard as a little echinoid’ according to Heding (1942). Y. talismani includes two subspecies: Y. talismani talismani R. Perrier, 1886 and Y. talismani elegans Heding, 1942 inhabiting in North Atlantic. Heding (1942) recognized two subspecies Y. bitentaculata: the cosmopolitan Y. bitentaculata attenuata R. Perrier, 1886 and Y. bitentaculata virginiensis Heding, 1942 from the North Atlantic.

In the materials collected during the Joint Russian-German expeditions deep-sea SokhoBio, Pacific Research Fisheries Centre (Vladivostok) and Kamchatka Research Institute of Fisheries and Oceanography (Petropavlovsk-Kamchatsky) expedition and on the basis of the collection A.V. Zhirmunsky Institute of Marine Biology of the Far Eastern Branch of the Russian Academy of Sciences new data on geographical distribution of Ypsilothuria bitentaculata attenuata R. Perrier, 1886 are obtained.

Material examined. 11 August 1987, Pacific Research Fisheries Centre, A.V. Zhirmunsky Institute of Marine Biology of the Far Eastern Branch of the Russian Academy of Sciences, R/V Tihookeansky, Iturup Island, 44°39.5’ N, 147°24.3’ E, depth 100 m, soil – silt, sand, (3 ind.); 06 June 2014, Kamchatka Research Institute of Fisheries and Oceanography, R/V MRTK-316, Southeast coast of Kamchatka, 52°00’ N, 158°38.3’ E, depth 236 m, soil – sand, gravel, collectors Danilin D.D., Nikulin S.V. (4 ind.); 27 July 2015, Russian-German deep-sea expedition SokhoBio, 71st Cruise, R/V Akademik M.A. Lavrentyev, 46°16.282’ N – 46°16.514’ N, 152°03.333’ E – 152°04.259’ E, depth 3347–3358 m (3 ind.); 09 October 2017, Pacific Research Fisheries Centre, R/V TINRO, Sea of Okhotsk, 56°38.5’ N, 154°28.1’ E, depth 146 m, foraminiferal sludge (2 ind.).

Ypsilothuria bitentaculata attenuata is widely distributed in the depths of the Pacific Ocean: along the Pacific coast of America from California to the Galapagos Islands, in the deep part of the Bering Sea (to the south-east of Olyutorsky cape, to the south of Navarin cape, to the north of the Commander Islands and in the strait between Kamchatka and Commander islands), near the south-east coast of Kamchatka, on the Pacific coast of Iturup Island (Kuril Islands), along the eastern coast of Japan, on the coasts of Mexico, Chile and New Zealand. The species also meet in the Indian Ocean. Depth (100–4400 m). Ypsilothuria bitentaculata attenuata was found near the Simushire Island (Kuril Islands), the south-east coast of Kamchatka and in the Sea of Okhotsk for the first time. Depth of habitation is 100–3358 m.
GROWTH OF THE BRITTLE STAR *OPHIURA SARSII* (ECHINODERMATA: OPHIUROIDEA) IN ARCTIC AND PACIFIC REGIONS [talk]

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Brittle star *Ophiura sarsii* is a common arctic-boreal species, which is dominant in many benthic communities. In the Arctic region it has wide circumpolar distribution range. In the Atlantic Ocean this species inhabits coasts of North America and Eurasia down to 35° N. In the Pacific Ocean, *O. sarsii* spreads as far as the Yellow Sea in the east and California in the west and divides into two subspecies: *Ophiura sarsii typica* and *O. s. vadicola*.

The aim of this study is to compare features of growth and lifespan of the brittle star *Ophiura sarsii* in different climatic regions.

Growth of the brittle stars *O. sarsii* was investigated in two locations: the Laptev Sea (depth 30-32 m) and the Sea of Japan (depth 173 m). In both cases we analyzed *O. sarsii typica* from the collection of Marine Research laboratory (Zoological Institute, Russian Academy of Science).

To estimate individual growth and age, we counted ring-shaped marks on the vertebral ossicle of brittle stars arms. Each visible growth ring was interpreted as annual age mark. Growth band radii were measured on scanning electron microphotographies. Von Bertalanffy and Gompertz equations were used to describe species growth.

In analyzed specimens of *O. sarsii* from the Laptev Sea population, the disc diameter ranged from 10 to 22 mm, and the number of visual growth mark varied from 12 to 19. In the Sea of Japan specimens, the disc diameter ranged from 4 to 23 mm, while the number of visual growth mark varied from 2 to 18.

Applying von Bertalanffy growth function, we estimated the asymptotic radius of ophiuroid’s ossicle (*R∞*) as 1702 μm for the Laptev Sea specimens and 1509 μm for the Sea of Japan ones; the growth constants (*k*) were 0.07 and 0.09, respectively. The results of estimating *R∞* with Gompertz equation were similar: 1437 μm in the Laptev Sea and 1244 μm in the Sea of Japan, the exponential decelerations of the specific growth rate (*g*) were 0.12 (the Laptev Sea) and 0.17 (the Sea of Japan).

Using von Bertalanffy and Gompertz growth parameters, we determined the maximum lifespan of *O. sarsii* to be 26-27 years in the Laptev Sea and 19 years in the Sea of Japan. According to A. Ravelo, the lifespan of *O. sarsii* in the Chukchi Sea and the lifespan value of *O. sarsii* in both investigated populations are close to those for the some species of Antarctic and Arctic regions.

Scanning electron microscopy was performed at the “Taxon” Research Resource Centre (Zoological Institute RAS) (http://www.ckp-rf.ru/ckp/3038/). This study was funded by RFBR and NSFC according to the research project № 19-54-53028.
A PHYLOGENETIC OVERVIEW OF EDROASTEROID ECHINODERMS
[talk]

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Edrioasteroids are a well characterized group of discoidal to globular echinoderms that were rare to common components of Paleozoic marine faunas. Known from every continent except Antarctica, they range from the Middle Cambrian to the Lower Permian. The most plesiomorphic clade, Walcottidiscidae, (2 genera) is characterized by wide ambulacra with four rows of floor plates and podial pores, multiteried cover plates, unfused oral frame plates, separated hydropore and gonopore pyramids, an unplated ventral surface, and lacks interambulacral epispires. Another Cambrian clade, Stromatocystitidae (2-3 genera) is characterized by ambulacra with biserial abradial floor plates, large interradial oral plates, epispires in the interambulacra, and a plated ventral surface. Edrioasterida (Late Cambrian to Late Devonian and divided into five suborders) are characterized by a interradial oral plates, abradial floor plates, simple cover plates, an aboral collar, and a short to long pedunculate zone. Totiglobidae (2 genera) bear a globular theca and plated ventral surface. Edrioasteridae (Four genera) have a globular theca with wide ambulacra and a short flexible pedunculate zone. Astrocytidae or edrioblastoids (4 genera) have a bud-shaped theca on a long, organized pedunculate zone. This edrioasterid clade was previously set aside as a separate class. Rhenopyrgidae (3 genera) has a greatly reduced oral surface and a greatly enlarged and flexible pedunculate zone. Cyathocystidae (2 genera) has a greatly reduced oral surface with the floor plates fused to the interradial oral plate and the pedunculate zone fused into a rigid cup.

Isorophida (Late Cambrian – Early Permian) is characterized by a plesiomorphically discoidal theca with imbricate interambulacral plating bordered by a peripheral rim and oral frame plates bordering the peristome. Pyrgocystitidae (10 genera) retains the abradial floor plates as hood plates and bears the food grove on imbricate, uniserial, abradial floor plates. Lebetodiscina (eight genera) loose the abradial floor plates, have simple biserial cover plates with cover plate passages, and an irregularly plated anal pyramid. Carneyellidae (3 genera nested within Lebetodiscina) has a paedomorphic oral area in which the oral plates are greatly enlarged and shared cover plates do not develop. Isorophidae (18 genera) bears narrow ambulacra with secondary cover plates that lack cyclical plate development, intrathecal cover plate extensions, and a valvular anal pyramid. Agelacrinitidae (6 genera nested within Isorophida) has cyclical cover plate development and lacks intrathecal cover plate extensions. Postibullidae (4 genera nested within Agelacrinitidae) has narrow and tall cover plates and a posterior oral protuberance. Lepidodiscinae (5 genera nested within Agelacrinitidae) has a greatly expanded, but unorganized pedunculate zone, and relatively large peripheral rim. Discocystinae (8 genera nested within Lepidodiscinae) has thick interambulacral plating, an organized expandable pedunculate zone, and small peripheral rim.
MOLECULAR PHYLOGENY OF SPATANGOID SEA URCHINS [poster]

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Whole mitochondrial genome sequences of 11 spatagnoid and 5 clypeasteroid species were obtained by the shotgun sequence using Ion PGM sequencer. Phylogenetic analysis was performed based on the datasets modified from mitochondrial genome. When each locus was used for analysis independently, all the results had no sufficient reliability, and the phylogenetic trees did not show the same topology. This was possibly due to the insufficient phylogenetic information in each region. With the expansion of the dataset to be analyzed, the ambiguity of the phylogenetic tree has been resolved. The most reliable phylogenetic tree was derived from the dataset comprising all the protein code regions (excluded 3rd codon), rRNA, tRNA and D-loop. This dataset brought not only higher posterior probabilities and bootstrap value but also the same topology between bayes and maximum likelihood analysis. The molecular estimate of phylogenetic relationship was incongruent with the phylogenetic tree generated from morphological data (Kroh & Smith 2010): in our molecular estimate the family Brissidae was polyphyletic, and the families Lovenidae and Maretiidae were merged. The result of AU test suggests that phylogenetic information contained in mitochondrial genome does not support the phylogenetic tree based on morphology. Some morphological traits for classification are closely related to ecology and could be easily acquired or lost through habitat changes, which might result in the mismatch between molecular and morphological estimates.
COMMON WALKING RULE AMONG FOUR-, FIVE-, SIX-, AND SEVEN-ARMED BRITTLE STARS [talk]

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Typical brittle stars show radial symmetry with five arms, whereas we can sometimes find individual difference in the number of arms, such as six or four. As arms repeat different times, neural networks in the central disk must differ in arrangement. How does a single species realize adaptive behavior with a different count in central divisions? The target behavior in our work is locomotion. Five-armed brittle stars are known to show coordination by left and right rowing arms. However, communication pathways from arm to arm remain unclear and none has probed into radial symmetry with other than five units. We aim to explore a common rule of post-stimulus locomotion using four-, five-, six-, and seven-armed intact individuals in Ophiactis brachyaspis. Employing Bayesian approach, we found the more arms a brittle star has, the lower probability it escapes in the opposite direction of aversive tactile stimulation. In combination with quantitative indices for left- or right-rowing degree and inter-arm synchronization, we generalized an average locomotion where the stimulated arm’s one second neighboring arm faces forward while the adjacent arms of the second work as active synchronized rowers. A neural network model can be suggested from the external individual behavior: an afferent signal runs along a circular pathway while locally counting how many arms it passes, so as to position a common anterior pattern regardless of the total number of arms. This decentralized system spotlights a great flexibility of animal behavior in response to body structure.
TWO UNDESCRIBED AND FIRST RECORD OF INTERSTITIAL SEA CUCUMBER (HOLOTHUROIDEA, APODIDA) FROM MALAYSIA [talk]

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Interstitial fauna constitutes microscopic organisms that inhabit the spaces between sand grains in intertidal as well as subtidal substratum. A survey of interstitial sea cucumber was conducted in several sandy intertidal beaches around Penang, Malaysia during low tide period. Sediments near the shoreline were scooped into a bucket up to depth of waterline. The sediments were then suspended by vigorous stirring and then sieved with a 500 μm mesh sieve. Interstitial sea cucumbers retained on the sieve were then collected, anaesthetized with 6% MgCl₂ solution, and preserved in ethanol. The morphology of the specimens were examined under stereo microscope. Spicules from body wall were extracted and viewed using a scanning electron microscope. Two new and undescribed sea cucumber were found, representing two genera (Leptosynapta and Rhabdomalgus) from the family Synaptidae. Spicules were absent in the body wall of R. sp. while L. sp. bearing anchor spicules and plate spicules with six perforations. Rhabdomalgus sp. were observed to use their tentacles to hold on to sand granule while L. sp. uses their sharp edges of anchor spicules to ‘hook’ on the sediments. This is a first record of interstitial sea cucumber for Malaysia. Further molecular genetic taxonomy techniques will be used to analyse the specimens in order to determine their taxonomic status.
PHYSIOLOGICAL CHARACTERISTICS AND REGULATION MECHANISM OF BODY COLOR FORMATION IN SEA CUCUMBER, APOSTICHOpus JAPONICUs [talk]

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Pigmentation processes occur from invertebrates to mammals and provide a traceable and relevant trait for understanding key issues in evolutionary biology such as adaptation, speciation and the maintenance of balanced polymorphisms. Body color and coloration patterns are important phenotypic traits associated with the survival and reproductive activities in many organisms, including camouflage, thermoregulation, mating selection, social interactions, desiccation resistance, salinity adaptation, and immunity. The sea cucumber Apostichopus japonicus, which has nutritive and medical properties, is considered the most valuable commercial species in many parts of Asia. Compared with the green morph, the purple and white morph are rare and have great appeal to consumers. However, little is currently known about the molecular and genetic mechanism of body color formation in A. japonicus, even in echinoderm. In this study, we used Illumina sequencing, IBT sequencing, LC-QTOF-MS, ChIP-seq, real time PCR, in-situ hybridization, immunohistochemistry, genetic breeding, et al. to reveal the molecular and genetic mechanism of body color formation in A. japonicus. Our results showed that there were fewer types of pigments in white sea cucumber than in the other color morphs and epidermis thickness and melanin content may be the newfound factors contributed to the differences of growth and survival rate among three color morphs. In the same time, we screened out some key genes, proteins and metabolites that may involve in sea cucumber pigmentation. Furthermore, we conducted in situ hybridization, immunohistochemistry, ChIP-seq, real time PCR, Western Blot, and polymorphism analysis experiments of MITF to reveal the regulatory mechanism. Then, combined with genetic breeding results, we proposed the potential mechanism of the body color formation of different color morphs of sea cucumbers.
BIOLOGICAL CHARACTERISTICS AND AQUACULTURE OF SEA CUCUMBER APOSTICHOPUS JAPONICUS [talk]


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As main producing region, the offshore area is the most important marine agriculture district, but the fishery resources have gradually declined recently. Particularly, the biological resource at bottom and near-bottom layers has been excessively utilized, wild fishery resources like Apostichopus japonicas have been nearly exhausted. The research team started the whole genome sequencing of A. japonicas, and studied the characteristics and mechanism of aestivation, albinism, regeneration of A. japonicas. Some new strains, i.e., high-temperature-resistant and fast-growing, white, purple, were bred selectively. For the demand of industrial facilities and systems for A. japonicas culture and stock enhancement, 11 serial new systems for ecologically efficient culture and stock enhancement of sea cucumber A. japonicas were developed. Such new facilities and systems achieved zero breakthroughs of A. japonicas culture and stock enhancement in areas where the culture condition is traditionally unfavorable; besides, such new systems greatly improve the unit-production of coffered A. japonicas culture and also improved the ecological pluralism of A. japonicas culture and stock enhancement. Therefore, these new facilities and systems provide equipment and technical support for the construction of marine ranching and sustainable development of A. japonicas culture and enhancement.
A NEW RHIPIDOCYSTID (BLASTOZOA) FROM THE MIDDLE ORDOVICIAN OF MARYLAND (USA) [poster]

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The 6th of June of 1966 the classic echinoderm worker J. Wyatt Durham obtained from collectors a small collection of rhipidocystid echinoderms from the Edinburg Formation in Maryland (USA). Specimens were collected in an old quarry, west of Conococheague Road, East of Wilson. The specimens arrived to the National Museum of Natural History (Smithsonian Institution) in 1969 by the hands of Mr. Thomas F. Phelan, who was Porter Kier’s Assistant at that time. Since then nobody have reported any information about those specimens with exception of James Sprinkle, who did a drawing of the brachioles in his 1973 monograph. In 2017 I rediscovered those specimens in a museum drawer at the Smithsonian, but there is not historical record about what happened with those specimens between 1969 and 2017.

Rhipidocystids are a small clade of Palaeozoic echinoderms, exclusively found in the Ordovician, which had flattened thecae, long brachioles and reduced stems. This group has been related with paracrinoids based on similar peristomial plate arrangement, 3 basal plates, position of main thecal apertures (gonopore, hydropore and periproct) and proximal stem morphology.

The new rhipidocystid collection consist in four well preserved specimens showing both sides of the thecae that consists of 11 large marginal plates and few thin plates closing the upper and lower integuments, with only two basals. Anal pyramid opens through the marginal plates in the upper left side of the theca. Brachioles are long and slender, with a very flexible proximal part and stiffer distal portion. Most distal brachiolars are biserial showing cryptic sutures.
A NEW CAMBRIAN ECHINODERM FROM THE KINZERS FORMATION INFORMS ON THE EVOLUTION AND DEVELOPMENT OF THE SKELETON IN EARLY ECHINODERMS [talk]

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Echinoderms are unique in possessing a calcite skeleton composed of multiple plates with a mesh-like microstructure called stereom. This distinctive microstructure is underpinned in modern echinoderms by a number of specific transcription factors and signaling molecules regulating the expression of a multitude of biomineralization genes. Different types of stereom microstructure occur in various Cambrian echinoderm clades, which suggests they employed the same genetically controlled biomineralization mechanisms that are observed in modern echinoderms. We report a new Cambrian echinoderm from the Kinzers Formation (Cambrian Series 2, Stage 4) in York (Pennsylvania, USA), which shows a clear differentiation in body plan structure, with ambulacral (axial) and interambulacral (extraxial) parts preserved in different ways. There are two available specimens collected from grey shales associated with trilobites, echinoderms (Camptostroma, Lepidocystis) and rare radiodontans. Energy dispersive X-ray spectroscopy confirms that the axial part of the body is rich in iron, similar to other biomineralized taxa from the Kinzers Formation, and was likely calcified in life; the extraxial part of the body has abundant carbon, suggesting this was originally organic material. The ambulacral construction in this new animal consists of large flooring plates with podial pores and multiple series of cover plates. The theca is preserved in soft tissue with apparently no obvious plating. This unique combination of characters with calcified axial elements and non-calcified extraxial parts suggest that a module of genes responsible for skeleton formation in early echinoderms was expressed in two independent spatial contexts. Future work on the evolution and development of the echinoderm skeleton should explore the possibility of independent, context-dependent biomineralization gene batteries controlling the skeleton formation in both axial and extraxial body regions.
THE SPECIAL BEHAVIOR AND PHYSIOLOGY OF SEA CUCUMBER (APOSTICHOPUS JAPONICUS) [talk]

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The movement and feeding behavior of the sea cucumber, Apostichopus japonicus are not well understood. A better understanding may provide useful information for the development of the aquaculture of this specie. Combining the advanced time-lapse photography technology with professional behavior-analysis software, the behavioral research system for A. japonicus has been conducted, and the movement and feeding behavior of A. japonicus have been systematically studied. The average movement speed of A. japonicas is around 1.6-3.4 cm/min, and the daily moving distance is around 20-50 m in the laboratory with normal condition. The influence of flow velocity, temperature, light on the movement behavior of the sea cucumber, A. japonicus was investigated. It is also found that the total distance traveled, cumulative duration of movement, and mean and maximum velocity for A. japonicus after melatonin injection with melatonin is suppressed. Feeding activities investigated by charge coupled device cameras with infrared systems indicated that all size groups of sea cucumber were nocturnal and their feeding peaks occurred at 02:00–04:00 AM. The medium and large-sized groups also had a second feeding peak during the day. Additionally, the peak activities of digestive enzymes were 2–4 h earlier than the peak of feeding. Meanwhile, the energy allocated to gonad growth increase significantly during reproduction of sea cucumber, but energy allocated to somatic growth decreased significantly over time. The total distance moved and cumulative duration of moving gradually decrease during reproduction.
THE EXPRESSION OF PIWI AND SEALI GENES IN HOLOTHURIAN EUPENTACTA FRAUDATRIX TISSUES DURING REGENERATION [poster]

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The piwi gene family codes regulatory proteins present in all Metazoa germlines and providing stem cells incomplete differentiation. This family genes expression of some organisms is not bounded just by germline but is involved in somatic tissues regeneration processes.

This research object is a holothurian Eupentacta fraudatrix able for complex of internals evisceration and following regeneration. In the course of holothurian Eupentacta fraudatrix transcriptome analysis two mRNA sequences were found: piwi and seali, homologous to Holothuria glaberrima piwi and its paralogue Strongylocentrotus purpuratus seali. E. fraudatrix coelomic fluid most part of which is lost during evisceration regenerates its cellular composition in the absence of the rest coelomocytes proliferation. The presence of piwi and seali genes expression products in these coelomocytes may suggest the occurrence of circulating pluripotent stem cells pool in this echinoderm species.

To prove piwi and seali genes involvement in E. fraudatrix regeneration processes their expression dynamics in coelomic fluid cells was studied on the intact species, after 1 hour, 24 hours and on the 7th day after evisceration. Since the researched genes are regulatory and function in small amounts to get accurate and repeatable results we used two pcr-analysis methods: droplet digital PCR (ddPCR) and real-time PCR (qPCR). It was determined that piwi and seali genes are expressed in coelomic fluid cells and are present in the intact animals in small physiological concentrations. After evisceration the expression dynamics showed differently directed character: the piwi gene expression raises during the first hour of regeneration then logically lowers through all experiment reaching close to “normal” values, meanwhile the seali gene expression lowers on the initial observation stages and significantly raises only on the 7th day after evisceration, making it possible to state the different role of these genes in E. fraudatrix regeneration process. qPCR and ddPCR techniques give comparable results, however ddPCR method gives more accurate and statistically significant data when measuring small expression differences.
GENETIC DIVERSITY AND POPULATION STRUCTURE OF A SPECIES OF OPHIUROIDEA IN THE WEIJIA GUYOT [poster]

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Seamounts are global hotspot of marine biodiversity but are fragile ecosystem. The seamounts in the northwestern Pacific are covered with cobalt-rich ferromanganese crusts. Potential commercial mining activities may have a severe impact on seamount biomes. Although the biological population between different seamounts can communicate by diffusion, the level of species connectivity between seamounts varies greatly, and the unique hydrological conditions of seamounts will retain the biological larvae, which will isolate the seamounts from the adjacent areas. Therefore, population structure and gene exchange within seamount may play an important role in slowing down the impact of human activities on biomes. In this study, we used the mitochondrial COI gene to analyze the genetic diversity and population structure of \textit{Ophioplinitthaca defensor} which may represent a dominant species in the Weijia Guyot. A total of 18 haplotypes were obtained from 26 sequences, and 80\% haplotypes were distributed in the southwestern part of seamount, the haplotype diversity index also showed the highest haplotype diversity in this region. The genetic differentiation coefficient and genetic distance analysis showed genetic differentiation between the Weijia Guyot \textit{O. defensor} population is small, and the haplotype network distribution showed no obvious geospatial pattern was formed. Nem >2 showed that there were more frequent gene exchanges between various populations, which may be the reason for the lack of geographical differentiation effects. Neutrality test and mismatch distribution maps reveal that demographic history may have experienced expansion events. In this study, the genetic diversity and population structure of the \textit{O. defensor} in a single seamount provided important information for further exploitation of cobalt-rich crusts and EIA in this area.

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A PRELIMINARY PHYLOGENETIC STUDY ON DEEP-SEA STARFISH BRISINGIDA, BASED ON SAMPLES FROM THE WESTERN PACIFIC OCEAN [poster]

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Brisingida are peculiar deep-sea starfish with small disk and many long arms, which bear a superficial resemblance to ophiuroids. Biological and phylogenetic studies have seldomly been conducted on Brisingida due to their deep-water occurrences and fragility for collection and preservation. In the past years, brisingids specimens have been collected from the western Pacific Ocean during Chinese cruises, which make good materials for morphological and molecular examinations. A total of 28 specimens were examined and 13 species belonging to 6 genera were identified, among which 3 species were new to science. Seventy-nine DNA barcoding sequences (COI, 16S and H3) were acquired for phylogenetic analysis. Phylogenetic trees were constructed using Maximum likelihood and Bayesian Inference methods. Both methods lead to a well-supported three-clades topology: genera Odinella/Novodinia/Brisingaster from family Brisingidae forming a basal clade, whereas other genera in Brisingidae clustering as a sister clade to family Freyellidae. This topology agreed with the results of previous cladistic study based on morphological characteristics (Mah, 1997, 1998). The divergent positions of two outliers Freyellaster fecundus and Freyella sp. were remarked, and a possible affinity between genera Freyellaster and Brisinga was suggested. Further, the boundary between genera Freyella and Freyastera was rather ambiguous, while the diversity of the latter seems to be underestimated. The position of the intermediate genus Hymenodiscus is not settled, appearing to be a paraphyletic group. The global distribution and in situ observations of several taxa in Brisingida are also discussed to provide more information on their diversity and ecological characteristics.

This study was the first to investigate on the phylogeny of order Brisingida using molecular data. Ten out of seventeen genera were included in the analysis, whereas data of the rest genera are still in need for a comprehensive review on the phylogeny and diversity of Brisingida.
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