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**zoologie**

**DEPARTMENTAL SEMINAR  
INTEGRATIVE ZOOLOGY  
Winter Term 2017**

**Programme and Abstracts**

Tuesdays, 10-11:30 hrs

SR 3, UZA1, Althanstraße 14, 1090 Wien





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## **12 years of bryozoan research - what soft body morphology can tell us about the evolution of bryozoans**

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Bryozoans are a group of colonial, sessile suspension feeders with over 6.000 recent and 15.000 fossil known species. Despite their high diversity and importance in aquatic ecosystems, little is known in certain research aspects like physiology of soft body morphology. Current specialists predominantly focus on taxonomy, mineralogy or for instance colonial complexity. Fortunately, molecular phylogenies have started to appear for this phylum in the past which confirm old notions that the freshwater Phylatolaemata are sister to the remaining two clades, the Cyclostomata and the Gymnolaemata, which themselves are in a sister-group relationship. The sparsity of broader morphological analyses called for a systematic allocation of characters for each of the given clades. Consequently, I summarized my main field of research on soft body morphology in a review that soon will be submitted. This review consists of thorough literature analysis, but also original observations and ideas especially from numerous serial sections and confocal laser scanning microscopy stacks. In this talk I will address few selected examples of what soft-body morphology can help us in defining clades, in giving evolutionary trends in organ systems and what key novelties are in the evolution of this phylum. Also some examples will show where the challenges and problems are in conducting these analyses.

## **Phaidra - the repository for the permanent secure storage of digital assets at the University of Vienna**

### **Susanne Blumesberger**

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### **Phaidra is ...**

... the repository for the permanent safeguarding of digital assets at the University of Vienna.

The service is available at: [phaidra.univie.ac.at](https://phaidra.univie.ac.at).

The digital objects archived in Phaidra get permanent addresses (e.g., handle, for books URN, for publications and research data DOI), are provided with structured metadata and found by search engines.

The operation and further development of the Fedora-based repository-based software is carried out at the University of Vienna. A test version of Phaidra can be found at:

<https://phaidra-sandbox.univie.ac.at/>

The open access objects from Phaidra can also be accessed via BASE.

### **Benefits of PHAIDRA**

- Open and free access (all employees and all students of the University of Vienna can actively use Phaidra)
- Persistent citation (handle-link)
- Differentiated access concept
- Data can be licensed
- Reliable long-term availability
- Dublin Core and LOM based metadata schemes

- All formats are allowed (preferred formats)
- Search based on apache solr
- The objects are found through web-search engines
- All objects in Phaidra can be linked in different ways.
- The metadata can be described in several languages
- Projects are supported with regard to a data management plan
- Visualization of the data in different ways (eg Bookviewer for books, Phaidra + for projects from the digital humanities)

## **Habitat destruction in Ghana, a crucial danger for the endemic cichlid species *Limbochromis robertsi***

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Habitat destruction due to road building, illegal gold mining using mercury and increase of farming activities in the region of Kyebi (Ghana, Eastern Region) destroyed big areas in this region, bringing a middle sized river, the Birim River, to nearly total disappearance. Remaining water pools are mostly polluted by mercury, fertilizers and other chemicals in use for farming.

As a result, most fish species and specimens in this river as well as in lower parts of small tributaries of the Birim disappeared too. Just few creeks in surrounding hills, which are range for the endemic cichlid *Limbochromis robertsi*, are still existing, but under strong influence of farming and deforestation. Additionally, new fish species (*Coptodon* sp.) entered upper parts of these creeks where the formerly did not occur, increasing pressure on this unique cichlid.

The presentation will give information about about the taxonomic and phylogenetic position of *Limbochromis robertsi* within the group of chromidotilapiine cichlids and will explain why this species is a very unique one.

The current habitat situation is compared with the one in the middle of the 90ies of the last century, using tools of Remote Sensing as well as results from former and recent terrestrial explorations of the sites around Kyebi, demonstrating the high risk of extinction for *Limbochromis robertsi*.

## **Comparative study on the nervous system of Tunicata in order to elucidate tunicate phylogeny**

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Tunicates are exclusively marine animals and as one of the major chordate taxa possibly closest living relatives to vertebrates. However, tunicate phylogeny remains ambiguous, because molecular phylogenetic studies of the interrelationships of tunicate taxa are contradictory. In order to elucidate chordate evolution we reconstruct the phylogenetic relationships of 19 tunicate families, belonging to all five major tunicate taxa. Our final character matrix includes 118 characters (109 binary, 9 multiple state) and 49 tunicate and 5 outgroup species. In addition to classical tunicate characters (e.g. structure of branchial basket, body division, colony formation, position of gonads), that traditionally were used in ascidian taxonomy, we focussed on neuroanatomical characters.

The latter played a major role in phylogenetic considerations in many other taxa.

Neuroanatomical characters are quite similar within tunicates in some aspects, but differ considerably in others. Our results confirm two monophyletic taxa within tunicates that are also described in molecular phylogenies, sessile Stolidobranchiata and planktonic salps. The phylogenetic relevance of some characters present in salps such as the absence of the brain-associated neural gland, specialized sense organs, conspicuous motoneurons, serotonergic neurons, and lateral nerve fiber tracts in the brain is difficult to ascertain, because these characters might be the result of the more active planktonic lifestyle in opposition to a sessile mode of life in ascidians. Our data also support the monophyly of Ascidiacea that has been debated by scientists for a long time. Apomorphies characterising Ascidiacea are for example sessile adults and serotonergic cells in the endostyle.

## **Evolution and development of the central nervous system in mollusks**

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The goal of this project entitled “Evolution and development of the central nervous system in mollusks” is to provide a first assessment of key neurogenetic processes in three molluscan species that belong to different class-level taxa and exhibit different degrees of nervous system centralization. Polyplacophorans lack major neural condensations, while bivalves possess several pairs of

interconnected ganglia. The highest level of nervous system centralization within mollusks can be observed in cephalopods, where most ganglia are fused to form highly complex brains. For most bilaterian animals, it has been shown that *Soxb* genes and Notch signaling are involved in regulating the specification, proliferation, local maintenance, and maturation of neural progenitors. To understand how the distinct neural architectures of mollusks are formed, we thus plan to compare the spatiotemporal distribution of *Soxb* expressing neural progenitors and Notch signaling pathway components, during development of the polyplacophoran *Acanthochitona crinita*, the zebra mussel *Dreissena polymorpha*, and the pygmy squid *Idiosepius notoides*. Furthermore, we will determine the proliferative properties of *Soxb*-expressing neural progenitors in *D. polymorpha* and assess how pharmacological inhibition of Notch signaling influences their specification, proliferation and differentiation. These data will allow us to shed light onto nervous system development and evolution within the diverse molluscan sublineages and should also provide insights into the driving forces behind nervous system centralization within the Mollusca.

## **The unusual life cycle of *Pherusella cf. brevituba***

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Bryozoans are colonial filter-feeders and inhabit predominantly marine benthic ecosystems. The most common and diverse groups of bryozoans are the calcified Stenolaemata and Cheilostomata,

whereas ctenostomes are uncalcified and comprise about 300 species. The ctenostome genus *Pherusella* comprises three species *P. tubulosa*, *P. brevituba* and *P. flabellaris*. *Pherusella brevituba* was first described in 1951 by Soule and was reported along the Pacific coast of North America. In 2005 *P. brevituba* was reported inhabiting seagrass leaves of *Posidonia oceanica* in the Mediterranean Sea for the first time and nowadays considered as an invasive species. So far, documentation and long term study of the life cycle and morphology of this species is lacking. Consequently, *P. brevituba* was regularly sampled along the Croatian coast of the North Adriatic Sea. Colonies rarely contained more than 4 to 6 zooids. Already young colonies of two zooids start to reproduce early and the maternal zooid produces up to four lecithotrophic larvae. Several colonies were kept under laboratory conditions which enabled the documentation and analysis of larval release and metamorphosis. Free-swimming larvae settle shortly after hatching on new uninhabited parts of *P. oceanica*. So far this species is not reported on any other substrate in the Mediterranean Sea and with its short and peculiar lifecycle it seems perfectly adapted to the growth pattern of *P. oceanica*. Currently, the general life cycle and preliminary morphological analysis shows distinct differences to the original *P. brevituba* from the Pacific which forms large, often erect colonies. Further studies will analyse the zooidal and larval morphology in more detail. Additionally, original material from the Pacific specimens will be obtained in order to verify the species status of the Mediterranean species.

## **The bryozoan family Adeonidae as potential model organism for evolutionary studies**

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Owing to their clonal nature and the presence of polymorphic zooids, bryozoans are potentially excellent model organisms in evolutionary studies that aim to answer questions concerning, among others, the development of new morphological traits, functional morphology, or carbonate secretion. As most taxa also have a decent fossil record, findings of analyses of modern species can be verified and traced back through time and space.

The family Adeonidae has been selected for such a comprehensive study as it combines numerous advantages. For instance, the Adeonidae are distributed globally and often form large, erect and colourful colonies, often in relatively shallow depths, which means that the species can be easily detected and sampled by scuba diving. Their colour and erect growth strongly suggests that the species host symbiotic bacteria that produce potent secondary metabolites in order to keep predators away. In addition, the species have evolved different types of heterozooids (termed avicularia) with which they can mechanically defend themselves. In contrast to most other bryozoans, which brood their embryos in globular structures that are exposed on the colony surface, and which are therefore prone to predation, brooding in Adeonidae takes place internally within specialised brooding zooids. All species are also well calcified and have a fossil record that goes back to at least the Eocene (i.e. some 50 million years). While the skeletons of all species are primarily calcitic, some have bimineralic skeletal walls and consist partly of aragonite.

In this talk I will give an introduction to the peculiar biology of the

Adeonidae, demonstrate the usefulness of this taxon in answering a variety of general and specific evolutionary questions, and present preliminary results concerning their phylogeny.

## **A glimpse into the past - Functional morphology and evolutionary biology of vertebrates**

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The EvoMoRG group (Evolutionary Morphology Group) at the University of Vienna, focuses on the interface between palaeobiology and evolutionary developmental biology of vertebrates, with the main task of the reconstruction of ancient life based on the anatomy of living species. In this talk, two main research subjects are presented.

One highly debated topic in recent years was the functional morphological signal of the vestibular system of vertebrates. This organ for spatial orientation is located in the bony labyrinth of the petrosal bone of the skull. In 1873, Joseph Hyrtl denied any locomotory evidence in the anatomy of the vestibular system. But since the benefits of non-invasive micro-CT scanning and 3D reconstruction software became quite popular in recent years, many different studies were proven the opposite. Even though an anatomical signal is detected in the vestibular system (e.g., diameter of the semicircular canals vs. radius of the semicircular canals), it differs between extant and extinct groups of interest.

Besides anatomical investigations of the ear, also the deep sea and its vertebrate creatures are under investigation in the EvoMoRG

group. Every night the greatest migration on Earth starts in the deep-pelagic where organisms move up to the meso- and epipelagic to find food and descend to deeper waters during the day. However, characteristics and morphological features of the locomotory system in these fishes have never been investigated. This project focuses on the extraordinary musculotendinous system of mesopelagic fishes based on microdissections of cleared and stained specimens in combination with iodine stained micro-CT scans.

## **Evolution of head structures in Coleoptera with special emphasis on the feeding apparatus and miniaturized forms**

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The structure of the feeding apparatus is extremely important, as it determines the biology and ecology of the species. Insect mouthparts display an impressive variability, and adaptations to an extremely broad spectrum of food sources. It is apparent that modifications in this character system had a major impact on the evolution and ecology of Coleoptera and other groups of insects. The megadiverse coleopteran suborder Polyphaga has evolved a plethora of feeding habits, with saprophagy and a specific feeding apparatus as a possible starting point. Ptiliidae (Staphyliniformia) includes the smallest free-living insects (0,325 mm). Head structures of different genera of Ptiliidae with saprophagous and sporophagous feeding preferences and different body size were

documented. Obtained data were compared with cephalic conditions in other saprophagous beetles and the evolution of the feeding apparatus in Coleoptera was discussed.

The results suggest that a complex feeding apparatus has evolved early in Coleoptera, probably in the stemgroup, with mandibular grinding molae and setose epipharyngeal and hypopharyngeal bulges (processes) belonging to the ground plan of the order. This condition is preserved in the small suborder Myxophaga and different subgroups of Polyphaga, but is not found in Archostemata and the carnivorous Adephaga. Despite of minute body size, the saprophagous feeding habits of Ptiliidae do not differ strongly from those of Myxophaga or other groups of Polyphaga. Within the family, a shift from primarily saprophagous feeding took place twice: first to sporophagy in the basal branch, and then to microsporophagy in the extremely miniaturized Nanosellini.

## **On the relation between sample preparation, interpretation and scientific progress: The finding of optical active mesostructures in *Artemia franciscana***

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Cryopreparation for transmission electron microscopy (TEM) based on high-pressure freezing and freeze substitution (FS) has proven as superior for sample preservation when compared to chemical fixation and processing of cells and tissues at ambient temperature. To accelerate the otherwise notoriously slow substitution process we

developed an agitation module that shortens the processing in an automatized FS unit from days to hours [1].

Recently, we adapted the FS under agitation to study the vitellogenesis and embryogenesis in the ovisac of the brine shrimp, *Artemia franciscana* [2]. This approach included the challenging task of preserving encysted eggs of the oviparous line of reproduction.

The talk introduces an instant and unique discovery that resulted from our methodological development, namely the finding of mesostructured intracellular inclusion in the ovisac lining of *A. franciscana*. The integrity of these 'zebra-striped' crystal-like flakes was maintained by means of cryopreparation, but not by conventional sample preparation at room temperature. Light microscopy, performed in cooperation with Thomas Schwaha, Dept. of Integrative Zoology, not only confirmed the existence of the striated flakes under native conditions; it also revealed the light dispersing activity of their striated superstructures. What is the function of the numerous intracellular 'optical gratings' during embryogenesis of the *A. franciscana*? What have these structures in common with mesocrystals that are currently in the focus of biophysicists and material scientists? The answers lie in interdisciplinary research that has to be linked with cryopreparation-based TEM.

[1] Goldammer et al. Protist. 2016;167(4):369-76.

[2] Hollerschwandtner. Msc-Thesis. 2016. University of Vienna

## **Annual Lab Safety Instruction**

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Documents of the lab safety instructions:

[https://zoology.univie.ac.at/fileadmin/user\\_upload/abt\\_morphology/Department\\_Seminar/Unterweisung\\_Department\\_englisch\\_2017\\_reduziert.pdf](https://zoology.univie.ac.at/fileadmin/user_upload/abt_morphology/Department_Seminar/Unterweisung_Department_englisch_2017_reduziert.pdf)

## ***Lucanus cervus* in Vorarlberg: distribution and development of a citizen science project**

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*Lucanus cervus* is the most known and most striking species of local coleoptera. Not only is it an eye-catcher, but it is also subject to annex II and IV of the FFH-Guidelines, introduced by the European Commission of Environment, which means this species is fully protected within the area of the European Union. This fact makes *Lucanus cervus* a common object of research. In 2017, the Austrian Environment Agency started researching the distribution of the species. The survey area was mapped in accordance with previously gathered data on *Lucanus cervus* in Vorarlberg. In 2018, there will be an additional monitoring of the species in cooperation with the Inatura Erlebnis Naturschau in Dornbirn. In addition to the field

research, a Citizen Science project will be developed. This is a program where not only scientists gather further data, but also non-scientific members of the public can help to enhance the body of knowledge on this endangered species. In order to attract attention for the project and to find motivated participants, print and electric media content will be created respectively. This speech will contain an overview of the investigations of 2017 and a preview of both the upcoming monitoring project, and the Citizen Science project.

## **Marchfeld Canal: the importance of a naturally designed watercourse for breeding birds**

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The Marchfeld Canal was built at the end of the 20th century primarily to irrigate the agricultural region Marchfeld. Near-natural structures like artificial bays, islands and zones of shallow water were designed aiming to create an ecologically valuable watercourse in this otherwise monotonous human-dominated farmland area. This study investigates whether the created structures attract birds using the watercourse and the bordering vegetation structures as breeding habitat. Hence, a total of 30 channel stretches (each with a length of 200 m) were selected between Langenzersdorf and Deutsch Wagram and surveyed for breeding birds. The proportions of the structural variables like shrubs, trees, reed, and vegetation overhanging the watercourse were assessed for each transect and the shoreline length was measured by using google maps. During the bird surveys a total of 43 breeding bird species were recorded, including 10 species

using the linear wetland habitat and 33 species using the vegetation structures bordering the channel. A generalized linear model evaluating the importance of habitat variables indicate a significant strong positive effect of the shoreline length and the cover of trees along the channel and a weak positive effect of the reed cover on bird species richness. The 2 most common wetland species were the moorhen (*Gallinula chloropus*) and the mallard (*Anas platyrhynchos*). The most common species of the vegetation structures along the channel were the nightingale (*Luscinia megarhynchos*) and the blackcap (*Sylvia atricapilla*). This study demonstrated that designing complex shorelines within artificial water channels by creating bays and small islands and maintaining a strip of woody vegetation along such channels positively affect bird species richness. Hence, artificial watercourses such as the structurally diverse Marchfeld Canal can contribute substantially to increase bird species richness within urbanised or intensively used agricultural landscapes.

## ***Lithobius*: a big genus of a small subphylum (Myriapoda) - phylogeny and evolutionary history**

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The subphylum Myriapoda encompasses more than 15,000 described species classified in Diplopoda, Pauropoda, Symphyla and Chilopoda. Approximately 1,200 species are from the order Lithobiomorpha (Chilopoda), with circa 500 sub-/species assigned

to the genus *Lithobius* Leach, 1814 (Lithobiidae). Classic taxonomic characters are insufficient to reconstruct the species interrelationships of this genus and its relationships to other lithobiid genera. Thus, further microanatomical and molecular analyses are necessary to shed light on its phylogeny and evolutionary history. During my PhD project, I am focusing on the genus *Lithobius*, thereby (i) aiming to reveal morphological characters with a phylogenetic signal to supplement an existing character set, (ii) acquiring molecular data from recently collected material and (iii) combining the morphological and molecular datasets for a phylogenetic analysis of the genus.

The morphological investigation focuses on the peristomatic structures, the mandibles and the first maxillae, which I study using light and scanning electron microscopy. Additionally, I carry out investigations on the mandibulo-tentorial complex and the reproductive system of both sexes using micro-computed tomography. The peristomatic structures (epipharynx and hypopharynx) of 35 species of the genus *Lithobius* and allied genera revealed eight characters with systematic potential and ongoing analysis of the mandibles and first maxillae continues to uncover additional characters. Combined analyses of the molecular and morphological data sets will be the next step in this research. With this integrative approach, I aim to elucidate the phylogeny and evolutionary history of the genus *Lithobius*.

## **Barcoding Vienna's wild bees, comparing traditional methods with innovative approaches**

**Julia Lanner**

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The accurate identification of wild bees demands taxonomic expertise, due to morphological similarities and the high abundance of cryptic species. For certain taxonomic groups, e.g., wild bees, DNA barcoding is particularly important as an additional determining tool also with respect to assessing their biodiversity. For over two decades, the Sanger method has been the standard technique and later has been used in projects dedicated to DNA barcoding. With the development of Next Generation Sequencing (NGS) methods a new era of sequencing has taken hold. The applicability of Illumina was tested in the present study on DNA barcodes of wild bees. Specimens were collected in communal gardens in Vienna. DNA isolation and amplification strategies were optimized to obtain high-quality DNA libraries. Identification analyses focusing on the Illumina sequences were computed. Although DNA barcodes derived from Illumina were comparatively short (418 base pairs), the sequences were specific. Moreover, the Illumina technique allows to deal better with some general problems of DNA barcoding.

Due to the additional information content gleaned from the Illumina DNA barcodes, first insights into the relationship between wild bees and their endosymbionts *Wolbachia sp.* were possible. Phylogenetic

analyses were calculated for both groups to test a putative co-evolution pattern. In general, *Wolbachia* sequences seemed to be quite closely related and there was no evidence for co-evolution. Interestingly, kleptoparasitic and their (putative) host species share the same *Wolbachia* sequences. This leads to the assumption that frequent horizontal transfer between cuckoo bees and their hosts appeared quite recently. Further investigations have to be performed to evaluate this aspect.

## **Comparative anatomy of the muscular system in marine bryozoans**

**Elena Belikova**

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Saint Petersburg State University, Russia*

Muscular system of the marine bryozoans remains understudied, with only a few species examined by the light and transmission electron microscopy. Besides, reconstruction of the muscular system with these methods is a difficult task because of its complexity and small size of the zooids.

To address this issue we used confocal laser scanning microscopy to examine representatives of all three known clades of marine Bryozoa: 11 species of cheilostomes, 4 species of cyclostomes and started to work on ctenostomes. Among Cheilostomata we focused on three major suborders: Malacostegina, Scrupariina and Flustrina (superfamilies Calloporoidea, Flustroidea, Buguloidea, Cribrilinoidea, Lepralioidea and Smittinoidea) representing major phylogenetic lineages of this order. In all species studied we identified five main muscle groups: apertural (including those of the operculum, vestibule and diaphragm), parietal muscles, lophophoral

muscles, retractors of the polypide and muscles of the digestive tract. The muscular system of the digestive tract, tentacles and operculum is relatively uniform in the studied species. Other muscle groups (vestibular and diaphragmal, parietal and retractors) are highly variable: we found differences in the number of muscle fibers, length and width of individual bundles, their position and attachment sites. Cylostome bryozoans possess apertural and lophophoral muscles, retractors of the polypide and muscles of the digestive tract. Instead of the parietal muscles, the polypide protrusion is performed by the ring muscles of the membranous sac.

Revealed differences in musculature correspond to the differences in the skeleton structure, representing different trajectories in the morpho-fuctional evolution in marine bryozoans.





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