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**DEPARTMENTAL SEMINAR
INTEGRATIVE ZOOLOGY
Winter Term 2018**

Programme and Abstracts

Tuesdays, 10-11:30 hrs

SR 3, UZA1, Althanstraße 14, 1090 Wien



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Of bored mollusks and boring bryozoans

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Bioerosion is a process of hard substrates being either eroded by external or internal bioeroders. Within the phylum Bryozoa, internal bioeroders evolved multiple times: few species bore mechanically whereas most have chemical means of dissolving mineralized substrates or tissues. All of these boring forms are currently assigned to ctenostome gymnolaemates. As uncalcified bryozoans the fossil record of ctenostomes remains restricted to few bioimmured or boring species that date back to the Palaeozoic. Recent studies on the biology and evolution of boring bryozoans are completely wanting. The last larger monograph dealing primarily with systematics and taxonomy of these forms dates back exactly 40 years. Hence there is a huge gap in our knowledge on boring bryozoans. In order to fill this gap, live material of boring bryozoans was analysed and preserved last summer for a broad analysis of the morphology of boring bryozoans plus obtaining sequences, which are so far not available for any boring species. In this talk I will present first observations and experiences with boring bryozoans, first morphological observations and future intentions.

Morphology and evolution of sensory and processing systems in mandibulate arthropods and of centipede ultimate legs

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In view of numerous hypotheses concerning arthropod phylogeny, independent data are needed to supplement knowledge based on traditional external morphology and modern molecular sequence information. One promising approach embraces the comparison of structure and development of the nervous system. Myriapods display conspicuous evolutionary novelties as well as characters considered plesiomorphic for Mandibulata, uniting Myriapoda, Crustacea, and Hexapoda. The organization of sensory organs as well as associated processing centers for visual, chemo- and mechanosensory information in the nervous system strongly gave support to the Mandibulata-hypothesis and the sistergroup relationship of Myriapoda and Pancrustacea. Another prominent example is the morphology of serotonin-immunoreactive neurons in the ventral nerve cord that can be identified individually and thus allows for establishing homologies on a single cell level. The talk will give insights into the evolutionary morphology of selected sensory organs and processing centers in the nervous system in arthropods and highlight a ‘neurophylogenetic approach’ to trace evolutionary transformations across Metazoa in general and Arthropoda in particular. In addition, I will present data on current and future projects to analyze evolutionary transformations of centipede ultimate legs (the last pair of legs) that show a considerable structural disparity and functional diversity. In many species, elongation and annulation in combination with an augmentation of sensory structures indicates a functional shift towards a sensory appendage. In other species, thickening and the reinforcement with a multitude

of cuticular protuberances and glandular systems suggests a role in both attack and defense. Moreover, sexual dimorphic characteristics indicate that centipede ultimate legs play a pivotal role in intraspecific communication, mate finding and courtship behavior.

A gordian knot – life cycle and biology of horsehair worms (Nematomorpha)

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Kurator Wirbellose Tiere 1

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Horsehair worms (Nematomorpha) are centimeter-long and very thin worms that can be found in late summer and early fall in diverse aquatic habitats. The rest of the year they are parasites of various invertebrate hosts. Fascinatingly, they reproduce in freshwater and start their development there, but the main hosts are terrestrial insects such as beetles, crickets and praying mantids. How the transitions between the aquatic and the terrestrial habitat are established, is still not completely clear, but it includes a behavioral change of the host induced by the parasite.

Besides presenting what we know about the life cycle, the talk will focus on morphology and morphogenesis as well as on phylogeny and biodiversity. Adults produce large amounts of gametes and several organs are adopted to the parasitic more of life. Nematomorpha are closely related to nematodes and are part of the Ecdysozoa. An alternative hypothesis regards nematomorphs as related to priapulids, kinorhynchs and loriciferans. To date about 360 species are known and new species are constantly described, especially from tropical regions. Besides structural analyses, molecular methods (barcoding) become increasingly applied in Nematomorpha and reveal, as in other taxa, the presence of cryptic species.

Pollination of runner beans (*Phaseolus coccineus*) by honey bees (*Apis mellifera*) in a greenhouse

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Extremely hot and dry summers caused major crop losses in scarlet runner bean varieties (*Phaseolus coccineus*) in Austria in the last years. For this reason, the project CHARACCESS of the AGES (Österreichische Agentur für Gesundheit und Ernährungssicherheit GmbH) compared different runner bean accessions in a greenhouse in spring 2018. This project focused on finding heat-resistant runner bean accessions to enhance food and nutritional security in the future. Usually bumble bees are used as pollinators in a greenhouse. Since short tongued bumble bees could become nectar robbers by biting through the runner bean flowers, the European honey bee (*Apis mellifera*) was chosen as pollinator in the greenhouse. The purpose of this master thesis was to investigate the development of *Apis mellifera* in the greenhouse and the foraging behavior of honey bees on runner beans and their role as pollinator. The differences in foraging behavior between greenhouse and open field, as well as the influence of heat stress on plant-pollinator interaction has been the focus. The results show that the situation in the greenhouse was a challenge for the bee colonies development. The bees stopped foraging on runner beans during enormous heat stress (35°C). *Apis mellifera* solely foraged nectar on the runner beans and was the predominant pollinator in the open field. The results of this study reveal important aspects of plant-pollinator interactions and demonstrate impacts of global warming on the pollination of runner beans.

Immunofluorescence staining in cardiovascular implants

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Implementation of cardiovascular implants has highly improved healthcare over the past decades. Still, the exposure of the devices' surfaces to the blood stream as well as activation of endothelial cells based on tissue damage cause a high risk of thrombosis, which may further lead to embolization. Moreover, the safety of xenogeneic tissue devices from animal donors is still an issue, since the risk of bacterial infection that leads to endocarditis remains. Histological techniques play a key role in the visualisation of device surrounding cells and tissues, and thus in further improvement of device use in terms of biocompatibility and reendothelialization. Immunohistochemistry in hard resin was already used to find biomarkers surrounding cardiovascular devices. This study aims to test immunofluorescence for its use in several types of implants (stents, occluders, conduits and artificial valves) embedded in glycolmethacrylate based resin. Embedded samples will be cut into shape and attached to plastic slides using silicone glue. After being sawed to 100-200µm, thin slices of 5-10 µm will be created with an EXAKT Thin Slice System (EXAKT Advanced Technologies GmbH, Norderstedt, Germany). Comparative staining with immunohistochemistry and immunofluorescence will allow testing for differences in the performance of both techniques. The study aims to compare the techniques by the means of markers against innate and cellular immune response, bacterial cell remains,

proliferating cells and smooth muscle cells. Detecting these markers in both staining techniques shall further allow to test markers that have not been examined in cardiovascular implants yet and may provide useful information in future biocompatibility screenings.

Ecological and genetic links in evolutionary transit of freshwater to marine taxa

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In general, systematic of eukaryotes state that all animal and plant phyla originate from one ancestor marine taxa, and this fact can be a starting point for research of evolutionary trends in certain taxa. A certain organism ingress from the marine environment to the freshwater, and vice versa, is driven by its tendency, needs or necessities to change the ecological niche. The colonization of an adjoining ecosystem and niche shift are, therefore, the product of rapid evolution, which may include physiological adaptations. Aquatic organisms are perfect for observing such changes due to the fact that they live in an environment whose parameters have minimal differences with respect to time and space. It has been proven that cosmopolitan organisms with short life cycles, such as macroalgae or macroinvertebrates, are more than suitable for field observation or laboratory analysis to understand rapid evolution or long-lapse genetic changes in these organisms. The cases of marine algal taxa *Polysiphonia subtilissima* and *Ulva flexuosa* are an example of rapid evolution and ecological niche shift, due to the fact that this marine algae have been reported in the last 30 and 100 years, respectively, on numerous locations around the world in strictly freshwater environments, where they formed stable populations. The niche shift occurred mainly by species adaptation to freshwater with high conductivity with no changes in their genetic structure. However, long-lapse genetic changes in the

Bryozoa phylum have shown that the common ancestor of this animals was a marine taxon, but the phylum consolidated in a freshwater environment. This freshwater macroinvertebrate colonized marine environments where they presently have higher diversity. The genetic structure has shown that, after the colonization of marine environments, the bryozoans began to ingress freshwater environments for a second time during their evolutionary history, and all these transits are also visible in their physiological structures. Bryozoans are specific as during their evolutionary time they managed to colonize two adjoining aquatic environments by establishing numerous genetic diversity.

Life of the ctenostome bryozoan *Pherusella* cf. *brevituba*

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Bryozoans are colonial filter-feeders and inhabit predominantly marine benthic ecosystems. The most common and highly diverse groups of bryozoans are Stenolaemata and gymnolaemate cheilostome which almost exclusively calcifying, while the group of ctenostomes are uncalcified and comprises about 300 species. The ctenostome bryozoan *Pherusella brevituba* was first described in 1951 by Soule and was reported along the pacific coast of North Amerika. The genus of *Pherusella* comprises three species *P. tubulosa*, *P. brevituba* and *P. flabellaris*. In 2005 *P. brevituba* was reported in the Mediterranean Sea for the first time, inhabiting seagrass leaves of *Posidonia oceanica* and were listed as invasive species. In the last couple years *P. brevituba* was regularly sampled along the Croatian coast of the North Adriatic Sea. Colonies rarely

contained more than 4 to 6 zooids. Even in young colonies of two zooids the reproduction starts quite early and the maternal zooid produces up to five lecithotrophic pseudo-cyphonautes larvae. The free-swimming larvae settles short after releasing on new unvegetated 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 grows pattern of *P. oceanica*. In 2017, colonies were kept under laboratory condition for several weeks until spawning while the metamorphosis of hatched larvae were documented. Additional morphological and molecular investigation will address the question whether this is an undescribed species or not.

Influence of androgens on the gestural signals of the foot-flagging frogs *Stauroides parvus*

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The project aims to test how the actions of androgenic hormones modify visual foot-flagging signals in male *Stauroides parvus*. Prior data show that the emergence of foot flagging – a signal that is produced by conspicuously waving the hind limb – is marked by a 10-fold increase in androgen receptors (ARs) within the skeletal muscles that control this movement, compared to frogs that do not foot flag. Testosterone increases the frequency of foot-flags. We hypothesize that activation of AR also influences the kinematics of the signal and increased Testosterone during advertising likely enables precise control of foot flagging.

Glowing mucus – Characterisation of the unique defence secretion of *Latia neritoides* (Gastropoda)

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Advisor: Gerhard Steiner

Bioadhesives from bacteria, plants and animals have proven their efficacy for 500 million years and been adapted throughout the needs and requirements of the organism producing them. Around 100 marine and terrestrial organisms are described generally to secrete adhesives (see Graham, 2005; Hennebert et al., 2015, and contributions in Smith & Callow, 2006; von Byern & Grunwald, 2010; Smith, 2016) but of these only a few organisms have already been characterized in detail or implemented into functional prototypes.

Biological adhesives are not exclusively used for settlement but often also fulfil other purposes as defence, predation or locomotion and are perfectly adapted morphologically, chemically and physically to the needs and requirements of the organism. However, still very little is known about the composition, production, secretion and properties of the vast majority of these systems.

The aim of this research project is to perform a detailed characterisation of the luminescent mucus of *Latia neritoides*. Since no biochemical and transcriptomic analyses have been undertaken on this species, this approach will give first insights in its gene expression as well as shed light on the chemical composition of the defence glue. Beside a detailed gland identification, furthermore a toxicological analyses is planned to evaluate its potential for new applications in the industrial or medical area.

Sensing from both ends?

Matthes Kenning

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The arthropodium can be regarded as one, if not the eponymous key innovation of arthropods. In taking on a sheer plethora of functions, arthropodia are one of the most versatile, most specialized, and thus probably one of the most widely modified features known in arthropods. Besides the head with its sensory and feeding appendages, it is the posterior end of the centipedes' body that shows a considerable disparity and diversity of appendages - the ultimate legs. In all centipedes, this last pair of legs displays a huge diversity of morphological and functional modifications that can be assigned to several not mutually excluding principles which will be briefly outlined in the first part. The second part will dive into two concrete examples showing that these transformations of the outer morphology are also subjected to a whole cascade of modifications in terms of neuroanatomy and behavior as demonstrated by a multimethodological approach comprising histology, immunohistochemistry, backfills, microCT, confocal laser scanning microscopy, scanning- and transmission electron microscopy as well as electrophysiology.

Tunnels inside snail shells: modern techniques help classification

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Some land snails, especially tropical ones have a door-like structure (an operculum), which closes the snail shell when the snail retracts to it. The operculum seals the shell so tightly that no gas exchange is possible. To overcome this problem, several families developed tubes, snorkels, bypass-channels to help gas exchange. These tubes are open on the outer end and lead to the inside of the shell. However, in the family Alycaidae the outer end of the tube is closed, creating a 150 year-old dilemma. Examination of the shell with scanning electron microscope revealed that there are extremely narrow (ca. 16 μm) microtunnels that are in contact with the tube. Knowing this, we started to search microtunnels everywhere, and found similar structures in other families of snails as well. Moreover, in a single, ca. 1 cm high shell from an old museum collection, we found several narrow microtunnels, which connected ca. 200 μm long cavities. This structure superficially looked like a complex network of snail parasites. Here I won't reveal the Century's most exciting malacological mystery. Come and listen to my talk, bitte.

Annual Lab Safety Instruction

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Documents of the lab safety instructions can be found under the link <https://zoology.univie.ac.at/facilities/>

Bringing light into the evolution of an enigmatic fish. Comparative analyses of cavernicolous and surface dwelling populations of *Garra barreimiae*.

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Organisms colonizing extreme habitats like caves represent a unique opportunity to gain insight into mechanisms of adaptation. Living in complete darkness often results in the same phenotypical changes like regression of eyes and pigmentation. Studying these troglomorphic traits can provide important insights into how evolutionary forces drive convergent and regressive adaptation. The cyprinid freshwater fish *Garra barreimiae* is endemic to Northern Oman and the UAE. Besides the harsh and arid climate, this taxon is quite common and inhabits all kinds of water bodies. In addition to the many surface populations, one troglomorphic cave population, inhabiting the Al Hoota cave in the midst of the Hajar mountains, is known. We investigated the population

structure between the cave and nearby surface populations by analyzing variable microsatellite markers. The results clearly show that the cave population is genetically isolated and gene flow can be detected only scarcely and unidirectional from the cave to the surface populations. Besides, phenotypic plasticity (exposure to light) seems to play an important role when it comes to the degree of troglomorphic traits (pigmentation, eye size). To further study the effects of light exposure on the phenotype, we conducted breeding experiments under controlled light regimes. We will employ histological analysis and μ CT scans to compare the degree of degeneration between specimens reared under different light regimes from both morphotypes and different developmental stages. In the course of an extensive phylogeographic framework, we investigated the genetic diversity within the distribution area of *G. barreimiae* including samples from 56 sampling sites. We received concordant results from analyzing three mt fragments as well as 18 nc microsatellite markers which show five genetically and geographically clearly differentiated groups, which we address as distinct species.

G. barreimiae is currently listed as “Least Concern” (IUCN Red List). Hence, the newly discovered *Garra* species-complex in northern Oman is in urgent need for re-evaluation, as desertification, habitat destruction as well as water shortage and potential chemical pollution pose serious threats to organisms occupying extreme habitats. A species description for the newly discovered taxa is in preparation and will provide the basis for a conservation reassessment.

Modular development in *Symplegma brakenhielmi* and the evolution of coloniality in styelid ascidians

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Understanding complexity as the number of modules that compose an organism or a biological system, the type of interactions between these modules and new hierarchies that describe these interactions. Also the capacity of self-organization of the new biological systems. This is precisely the case of the colonial organisms evolution from solitary ancestors in the Styelids tunicates. Because in the evolution of colonial forms it is possible to observe an increment in all the aspects defined in the concept of complexity in biological systems. First, in colonial biological systems there is an increment in the modules that compound the system (i.e. zooids). In solitary organisms the multicellular individual is the unity, that is transform in a component of the modular architecture in colonies. In these colonies of tunicates there is an inter-generational division of labor, where one generation is feeding (i.e. zooids), a second undergoing morphogenetic and inductive processes (i.e. buds), and a third undergoing phagocytosis (i.e. zooid during regression). I am interested in understand how is the regulation of the asexual developmental processes that occurred simultaneously in the modules of the colonies? My proposal is that the regulation of the simultaneous developmental processes that occurred in colonies is mediated by the system of extracorporeal blood vessels, which maintain physically the cohesion of the individuals, the plasma and migratory blood cells transport signals between the individuals of the colonies. By studying the genus *Symplegma* using in vivo

observations of the budding process, description and classification of the extracorporeal blood vessels system and the blood cells, by cytohistological assays and transmission electron microscopy and systematic surgeries.

What we do in the Sea of Japan? Molluscs, of course!

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In September/October 2018, we visited Maizuru Marine Fisheries Research Station (Kyoto University) in Japan. The opportunity to join collection trips with the research vessel, generously provided by Yoshiaki Kai (professor at the marine station) and Hiroshi Saito (National Museum of Nature and Science, Tokyo) gave us access to the marine soft bottom community of the Sea of Japan. Due to the biogeographic history of this marginal sea and the varying degree of separation from the western Pacific, its molluscan fauna is characterized by reduced diversity and increased number of endemic species.

Sampling the muddy bottoms outside Maizuru Bay yielded four species of each Caudofoveata and Scaphopoda, respectively. We documented the behaviour of live animals prior to preserving them for morphological and molecular analyses. During the last years, we even managed to obtain caudofoveate developmental stages, a notoriously difficult task in these animals. At present, we are setting off for a comprehensive research project on caudofoveate development and aim to intensify the cooperation with our Japanese colleagues.

Tagfalter-Monitoring in Wien (Butterfly Monitoring in Vienna)

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In recent years, butterflies have become increasingly important as indicators for biodiversity as well as environmental and climatic changes. Their sensitivity to changes in their habitats as well as their specific requirements to living habitats mark them as ideal bioindicators. In order to obtain sufficient amount of data, it is necessary to carry out extensive monitoring. Many European countries already employ regular, standardised butterfly-counts. An example for such programmes is the UK Butterfly Monitoring Scheme which, from 1976 onwards, assisted by volunteers, has produced the greatest butterfly- database to this day. Such comprehensive databases enable valuable scientific prognoses; future developments of species and populations can be gauged in utilising such data. While some butterfly-monitoring projects in Austria have been carried out in the past, they have been largely unsatisfactory and insignificant; the regions chosen for previous monitoring have been too restrictive and small to allow for predictions about the current state of butterfly populations in Austria. Therefore, it is the main goal of the present diploma thesis to initiate an extensive monitoring-programme for butterflies in Vienna. To achieve this goal, 7 areas (all of them 450 metres long) within Vienna have been chosen for a detailed monitoring. Those areas have been investigated from April 2018 until September 2018, following strict criteria. The ensuing lists of species, counts of individuals as well as experiences of the conductor of the study shall enable further steps of butterfly monitoring in Vienna.

Reproduction in trochid gastropods

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Trochid gastropods (Vetigastropoda) are widely distributed throughout the Indo-Pacific and Atlantic Oceans, occurring in tropical and temperate regions where they occupy rocky intertidal to subtidal habitats. As grazing herbivorous gastropods they feed primarily on biofilms. The reproductive biology of these gastropods, however, is poorly investigated. Although trochid species are locally abundant in shallow coastal areas, little is known about their reproductive cycles. Especially, the time of spawning in the Mediterranean Sea and, whether single species are broadcast-spawners or lay egg clutches are open questions. In this study, trochids were collected monthly from April to October 2018 at three different sites along the shallow limestone coastline in Pula and Vistar (Croatia). Specimen will be identified by morphological features by their shell and, partly, by DNA-barcoding to avoid missidentifications, in particular of juvenile specimens. After shell removal, gonads of all individuals will be analysed to determine the sexes. Female gonads will be dissected to assess oocyte numbers and sizes in monthly intervals. During data collection, 182 individuals, including species of the genera *Phorcus*, *Steromphala*, *Clanculus* and *Gibbula*, were sampled in total. Data such as water temperature and depth will be included in further analysis. The purpose of the present study is to describe the timing of gonad maturation to determine peak spawning season for each species in the study area. This will help to understand ecological niche differentiation of these closely related and often sympatric gastropod species.

Comparative analysis of the reproduction system in whip spiders (Arachnida: Amblypygi)

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Whip spiders (Arachnida: Amblypygi) are an arachnid taxon with raptorial pedipalps and an elongated first pair of legs, which function as tactile organs. They also exhibit a prolonged ritualized courtship behavior and reproduce through indirect insemination via a stalked spermatophore. This spermatophore as well as the corresponding female organs used for the uptake of the spermatozoa, the gonopods, are a result of coevolution and have been shaped by sexual selection. Due to this, they show a remarkable degree of variance between amblypygid taxa and thus are viable characters for taxonomic analysis. While a couple of comparative studies have been done on these structures, the rest of the reproductive tract has been rather neglected. The male reproductive tract consists of paired testes and vasa deferentia, sperm reservoirs, ventral glands, lateral glands, secretory reservoirs with blind ventral tubes and the unpaired genital atrium with the spermatophore organ. The female reproductive system consists of paired ovaries and oviducts, an unpaired uterus and the unpaired genital atrium with the gonopods. Since this study provided by Weygoldt et al. (1972) on *Phrynus marginemaculatus* C.L. Koch, 1841 is the only data available on the entire reproductive system of whip spiders so far, it is in urgent need of revision. Therefore, I attempt to reproduce Weygoldt et al.'s data and reconstruct the entire reproductive tract of male and female whip spiders using the modern 3D visualization software AMIRA. Visualizations will be started with the phrynid whip spider *Phrynus hispaniolae* Armas & Perez Gonzales, 2001, which will then be compared to section of the reproductive system of the remaining

euamblypygid taxa. MicroCT sections are available on specimens of all four euamblypygid taxa (Charinidae, Charontidae, Phrynichidae and Phrynidae). Goal is to get a comparative morphological overview, discuss the resulting similarities and differences across the Euamblypygi and determine the possible taxonomic value of these structures.

Expression of mesodermal genes in the polyplacophoran mollusc *Acanthochitona crinita*

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Germ layers are distinct cell layers that form during embryonic gastrulation. Their derivatives form tissues and organ systems in the vast majority of metazoan animals. Most metazoans develop at least two germ layers, the outer ectoderm and the inner endoderm. The third germ layer, the mesoderm, is argued to be the evolutionary youngest germ layer that probably evolved after the cnidarian-bilaterian split. It either forms by cells that immigrate into the blastocoel from the blastopore margin (many protostomes), or by detachment from the archenteron wall, common in deuterostomes but also found in some protostomes. Comparative studies have shown that genes that are involved in mesoderm formation in bilaterians are expressed in both, ectoderm and endoderm in cnidarians, suggesting that these genes were co-opted into mesoderm formation in bilaterians. The genetic regulation of mesoderm specification in lophotrochozoans still remains largely unclear. Expression of genes involved in mesoderm formation have been studied in some platyhelminths, annelids, brachiopods, and molluscs, including the gastropod *Crepidula fornicata* and the

bivalve *Septifer vulgaris*. These data show that *twist* expression is often located around the blastopore. Mesodermal expression pattern has also been observed for other genes including *brachyury*, *mox* and *snail* in the mesentoblast as well as in the ectomesoderm and in muscle precursor cells. The present study aims to expand the database on mesodermal gene expression in molluscs. To this end, gene expression patterns of seven genes known to be involved in the formation of the mesoderm or its derivatives in other lophotrochozoans (*Myosin heavy chain*, *Hairy and enhancer of split*, *Twist*, *Snail*, *Brachyury*, *Evx* and *Mox*), will be studied in the polyplacophoran mollusk *Acanthochitona crinita*. The results will be compared to other molluscs and lophotrochozoans in order to assess whether the expression domains of these genes (and thus their putative functions) are conserved throughout Mollusca or even Lophotrochozoa.

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