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Poster Abstracts

Posters*:

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Cooperative minds in the abyss: reproductive adaptation and social coordination in deep-sea Spionidae (Annelida)

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Deep-sea benthic habitats are typically characterized by low annelid diversity, yet several taxa display unexpectedly complex behaviors that challenge traditional assumptions about polychaete biology. In environments defined by extreme pressure, limited food availability, and spatially heterogeneous resources, cooperative sexual strategies may offer substantial evolutionary advantages. However, direct observations in deep-sea annelids have remained scarce due to technological limitations.

In this study, we present high-resolution images and videos in their natural environment as well as morphological data uncovering the reproductive adaptations and structured interactions among deep-sea Spionidae. Using autonomous imaging platforms, we captured striking behavioral patterns including cooperative mating behavior, coordinated sediment manipulation, and collective foraging. Morphological approaches give hints towards the anatomical adaptations related with such impressive annelid behaviors.

Our observations further reveal behavioral traits not previously attributed to annelids: excessive mating dances and reproductive cuddle piles combined with deceptive behavior, in which subordinate worms employed misleading postures or rapid color shifts to distract conspecifics and gain temporary access to the best mating grounds; and signs of hierarchical structuring, with certain individuals occupying consistently advantageous positions within the annelid cuddle piles.

These findings indicate a level of anatomical adaptations as well as related behavioral happenings far exceeding expectations for deep-sea annelids. We propose that such cooperative strategies, supported by morphological changes of the annelid body plan, may represent key adaptive responses enabling survival and reproduction in low-diversity deep-sea ecosystems. Our study highlights the importance of in situ observations of complex behavior in extreme marine environments and opens new avenues for comparative morphological research questions in Annelida.

Impact of body size and wing morphology on the sound frequency of calling songs in the field cricket *Gryllus bimaculatus*

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As a mechanism of female choice for larger males as mating partners, it was suggested that female crickets should prefer conspecific males that produce calling songs with lower sound frequencies. However, several studies failed to show a correlation between male body size and the sound frequency of their calls. Male field crickets sing by rhythmically rubbing their front wings together, which have specific structures for sound production. During each wing-closing movement, a sound pulse is produced when the hard edge of the left wing (plectrum) scratches over a line of cuticle teeth (file) at the ventral side of the right wing. The resulting vibration of both wings are amplified, phase shifted, filtered and emitted as sound waves by membranous wing areas (chord, harp and mirror). Here we analysed how different body size indicators (mass, length and width) and the morphology of wing structures for sound production (file length, teeth distance, as well as chord, mirror and harp area) correlate with the dominant sound frequency of the calling song within and across 2 captive populations of *Gryllus bimaculatus* that differ significantly in body size (L-crickets, S-crickets). To test for the impact of their genetical differences and developmental conditions, we also produced hybrids by crossbreeding (H-crickets) and raised S-crickets under L-cricket conditions (S_L-crickets). The sound frequency of the calling song did not significantly correlate with any of the other parameters within either of the 4 groups, but significant correlations were found between body size, wing areas and sound frequency when tested across all tested animals.

Diversity and development of the prototroch in Trochozoa

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The prototroch, a preoral ring of ciliated cells used for swimming and feeding, is the eponymous structure of the trochophore, the iconic larva of Trochozoa. The cell-lineage of the cells constituting the prototroch, the trochoblasts seems to show a stereotypic pattern in nearly all investigated species. The trochoblasts cease to divide already early during embryogenesis and start to develop cilia, making the resulting prototroch the first differentiated structure in the trochophore. As a strictly larval structure, the prototroch is restricted to the larval phase of the trochozoan life-cycle. Although the prototroch has been in the focus of investigations for more than 100 years, there are still open questions regarding (1) the exact composition of the prototroch in different trochozoan lineages, (2) the maintenance of prototroch cells during larval development, and (3) the fate of the prototroch cells during metamorphosis of the trochophore to the juvenile. These questions are addressed using different stains and detection with CLSM in several trochozoan species. The results show that the prototroch is a structure that has diversified considerably during the evolution of its bearers.

Strong modifications of abdominal sclerites in Pselaphinae (Coleoptera: Staphylinidae) as an adaptation to association with ants

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Rove beetles (Staphylinidae) are generally known for their shortened elytra and highly flexible abdomen, which in combination with pygideal adrenal glands, is used for defense. Although Pselaphinae belong to Staphylinidae and also use their abdomen for protection, they followed a different evolutionary path and have undergone a row of drastic morphological modifications. These tiny (0.7 - 4mm) beetles possess highly sclerotized, relatively immobile abdomen, where some segments may even be fused. Those adaptations might likely have happened due to their strong association with ants. One way to survive these unavoidable encounters is to hide, optically or chemically. Another way is to strengthen your exoskeleton to avoid being crushed. This evolutionary path has likely led to the vast diversification of Pselaphinae (>10,000 described spp.).
Until recently, the morphological documentation of most pselaphine species has been quite sparse, with almost no information on the inner structures. With the help of µCT and 3D reconstructions we thoroughly examined the abdominal structures of a myrmecophilous pselaphine, *Batrisus formicarius,* and compared them with those of other pselaphines, as well as those of closely related non-pselaphine rove beetles. What we found in *Batrisus formicarius* is not only a heavily sclerotized abdomen with fused segments, but a series of internal adaptations of the exoskeleton. Deep cuticular invaginations (foveae) form massive internal crossbars that provide stability. Additionally, sclerotized bubble-like structures strengthen weak points between the segment boundaries. Together with similar structures in the thorax and a robust head *Batrisus formicarius* and other pselaphines are well adapted to live close to ants, which offers plenty of new accessible niches.

Comparative gait analyses in two differently sized drosophilid fly species running on slippery and non-slippery substrates

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The scarcity of species-specific data on insect locomo5on hinders the integra5on of behavioural, ecological and evolu5onary knowledge for the most species-rich group of animals. This lack of informa5on contrasts sharply with the growing number of theore5cal approaches to animal locomo5on, which highlight the dependency of locomo5on traits, such as specific adapta5ons in dynamics, energe5cs and control, on morphological characteris5cs. In order to probe model outcomes within a rather narrow framework, here, we examine the level locomo5on of two drosophilid fly species compara5vely that differ in size and weight. Following ini5al compara5ve morphometric analyses of leg and aDachment structures, we inves5gated the walking behavior of wild type specimens of *Drosophila melanogaster* and the twice as large *Drosophila virilis* on a experimental running track equipped with

flooring of differing surface structures. To simulate the range of surface condi5ons that the animals would usually encounter in their natural habitats, the flooring was made from slippery PTFE, non-slippery paper, and microrough sandpaper. The runs were recorded simultaneously from top and side using a high-speed video system, which enabled us to analyse the horizontal and sagiDal kinema5cs and dynamics of the body, as well as the coordina5on paDerns of the legs. With this approach we strive to answer the ques5on of how the locomotor system of differently sized Drosophilids copes with different substrates.

Characterisation of the defence system of *Latia neritoides* (Mollusca; Gastropoda; Hygrophila)

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Bioadhesives are produced by various organisms, ranging from prokaryotes to plants and animals. The biologically often complex substances evolved over millions of years to adapt to specific needs such as attachment to the substrate, food capture, predation, and defence. The latter is the case in *Latia neritoides*, an endemic freshwater snail of the northern island of New Zealand/Aotearoa. When attacked by predators, the snail releases a bioluminescent mucus, spread by the fast-flowing water to deter them. This mucus is also sticky and adheres to the predators themselves. Regardless of their hypothesised function, the underlying gland system and production origin remain largely understudied, and some of the chemicals involved in the bioluminescent as well as sticky secretions remain elusive as well.
Histochemical and morphological examinations of the lateral foot region revealed two promising types of glandular cells. However, personal observations suggest that the luminescent component is primarily released from the pneumostome. Using a µ-CT stack, we examined the entire animal for mucus reservoirs and alternative glandular cell structures that may be involved in the defence mucus system. Comparison of the protein profiles generated by electrophoretic separation of the defence and trail mucus shows substantial variation in total protein concentration, number and physicochemical properties of the proteins. Among those, we have discovered unknown proteins that appear to be unique to the luminescent mucus.
Broadening our understanding of these unique proteins in defensive mucus enhances our knowledge of the luminescent mucus system of *Latia neritoides* and contributes to the development of novel aqueous medical adhesives suitable for moist environments, including tissue adhesives and haemostatic agents.

Taxonomic revision of the bee-mimicking robber fly genus Hyperechia Schiner, 1866 (Diptera: Asilidae), including seven new species and four new synonyms

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The large and charismatic, carpenter bee-mimicking robber fly genus *Hyperechia* Schiner, 1866 (Diptera, Asilidae, Laphriinae) is reviewed for the first time in 50 years using morphological examination of 873 museum specimens and 446 photographic records. 21 valid species (including seven new to science) are recognized and four new junior synonyms are found. All species are depicted (including sexual dimorphism and intraspecific variation as well as genital morphology for selected species), and a diagnosis for the new species is presented. The expanded record distribution of *Hyperechia* is mapped, the genus is now known from almost every country of Sub-Saharan Africa as well as India, Sri Lanka, Indonesia and Malaysia. A photographic record from Saudi Arabia (most likely representing *H. pellitiventris* or an undescribed species) expands the known range into the Palearctic region. The occurrence of *H. bomboides* on Cabo Verde represents the first record of the family on this archipelago. *Hyperechia* were found to be specialized on Hymenoptera as prey and bees of the genus *Xylocopa* as larval hosts, representing the second recorded instance of a parasitoid lifestyle within Asilidae. Larvae and pupae are depicted and the loose connection of mimicry and host specialization is discussed. Known hosts are shown for all species while mimicry models and phenological data are shown exemplarily. This revision finally makes a neglected taxon identifiable for both researchers and amateurs, thereby representing one piece to the puzzle of illuminated biodiversity. It sets the foundation for further molecular and morphological research on the unique lifestyle of this bee-

Symbiosis establishment between the acoel *Convolutriloba macropyga* and the green algae *Tetraselmis Sp*.

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Acoels are marine invertebrates found across all oceans and a remarkable range of habitats, from shallow coastal waters to deep-sea environments. Their ecological success is partly attributed to the ability of many species to form photosymbiotic relationships with algae or dinoflagellates. *Convolutriloba macropyga*, a member of the Convolutidae, establishes photosymbiosis with green algae and has attracted interest not only for this association but also for its unusual dual reproductive mode. This hermaphroditic species can reproduce both asexually and sexually, resulting in two distinct routes of symbiont acquisition: vertical transmission of algae during asexual reproduction and horizontal uptake from the environment during sexual reproduction. Horizontal acquisition occurs through ingestion of free-living algae, yet the cellular and morphological steps underlying symbiosis establishment have been poorly investigated so far. By means of confocal imaging, this study investigates the early changes in number and spatial distribution of *Tetraselmis* sp. algae taken up by the juveniles within the first six days after the initial contact. We observed a progressive increase in the number of acquired algae during

longer exposure periods. Notably, algal numbers continued to rise even after exposure ceased, suggesting proliferation of algae within the juveniles' tissues. Furthermore, algae distributed near the body walls increased with prolonged passing of days, resembling the symbiont distribution at the body periphery typical of adults. This pattern points to a movement of algae towards morphologically relevant regions associated with stable photosymbiosis even after just a few days from algal uptake. Our findings elucidate the earliest events driving the establishment of photosymbiosis in *C. macropyga* and provide insight into general patterns of horizontal symbiont acquisition in acoels. Understanding these initial steps may contribute to a broader perspective on the evolution and morphology of host–symbiont integration in marine invertebrates.

The ear region of dormice: Part I. Septal compass of the middle ear cavity in extinct and extant glirids (Gliridae, Mammalia)

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The ear region of rodents is highly specialized and plays an essential role in communication. Rodent ear morphology can also be used to distinguish between different locomotion styles. Inside the bony skull, rodents have an inner ear with a vestibular system for sensing the equilibrium of the organism and a well-developed middle ear for detecting sound, composed of a cavity and three auditory ossicles (malleus, incus, and stapes). In the rodent family Gliridae**,** commonly known as dormice, the middle ear cavity shows several morphological specializations that support their sensitive hearing abilities. The middle ear is relatively spacious in many species, providing good acoustic resonance and improving the transmission of sound vibrations. This enlarged cavity is separated by distinct bony septa, the distribution pattern of which represents a phylogenetic signal. In this study, this distribution is visualized and interpreted with the 'septal compass' and 'septal formula' to elucidate phylogenetic issues in extant and extinct species. Except *Glis glis*, all the investigated glirids possess a posterior medial diverticulum. A high number and complex distribution of bony septa in the Japanese taxon *Glirulus japonicus* is seen and does not fit in any other septal compass schema of Eusciurida (sciurids, glirids, *Aplodontia rufa*). The specimen of the extinct insular giant *Leithia* sp. investigated here possesses an additional ventral cavity, which is not seen in any other species in our sample. The distribution of septa in the epitympanic recess is variable and does not represent any phylogenetic distribution known up to now. Therefore, it becomes apparent that investigating the bony septa of the middle ear alone is insufficient for phylogenetic analyses. For further studies, we will include characters of the auditory ossicles and the bony labyrinth to better understand the variation of the internal ear architecture within the dormouse lineage.

Bone to be wild:
A microanatomical study of the long bones in two caudates species

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Amphibians are speciose living at the interface between terrestrial and aquatic environments with various reproductive strategies. While some are still strongly linked to water and changed morphotype through mating season and stay a long time in the water, other just lay their young, already larvae instead of eggs and go directly back to land. These different strategies could have an impact the bone microanatomy which is a really plastic structure. To explore this possibility, we selected two species of Salamanders, *S. Salamandra* and *I. alpestris*. For the first, only female go back in water and lay the offspring in water then go directly back to land, while the later stay in water through mating season, male even developing a different morphotype. We found that while larvae are clearly separate from adults for both species, there is no clear distinction for juvenile which are either microanatomicaly considered larvae or fully adults. In adults, mating season and the laying of young in water is not visible for S. Salamandra. In I. alpestris, while we previously thought that the external morphotype could reflect the microanatomical organisation, it is not the case. However, if we separate individuals by the time they were taken in nature (out of mating season, before mating season, mating season and after mating season), we can observe a difference especially between out of mating and after mating). These results offer a brand-new perspective on microanatomical studies in amphibians and on the importance to allow of the moment the specimens was taken for collections.

Look, lock, lunch: Vision in robber flies with different hunting strategies

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Robber flies (Diptera: Asilidae) are predatory insects that rely on visual perception to locate and capture prey. They perch in open spots before hunting down their prey in fast and short pursuits. Within the family, three perching positions have been evolved: 1) head pointing downwards, 2) head pointing upwards, and 3) flexible body orientation during perching. Our study examines the variations in the visual systems of robber flies that employ these hunting strategies and investigates how vision relates to ecological roles. We applied micro-computed tomography (µCT) to acquire detailed three-dimensional data on the compound eyes of multiple species spanning the robber fly phylogeny. Using this data, we compared the topology of facet sizes and inter-facet angles across compound eyes and inferred information on visual acuity, sensitivity, and visual field size and orientation. Our imaging and analysis pipeline uncovered relationships between eye morphology, vision, and ecological specialization in these formidable hunters.ter

Upward vision: How mayflies split their visual world

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Male *Cloeon* mayflies possess hypertrophied dorsal "turbanid" eyes whose functional role has remained poorly quantified. Here, we compare the visual sensitivity, spatial acuity, and field-of-view (FOV) of these dorsal eye regions with those of the male's lateral compound eyes and with the standard compound eyes of females. Using a yet unpublished computational method that extracts facet positions, facet diameters, and inter-facet angles from grating phase contrast micro-CT (GBPC-CT) scans, we estimate regional optical performance across eye types. GBPC-CT allows unprecedented tissue contrast without potential artefacts in the delicate eyes from drying or staining. Our analyses show that turbanid eyes exhibit substantially enlarged facets and reduced inter-facet angles, conferring enhanced sensitivity and improved vertical acuity relative to lateral regions. We additionally characterize the dual-rhabdom architecture of turbanid ommatidia and contrast it with the single-rhabdom design of standard compound eyes. Our results provide the first quantitative, whole-eye comparison of visual capabilities in male and female *Cloeon*, refining hypotheses about the role of dorsal eye specialization in mating and species recognition.

Three-dimensional sonography for imaging of human facial muscles: establishment of a standardized examination protocol

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Two-dimensional sonography is a standard for facial muscle imaging in patients with facial nerve related diseases. However, this neglects the fact that these are three-dimensional (3D) structures that deform in complex ways during mimic movements and emotional expressions. Volumetric 3D measurements in computed tomography or magnetic resonance imaging are time-consuming, expensive, and are not suitable for frequent repeat measurements. 3D facial sonography could be an alternative, that could even be used in motion.
A protocol has been developed to enable standardized recording of facial muscles, as well as the masseter muscle, as a control. Magnetic field-based tracking of a linear 15 MHz ultrasound probe and specialized software allow images from a standard sonography recording to be spatially arranged. The muscles are then manually segmented using 3D data analysis software.

The protocol was tested on the first group of healthy participants. 3D volumetry and gray value analysis were established for the following muscles: *M. occipitofrontalis* (Venter Frontalis), *M. orbicularis oculi*, *M. zygomaticus major*, *M. orbicularis oris*, *M. depressor anguli oris*, *M. depressor labii inferioris*, *M. mentalis*, *M. masseter*. This study outlines the protocol's development process, the results and limitations of the measurements taken thus far.
3D sonography, following our protocol, has the potential to become a reliable method for examining facial muscles at rest and their deformation during contraction. This will establish a better understanding of the complex facial muscle deformation during facial expressions in healthy individuals, as well as in patients with impaired facial motor functions. Further test measurements, including patients with facial palsy, are necessary to verify its reliability. However, to make the leap to clinical practice, it must be possible to automate segmentation and minimize this time-consuming part of the process.

The detailed head anatomy of the barklouse Loensia (Psocodea: Psocidae)

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The bark- and true lice (Psocodea) are a pivotal group in the insect tree of life with more than 12,000 described species. Linked to their evolutionary success is the high diversity of feeding modalities, ranging from nearly generalized chewing-biting types to the evolution of stylets used for piercing and sucking that are retracted inside the head during rest (entognathous condition) in the Anoplura. While the head morphology of the parasitic forms received a reasonable amount of scientific attention in the last century, studies on the head anatomy of “Psocoptera” are scarce. Our knowledge of the atmospheric water-vapour absorption apparatus or the histology of head tissues in general is still fragmentary. We studied the head anatomy of the genus Loensia (Psocomorpha: Psocetae) using (SR)-µCT, histology, photography and SEM, and examined both female and male specimens. The major difference between both sexes was the relative volume of the compound eyes (ca. 40% in male vs. ca. 15% in female) and enlargement of the optic lobes, suggesting males majorly rely on enlarged compound eyes for mate finding. Several new terms for previously undescribed structures are introduced such as the medial rods of the salivary sclerite or the lamellate band of the mortar. Some complications of the muscle homology introduced by previous authors were resolved and compared to all previously published data on psocodean head anatomy. We also found a small labial muscle, originating laterally on the prepalpiger lobe and inserting on the lateral base of the labial palp, that was not described before in Psocodea. The water-vapour absorption apparatus is unlike in previous treatments not only a single apomorphy but represents a character complex consisting of at least 10 different character states. This apparatus was likely one of the key innovations in the evolution of Psocodea and allowed for their widespread diversification.

Apocrita to Aculeata: Evolutionary Insights from the Genitalia of Trigonalyidae

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Trigonalyidae is an enigmatic family of narrow-waisted wasps (Apocrita). Their life history is fascinating and they are a key morphological bridge to the stinging wasps, Aculeata, but knowledge on this group is limited. Previous work on this phylogenetically important group has used CLSM and SEM, which provide useful yet limited information about internal structures of the genitalia and provide constrained views for understanding the geometry of the system. The objectives of the present work are to use µ-CT-based digital dissection: (1) to establish homologies of the genital skeletomusculature; (2) to recognize previously overlooked morphological features; and (3) to provide a new level of observational detail for the genital groundplans of Aculeata and Apocrita. Insights include the discovery of additional muscles in Trigonalyid genitalia, retention of the so-called “digiura” of the volsella, and reconstruction of structures interacting with the penites. Notably, the endophallic sclerite was observed, which is functionally significant yet has previously only been directly observed once. This work provides a foundation for expanded morphological work on the genitalia of a megadiverse insect order—the Hymenoptera.