33rd European Congress of Arachnology

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# Abstracts



**Please note:** The last name of the presenter is underlined!

# Oral contributions

## *Keynotes*

Keynote Speaker

# The evolution and environmental sensitivity of reproduction in Opiliones (i.e. why you should study harvester sex!)

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Opiliones have fascinating sex lives, from the evolution of intromittent sex organs and nuptial gifts, to alternative reproductive tactics and bizarre behavioral adaptations. This talk covers some of the major themes in Opiliones reproductive research, starting with the evolution and environmental sensitivity of alternative reproductive tactics, male polymorphisms, mating systems, and parental care in Brazilian species. The talk then dives into reproduction in North American harvesters in the leiobunum clade. Leiobunum harvesters show incredible morphological, physiological, and behavioral diversity—from weaponized penes and barricaded opercula to solicitous and aggressive behavior from both sexes and variation in the composition of nuptial gifts—reflecting multiple evolutionary transitions from cooperative-based mating to conflict-based mating. Mating behavior is also very sensitive to environmental variation, including temperature, water availability, and social experience. Incredibly, individual recognition may be an important determinant of the incidence of aggression and multiple mating during reproductive encounters. Overall, Opiliones comprise an incredibly variable clade well-suited to ask important questions about the evolution and environmental sensitivity of reproduction from a diversity of perspectives and research approaches.

Keynote Speaker

# Visual attention in jumping spiders

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Jumping spiders face a challenge: equipped with a brain little bigger than a sesame seed, they must integrate and interpret streams of visual information from their eight eyes and make appropriate behavioral decisions rapidly and accurately. Visual attention is the selective processing of this flow of information in real time. In this talk, I'll begin by describing experiments in which we tested spiders' ability to learn to attend to different visual cues in a variety of ecological conditions. I will describe in more detail how the moveable principal eyes and non-moving secondary eyes work together, illustrated with experiments using eye masking and a specially designed eyetracker that allows us to track the gaze direction of principal eyes as the spiders watch videos. I will discuss how cross-modal cues, such as sound and pheromones, influence visual attention. Finally, I will briefly discuss our current work using neural recording techniques to look more deeply into mechanisms of visual processing, as well as our exploration of other spider families to build a phylogenetic perspective of the evolution of distributed visual systems.

Keynote Speaker

# Ecology and conservation of European salt-marsh spiders

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Terrestrial arthropods in salt marshes are composed by different taxa with various trophic habits and life history traits which all have in common to cope with unusual stressors for them, i.e. regular submergence by seawater and associated high salinities. How dominant groups of arthropods like spiders withstand prolonged immersion and osmotic shocks, and consequently what would be the impact of sea-level rise on this compartment, remains little understood nowadays. In this talk we will review works that have been done to evaluate such avoidance and resistance strategies, using e.g. field survey (along land-sea transects of increasing soil salinities), field (especially with different frequencies of flooding) and laboratory experiments. Field samplings and experiments along gradients of soil salinity and flooding frequency revealed the existence of several distribution ranges along the marsh, including specialist -halophilic- taxa, suggesting species are differentially filtered by one, or both, of these factors, or other co-varying factor (e.g. food availability / quality). Experiments in laboratory suggest that salinity mostly drives species survival, and thereby species distribution within and between habitats. Studies on the impact of salinity under controlled conditions revealed very contrasted responses among arthropod taxa, with an important dichotomy between osmo-conformers (e.g. springtails) and facultative osmo-regulators (such as spiders), the latter displaying better survival at low salinity level. Laboratory experiments on flooding effects also revealed the existence of original behaviors displayed by terrestrial arthropods before or during submersion. In the last part, we will discuss which management practices are best suited to promote spider diversity and populations of specialist species in salt marshes.

Keynote Speaker

# Comparative functional morphology and biomechanics of scorpions

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The approximately 2.700 species of scorpions in the world are often categorized into ecomorphs, such as sand specialists, rock specialists, and burrowing species. We looked into the validity of scorpion ecomorphs, and compared the functioning and performance of the body parts that seem to vary most with ecology; the legs, pedipalps and to a lesser degree, the metasoma. We present the results of several comparative studies on each of these functional complexes. We show that the clinging performance of the claws varies between species and ecomorphs. We also show how the walking legs and metasoma interact in locomotion in defensive and ambulatory postures. After a brief discussion of the comparative functional morphology of the pedipalps, we discuss species differences in the performance of the metasoma during defensive strikes. Further, the comparative functional morphology and mechanics of the telson and the associated defensive behaviors are discussed, as well as a selection of our recent findings on scorpion venom. We conclude that despite their conserved body plan, scorpions have adapted the functional complexes of the pedipalps, legs and metasoma to allow for differences in performance to fit the ecological demands that may differ between species and ecomorphs. The data presented consist of both published and hitherto unpublished material.

# Oral contributions

## *Short talks*

Evolutionary Biology
*Short talk*

# Good things come in small packages: Exploring the potential of Low-coverage genome sequencing for evolutionary research in spiders

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High-throughput sequencing (HTS) has become the preferred source of data for phylogenomic and molecular evolution studies. Unlike Sanger sequencing, HTS allows the sequencing of millions of fragments simultaneously, dramatically increasing the amount of data obtained per run. The possibility of generating larger datasets in such a time and cost-efficient way is fostering the gaining of a more comprehensive insight into biological evolution at multiple levels.
Low-coverage whole genome sequencing (lcWGS) has emerged as a popular HTS approach for the generation of phylogenomic data from model and non-model organisms. It is a cheaper alternative to whole-genome sequencing, and requires less computing power and processing time. Moreover, unlike target-enrichment methodologies, lcWGS minimizes wet lab tasks replacing it by in-silico recovery of a vast array of loci, facilitating the combination of new and legacy data from different sources, such as Sanger sequencing and target enrichment.
Here, we present the results of using low coverage genomes, ranging from 1X to 10X sequencing depth, for assembling and annotating complete mitogenomes and recovering ultra-conserved elements (UCEs) and usual Sanger phylogenomic nuclear markers (18s, 28s, h3, h4 and its) from specimens belonging to the spider family Dysderidae and allies. With the recovered data, we aim to interrogate on the evolution of the red devil spiders both at the species level, through phylogenetic inference, and molecular level, through mitogenomic synteny analysis. We summarize the impact of sequencing coverage on the loci recovery success. Our results showcase the potential of lcWGS as a cost-effective approach for evolutionary research.

Faunistics & Biodiversity
*Short talk*

# Community structure of spiders in the Indian Thar desert

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The knowledge about the species of a habitat (both resident and transient/ dominant and rare) is a vital step to plan the conservation measures. The aim of this study was to assess the dominance structure and constancy of spiders in three different habitats (Sand dunes, Riparian and Rocky) of the Thar desert. For this spiders of each habitat were classified into five classes (Eudominants, Dominants, Subdominants, Recedents and Subrecedents) based on percentage of dominance and three classes (Constant, Accessory and Accidental) based on constancy of occurrence. The eudominant species in sand dunes and rocky desert belonged to the family Thomisidae. These species were *Tmarus* sp. 1 and *Tmarus kotigeharus* respectively. There were two eudominants in Riparian habitat (*Oecobius putus* and *Menemerus bivittatus*). Through the analysis of constancy of all the species in the Thar desert, it was revealed that three species were constant in all the three habitats. The number of accessory and accidental species were far higher than constant species in all the habitats which indicates the presence of unstable population of spiders.

Metabarcoding
*Short talk*

# Ground and above-ground spiders' predatory choices: their biocontrol potential in Mediterranean vineyards and olive orchards

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Spiders are common generalist predators in agroecosystems that usually prey on various prey, even pests. Due to their varied hunting strategies and behavioural traits, they can also have specific trophic niche dimensions. Therefore, their role in the biocontrol of pest species remains ambiguous. Here we studied the natural diet of ground and above ground spiders present in Mediterranean vineyards and olive orchards in southern Croatia. We collected 200 spider specimens from five families of ground-dwelling (Lycosidae, Gnaphosidae), leaf-dwelling (Thomisidae, Oxyopidae), and web-building spiders (Araneidae). We investigated their natural diet utilizing molecular metabarcoding and taxonomic assignment of the gut content. The preliminary results show that spiders have a diverse diet and that the diet differentiates between predator taxa, sampling period and different agroecosystems. For example, spiders collected in olive orchards preyed on Bacterocera oleae (Diptera: Tephritidae), a common pest in olive orchards. Gut content metabarcoding is a suitable method for studying trophic interactions of spiders in Mediterranean agroecosystems, but more research is needed to understand such complex trophic networks fully.

Latrodectus Symposium
*Short talk*

# Control, context, and choosiness: Flipping the lens to see female plasticity in Latrodectus species

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Adaptive developmental plasticity (ADP) may evolve when the traits that confer reproductive success vary with context, with adult context indicated by cues available during development. ADP cues trigger developmental changes, resulting in phenotypes matched to the challenges experienced as adults. The form of sexual selection on male widow spiders (genus *Latrodectus*) shifts in nature along with variation in demography (social context). Cues of this shift trigger ADP; changing male development, adult physiology, and morphology. Here, we examine whether ADP affects longer-lived *Latrodectus* females, and focus on how shifting social context may affect optimal levels of choosiness (~the likelihood of expressing a mate preference). We exposed developing females to cues of future mate availability by simulating natural opportunities for assessment of social context in *Latrodectus hesperus* (western black widows) and *Latrodectus hasselti* (redbacks). Females exposed to cues of high (compared to low) mate availability as juveniles showed increased expression of mechanisms of choosiness in their first mating as adults. This included shifts in mating plug placement, in premature cannibalism, and in copulation frequency, all of which increase female control over post-copulatory sexual selection. Plasticity in female preferences for male traits is known to be affected by juvenile social experience in other species, but there has been much less focus on variation in choosiness. This work thus extends our understanding of factors shaping female choice, illustrates the complex ways in which ADP can link demography to sexual selection, and supports the development of Latrodectus as a model clade for studies of plasticity.

Systematics & Biogeography
*Short talk*

# *Lycosa piochardi* Simon, 1876 - Population structure in a variable species

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The large wolf spider *Lycosa piochardi* Simon, 1876 is found throughout the Middle East, and is adapted to various biomes and climatic conditions. High variability in genital and somatic characters is recorded within and between populations. We hypothesized that some of this phenotypic variability may be explained by a reduced gene flow between populations found in desert habitats and populations found in Mediterranean habitats. An alternative hypothesis is that the gene flow is unhindered by the climatic gradient, which may explain the high local phenotypic variability, while the differences between populations would be the result of current selection pressures and phenotypic plasticity. To test our hypotheses, we sequenced 90 *L. piochardi* specimens, collected from throughout the climatic gradient of Israel, using restriction site-associated DNA sequencing (RAD-seq). In this talk I will discuss the different hypotheses in light of our preliminary results.

Systematics & Biogeography
*Short talk*

# Of liars and gluttons, explaining asymmetries in species richness across the red devil spiders (Araneae, Dysderidae)

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The remarkably variability in species richness across the Tree of Life has fascinated biologist for long, yet identifying the factors underlying these asymmetries has been challenging. We propose to gain insights into the processes and underlying factors responsible for the heterogenous distribution of species richness by focusing on the spider family Dysderidae. The family is ideally suited for investigating macroevolutionary dynamics. This six-eyed family of nocturnal ground hunters is of moderate (570 spp), yet unevenly distributed diversity. Two (*Dysdera* and *Harpactea*) out of the 24 genera, make up 80% of the family species diversity, while half of the genera include three or less species. Here, we present the results of a target, multi-locus phylogenetic analysis, using mitochondrial (COI, 16S and 12S) and nuclear genes (H3, 28S and 18S), of an exhaustive taxonomic sample within Dysderidae and across related families (Synspermiata). We further estimate divergence times using a combination of fossil and biogeographic node calibrations to test shifts in diversification rates. Our results reveal the polyphyly of the genus *Harpactea*, suggesting that its high species richness is partially an artifact. The origin of the family most likely post-dated the break-up of Pangea, and the highly dynamic tectonic and climatic history of the region played a key role in its diversification. We identify a significant increase in net diversification associated with the origin of cheliceral modifications in the *Dysdera* lineage, which may hint at the importance of recurrent transitions in the level of trophic specialization in accelerating species diversification

Faunistics & Biodiversity
*Short talk*

# Assembly processes in spider communities from the Swedish Malaise Trap Project

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The Swedish Malaise Trap Project (SMTP) was a nationwide biodiversity inventory study conducted between 2003 and 2006. A total of 74 malaise traps were established in 54 locations that are considered high conservation value sites. Malaise traps are tent-like structures that are primarily used to sample flying insects, but also catch considerable numbers of other arthropods. Spiders are important predators in most terrestrial ecosystems and are good indicators of local habitat conditions. The traps yielded a surprisingly high number of spiders, 33.381 individuals from 27 families, 184 genera and 367 species. Our samples comprise almost half the number of recorded species in Sweden and a higher number of web-building and foliage-living species compared to pitfall trap samples.
Linyphiidae made up the largest part of the sampled individuals and their dominance increased with higher latitudes. Latitude and associated predictor variables were generally important predictors of the species composition in local spider communities. With this dataset we show how both, dispersal limitation and environmental filtering contribute to the distribution of spiders in Sweden based on local habitat properties, climatic conditions and traits of spider species, such as body size, phenological type or hunting guild. Together with the addition of the data to the Swedish biodiversity portal (SLU Artdatabanken), our results contribute to a much improved understanding of spider biodiversity in Sweden and assembly of spider communities in general.

Behavior
*Short talk*

# Deflective patterns through the eyes of a jumping spider

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Patterns and structures resembling a head but located on the opposite end of the body are assumed to be antipredator adaptation aimed at deflecting initial predatory strikes to the regions which are expendable or highly defended. Such patterns, often referred to as 'false heads', seem to increase the probability of prey survival after being noticed by the predator. Deflective patterns have been reported in vertebrates, but they are the most common and diverse in small arthropods, which suggests that the major receivers of these signals are small visual predators, such as other arthropods. To test how these patterns affect predatory decisions of a small visual predator I presented manipulated images of virtual prey to jumping spiders. I tested how the presence of deflective patterns, the complexity of these patterns and prey motion affect approach and strike of *Yllenus arenarius* (Araneae, Salticidae). In the study I used naïve spiderlings, which enabled to test the role of preprogrammed mechanisms in head pattern identification. The spider response to the images presented on a miniature screen was recorded and analyzed. The results demonstrate that in stationary prey even very simple deflective patterns can efficiently redirect predatory strikes. The study also provides the evidence that the complexity of deflective patterns increases the probability of redirecting predatory strikes in moving prey, which underlines the effectiveness of 'false heads' as antipredator adaptation not only in stationary, but also in moving prey.

Systematics & Biogeography
*Short talk*

# Different ecomorphs affect the species response to ecological release in red devil spiders (Araneae: Dysderidae) on islands

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Ecological release is defined as the expansion of range, habitat and/or resource usage by an organism following colonisation of a new region. This phenomenon is ubiquitous in oceanic islands, where colonising species whose ancestors evolved in highly competitive environments experiment relaxed selection because of reduced species richness. In addition, factors other than competition levels may also be involved in the species' ability to expand their niche. Ecological specialization, for instance, has been frequently considered as an evolutionary dead end, preventing the reversal to a more generalist state.

To evaluate the impact of ecological release, here we integrate geometric morphometric methods, stable isotope analyses and species distribution models. Specifically, we investigate the implications of different cheliceral morphotypes on ecological release, in three *Dysdera* species in the Canary Islands that colonized younger depauperate islands from older and species-rich sources. These morphotypes, which evolved convergently multiple times during the diversification of the group, are associated with different levels of trophic specialization.

Our results revealed a strong influence of cheliceral types on predicting the magnitude and direction of the ecological release in the three species when colonizing low competitive islands. Contrary to our expectations, species with morphotypes associated to a more specialist diet, tended to expand the trophic niche, increased their spatial range and changed their phenotype, when compared to generalist species. Our study constitutes one of the first examples of the use of a multidisciplinary approach to better understand the effects of ecological release on colonizing species with contrasting trophic preferences.

Behavior
*Short talk*

# Personality predicts mode of attack in a generalist ground spider predator

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Personality traits, such as boldness and/or aggressiveness, have long been accepted to have a profound influence on many aspects of the lives of animals, including foraging. However, little is known about how personality traits shape the use of a particular attack strategy. Ground spiders use either venom or silk attack to immobilise prey. In this study, we tested the hypothesis that behavioural differences among individuals (measured as boldness and aggressiveness) drive the use of a particular attack strategy. We used a generalist ground spider, *Drassodes lapidosus*, and recorded the mode of attack on two types of prey, dangerous and safe. Moreover, we measured the size of the venom gland to test the effect of venom volume on the personality and the mode of attack. *Drassodes* individuals showed consistent behavioural differences in the way they attacked prey. Venom attack was significantly related to increased aggressiveness when attacking dangerous prey and to increased boldness when attacking safe prey. Silk attack was significantly related to shyness/docile traits. The volume of venom was not related to the attack strategy. We conclude that personality traits are important drivers of prey capture behaviour in generalist ground spiders.

Ecology
*Short talk*

# Scale-dependent drivers of the prey composition in spiders

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Spiders are dominant predators in terrestrial ecosystems with known effects on prey populations and associated ecosystem functions. Yet, our understanding of how drivers that act at different spatial scales affect the prey composition of spider species is rather limited. Based on empirical studies and a literature database, we summarize how drivers along spatial scales (from species traits to climate) affect the composition of spider prey. Microhabitat conditions and traits both affect the composition of prey, a result that holds potential for the future development of management strategies that focus on biological control services. The prey composition of spider communities differs fundamentally between major land-use types. Land-use conversion will not only affect spider and prey communities directly, but also alters the prey composition independent of local changes in prey availability. At the largest spatial scales, both, climatic conditions and landscape composition affect the composition of arthropod communities, but have comparatively weak effects compared to the other drivers. This result further suggests that the composition of prey is at least partially independent of local availabiliy of potential prey. This conclusion is also supported by empirical studies that recorded significant differences between the composition of potential prey communities in different land-use types, without significant effects on the actual prey composition. It is essential to address knowledge gaps considering direct and indirect effects of different drivers on the prey composition in spider communities to predict future consequences of global change on the functional role of these important predators in natural and managed ecosystems.

Ecology
*Short talk*

# Parasitation rate of web-building spiders by hymenopteran parasitoids depends on elevation, habitat, and spider traits

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The effects of elevational gradient on species diversity are a frequently addressed theme in ecology but its effect on the intensity of biotic interactions remains poorly known. We studied the change in parasitation rate of web-building spider hosts by hymenopteran parasitoids from the *Polysphincta* genus group (Ichneumonidae) in forest ecotones along the elevation gradient from 150 m a.s.l. to 1420 m a.s.l. in Central Europe. Except for elevation we also tested the impact of habitat type and traits of spider hosts (web type, ontogeny, and sex). We inspected 24.685 web-building spiders for the presence of parasitoid larvae. We found that the overall mean parasitism rate was relatively low (4%) but the differences among localities were considerable. The parasitisation rate showed a hump-shaped relationship with elevation. The habitat type influenced the parasitism rate and the highest non-forest riparian vegetation while the lowest parasitisation rate was in agroecosystems. differed significantly among web types and the orb-web spiders had the highest parasitisation rate, followed by space-web, and sheet-web building spiders. The hump-shaped relationship between elevation and parasitisation rate and the habitat-specific parasitisation rate follow the often-observed patterns in spider diversity. The higher spider diversity might enable resource partitioning among parasitoid wasps and more efficient resource use. The differences among web-types suggest that web-type acts not only as a capture device but also as a defence.

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Latrodectus Symposium
*Short talk*

# ‘Wreck of the hesperus’: Cryptic species discovered within the Western black widow spider (*Latrodectus hesperus*) using mitochondrial and nuclear DNA

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The neurotoxic *Latrodectus* spiders are distributed world-wide with some species found in relatively restricted geographic locations, and others apparently widespread across broad regions. Widow spiders are medically important with some species known to inhabit human structures and urban landscapes. Here we examine molecular variation in *Latrodectus hesperus*, the ‘western black widow,’ reported to range from British Columbia in Canada, and south to Mexico, from the western U.S coast and east to Nebraska, Kansas, and Oklahoma. We used a multi-gene approach to characterize genetic variation among samples collected from 40 locations spanning the geographic range of the species. We uncovered substantial genetic variation, with phylogenetic structure indicating the presence of three distinct lineages. Analysis using Species delimitation methods, including Automatic Barcode Gap Discovery (ABGD), Bayesian Poisson Tree Processes (bPTP), and the Geneious species delimitation plugins [P ID (Liberal), P(RD) and P(AB)] support the hypothesis that *L. hesperus* comprises three independent species. Conservatively, these well supported clades can be categorized geographically as 1) lower elevation, temperate, Coastal British Columbia, 2) higher elevation, arid Rocky Mountain (from inland B.C.) to the Neotropics, and 3) lower elevation, temperate California through the higher elevation, arid, Southwestern USA and Mexico. There is some geographic overlap in the latter two distributions, possibly due to human-mediated transport. The division of *L. hesperus* into multiple species has important implications for both ecological and evolutionary interpretations.

Evolutionary Biology
*Short talk*

# Monogyny and introgression in New Zealand fishing spiders (*Dolomedes*)

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Monogyny is the mating system whereby males will only mate with one female in their lifetime. This is seemingly contradictory to classical sexual selection theory, which predicts that males should mate with as many females as possible. Despite this, monogyny is widespread throughout the animal kingdom. Spiders are often used as a study group for the evolution of monogyny. In spiders, monogyny is associated with sexual cannibalism, genital damage, male-biased sex ratios, protandry and female-biased sexual size dimorphism. The exact causal relationship of these factors is unclear. Related to mating behaviour is introgression, the movement of genes from one species to another. This is often described using only phylogenetic methods, with little focus given to the morphology and behaviour that drives and maintains it, even though it is likely to be affected by mating systems.
My research addresses two major gaps in our understanding of monogyny evolution and introgression, by 1) comparing the mating systems and mating system elements of closely related spider species, and 2) investigating how mating systems can both facilitate and limit introgression. *Dolomedes* (fishing spiders) is a genus of Pisauridae represented by four species in New Zealand, including two sister species: *D. aquaticus* and *D. minor*. Whilst study on these species has been limited, evidence suggests that *D. aquaticus* is monogynous and *D. minor* is polygynous (males will mate with multiple females). Additionally, there is a one-way introgression between the two species, which is also geographically restricted.

Ecology
*Short talk*

# Early detection of an invasive harvestman in an oceanic island? Remarkable findings of *Parabalta reedii* (Opiliones, Gonyleptidae) in the Juan Fernández archipelago, Chile

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The Juan Fernández islands (Chile) are a volcanic archipelago, 670 km away from the continent. Arachnids still remain understudied in those islands. We report the first two records of *Parabalta reedii* (Butler, 1874)) (Opiliones, Gonyleptidae) from the Robinson Crusoe Island. One specimen was collected near San Juan Bautista town (in 2011), while a population was documented in 2020, in secondary forests also around town. Since other arachnological expeditions did not report the presence of this species, it is suggested that these findings might correspond to an incipient introduction, possibly associated with imported goods from the continent. Otherwise, it would be hard to explain why such a conspicuous harvestman has not been noticed before. An accurate assessment of the native or introduced nature of these populations will require further mainland and island surveys, as well as molecular studies. We aim to call the attention to a possible new invasive species in the Juan Fernández archipelago. Oceanic islands have a strong conservation value because of their high levels of endemicity and vulnerability to biological invasions. This finding could be considered as a warning call for other potential arthropod introductions.

Behavior
*Short talk*

# Antero-lateral eyes input reverses the response to biological motion in a jumping spider

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During their evolutionary history, spiders have developed a modular visual system. Splitting tasks across eyes – and consequently brain areas – decreases the overall computational load. Previously believed to be specialized in motion detection, jumping spiders' secondary eyes have recently been found capable of motion discrimination, triggering further inspection with the principal eyes for patterns of Brownian motion, more than for patterns of Biological motion. What remains unclear, is which of the three pairs of secondary eyes is responsible for such discrimination. To find out, we subjected 180 spiders to 3 tdifferent reatments. In the ALE treatment, we covered all the eyes of the spider but the antero-lateral using white, water-based paint. In the PLE treatment, we covered all the eyes but the postero-lateral. In the Control treatment, only the principal eyes were covered. The spiders were then placed on a spherical treadmill setup, in front of a monitor. Here, we presented pairs of moving stimuli – one depicting Brownian motion, while the other depicting Biological motion – translating synchronously. The spider pivoting toward one of the two stimuli was considered a choice and thus recorded. We found that ALE spiders preferentially turned towards biologically moving stimuli, Control spiders had a slight preference for Brownian motion, while PLE spiders showed no preference. The preference reversal with ALEs in respect to the previous observations poses new questions about the origin of this preference, suggesting an interaction between low-level detection performed by one eye pair and refined analysis performed by others.

Metabarcoding
*Short talk*

# For all audiences: Incorporating immature stages into standardised spider inventories has a major impact on the assessment of biodiversity patterns

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Because of their challenging taxonomy, arthropods are traditionally misrepresented in biological inventories and monitoring programs. However, arthropods are the largest component of biodiversity, and no assessment can be considered informative without including them. Arthropod immature stages are often discarded during sorting, despite frequently representing more than half of the collected individuals. To date, little effort has been devoted to characterising the impact of discarding non-adult specimens on our diversity estimates.

Here, we use a metabarcoding approach to analyse spiders from white oak communities in the Iberian Peninsula collected with standardised protocols, to assess (1) the contribution of juvenile stages to local diversity estimates, and (2) their effect on the diversity patterns inferred across communities. We further investigate the ability of metabarcoding to inform on abundance. We obtained 363 and 331 species as adults and juveniles, respectively. Species represented only by juveniles contributed an average of 35% additional species to those identified from adults. Differences in composition between communities were greatly reduced when immature stages were taken into account, especially across latitudes. Moreover, our results revealed that metabarcoding data are to a certain extent quantitative, but some sort of taxonomic conversion factor may be necessary to provide accurate informative estimates.

Although our findings do not question the relevance of the information provided by adult-based inventories, they also reveal that juveniles provide a novel and relevant layer of knowledge that, especially in areas with marked seasonality, may influence our interpretations, providing more accurate information from standardised biological inventories.

Systematics & Biogeography
*Short talk*

# Seeing with new eyes - A peculiar new Araneoid from the Ecuadorian Amazon region

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Vision is a characteristic morphological trait in animals that evolved from an eye spot to a camera-style eye in only half a million years (Nilsson & Pelger 1994). Vision occurs only in 20% of the phyla found on the planet, from which three, Mollusca, Arthropoda, and Chordata account for 96% of the species (Land 1992). Within Arthropods, Arachnids have the most diverse group of camera-type eyes, and spiders present impressive variation in eye numbers, position, and function, relating to their predatory life (Morehouse 2017). The external placement and internal arrangement of eyes determine the field of view of each eye (Land 1985). Forward-facing binocular vision is a result of overlapping visual fields and is imperative for good distance judgment (Chrisopher et al. 2010). Herein we introduce a new Araneoid species with a unique eye pattern never observed before. This new Araneoid principal eyes (AME), as well as the secondary eyes (PME), are positioned laterally on the carapace with no direct forward-facing eyes. In addition, this new species lost the flagelliform spigots present on the posterior median spinnerets of most Araneoids, consequently the ability to produce a functional orb-web. We hypothesized that this new Araneoid unique characteristics constitute a shift in typical Araneoid web-building predatory behaviour, to a free-living, sit-and-wait predator. Further data is needed to fully understand the lifestyle and, the phylogenetic placement of this spider in the tree of life, nevertheless this novel species presents a unique “new look” into the spider family picture.

Systematics & Biogeography
*Short talk*

# *Comaroma* is not an anapid spider (Arachnida, Araneae, Araneoidea)

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*Comaroma* Bertkau, 1889 is small genus (six species) of minute six-eyed cryptozoic araneoids with relict disjunct distribution (Europe, temperate Far East and California). Its familial placement remained controversial for a long time; at present, since the article "*Comaroma* is an anapid spider" by Kropf (1990), it is on the list of Anapidae.
However, this attribution seems to be a "choice the lesser of two evils". *Comaroma* turned out to be the stumbling-block in the large-scale phylogeny of Symphytognathoidea provided by Lopardo & Hormiga (2015): to treat this genus as a member of the family Anapidae, they had to permit eight reversions (!) and seven cases of independent parallel evolving of characters in their cladogram.
*Comaroma* lacks both of the two unique synapomorphies of Anapidae, i.e. the cheliceral gland-mound fused with the proximal tooth and the pore-bearing depression at the edge of the carapace. It also lacks some of the synapomorphies of Symphytognathoidea, e.g. a row of ciliate setae on the cheliceral retromargin. This genus retains such features as the male epiandrous spigots and the retrolateral paracymbium, lost in all the other anapids, and retains the haplogyne female genitalia without fertilization ducts, a feature unique for symphytognathoids. At the same time, *Comaroma* has numerous generic autapomorphies, e.g. the tear-shaped aperture of tarsal organ and a row of pore-bearing tubercles on tibia I.
Therefore, we support recognizing the separate family Comaromidae Wunderlich, 2004 to include this genus; comaromids seem to be a sister-group of all the other symphytognathoids.

Faunistics & Biodiversity
*Short talk*

# The Fauna Portal Australia - a web-based diagnostic platform documenting undescribed species

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The large majority, approximately 70–80% of Australia's invertebrate fauna, is undescribed. For example, some 4.000 Australian spider species are currently named and species estimates have place the true diversity of this order in Australia between 8.500 and 20.000 species. Over the last five years (2017–2021), an average of 56 species were named each year. Assuming a similar speed of discovery, it would take 90–276 years (depending on the species estimate) to describe the remaining Australian araneofauna (questionable with little recruitment in the taxonomic workforce in Australia). Meanwhile, it is virtually impossible to use spiders in environmental studies or assess their distribution patterns, particularly of rare species of conservation significance.
The Fauna Portal Australia (www.faunaportal.org) aims to provide a stopgap for the documentation and identification of Australia's undocumented invertebrate fauna. It is based on a taxonomically stable nomenclatural system derived from proven zoological principals (reference specimen in public institutions and diagnosis) supported by an underlying database that provides genus- and species-level nomenclatural codes. Diagnostic images for each species allow for an identification of each species and these images are accessible via filters for projects, morphology, sex and/or developmental stage and distribution (either by state or a region selected via map). Documentation of a new species is fast due to the simple backend design of the website. A user-restricted sections allows developing projects hidden to the public. We believe, the Fauna Portal has the potential to speed up species discovery, documentation and identification in Australia and support environmental and taxonomic research.

Metabarcoding
*Short talk*

# The winter activity and natural diet of winter-active spiders on pear trees

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Modern agricultural pest management systems, such as integrated pest management systems (IPMs), rely on naturally occurring generalist predators, such as spiders, to suppress pests. Still, little research has been done to assess their overall effectiveness, especially over the winter period when their potential is high. In this study, we focused on three genera of winter active spiders Clubiona, *Philodromus* and *Anyphaena*, common predators on pear trees during winter. We investigated their natural diet and compared it between two management types, IPM and organic. We performed a molecular gut content analysis to identify the prey. The prey composition during winter was not affected by management type and was dominated by pest prey. However, in early spring, spiders in IPM orchards preyed more frequently on indifferent prey (mostly dipterans), while the spiders from organic orchards preyed mostly on pests. *Anyphaena* had the highest predation frequency on non-intraguild prey of all three spider genera while the other two genera preyed at a rate of two to three times lower. Although more information is needed to quantify direct and indirect interactions in complex arthropod food webs in pear orchards, the results obtained from this research provide another evidence that these winter active spiders, especially *Anyphaena*, are important in pest control over winter.

Phylogeny Symposium
*Short talk*

# The fossil record of chelicerates and their phylogeny

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The arachnids and their relatives have a rich fossil record spanning 500 million years. These fossils provide unique insights into the evolution of the Chelicerata: they inform dates of divergence, demonstrate character acquisition through the evolution of the group, and include extinct orders that could not be predicted from extant chelicerate diversity. Phylogeny is a key element to understanding the evolution of this branch of the arthropods. Parts of the chelicerate and arachnid tree of life remain contentious, however. This talk will explore the chelicerate and arachnid fossil record in this context. We will: provide an overview of the history of major chelicerate clades in deep time, and the impact that this has on our understanding of the group's phylogeny; highlight the implications for major innovations, radiations, and timings in chelicerate evolution; and explore potential frameworks for terrestrialisation in the group. The talk will also summarise the benefits and drawbacks of including fossils in phylogenies, and explore potential reasons why resolving ordinal relationships within the arachnids is challenging given the origins and nature of the group.

Systematics & Biogeography
*Short talk*

# Speciation and eye evolution in two parthenogenetic species of *Sarax* (Amblypygi) from the Levant

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Whip spiders can be found in tropical and sub-tropical regions, where they inhabit shaded humid environments. This habitat preference makes them pre-adapted to life in subterranean conditions, where in turn, additional adaptations occur and may lead to speciation. Two whip spider species are known from Israel: *Sarax ioanniticus*, a widely distributed parthenogenetic species found across the eastern Mediterranean, and *S. israelensis*, a troglomorphic species that is endemic to caves in Israel. The two sympatric species have superficial morphological similarities, with few diagnostic characters, and can be found in proximity within man-made caves. In recent years, we utilized morphological and molecular tools to investigate the relatedness of these species, their mode of speciation, eye development mechanisms, as well as their population genomics. We found that *S. israelensis* is genetically distinct from *S. ioanniticus*, even when inhabiting the same chamber of a cave. Within each species, we found almost no genetic variability, a result of their parthenogenetic life history. These genetic invariances hamper our ability to determine the biogeographic history of *S. israelensis*. Although these species are genetically invariant, we found considerable within-population variation in the degree of eye reduction, particularly in the troglomorphic species S. israelensis. We identified several RDGN genes that are involved in the formation and reduction of eyes in these species. Our results suggests that variation in eye morphology in *S. israelensis* is driven by epigenetic mechanisms. These findings are significant to the recognition and delimitation of cave-adapted species and have consequences for assessments of conservation priorities.

Faunistics & Biodiversity
*Short talk*

# *Atypus karschi* Dönitz, 1887 (Araneae: Atypidae): an Asian purse-web spider established in Pennsylvania, USA

Milan Řezáč; Steven Tessler; Petr Heneberg; Ivalú Macarena Ávila Herrera; Nela Gloríková[1]; Martin Forman; Veronika Řezáčová; Jiří Král

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The genus *Atypus* Latreille, 1804 occurs in Eurasia and northern Africa, with a single enigmatic species, *Atypus snetsingeri* Sarno, 1973, known only from a small area in southeastern Pennsylvania in eastern USA. A close relationship to European species could be assumed based on geographic proximity, but *A. snetsingeri* more closely resembled Asian species. This study was undertaken to learn more about the genetics of *A. snetsingeri*, its habitat requirements and natural history. Molecular markers (CO1 sequences) were compared to available data for other atypids and showed that *A. snetsingeri* is identical with *A. karschi* Dönitz, 1887 native to East Asia. Natural history parameters in Pennsylvania were also similar in every respect to *A. karschi* in Japan, therefore, we propose that the spider is an introduced species and the specific epithet *snetsingeri* is relegated to a junior synonym of *A. karschi*. Cytogenetic analysis showed an X0 sex chromosome system (42 chromosomes in females, 41 in males) and we also detected nucleolus organizing regions and heterochromatin, the latter for the first time in the Atypoidea. In Pennsylvania the spider is found in a variety of habitats, from forests to suburban shrubbery, where the above-ground webs are usually attached vertically to trees, shrubs, or walls, although other webs are oriented horizontally near the ground. Prey include millipedes, snails, woodlice, carabid beetles and earthworms. Atypus karschi is the first known case of an introduced purse-web spider. It is rarely noticed but well-established within its range in southeastern Pennsylvania.

Latrodectus Symposium
*Short talk*

# Body size, not personality, explains both male mating success and sexual cannibalism in a widow spider

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Theory suggests that consistent individual variation in behavior relates to fitness, but few studies have empirically examined the role of personalities in mate choice, male-male competition and reproductive success. We observed the Mediterranean black widow, *Latrodectus tredecimguttatus*, in the individual and mating context, to test how body size measures and two functionally important aggressive behaviors, i.e., male aggression towards rivals and female voracity towards prey, affect mating behaviors, mating success and sexual cannibalism. We specifically selected voracity towards prey in females to test the "aggressive spillover hypothesis", suggesting that more voracious females are more sexually cannibalistic. Both females and males exhibit consistent individual differences in the examined aggressive behaviors. While larger males win contests more often and achieve more copulations, neither male nor female size measures correlate to aggression. Female voracity does not correlate with aggression towards mates and sexual cannibalism, rejecting the "spillover hypothesis". However, occurance of sexual cannibalism positively relates to longer insertion duration. Furthermore, the smaller the ratio between male and female body lengths the more likely a female attacked and cannibalized a mate. We show that individual variation in aggression levels plays no direct role in the mating behavio of the Mediterranean black widow. Instead, body size affects male mating success and occurences of sexual cannibalism in females.

Metabarcoding
*Short talk*

# Greenland glacier foreland research: Combining DNA gut content analysis with SEM and GLMM shows bottom-up and top-down mechanisms

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Arthropod food webs were explored at a glacier foreland area in West Greenland and the data set was analyzed by SEM and GLMM to detect bottom-up and top-down food web control mechanisms. The SEM analyses were supported by DNA metabarcoding.
We observed a shift from bottom-up to top-down cascades between arthropod predators and their potential prey animal populations mainly driven by increasing temperatures away from the glacier. In the early stage of the vegetation succession, bottom-up mechanisms were found while in the later stage of succession, top-down mechanisms prevail.
SEM revealed that bottom-up mechanisms were important for the linyphiid spider and harvestman populations while top-down mechanisms were important for the ground beetle populations. These mechanisms may be closely related to hunting strategies of the predators as a bottom-up mechanism may be connected to sit-and-wait behaviour while top-down mechanisms may be related to active-search behaviour.
Instances of intraguild predation (IGP) were common among all arthropod predators. Particularly in the guts of the linyphiid spider, *Collinsia holmgreni*, many trophic linkages to other linyphiid and lycosid spiders were detected. The IGP-ratio of C. holmgreni was negatively correlated with the activity-density of available prey animals.
The consequence of increasing temperatures is a complete extinction of the cold adapted linyphiid species like *C. holmgreni* which is not found in the warmer climax vegetation where lycosid spiders dominate.
Increasing predator:prey ratios in relation to increasing vegetation density were found for the spider and harvestmen predators as IGP and cannibalism may be dampen by increasing vegetation complexity.

Faunistics & Biodiversity
*Short talk*

# BIO-GEEC: The German-Ecuadorian Biodiversity Consortium. A new era of biodiversity (and spider) research?

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Ecuador is one of the most biodiverse countries in the world and of considerable interest for evolutionary biologists, including arachnologists. The challenges of documenting and preserving this biodiversity are great and the ongoing changes in the political landscape (e.g. NAGOYA protocol and ABS) impose further challenges for biodiversity researchers, but also offer new chances. Three years ago, the BIO-GEEC consortium was established between four German and four partnering Ecuadorian research institutions, aiming to develop a pipeline for rapid biodiversity documentation through automatized barcoding workflows, development of a web app, common research and teaching activities, and establishment of software and physical hardware. As part of the project the arachnid fauna was also targeted across habitat gradients reaching from the lowland Amazonas rainforest to high altitude paramo habitats. The results of these collections, altogether 2.500 spiders and 2.000 DNA barcodes that were targeted in several field trips, showcase an immense diversity of mostly undescribed species which we present here in parts. Exciting discoveries include cave-dwelling funnel-web tarantulas (Dipluridae) and new species of recluse spiders (*Loxosceles*). Spiders aside, the BIO-GEEC Project is arguably the prototype of how integrative biodiversity projects could be led in the future considering the increasingly complex political and legislative landscape. We share our experiences in managing such a trans-national project that involves several institutions and ministries, scientists from various research fields (molecular biology, bioinformatics, zoology, botany and soil sciences), discuss challenges and successes, the fair management of resources, and the implementation of common research and teaching activities.

Evolutionary Biology
*Short talk*

# A masculinizing supergene underlies the male dimorphism of *Oedothorax gibbosus*

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In many species, individuals can develop into strikingly different morphs, which are determined by a simple Mendelian locus. How selection shapes loci that control such complex phenotypic differences remains poorly understood. In the dwarf spider spider *Oedothorax gibbosus*, males develop either into a 'hunched' morph with conspicuous head structures or as a fast-developing 'flat' morph with a female-like appearance. We show that the hunched-determining allele contains a unique genomic fragment of approximately 3 megabases that is absent in the flat-determining allele. This fragment comprises dozens of genes that duplicated from genes found at the same as well as different chromosomes. All functional duplicates, including a duplicate of the key sexual differentiation regulatory gene doublesex, show male-specific expression, which illustrates their integrated role as a masculinizing supergene. Our findings demonstrate how extensive indel polymorphisms and duplications of regulatory genes may contribute to the evolution of complex Mendelian traits, sex-limited reproductive morphs and the enigmatic evolution of the exaggerated sexual traits of dwarf spiders and animals in general.

Faunistics & Biodiversity
*Short talk*

# Biodiversity patterns of pseudoscorpions in the Dinaric Karst

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Dinaric Karst of the Western Balkan Peninsula is one of the major biodiversity hotspots, containing a plethora of endemic taxa and cryptic species, including an exceptional subterranean fauna. Pseudoscorpions are one of the most diverse arachnid lineages in Croatia with 146 described species. Among these, the genera *Neobisium* and *Chthonius* are especially diverse and many species have been described from the Dinaric Karst in the last 30 years. However, the present state of taxonomy is highly problematic because type specimens are either lost or deposited in private collections, and many type localities are vague, thereby slowing down, or even completely preventing, taxonomic revisions. We morphologically examined 2.208 specimens collected from 172 localities in the Dinaric Karst and generated molecular data from two genes: mitochondrial COI for 502 specimens, and nuclear 28S for 96 divergent haplotypes within the families Chthoniidae and Neobisiidae to reveal patterns of genetic diversity; construct the first evolutionary trees of Croatian pseudoscorpions; and test the monophyly of species and genera from the Dinaric Karst. Several species delimitation methods were used to examine concordance between sequence clustering and traditional taxonomy. Preliminary data indicate a high level of intraspecific variability and the presence of several cryptic and/or undescribed species and at least one undescribed genus. Our study forms the baseline for in-depth taxonomic studies that focus on biogeography and evolutionary patterning for taxa from the Dinaric Karst. Furthermore, we identified hotspots of subterranean biodiversity at the genetic level, which facilitates the protection of endemic species and their subterranean habitats.

Ecology
*Short talk*

# Fantastic silks and where to find them: A correlation of habitat variables and spider silk properties

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For more than 350 million years, silk has played a central role in the survival of spiders, thus evolving into a variable and outstanding biological material. Mechanically well performing silks are known especially from spiders with orb webs, as structures that reach exceptionally high toughness are needed to withstand the impact of flying prey. Silk mechanical properties, however, do not only differ among prey capture ecologies, but show notable interspecies and intraindividual variability within the orb weaver guild. To date, little is known about the ecological drivers of this variability. In the presented work we investigated the correlation of macro habitat (rain intensity, aridity and altitude) and microhabitat variables (placement of spider web, surrounding vegetation), as well as spider size, with tensile properties, both between, and within species. To that end, 50 orb weaving spider species and their silks were collected in vastly different habitats in Valle del Cauca, Colombia. Silks properties were investigated by tensile testing and analysed using linear and mixed linear models, Akaike information criteria and phylogenetic independent contrasts.

Faunistics & Biodiversity
*Short talk*

# Dangerous arachnids in war: how to better protect soldiers of the Austrian Armed Forces in Africa from scorpions, spiders and ticks!

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The Austrian Armed Forces (Military Geo Spatial Institute, MGSI) initiated a collaboration with the Natural History Museum Vienna (NHMW) in 2012 to obtain detailed information about potentially dangerous animals (e.g. big cats) or venomous animals (e.g. snakes), as they can bring unexpected threats for soldiers during international military missions in African countries. As kind of a new approach the whole spectrum from protozoa to vertebrates were considered and checked, including also parasites (e.g. nematodes) and vectors (e.g. mosquitoes) that pose a risk at humans by the transmission of diseases caused by viruses, bacteria or protozoa. A Geographical Information System (GIS) linked database including datasets with detailed biological information was established to derive relevant aspects for operational areas in West, North and East Africa. This provides a basis for communicating appropriate behaviour, suitable preventive measures and first aid recommendations. Data were gathered from multiple sources such as relevant scientific literature, data of museum's collections (including NHMW), and online networks. The database is managed in QGIS 3.4, which allows to connect all data records with GIS-based information as well. This ongoing project provides an important tool for Austrian soldiers in foreign operational areas by processing researched data on a multidimensional GIS-based level with the possibility for appropriate visualization. Furthermore, we hope to get in future additional data by soldiers which will help to improve the knowledge on species in regions with little access due to difficult conditions. So far, 70 scorpions, 43 spiders and 88 ticks were identified as potential threats.

Ecology
*Short talk*

# Structural stabilization function of spider web decorations

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Animals use decorations for various purposes including: mating, foraging, crypsis, and others. Web-building spiders can use decorations for several functions, such as predator avoidance and prey luring. However, most studies have focused on the visual signals deployed by these decorations and their related functions with few studies investigating the mechanical effects of decorations on the web. Web-building spiders often adjust the tension of their webs to increase the efficiency of transmitting vibratory information from prey, potential mates, and other foreign bodies and improve prey capture. *Cyclosa* orb-web spiders incorporate egg sacs in their webs, both as camouflage and reproductive function, respectively. In this study, I hypothesized that egg sac decorations in Cyclosa mulmenesis webs serve as more than visual signals, but enhance mechanical functionality of webs. I predicted tension will increase and damping ratio will decrease when the number of decorations increased. Webs were separated into three groups: no decoration, few decorations (1-4 egg sacs), and many decorations (5-8 egg sacs). Cyclosa mulmenesis lives near windy seashores, so in this experiment, I also examined the effect of wind on the aforementioned web characteristics. Results indicate that incorporating more egg sacs can help stabilize the web by increasing both web tension and decreasing damping ratio. High web tension can facilitate the transmission of prey vibrational signals. A lower damping ratio indicates that the post-disturbance undulation of webs is reduced as egg sac decorations absorb kinetic energy.

Ecology
*Short talk*

# Spiders, cave and global warming: a Descent into the Maelström

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According to direct field observations and theoretical models, anthropogenic global warming may significantly influence and modify the underground cave climate in different ways compared to what happens outside. Recent evidence proved how cave-dwelling organisms will be affected by such alterations, mostly depending on their level of subterranean adaptation. In this respect, spiders of the genus *Troglohyphantes* (Linyphiidae) are an excellent model study, showing high functional diversity, poor dispersal ability, narrow ecological requirements, and restricted distributions. On the basis of 10-years field data, we related the climatic profile of more than 350 localities to presence/absence data of *Troglohyphantes* species in the Western Alps, via Ecological Niche Modeling (ENM). We generated the current potential distribution in the study area and we projected the present-day model into three different global warming scenarios. Future forecasts show a general decline all over the study area. We experimentally corroborated our predictions by testing the thermal tolerance of these spiders using standard climatic test cabinets. As a result of their adaptation to a thermally-constant environment, *Troglohyphantes* spiders display a general stenothermal profile. However, their specific response to increasing temperatures varies according to the degree of subterranean adaptation. Model predictions and physiological tests converge in supporting a significant decline in habitat suitability with respect to climatic alterations due to climate change. All in all, the existing wealth of threats insisting upon subterranean biota and the ecological and biogeographical peculiarities of these spiders, strengthen the importance of considering these species in international and national conservation measures.

Systematics & Biogeography
*Short talk*

# Species delimitation in allopatric *Pardosa* using ddRAD sequencing

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Delineation of closely related allopatric species remains a major challenge in taxonomy. In allopatry, differences in morphology and DNA sequences can be observed but interpretation of their importance for species delimitation remains largely subjective.
Spiders of the genus *Pardosa* are known for their challenging taxonomy due to morphological similarity and controversial DNA barcode (COI) patterns. We have attempted to shed light on species status of three allopatric *Pardosa* species (*P. hyperborea, P. saltuaria, P. oreophila*) from Europe and Canada using DNA barcodes and ddRADseq.
Analysis of COI suggests that populations of European and Canadian *P. hyperborea* diverged to the extent that allows assigning species status to both of them. Simultaneously, COI showed high similarity between European species/populations except for Pyrenean lineage. Delimitation derived from ddRADseq datasets analysis confirmed independent species status of European and North American *P. hyperborea, P. saltuaria* and *P. oreophila* from Pyrenees. To clarify conflict between mitochondrial and nuclear DNA patterns, we applied D-statistics test and fastsimcoal2 modelling to ddRADseq data. The results suggest introgression between species in Europe. Hence, we propose reinstating *P. luteola* for North American *P. hyperborea*, keep species status unchanged for *P. saltuaria* and describe Pyrenean population of *P. oreophila* as new species.
While species delimitation remains partially subjective and insufficiently standardized, ddRADseq data proved to be abundantly informative for delineation of *Pardosa* species notorious for their conflicting COI patterns. We suggest that ddRAD is comparable in its precision to standard morphological species delimitation and can be reliably used for challenging taxonomic cases.

Evolutionary Biology
*Short talk*

# „Love bites“ in Sparassidae Bertkau 1872—more usual than thought?

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There are only few direct observations of male fang use during mating of spiders. Indirect evidences are scars, e.g., in *May* Jäger & Krehenwinkel 2005 or *Thunberga* Jäger 2020. From their position, distance and their nature these scars are supposed to be caused by male spiders with their fangs. When preparing a manuscript with 100 new species of the genus *Pseudopoda* Jäger 2000, more such cases became evident. A survey through published records and the collection of the Senckenberg Research Institute was conducted. Results are shown and an outlook for other families is given.

Behavior
*Short talk*

# Analysis of prey handling reveals an unsuspected use of cribellate nanofibers

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Spiders use a variety of different strategies to capture and subdue prey. We found this diversity already while studying the capture strategies of paraphyletic cribellate spiders. These spiders all share the cribellum, a spinning plate producing thousands of cribellate nanofibers. Families belonging to this group build differently shaped webs, including typical orb webs as well as no web at all (the hunting spider *Zoropsis*). Furthermore, spiders either suck their prey, leaving the exocuticle intact, or chew it until complete digestion of the prey. Furthermore, some chewers and suckers also wrap their prey before consumption.
While studying the use of silk in spiders wrapping their prey, we observed that *Uloborus plumipes*, *Deinopis subrufa* as well as *Oecobius navus* used the pectunculus, a specialized comb on the fourth leg near the calamistrum (the comb associated with the extraction of the above-mentioned nanofibers). A closer examination of the pectunculus of Uloborus plumipes by shock-freezing the spider during wrapping, shaving off the pectunculus and investigation of the wrapped prey parcels revealed that this comb is used to brush out cribellate fibres from the cribellum in the initial wrapping phase. This behaviour makes sense, as Uloborids are small spiders and lack venom glands. A powerful grip of prey is crucial for them to subdue large prey like hoverflies. This result joins into the discussion on the co-development of cribellum and calamistrum, as this is the second example of cribellate spiders extracting nanofibers without using the calamistrum.

Faunistics & Biodiversity
*Short talk*

# Forest refugia of the Western Ghats of India – a 'museum' of ancient pseudoscorpion lineages

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The Western Ghats (WG) of India is a 1600 km long mountain chain running parallel to the western coast of India. Having a complex geo-climatic history, the WG harbors high biodiversity and endemism across its heterogeneous landscape and together with a highly threatened ecosystem, it is recognized as one of the 'hottest' biodiversity hotspots in the world. Most studies have explained diversity patterns across the WG using vertebrates, however, the processes impacting the highly endemic invertebrates are poorly understood. Here, we investigated the evolutionary history of an ancient and widespread pseudoscorpion lineage (Family Chthoniidae, Tribe Tyrannochthoniini) by performing biogeographical and diversification analyses. We included sequence data from one mitochondrial and two nuclear loci for a total of 1.947 aligned sites from 45 terminals from the WG and 22 outgroup terminals from other parts of the world. Our results indicate that Tyrannochthoniini is an ancient lineage with high species diversity in the WG. Results supports a 'museum' model of diversification for WG Tyrannochthoniini and indicate that vicariance across the Palghat Gap, a major biogeographical barrier in the WG, and dispersals along elevation gradients, have shaped the pseudoscorpion fauna. Our study thus provides insight into the historical biogeography of relictual taxa in the WG and highlights the importance of integrating invertebrates, particularly soil-arthropods, into planning conservation strategies in this hyper-diverse region.

Latrodectus Symposium
*Short talk*

# Black widows on an urban heat island: the behavior, ecology and evolution of an urban arthropod pest

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To understand the mechanisms that allow some organisms to dominate urban ecosystems and thus compromise biodiversity, we have been quantifying life history differences between urban and desert populations of the black widow spider, *Latrodectus hesperus*, an arthropod pest species across urban ecosystems of western North America. Human disturbances such as urbanization have been projected to cause the extinction of a large proportion of biodiversity within the next century Urban ecology is full of studies showing the impact of urbanization, but severely lacking in studies that identify mechanisms responsible for these changes. Here I will summarize our laboratory's work over the past 5 years, both documenting urban-desert differences in black widows, and documenting the impact of a 6℃ urban heat island on the life history of urban black widows.

Ecology
*Short talk*

# A preliminary study on the habitat association of lynx spiders from the Western Ghats of India

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Spiders are strongly influenced by plant architecture, rather than being randomly distributed in the vegetation; structures such as rosette-shaped clusters of leaves or glandular trichomes are particularly common in plants that have associations with spiders. Most of the plant-spider relations are mutualistic in nature. Family Oxyopidae, one of the less studied group of spiders compared to another spider families irrespective of its greater importance in predation of the insect pests. This study specifically concentrates on the plant association of lynx spiders with special reference to species abundance, species richness, species density on the host plant and monitoring the features of the host plants. The data of pre-monsoon, monsoon, and post-monsoon seasons were collected from various geographical areas of Western Ghats. *Chromolaena odorata*, *Lantana camara*, *Araucaria columnaris* are the plants which shows more species abundance in the case of genus *Oxyopes*. Whereas members of the genus *Hamataliwa* usually observed on lower shrub like wild vegetable plants including *Capsicum annuum*. Nilambur teak museum garden which is a combination of flowering plants, medicinal plants, herbal plants, and teak plants constitute more species richness than Ponmudi hill station, which abundant in homogenous vegetation. This proves the hypothesis of more the plant diversity, more will be the species richness. Mangroves of Kannur shows greater species abundance proves more homogenous the vegetation more will be the species abundance for Oxyopidae. It is clearly evident from this study that the members of the Oxyopidae extends its plant preference beyond the commonly prefered throny rosette shaped cluster plant.

Metabarcoding
*Short talk*

# Maximizing return on investment: HTS and Nanopore sequencing for spider phylogenetics

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Recent improvements in sequencing technology have greatly increased the power and cost-effectiveness of molecular phylogenetic methods. The same basic techniques used in DNA metabarcoding can also be applied to high-throughput single-specimen barcoding, allowing the simultaneous generation of data from multiple genetic markers for large numbers of specimens. At the same time, advances in long-read sequencing make it straightforward to obtain highly informative amplicons rapidly and at low cost. Here, I discuss two projects, one recent and the other ongoing, on high-throughput molecular phylogenetics of spiders. In the first, we use Illumina-based HTS of short barcode markers to resolve evolutionary relationships within the iconic adaptive radiation of Hawaiian Tetragnatha spiders. The results suggest multiple drivers of speciation in this system, with nonadaptive diversification (niche conservatism) and competition-mediated character displacement appearing to trigger divergence in the largest number of clades, while evidence for adaptation to novel environments is found in only a few lineages. The second project, which is still ongoing, aims to develop a rapid multi-locus protocol for obtaining long-read phylogenetic amplicons across the spider tree of life using ONT (Nanopore) technology. We present the results of a pilot study in which we successfully generate ca. 5300 bp of data, using two simple PCR reactions, for fifteen spider families representing most of the major clades of Araneomorphae. Our results are congruent with recent phylogenetic hypotheses for the spider tree of life. Both projects demonstrate the efficacy of next-generation and third-generation sequencing as simple and powerful tools for resolving evolutionary relationships.

Systematics & Biogeography
*Short talk*

# Detecting cryptic diversity in Korean endemic harvestmen (Arachnida, Opiliones, Kaolinonychus) using integrative taxonomy and machine learning methods

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In taxonomy, a common traditional practice is to define species based on a few specific morphological traits, for example those that are known to play an important role in mating, such as genital morphology. Although extremely useful and widely used, a morphological-only approach may overlook cryptic species, lineages that are genetically distinct but not easily distinguished by the morphological traits. As modern molecular genetics and increasingly sophisticated quantitative analysis techniques are introduced into taxonomy, more recent works in a lineage may demonstrate that the single morphologically cohesive species can consist of multiple hidden species that have each undergone independent evolution. Here, we explore the possibility of cryptic diversity in *Kaolinonychus*, a poorly studied harvestmen genus endemic to Korea currently composed of a single species with two subspecies. For this, we gathered both genetic sequence data and 65 morphometric characters to conduct phylogenetic, population genetic and multivariate analyses including machine learning (ML) methods, for which recent studies have demonstrated their practical performance in species delimitation. Using these analyses, we conducted discovery-based analyses for establishing hypothetical species and then tested these hypotheses in the validation stage. As a result of our integrative taxonomic analyses, we identified multiple distinct lineages in *Kaolinonychus*. We conclude with high confidence that at least the two subspecies of *K. coreanus* need to be elevated to separate species. Furthermore, we propose that the integrative taxonomic method used in this study can be applied to detect the possibility of cryptic diversity in various taxa.

Ecology
*Short talk*

# Effect of habitat complexity on web pattern in orb web builders (Araneae: Araneidae)

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Family Araneidae is a large cosmopolitan family. One of the important behaviour of araneids are web building. The structural complexity of a habitat affects the abundance, diversity and behaviour of organisms residing there. Web-building behaviour of spiders is greatly dependent on their physical surroundings and its complexities. The study was to analyze the changes in the web pattern of the selected spider species of the family Araneidae as the complexities of the habitat changes. Three different habitats; open grass land, teak plantation and scrub jungle, having different levels of habitat complexities, were taken. Web pattern of *Argiope pulchella*, *Neoscona nautica* and *Cyclosa confraga* were analysed in the study. Various web parameters including the number of radii, spirals, hub spirals, diameters of the web, body length of spider were observed. Using the data, capture area of the web were calculated by employing the 'Ellipse - Hub formula'. It was observed that the webs built in more complex habitat was smaller than the webs built in less complex habitat. From the results it was clear that as the habitat complexities and microhabitat changes, all the considered parameters were also changed. This study is an evidence which indicates the changes in the habitat by both biotic and abiotic factors can directly affect the behaviour of spiders inhabiting the area and it can be visualized from their web pattern.

Evolutionary Biology
*Short talk*

# Sex-specific body size architecture explains the evolution of sexual-size dimorphism

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Evolutionary emergence and maintenance of sexual dimorphism remain a puzzle since the time of Darwin. A common assumption for sexual dimorphism presence is that sexual conflict, i.e., different evolutionary optima of the same trait between sexes, has been resolved, but the resolving mechanisms usually remain unknown and subject to the current debate. A well-known example of sexual size dimorphism (SSD) exists in many spiders. Studying the extremely sexually size-dimorphic African hermit spider, Nephilingis cruentata, with females ~76 times larger than males, for several generations in the laboratory we here shed light on how SSD may have emerged and be maintained. Specifically, we tested whether the sexes differ in adult body size architecture, which would de-couple the evolutionary foundation between sexes. We inferred that adult body size is indeed determined differently between the sexes: adult body size is determined in females predominantly by genetic effects and in males predominantly by maternal effects. These results support a hypothesis under which sexual conflict is resolved, and SSD maintained, through sex-specific trait architecture that allows size evolution to proceed at a direct genetic level mostly in females, with very little consequence on male size. These results suggest a previously often suggested, and here demonstrated, straightforward mechanism that avoids intra-locus sexual conflict and explains how evolution is possible towards sex-specific optima of the same trait.

Evolutionary Biology
*Short talk*

# Nailing the horseshoe: Reconciliation of Xiphosura gene and species trees reveals ancient hybridization as driver of whole genome duplication

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Bifurcating trees have been a traditional choice to reconstruct evolutionary relationships, implicitly assuming that each speciation event results in two daughter lineages. Interrogation of genes has shown in many cases that evolutionary history can be reticulated, as a result of non-hierarchical gene flow events such as introgression and hybridization. Reconstructing the reticulated genetic history compounds the intractability if the lineage has undergone whole genome duplications and deep divergences. Horseshoe crabs an order of marine arachnids that comprise four extant species, some of which are known to hybridize. This group has a rich fossil record, indicating an ancient origin, which has led to the interpretation that extant species are “living fossils”. We queried the genomes of all Xiphosura to detect signals for reticulation and found evidence for allopolyploidy in the lineage subtending the four extant species. This phenomenon is likely the driver of threefold whole genome duplication in this group. Additionally, we used fossil-based calibrations to estimate divergence dates on two alternative placements Xiphosura in the phylogeny of Chelicerata. Exclusion of xiphosuran ingroup fossils from the Mesozoic increased the uncertainty in the dating of this group, but radically altered the crown age of Xiphosura. Our results suggest that crown age of the extant horseshoe crabs may be much younger than recently inferred.

Faunistics & Biodiversity
*Short talk*

# Seasonal dynamics in the diversity of long jawed spiders (Araneae: Tetragnathidae) in Wayanad Wildlife Sanctuary of Western Ghats, India

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Seasonality act as a key aspect in understanding species composition and diversity patterns of spider population. Wayanad Wildlife Sanctuary falls within the Nilgiri Biosphere Reserve on the Western Ghats, extremely rich in arthropod diversity and remarkable for salubrious climate with well pronounced wet and dry seasons. This study aims to determine seasonal dynamics in the diversity and abundance of Tetragnathid spiders in different habitats such as moist deciduous forest, riparian habitat, seasonally waterlogged grassland and teak plantation of Wayanad Wildlife Sanctuary. In four different habitat types, estimated Shannon diversity exhibited maximum during monsoon season. The highest species richness was recorded in riparian habitat. The abundant species were *T. mandibulata*, *T. keyserlingi* and *T. versicolor*. Overall seasonal patterns in spider abundance of three habitats (moist deciduous forest, seasonally waterlogged grassland and teak plantation) decline in the pre-monsoon and post-monsoon periods, while in riparian habitat, the abundance was slightly higher in the post-monsoon season, followed by monsoon and pre-monsoon seasons. The species composition in different seasons were influenced by physical conditions of the environment. Moreover, higher species richness, abundance and diversity of spiders during monsoon period was probably due to increased plant biomass and high availability of food.

Evolutionary Biology
*Short talk*

# Evaluating existence of female pre-existing biases for novel visual traits in nocturnal arthropods

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Female choice plays an important role in mating system, and is a major driving force for the evolution of male phenotypic traits. We defined this phenomenon as female pre-existing biases. Female pre-existing biases is defined as female preference on particular novel sexual traits of males, even though such trait does not exist in conspecific males. Such phenomenon has been demonstrated in a number of vertebrates. For example, female swordtail fish prefer males with sword-tail added, no matter the males are con-or heterospecifics. Besides, female grass finch preferred males with artificial white crest added, even though such trait did not exist in such species. Such phenomenon has also been reported from wolf spiders and jumping spiders. However, most relevated studies focus on visual traits of diurnal animals. It is not clear whether nocturnal animals also exhibit pre-existing female biases for novel visual traits. It is generally believed that nocturnal arthropods mainly use vibratory or acoustic cues during courtship interactions. However, recent studies demonstrated that visual signals play important role in the courtship interactions of nocturnal arthropods such as fishing spiders or brown huntsman spiders. In this present study, I will conduct experiments by manipulating the white stripe markings to empirically verify existence of female pre-existing biases. Responses of female *H. simplex* to these treatment groups will be monitored using infrared video cameras. In my expectation, white stripes added group will have a higher rate of mating success.

Morphology & Physiology
*Short talk*

# Diversifcation through gustatory courtship: prosomal shapes and glands and their convergent evolution

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Sexual selection has been considered to promote speciation. Sexually dimorphic species have been used to explore the supposed effect, however, with mixed results. In dwarf spiders (Erigoninae), many species are sexually dimorphic - males possess marked prosomal modifications varying from moderate elevation to bizarre shapes. These structures have been shown to produce substances that are taken up by the female. Since the transfer of substances increases male mating probability and female oviposition rate, the dimorphic traits evolved in the context of sexual selection. Here, we explore the evolutionary lability of these traits by investigating 1) if modified prosomata are inherently linked to nuptial-gift-producing glands, 2) if gland evolution preceded that of the modified prosomal shapes and by assessing 3) the probability of convergent evolution and cryptic differentiation, aiming at assessing the role of this trait complex in species divergence. We reconstructed the dimension of the glandular tissue and the muscular anatomy in the anterior part of the prosoma of 76 dwarf spiders and three outgroup species using X-ray micro-computed tomography. We incorporated the location of glands and muscles into an existing matrix of morphological traits of these taxa and reanalyzed their phylogenetic relationship. Our result supports that possession of glandular equipment is the ancestral state. The manifold modifications of the prosomal shape have evolved convergently. We found differences in glandular position between congeneric species with both modified and unmodified prosoma, indicating that glandular position is highly susceptible to changes. We reported on seven cases of gland loss, which suggest considerable maintenance costs of glandular tissue and nuptial feeding. Our results demonstrate divergent evolutionary patterns of gustatory-courtship-related traits, and a likely facilitating effect of this type of sexual selection on speciation.

Evolutionary Biology
*Short talk*

# Evolution of genome size and DNA base composition in entelegyne spiders

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Genome size represents a specific characteristic of the species, being useful for the analysis of genome evolution, as well as an important prerequisite for whole genome sequencing. 2C value (diploid genome size) vary dramatically among eukaryotes and this variation could have minor relationship to organismal complexity or karyotype structure. Spider species differ in various life-history traits including genetic characteristics. With more than 50 thousand of spider species described, in only less than 150 species the genome size has been established so far. We perform estimation of genome size and DNA base composition using flow cytometry in 148 species belonging to 29 families representing a cross-section through all major clades of entelegynes. We found high variation in genome sizes of entelegynes, it varied between 2C = 1.174 Mbp in male of *Pachygnatha listeri* (Tetragnathidae) and 2C = 20 167 Mbp in female of *Cicurina cicur* (Hahniidae). Interestingly, some families displayed considerable variability in genome size e.g. Theridiidae (2C ranges from 2.347 to 11.023 Mbp) and Salticidae (2C ranges from 4.258 to 16.601 Mbp). Due the different number of sex chromosomes in male and female, 2C of females were bigger than in males. In all species we found AT biased genome with the mean value of GC base content 34.81 %, which is in accordance with data published for non-enetelegyne spiders.

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Latrodectus Symposium
*Short talk*

# Disappearing widows: an unsolved mystery

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Nests of adult female desert widow spiders, *Latrodectus revivensis* and *L. pallidus*, are highly visible in the desert shrubland and preserve a complete record of individual productivity that can be monitored and compared over the years. A yearly survey from 1992-2000 was conducted of nests of *L. revivensis* in the Negev highlands near Sede Boqer, Israel. Two additional surveys were added in 2009 and 2015. We surveyed *L. revivensis* nests at the end of the reproductive season (December or January) and recorded the number of eggsacs present in each. In 1994 nests of *L. pallidus* appeared and were added to the survey. A subset of *L revivensis* nests was collected to analyze prey remains, and eggsacs were opened to count the contents (eggshells or young). The abundance of *L. revivensis* declined sharply in 1994 and did not recover over the remaining census period. There was a weak positive relationship between rainfall in the previous wet season and the number of nests (log-transformed) in the following reproductive season (r2=0.306), yet nest numbers did not increase in three years following above-average rainfall. There was no significant relationship between previous-season rainfall and the number of eggsacs/nest, and only a weak positive relationship between rainfall and the number of prey/nest (r2=0.095). While precipitation is generally a main determinant of arthropod abundance and productivity in desert ecosystems, this is seemingly not the case here. Nor does the abundance of *L. pallidus*, which was <30 in any survey, explain the decline of L. revivensis.

Latrodectus Symposium
*Short talk*

# Eight Legged Models Hit The Runway! : How venomous spiders are useful models for investigating the role of ecological factors in driving predator-prey evolution.

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Predation is one of the most fundamental ecological interactions and can drive processes ranging from trait evolution to species invasions and ecosystem stability. However, due to the difficulty of quantifying the functional ability of predatory traits, it is difficult to test fundamental theory linking traits to predator-prey interactions. One quantifiable predatory trait is the potency of a predator's venom to their prey. Venom potency is quantified through LD50 (median lethal dose) and ED50 (median incapacitation dose) experiments, methods that determine how much of a species venom it takes to kill or incapacitate 50% of a test population of prey species respectively. By using a quantitative measure of a predatory trait, we can test what ecological factors drive venom potency evolution.
My research focuses on testing for the ecological drivers of venom potency in spiders and tarantulas by using their LD50 venom potency data and other ecological factors, collected from the literature. By running models with the data through R statistical analysis software, we tested how factors such as body length, web/non-web usage and LD50 prey model type drive venom potency in spiders and tarantulas. We find that smaller, web-using species tend to produce lower LD50s and therefore have higher venom potencies in general and that LD50s performed on invertebrate prey models tended to be higher (weaker potency) than LD50s performed on vertebrate prey models.

Faunistics & Biodiversity
*Short talk*

# Under the hoofs of herds: spiders and harvestmen of two grazing reserves in the Czechia

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Refaunation/rewilding by large ungulates represents a cost-efficient approach to managing natural biotopes and may be particularly useful for areas whose biodiversity depends on disturbance dynamics and is imperilled by successional changes. To study impacts of refaunation on arachnids, we focused on spiders and harvestmen inhabiting the former military training range Milovice and Traviny, Midlle Bohemia, refaunated since 2015 by a combination of Exmoor pony ("wild" horse), Tauros cattle ("aurochs"), and European bison. The study sites were located in former military training area Milovice and Benátky nad Jizerou-Traviny, regional biodiversity hotspot, where wild horses, european bisons and aurochs were introduced as an active measure aimed at biodiversity conservation. Localities were xeric shrubs, dry meadows with sparse vegetation and solitary trees and bushes. We collected spiders and harvestmen in both areas by pitfall traps, individual sampling and surface window traps. Altogether 1627 spiders from 149 species and 372 harvestmen from 6 species were collected. 29 species of spiders were belong to the Czech redlist of spiders and many regionally rare species. Remarkable species were e.g. *Microdipoena jobi*, *Neriene furtiva* and *Cozyptila blackwalli*, from harvestmen was numerous on both localities *Lacinius horridus*. By blocking succession, large ungulates support heterogenity biotopes mozaic and use as refugium for many endangered and regionally rare spiders species. Restoring large ungulates populations represents a great hope for conserving not only for endangered arachnids.

Latrodectus Symposium
*Short talk*

# The Defense Mechanisms of Brown Widow Spider Eggs against Bacterial Invasion

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Arthropod eggs provide a rich source of nutrients for the developing embryo, making them a favored food source for other organisms. Brown Widow spider, *Latrodectus geometricus* (Theridiidae), eggs were tested for antibacterial defenses and the mechanisms by which the eggs are protected from pathogenic bacteria were investigated. The antibacterial activity of the eggs was shown by inhibition of bacterial growth on an agar plate, liquid culture, and by retarded biofilm formation. The defense strategy against bacterial invasion was demonstrated in the whole egg, whole egg extract, egg surface extract, eggshell, and eggshell extract. All egg components exhibited potent inhibition of growth of the Gram-positive *Staphylococcus aureus* and the Gram-negative *Pseudomonas aeruginosa*, *Klebsiella oxytoca* and *Escherichia coli* K12. Brown widow eggs are spherical, ~1 mm in diameter, and coated with a dense layer of spheres with a diameter of 0.4 to 3.6 µm. The physical structure of the L. geometricus egg is unique since the whole egg was found to be hydrophobic with a low positive electric charge, while the egg spheres were superhydrophilic. The egg's hydrophobicity, the superhydrophilic nature of the egg spheres, and their low positive electric charge - each of these properties, separately and together, limit bacterial ability to adhere to the egg surface of the egg and form a biofilm. We suggest that the unique physical traits of the egg surface, combined with its antibacterial chemical properties, reduce bacterial adhesion to the egg surface, prevent biofilm formation, and thus prevent bacterial contamination.

Faunistics & Biodiversity
*Short talk*

# Guild structure analysis of spiders in different habitats of Thar dessert

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The great deserts of Thar constitutes a unique ecosystem and are characterized by extreme temperatures, low and fluctuating rainfalls and dry winds. The knowledge about the guild structure is the fundamental step in conservation of the focal species as well as the habitat. The aim of this study is to understand the dominant guilds and the guild structure of different spiders in different habitat like rocky desert, semi stabilized sand dunes and riparian habitat of the Thar Desert. The study revealed that the selected habitats have 7 guilds in which the other hunters were the most species rich guild (43%) followed by orb web weavers (28%) and ground hunters (13%). The most abundant guild was other hunters (40%) followed by ambush hunters, orb web weavers, sensing web weavers and so on. The study testified that the habitat complexity held the major attribute of the guild structure by revealing that the riparian habitat proved to house all the 7 guilds while the rocky desert and the semi stabilized sand dunes accommodated only 5. The plant species composition and environmental parameters are also observed to have effect on the guild structure of each habitat.

Metabarcoding
*Short talk*

# Spiders as a monitoring tool for arthropod biodiversity – gut content metabarcoding and its uses

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Spiders are top predators in temperate grassland biomes. Their diet is susceptible to any factors that change the abundance and diversity of their arthropod prey. Using molecular gut content analyses and metabarcoding, we investigate spider diet composition in grassland ecosystems. By combining the findings with data on taxonomic composition of spider- and arthropod communities, we can draw valuable information on the relationship between environmental conditions and diet composition in spiders. Furthermore, we want to introduce the gut content DNA of spiders as a tool for monitoring arthropods. Using the same metabarcoding approach, this could prove as a valuable alternative or complementary approach in the toolbox of modern monitoring for arthropods.

Ecology
*Short talk*

# Trends in habitat suitability of water spiders in Europe: a conservation perspective

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Wetlands, one of the most biodiverse ecosystems in the world, are increasingly subjected to loss and degradation due to changes in climate and land-use. These factors impact the unique biodiversity of wetlands, including numerous invertebrates that depend on them. Here we investigated the current and future habitat suitability of *Argyroneta aquatica* and *Dolomedes plantarius*, two spider species dependent on wetlands. We evaluated future trends in their geographic range, aiming at assessing their extinction risk according to the International Union for Conservation of Nature (IUCN) Red List criteria, at both global and regional levels. We investigated present and future distribution ranges using species distribution models for two integrated emission scenarios (SSP1-2.6 and SSP5-8.5) and combining three general circulation models. We found a significant future northern shift in the geographic range and a reduction in habitat suitability for both species, particularly for the Central-Eastern and Western European populations. The application of the IUCN criteria qualifies *D. plantarius* for the Vulnerable and *A. aquatica* for the Near Threatened Red List category. Future effects of climate change are likely to lead to increasing extinction risk in both species. Regional assessments provided a similar pattern of range reductions and population vulnerability across all European regions except for Northern Europe, which is expected to become a climatic refugium for both species. Conservation strategies should be directed towards limiting the impact of climatic and non-climatic stressors on wetlands, and towards implementing management plans and restoration programmes to increase habitat suitability and connectivity among wetland patches.

Latrodectus Symposium
*Short talk*

# A revised phylogeny of the widow spider genus *Latrodectus*

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We present a fossil calibrated molecule phylogeny of the widow spider genus *Latrodectus*. Data from previous studies are combined with expanded taxonomic coverage and sequences from three loci: COI, 16S, and 28S. Multiple standard view photographs of nearly all specimens are made available. We analyze of the evolution of male and female size. Wherever possible, specimens have been included from near the type localities of both currently recognized and synonymized species. Several changes to taxonomic nomenclature are implied by our analysis, including both resurrection of disused names and synonymy of current ones; we highlight cases where further study will be required to resolve persistent ambiguity.

Systematics & Biogeography
*Short talk*

# Little brown bugs: machine learning on challenging collections

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Machine learning is already being used by citizen scientists to contribute to our knowledge of biodiversity. Records of which species have been observed where and when is becoming increasingly critical to understanding our changing world. But image libraries that are the raw material of machine learning applications are unevenly available across taxa, with smaller bodied, more diverse, and less distinctive and colorful groups lagging behind; we refer to such groups collectively as Little Brown Bugs. Effective machine learning applications require a large though unspecific number of images for each species. The world's museum collections are archives of specimens, containing large series of common species and often the only accessible examples of many lesser known species. Our objective is to understand how museum collections material can fill gaps in image libraries suitable for machine learning, and what level of determination power we can anticipate from such systems. We report on a pilot dataset based on seven species of linyphiid spiders. These species were selected to represent a gradient of taxonomic challenges. Specimens were photographed both individually using a high resolution extended focus composite system and with multiple individuals in multiwell plates. We compared libraries based on images of genitalia to libraries based on somatic morphology. This allowed us to explore tradeoffs in time, effort, and performance. The Little Brown Bugs project has complementary investigations focused on staphylinid beetles and bumble bees. In this context, the spider study exemplifies a taxon curated in alcohol where genitalic characters are decisive in traditional taxonomy.

Latrodectus Symposium
*Short talk*

# Effect of Resource availability on the web structure of female western black widows: Do physiological trade-offs constrain web structure?

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A major challenge is to understand what generates and maintains consistent behavioral variation among individuals within animal populations. Physiological trade-offs, where expressing one behaviour is achieved at the expense of another, could favor the maintenance of behavioural differences among individuals. However, few studies have investigated how allocation to different physiological functions varies over time and with resource abundance. Western black widow spiders build persistent webs that include structural threads to protect against predators and sticky trap threads to capture prey. The number of trap and structural threads differs consistently among individuals. To quantify the intensity of a potential trade-off among web components, we assessed the relationship between the number of structural and trap thread. We also tested whether varying food abundance affected the expression of individual differences in web structure. We monitored web structure under three levels of prey abundance every twelve hours for a week in laboratory conditions. We found no evidence for a physiological trade-off between trap and structural threads. Spiders that produced more structural threads also produced more trap threads. However, the magnitude of individual differences in web structure was higher when spiders were fed ad libitum and varied over time during the web construction phase. Given that producing silk is costly, the absence of a trade-off suggests that spiders do not need to balance resources invested in structural and trap threads. Variation in web structure might be constrained by other resources or governed by a trade-off between the web and other functions (e.g. fecundity or survival).

Faunistics & Biodiversity
*Short talk*

# Endosymbiont diversity across native and invasive brown widow spider populations

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The invasive brown widow spider, *Latrodectus geometricus* (Araneae: Theridiidae), has spread in multiple locations around the world and, along with it, associated organisms including endosymbionts. We investigated endosymbiont diversity and prevalence across putative native and invasive populations of the brown widow spider. We characterized the microbial community in the native and invasive ranges via high throughput 16S sequencing of adult females, and then validated the presence of two prevalent symbionts, *Rhabdochlamydia* and *Wolbachia*, via taxon-specific diagnostics. We found at least three strains of *Rhabdochlamydia* as well as *Wolbachia* (strain: Supergroup F). We also found *Rhabdochlamydia* and *Wolbachia* in eggs, suggesting that it is an inherited endosymbiont. We then screened 112 adult female spiders from invasive populations from Israel and the United States and putative native populations from South Africa for *Rhabdochlamydia* and *Wolbachia*. We found *Rhabdochlamydia* widespread in all populations, but not in all individuals, which suggests that it has a functional role or is a successful reproductive manipulator. *Wolbachia* was found across all countries, with two strains identified, but in lower prevalence in sites in the U.S. than in sites in Israel. In addition, we found geographic variation in endosymbiont presence: spiders from Israel were more likely to be infected with *Rhabdochlamydia* than those from the US, and less likely to be infected with *Wolbachia* than those from South Africa. This pattern is consistent with hypotheses regarding the loss of endosymbionts throughout species invasion. Characterizing endosymbiont diversity may shed light on the process of invasive spread and adaptation.

Latrodectus Symposium
*Short talk*

# Invasive brown widow spiders avoid egg sac parasitism and predation despite high densities

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Many invasive species thrive in urban, disturbed habitats, which may contribute to their success and spread, as species can reach high densities and there are often fewer predators and parasites present. We investigated the effects of seasonality, host density, and habitat type on egg sac parasitism by a wasp, *Philolema latrodecti*, in two widow spider species, one native to Israel, the white widow, *Latrodectus pallidus*, and one urban invasive species, the brown widow, *Latrodectus geometricus*. In a year-long survey, we found that parasitism rates rose in tandem with increasing host density. To test density-dependence of parasitism in both spider hosts, we measured spider host population density and egg sac parasitism rates in 17 sites across the Negev Desert. In *L. pallidus*, denser sites were more heavily parasitized, but extremely dense *L. geometricus* populations had low rates of parasitism. In an egg sac transplant experiment in settled and natural habitats, typical of brown and white widows, respectively, we found no parasitism of either species in the settled habitat, compared to 30% parasitism of egg sacs of both species in the natural habitat. Furthermore, we found higher predation of *L. pallidus* egg sacs, particularly in the natural habitat. These results suggest that natural habitats preferred by *L. pallidus* have a higher abundance of predators and parasites. Overall, we found high parasitism that varied with population density in white widow populations, but that dense, urban invasive brown widow populations are not heavily parasitized or predated, which may contribute to their invasion success.

Morphology & Physiology
*Short talk*

# Feeling with a fingernail: Extero-proprioreceptive sensilla in the pretarsal claws of the wasp spider *Argiope bruennichi* (Arachnida: Araneae)

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External mechanoreceptors respond to touch, sound, or substrate vibration. In spiders, mechanoreceptive cells are found in trichoid sensilla ('tactile hairs' and filiform trichobothria) and in slit organs of varying complexity. However, the tips of the legs, the tarsal claws, are always in touch with the substrate, but were widely thought to lack nerves. As a derivative of the tarsal claw, the male copulatory organ (genital bulb at the tip of the pedipalp) was therefore considered to be a numb structure, raising the question of how male spiders can perform precise maneuvers with a numb structure when interacting with the complex female genitalia during mating. The assumed lack of innervation has for decades driven hypotheses about mechanical interaction, sperm transfer, sperm storage and cryptic mate choice in spiders. In contrast to this common knowledge, nerves were found in the genital bulb of the male pedipalps reaching up to the sperm transferring structure (embolus) in all spiders studied from diverse families. Therefore, we revisited the sensory equipment of tarsal claws in the walking legs of the wasp spider *Argiope bruennichi* using electron microscopy and histology. We found a group of internalized sensilla projecting in the main and median claws of each walking leg. Each sensillum consists of 3-4 receptor neurons. Their dendritic processes terminate as elongated tubular bodies that traverse the claw cuticle and connect to an elongated, cap-like structure beneath the middorsal surface of the claw cuticle. We therefore conclude that there is a sensory organ in the tarsal claws that resembles scolopidial exteroreceptors of crustaceans and insects. It probably enables the spiders to sense the bending of the tarsal claws when they move in the web. The function of the sensory organ in the male pedipalp is probably also mechanoreceptive, providing the male with sensory feedback during mating.

Faunistics & Biodiversity
*Short talk*

# Alien arachnids in caves

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Invasive alien species represent a serious threat to native species and to ecosystems. Compared to surface ecosystems, subterranean environments are generally highly vulnerable due to their peculiar features, including permanent darkness, scarce energy inputs, and microclimatic stability. Consequently, assessing the effects of alien species in these habitats is considered among the most relevant aims in subterranean biology. Over 200 alien species of arachnids have been observed in Europe over the past 200 years, more than 180 are spiders, and 30 of them invaded underground ecosystems. However, the presence of alien species in underground environments has certainly not attracted the attention of the scientific community. We conducted a systematic literature survey to obtain an extensive list of publications that reported the presence of non-native arachnids in subterranean ecosystems around the world, to evaluate their potential impact on these habitats. Our results have yielded information on the presence of alien arachnids belonging to 8 different orders, most of which are spiders. The presence of alien arachnids is reported on every continent except for Africa and Antarctica. The main ways of dispersions seem to be linked to commercial activities. Furthermore, most of the species appear to have been established in the new habitats. Negative impacts have been documented for a small number of arachnids, mostly related to increased competition with native species. More in-depth studies would be desirable for a greater knowledge of the real distribution of alien species in subterranean habitats and of the impacts they can cause on local species.

Evolutionary Biology
*Short talk*

# Museomics and the evolution of color and size in *Zodarion* ant-eating spiders

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The species-rich and strictly myrmecophagous spiders of the genus *Zodarion* show diversified defense mechanisms, including mimicry of different ants and/or nocturnality. Using hyRAD, a recently developed phylogenomic technique designed for optimized sequencing of museum material, we initially reconstructed the phylogeny of *Zodarion* using 53 species from most of its distribution range, more than doubling taxon sampling of a previous phylogenetic analysis of the group. We processed the resulting matrix of 300 loci with concatenation-based and coalescent-based phylogenetic inference methods, obtaining high to moderate support for the relationships across the *Zodarion* tree of life, and providing solid grounds for downstream analyses. We then estimated the evolution of color and luminosity of the prosoma and specimen size across *Zodarion*, traits that have diversified across the group and are linked to specimen protection, and we also explored potential connections in the change of these features. Our study provides insights into the effects of potentially strong selective pressures on the evolution of this highly specialized spider group. It also opens a way for informed targeted selection of *Zodarion* taxa for future research on the group's remarkable morphological, ecological, and physiological adaptations to the specialization on ants. Finally, our study exemplifies the utility of hyRAD for phylogenetic studies using museum material.

Behavior
*Short talk*

# Hunger and not Personality Determines Task Participation in a Spider Society

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Task specialization is a hallmark of social success as it can minimize among-individual conflict in task participation, and thereby optimize colony productivity. Task specialization is therefore predicted to manifest as a consequence of social evolution. While age or caste in some species explains task participation, a recent hypothesis states that personality type determines differential task participation and thereby facilitates specialization. The social spider *Stegodyphus sarasinorum* exhibits no castes or conspicuous dominance hierarchies or age polyethism, yet shows consistent among-individual differences in prey capture. We tested whether one personality trait (boldness) determines task specialization by exploring the determinants causing consistent participation in prey attack. By integrating a personality type and individual hunger, we tested two mutually exclusive hypotheses. (i) Among-individual differences in personality determine consistent differences in participation in prey capture, leading to specialization. (ii) Individuals are flexible, and individual hunger state determines the propensity to capture prey. We found that hunger state was the only significant determinant of attacking prey. By reversing individual hunger state, we were able to dramatically increase or decrease individual attack propensities. Spiders exhibited consistent among-individual differences in boldness, yet this personality type did not predict foraging participation. Therefore, we found no evidence for behavioural specialization in prey capture. Our study emphasizes the importance of internal state as a mechanism underlying variable task participation, suggesting caution in attributing behavioural specialization to personality without appropriate integration of state-dependent effects.

Ecology
*Short talk*

# Ecological specialisation and reproductive isolation among closely related sympatric ant-eating spiders

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Biological divergence results from several mechanisms. Defensive mechanisms, such as Batesian mimicry, can cause reproductive isolation via temporal segregation in foraging activity, particularly, in species which closely associate with their model. This seems to be the case of ant-eating spiders which can be inaccurate Batesian mimics of their prey. Here, we focused on *Zodarion nitidum*, which has two forms occurring in sympatry, black and yellow. We investigated whether these morphotypes have diverged in their ecology. We measured the two morphotypes' phenotypic resemblance to a mimetic model, tested whether they were protected from predators, investigated their circadian activity, surveyed the prey they hunted, modelled their distributions, performed crossing experiments, and estimated their degree of genetic differentiation. We found that the black morphotype is ant-like, resembling *Messor* ants, and it was not distinguishable from their ant models by four potential predators. In contrast, the yellow morphotype seems to use predator avoidance as a defensive strategy. Additionally, the two morphotypes differ in their circadian activity, the yellow morphotype being nocturnal and the black one being diurnal. The two morphotypes hunt and associate with different ant prey and possess marked differences in venom composition. Finally, crossing trials showed complete pre-mating isolation between the two morphotypes, but there was no evidence of genetic (mitochondrial data) or environmental niche differentiation. We conclude that the two morphotypes show evidence

Ecology
*Short talk*

# Top-down control of spiders in temperate and tropical forests

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One of many factors that influence primary productivity is community interactions (e.g., leaf consumption by herbivores). Spiders are known as generalist predators, but their contribution to keeping the forest green (i.e., controlling the herbivore's population) is not highlighted compared to other predators, especially on a bigger scale. Here, we investigated the top-down control by spiders through a manipulative experiment (i.e., exclusion of birds, bats, and ants). Removal of these predators demonstrated the importance of top-down control by spiders in influencing herbivory activity. We focused on the naturally occurring plant species in temperate (EucFACE Experiment, New South Wales) and tropical (Daintree Rainforest Observation, Cairns) forests in Australia, both on the forest floor and the canopy. We quantified the rate of herbivory activity by measuring the leaf area before and after a one-month-long experiment (two replication). The preliminary data showed that spiders were among the abundant predators, with Salticidae as the dominant family.

Ecology
*Short talk*

# Trait-mediated response to urbanization in spiders: a case study in the city of Torino (NW-Italy)

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The role of functional traits in mediating species response to human disturbance is still unclear, but evidence in literature suggests that dispersal capacity plays a key role. To verify this, we tested the response against urbanization of three spider species commonly found in urban areas and characterized by different dispersal traits: a sedentary — *Asagena italica* (Theridiidae) —, a cursorial — *Pardosa proxima* (Lycosidae )— and a ballooner species — *Erigone autumnalis* (Linyphiidae). Spiders were collected in 2017 with pitfall traps in the municipality of Turin (NW-Italy) in both isolated patches and green areas along an urbanization gradient. We modelled the response of the three species in terms of variation of individual abundance and intraspecific variation of body size against patch isolation and urbanization density. Our results showed different patterns, with *A. italica* showing an abundance increase along the urbanization gradient, possibly mediated by competition, but no clear trend was observed in terms of body size variation. The body size of *P. proxima* increased in isolated patches with increasing urbanization, possibly mediated by intraguild predation, while no significant patterns emerged in terms of abundance. The number of individuals of the most dispersive species (*E. autumnalis*) was higher in isolated patches, suggesting a role of reduced competition, but individuals were smaller in isolated patches, possibly related to a more effective dispersion of small individuals. Overall, our results point out that a trait-based perspective is required to obtain a better understanding of the species responses against urbanization.

Morphology & Physiology
*Short talk*

# MicroCT analysis of the copulatory mechanism reveals an active female participation in the genital coupling of the entelegyne spider *Aysha proseni* (Anyphaenidae)

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Sperm transfer in spiders is achieved by copulatory organs on the male's pedipalps (i.e., palpal organ), which can be rather simple or a complex set of different sclerites and membranes. During copulation, these sclerites can be used to anchor in corresponding structures in the female genitalia using hydraulic pressure. In the most-diverse group of Entelegynae, the RTA clade, the female role in the coupling of genitalia is considered rather passive, as conformational changes of female genital structures during copulation are almost unknown. Here, we reconstruct the copulatory mechanism of *Aysha proseni* (Anyphaenidae) using µCT data of cryofixed mating pairs. We reveal that the female bears an inflatable structure in the anterior area of the epigyne, which becomes actively inflated during the copula, while in functional contact with the male retrolateral tibial apophysis (RTA). Furthermore, we show that the male genital functions (i.e., primary locking, secondary locking, functional conduction and internal bracing) are all achieved by complex projections, grooves and membranes of the male palpal tibia, a situation that is exceptional in Entelegynae. We will discuss our findings with regard to the possible role of the female inflatable structures in sexual selection and hypothesize similar mechanisms for other spider taxa with comparable structures associated to the female genitalia.

Evolutionary Biology
*Short talk*

# The diversity and evolution of spider spinning organs

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The silk-spinning organs and associated glands are among the most diverse and biologically meaningful organ systems in spiders. The way of life, hunting strategies, web design and ancestry are reflected in the morphology of their spinning organs in a complex and rich way. We present an overview of the diversity of structures that comprise the spinning organs, including spinnerets, glands, spigots and associated setae. We mapped the origin, repeated evolution and losses of important structures over a large phylogenetic tree with more than 500 species based on genetic sequence data. Among the most remarkable findings are the many convergences to similar morphologies and functional solutions, such as the reduction in the number of major ampullate gland spigots, probably related to dragline performance, the multiple origins and diverse physical principles of silk stickiness, and the loss of many of these novelties after changes in life style.

Systematics & Biogeography
*Short talk*

# Revisiting 'the common wolf spider' of western ghats *Pardosa sumatrana* (Thorell, 1890) in light of genitalic polymorphism

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In spider taxonomy genitalic morphology is considered as the most accurate information for species level identification. But, it is less practical in the case of families like Lycosidae, especially genus like *Pardosa* C.L. Koch, 1847 because of variations present in genitalic structure, termed as genitalic polymorphism. The term genitalic polymorphism in *Pardosa* was introduced by Jocque (2002) and quoted this as a possible reason for their misidentification. Before that, Buchar (1980), Alderweireldt & Jocque (1992) also reported intra-specific variations of genus *Pardosa*. Morphologically they are very similar and exhibit strong intra-specific variations. So, many of the morphological features are non- informative for their species level identification. Members of *Pardosa* are studied extensively but, genitalic polymorphism in the group results in various misplacements. Here we are revisiting *P. sumatrana*, one of the common wolf spider species from Kerala region of Western Ghats, a biodiversity hotspot considering genitalic polymorphism. Various individuals especially females found to have considerable variation in genitalic and abdominal characters. This report of genitalic polymorphism underlines the need of an extensive study in *Pardosa* of Western Ghats, along with genomic data and revises the classification of the taxa.

Faunistics & Biodiversity
*Short talk*

# Spiders newly observed in Czechia in recent years – overlooked or invasive species?

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To learn whether the recent increase in the number of Central European spider species reflects a still-incomplete state of faunistic research or real temporal changes in the Central European fauna, we evaluated the records of 47 new species observed in 2008–2020 in Czechia, one of the faunistically best researched regions in Europe. Because of the intensified transportation of materials, enabling the introduction of alien species, and perhaps also because of climatic changes that allow thermophilic species to expand northward, the spider fauna of this region is dynamic. Our analysis showed that only 15 spider species newly recorded in Czechia likely belong to the indigenous fauna. The remaining two-thirds likely appeared in this region recently. Half of these species are likely thermophilic species that expanded their distribution to the north, possibly due to global warming, and the second half are subtropical or tropical species introduced to heated buildings. Only three species were introduced to natural habitats, and only two of them, *Mermessus trilobatus* and *Erigone autumnalis* (Linyphiidae), can be considered true invasive species.

Morphology & Physiology
*Short talk*

# The usability of legacy material: a micro-CT approach

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Micro-CT scanning has been used in systematic and evolutionary studies because of its unique capabilities to visualize and reconstruct 3D models of external and internal morphological features. Also, this technique has minimal impact on specimens by comparison to other visualization methods (e.g. histology). Most studies rely on freshly collected material minimizing artifacts due to improper fixation and allowing the use of more invasive procedures (e.g. critical point drying). Natural history collections grant access to rare and significant taxa; however, they do not have standardized fixation and preservation of specimens, and usually do not allow destructive sampling. Here we analyzed the usability of collection material to study the spider neuroanatomy. We applied a minimally destructive contrast enhance technique (PTA staining with scan in EtOH) to two groups of female *Araneus diadematus*: freshly captured (n=11) vs. legacy material 70+ years old (n=10). We qualitatively and quantitatively assessed the viability of micro-CT scanning on both groups and the impact of aging on the neuroarchitecture. We compared the volumes of the syncerebrum and the gross shape of the brain using 2D geometric morphometrics and found no significant differences in either. Our results suggest that museum specimens do not degrade over time in a way that might bias the study results (as long as material is correctly preserved). This, together with the relatively low-impact nature of the micro-CT protocol applied here, could facilitate the use of old, and rare material from collections in the study of the neuroanatomy and other soft internal anatomical features.

Ecology
*Short talk*

# Patterns of a quarter century decline of spiders in arable ecosystem

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Due to agricultural intensification, habitat loss and climate change it is undeniable that populations of many arthropods are declining. We need to understand specific, community-level processes for each major taxa, including spiders, to mitigate this decline. For this, long-term repeated studies are a huge asset. We studied the temporal changes in spider communities of a concrete field and its grassy boundary, where both in 1996-1997, and almost 25 years later, in 2019-2020 alfalfa was grown without the use of insecticides and without much change in the surrounding landscape. With the current samples we exactly applied the sampling methods (pitfalls and suction sampling) and seasonal coverage of the past period, resulting in 803 and 700 samples, respectively. We found a significant decline in the abundance of spiders in both habitats, while species richness did not change markedly. However, with ordination methods we detected a marked difference between the community composition of the two sampling periods and found that in the current samples the spider community in the grassy boundary became more similar to that of alfalfa, indicating a homogenization process. The weighted trait of naturalness of the respective spider communities, based on the fidelity of spider species to natural habitats, showed a significant decrease in the field boundaries; however, this pattern was not observable in alfalfa. We conclude that arthropod decline in the case of spiders does not necessarily mean a decline in species richness, rather we observed a decrease in abundance, especially in spiders associated with natural habitats. Funding: NKFIH-OTKA-K134811

Ecology
*Short talk*

# Spiders and their prey in integrated pest management and organic apple orchards in Eastern Germany

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Apple orchards in Germany are facing frequent pest infestations which may cause significant economic damage. In our study, we aim to understand how management of apple orchards affects web-building spiders and their prey. In total, 16 apple orchards under integrated pest management (IPM, N=8) and 8 organic farming (OF, N=8) were sampled in Eastern Germany. We collected 3535 web-building spiders and 2976 prey remains from their webs from the tree canopies and the work rows. Interaction networks between web-building spiders and prey were characterized by 50% (canopy) and 114% (work row) more spider species in the IPM compared to the organic orchards. Predation by web-building spiders was lower in the work rows compared to the canopy, but aphids, mosquitos and wasps were the most dominant prey taxa in both management systems and habitats. Web-building spider species on average had more links to prey taxa in the canopy than in the work rows, but prey taxa on average had more links to predator species in the IPM compared to the OF. Orchards under OF are more disturbed by mechanical treatments for weed control in the work rows, which impacts web-building spiders and their prey. The observed higher predation in the canopy may result from the fact that the surrounding landscape acts as a sink for highly mobile prey taxa. An improved understanding of the interactions between predators and prey can help to develop and focus on conservation biological control and spiders as major natural enemy group.

Latrodectus Symposium
*Short talk*

# Immature mating and re-mating in a cannibalistic spider: Does lower male investment lead to higher female re-mating rates?

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Male mate choice is reflected through the decision of whether to mate, or through the amount of resources invested into a given mate. In the self-sacrificial brown widow spider *Latrodectus geometricus*, males can mate with either adult or subadult females. Although males prefer to approach and mate with adults and invest considerably less into mating with subadults (short courtship, no self-sacrifice), both tactics result in similar numbers of offspring. We asked if differential courtship investment affects female re-mating rates, expecting subadult-mated females to re-mate more often than adult-mated females. Subadult and adult females were equally likely to mate with the first male they were paired with. Male size was unrelated to mating success with unmated adult females, but negatively correlated with mating success when males were paired with subadults. Surprisingly, subadult-mated females paired with a second male upon adulthood were significantly less likely to re-mate than females who first mated as adults. Our experiments show that despite their low investment in terms of courtship effort, males mating with subadults do not face a heightened risk of sperm competition, though they may face costly reproductive delays or failure since subadult females must moult to maturity before producing an egg-sac. Female re-mating patterns indicate that adult and subadult females differ in choosiness, which may be related to costs and benefits of choice itself, rather than the investment of males in the mating.

Metabarcoding
*Short talk*

## Spider web eDNA as a tool for web ecology research

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Roughly half of all spider species are sit-and-wait predators that hunt using silken traps called webs. Innovations in silks and how spiders use them in webs are likely among the most important factors affecting the evolutionary diversification of orb weaving spiders. Even though spider webs differ strongly among spider taxa, the connection between their architecture and their prey-catching characteristics are famously problematic to study in situ. In a pioneering field experiment, we used DNA metabarcoding of eDNA obtained from spider webs, to test a new potential research tool for determining whether and how differences in orbweb architecture might influence the spiders' potential prey. We investigated webs of two similarly sized araneid species, *Argiope bruennichi* and *Larinioides sclopetarius*, that occupy different habitats and construct similarly sized, but architecturally different webs. We exposed laboratory constructed webs in the natural habitat of *A. bruennichi* and aimed at answering two main questions: i) Do web architecture differences in webs of these two species influence the potential prey intercepted by these webs?; and ii) Does the presence of stabilimentum in the web of A. bruennichi influence its potential prey intercepted? Using eDNA metabarcoding, we determined the potential prey communities of all webs and used alpha and beta diversity analyses to estimate the potential differences in these communities.

Evolutionary Biology
*Short talk*

# Discovering the developmental genetic basis for chelicera fate specification and postembryonic sexual dimorphism

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The chelicera constitutes an ancient, iconic appendage type that has been adapted and modified in myriad ways for functions like prey manipulation, envenomation, grooming, and reproduction across Chelicerata. Yet, little is known about the developmental genetic basis for fate specification of the chelicera, much less how chelicerae achieve their diverse, often sex-specific, morphologies. The harvestman *Phalangium opilio* is the foremost model system for investigating cheliceral development, given established genomic and functional resources for this species, as well as the incidence of sexually dimorphic cheliceral “horns” that are used by adult males for intraspecific combat. Here, we interrogated the genetic basis for cheliceral and pedipalpal fate specification using gene silencing approaches in developing harvestman embryos. We demonstrate how interfering with transcriptional factors at key points in development result in homeotic transformations of mouthparts to legs, and vice versa. Separately, we identified the postembryonic stages where the cheliceral horn polymorphism is established, and generated tissue-specific RNA-Seq datasets to characterize the transcriptional dynamics of horn primordia in juvenile majors, minors, and females. The resulting datasets provide the first windows into the mechanistic basis for the development of sexually dimorphic armature in Opiliones.

Phylogeny Symposium
*Short talk*

# The implications of arachnid paraphyly and the future of chelicerate phylogenomics

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Deciphering the evolutionary relationships of Chelicerata (arachnids, horseshoe crabs, and allied taxa) has proven notoriously difficult, due to their ancient rapid radiation and the incidence of elevated evolutionary rates in several lineages. Although conflicting hypotheses prevail in morphological and molecular data sets alike, the monophyly of Arachnida has been nearly universally accepted for over a century. Here, I review recent paradigm shifts in chelicerate phylogeny, emphasizing conflicting outcomes of several phylotranscriptomic studies over the past decade. I show that analyses sampling all arachnid orders consistently reject arachnid monophyly and recover a derived placement of Merostomata within Arachnida, regardless of analytical approach to orthology inference, filtering by slowly-evolving genes, use of site heterogeneous models, and inclusion of morphological datasets as standalone or combined analyses. The ensuing tree topologies substantiate more complex scenarios of evolutionary transitions between aquatic and land habitats than previously envisioned, an observation that is supported by phylogenetic patterns within diverse arthropod groups (e.g., Acariformes; Decapoda; Isopoda), as well as the fossil record of taxa like scorpions. Considering the invertebrate phylogenomic literature more broadly, I propose that adaptations to life in terrestrial habitats underlie positively misleading levels of morphological convergence across the tree of life, driving the historical perception that terrestrialization is an uncommon or unlikely phenomenon. I further postulate that the future of chelicerate phylogenomics must emphasize higher-level phylogenetic data structures, such as whole-genome queries of rare genomic changes, for empirical cases where traditional analyses of morphological and molecular sequence datasets have reached a point of diminishing returns.

Morphology & Physiology
*Short talk*

# Physiological and ecological consequences of a functional trade off in scorpion chelae

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Functional trade-offs occur when a trait enhances the performance of one task at cost of another. One particularly known trade-off exists between speed and force. If the constrains of such trade-off on the musculoskeletal system have been extensively explored in many different systems, the resulting implications in an ecological context are often overlooked.
Scorpion chelae are a remarkably variable character in an order where the general "bauplan" has remained practically unaltered since their colonization of land. Chela shapes range from robust and stout to slender and more elongated. Chela shape is tightly correlated with closing performance, the fastest species are the weakest and the slowest species the strongest. However, how chela shape constrains the arrangement of the closing muscles to favor either a fast or strong closing performance is still unclear. By analyzing synchrotron µCT scans of chela closing muscles in two species at the extremes of the morphological range, I found differences in the number and in the architecture of closing-muscles. Furthermore, by measuring the length of sarcomeres in several species of scorpions across the morphological gradient, I found differences in sarcomere length across closing muscles and across the different types of chelae. These results seem to suggest that species bearing stout and robust chelae tended to evolve toward higher force while species having slender and more elongated chelae toward higher speed. This speed-force trade-off may deeply affect the role of chelae in the ecology of scorpions, specifically in their defensive behavior, foraging ecology, and sexual-related contexts.

Faunistics & Biodiversity
*Short talk*

# Biodiversity of spiders from the cotton growing areas of Punjab, Pakistan

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The present study was designed to record the diversity and population dynamics of different predatory spider species in the cotton agroecosystems of two well-known cotton-producing districts of Punjab, Pakistan. The study was conducted from May to October 2018 and 2019. Sampling was done on fortnightly basis using pitfall traps, sweep netting, visual counting, and hand-picking methods. A total of 10.684 spiders representing 39 species, 28 genera, and 12 families were recorded. Collectively, Araneidae and Lycosidae families contributed 58.55% to the total spider catch. *Neoscona theisi* (Walckenaer 1841) of the family Araneidae was the dominant species with a 12.80% share among the total catch. The estimated species richness of spiders was 95%. Their densities fluctuated with time, however, their peaks were observed in September and/or early October in both districts during the study period. The cluster analysis separated both districts and their selected sites. There was a non-significant association between humidity and rainfall with the active density of spiders. As spiders are efficient biocontrol agents, their number can be enhanced by minimizing the practices which are harmful to these beneficial arachnids.

Morphology & Physiology
*Short talk*

# Chemosensing in spiders: a behavioral and ultrastructural perspective

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The chemical sense plays a pivotal role in most animal for detecting prey, avoiding predators, finding and assessing potential mating partners. The chemical sense is roughly divided in perception of volatile and contact chemical stimuli, generally called olfaction and taste. In most arthropods, olfaction is achieved by cuticular wall-pore sensilla and taste by tip-pore sensilla. The available studies on the external morphology of several spider species suggest that spiders lack wall-pore sensilla. However, there are many behavioral observations that demonstrate attraction of males to signaling females. Thus, how spiders smell has remained a conundrum. We address the sensory equipment of spiders using transmission electron microscopy and ask if there are cryptic differences between tip-pore sensilla depending on their location on the body appendages. We hypothesize that tip-pore sensilla that are in contact with substrates are specialized in gustation whereas those that are not in contact with the substrates are specialized in olfaction. Consequently, they should differ in the details of their ultrastructure. We used an orb-weaver (*Argiope bruennichi*) and a cursorial hunter (*Pisaura mirabilis*) for comparison. After assessing each podomere of the body appendages of males and females in different behavioral contexts we found that only the distal podomeres (tarsi and metatarsi) are contact zones. We currently focus on *A. bruennichi* and investigate the tip-pore sensilla on the tarsus and on more proximal podomeres (femora/tibia) using transmission electron microscopy. This comparison will reveal whether there is a cryptic disparity in ultrastructure between contact and no-contact zones of the spider's legs.

Behavior
*Short talk*

# Male vibratory courtship does not affect female predatory behaviour in the cursorial spider, *Pisaura mirabilis*

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Male courtship can serve various purposes such as species recognition, indication of quality or mating status. Spiders are known for sexual cannibalism; therefore, we can expect that male traits evolved to reduce the risk of being cannibalized. Spiders are also known for using substrate-borne vibrations to sense their environment. In orb-web spiders, male vibratory courtship can delay female predatory behaviour, presumably to protect males from female attack as they traverse the web (Wignall & Herberstein 2021). *Pisaura mirabilis* is a cursorial spider that does not make a web, but males produce substrate borne vibratory courtship when they encounter female dragline silk (Eberhard et al. 2021). This raises the question of whether male vibratory courtship similarly delays female predation in *P. mirabilis* as was shown for an orb-web spider. We investigated whether male vibratory courtship signals delay female predatory response. We tested this hypothesis by playing back male vibratory courtship, white noise or a silent control while simultaneously exposing females to prey (N=52). We found no delay of female predatory response to prey, nor other differences in female predatory behaviour between treatments. Our results suggest that male vibratory courtship does not serve to reduce female aggression towards courting males in *P. mirabilis*.

Eberhard,M.J.B., Möller,T.A., & Uhl,G. (2021). Dragline silk reveals female developmental stage and mediates male vibratory courtship in the nuptial gift-giving spider *Pisaura mirabilis*. Ethology, 127,267-277.
Wignall,A.E., & Herberstein,M.E. (2021). Male courtship reduces the risk of female aggression in web-building spiders but varies in structure. Behavioral Ecology, 33(1),280–287

Latrodectus Symposium
*Short talk*

# Genetic Architecture of SSD and Male Self-Sacrificial Traits in a Sexually Cannibalistic Widow Spider

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The eSSD syndrome describes a combination of dwarf males, giant females with monogyny, an extreme mating system. Australian Redbacks, *Latrodectus hasselti*, are a well-studied example for eSSD. Males show a series of adaptations to facilitate mating and monopolisation of paternity, including a copulatory somersault, mating plugs and an abdominal constriction that prolongs life despite sexual cannibalism.
The recently diverged *Latrodectus katipo*, however, has completely different traits. L. katipo has a lower degree of SSD and does not show any cannibalism or abdominal constriction during mating. Besides, males do not use copulatory plugs and both sexes are polygamous. *L. katipo* females are able to mate with *L. hasselti* males and produce fertile offspring. By using this hybridization, we will observe the inheritance of mating behaviours of crosses and backcrosses and phenotype their morphology. Phenotyping will be accompanied by genomic data obtained by Henrik Krehenwinkel and colleagues. Thereby, we can test hypotheses about the evolution of extreme traits under sexual selection and sexual conflict, and unravel the genetic architecture of monogyny in *L. hasselti*.

Faunistics & Biodiversity
*Short talk*

# SPIN-CITY*: can spiders adapt to city living?

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Cities are anthropogenic areas that differ markedly in (a)biotic characteristics compared to the surrounding countryside. Urban centers can heat up considerably due to the urban heat island effect (the use of building materials that trap heat, the loss of plants, wind, and water) and are typically characterized by a reduced insect community. This leads to specific thermoregulatory and dietary challenges, especially for ectothermic predators. The European garden spider (*Araneus diadematus*) exhibits a remarkable, continuous colour variation, ranging from pale to dark individuals and displays high plasticity in web building. Thermal melanism theory predicts that the increased urban temperature prompts an evolutionary response leading to paler individuals in urban areas that can stay cooler compared to their darker counterparts. Additionally, adapting to a lower availability of smaller prey would result in the construction of webs with smaller meshes. To test this, we determined spider colour, body size and web characteristics of spiders in 14 European and North American cities along an urban/rural gradient in an ongoing, international collaborative effort (more info on: https://www.spiderspotter.com/en/info/for-scientists). Our results demonstrate high variability in both the densities of *A. diadematus* and in the response of spider traits to urbanisation which is likely driven by specific city characteristics.

*SPIN means spider in Dutch

Faunistics & Biodiversity
*Short talk*

# Araneofauna in the Republic of Moldova: past and future

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Study of spiders was fragmentary and unsystematic in the Republic of Moldova for a long time. Currently 294 species are known from the electronic source https://araneae.nmbe.ch/ (2022-year version), 292 species were listed by Mikhailov in 2013 in his non-annotated checklist.
The history of the spider research can be divided in three periods. The first period lasted when the territory of Moldova with border changes was called Bessarabia (1893–1940). It was characterized by individual and mostly private collections of Araneae and related analysis of them. The second period of spider study took place when Moldova was a part of the Soviet Union (1940–1991). The research during the period concerned diversity of spiders and their relation to ecosystems of agricultural plots, forests and orchards. The third period can be distinguished from the time when the Republic of Moldova obtained independence to our days (1991–2021). In that period mainly new findings were made from analyzing collections and data of previous studies.
From spring 2021 to spring 2022 there was the modern research on spiders in Moldova. Data from past publications were analyzed, selected and combined. New samples were collected from different parts of Moldova, examined, identified to the species-level and composed systematic Araneae collection. Overall 351 spider species are related to the fauna of Moldova according combined data with past and present records. The collection 2021–22 includes 85 species with 38 new species for the country.

The research was supported by the project EVOLANTER 20.80009.7007.02.

Metabarcoding
*Short talk*

## eDNA – a new application for monitoring spider diversity?

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Biodiversity assessments are used to evaluate ecosystems and to classify habitats. However, many classical monitoring methods are highly invasive and could lead to further damage when applied in high-scale studies. Hence, new methods have to be created and tested. The usage of environmental DNA is known to work for aquatic ecosystems and the number of its applications grows every year. Lately, newer studies have shown the functionality of eDNA for terrestrial ecosystems. Since spiders control insect populations, this group is often focused in biodiversity assessments. Here, we test how precisely the eDNA-based approach reflects the real diversity of spiders on a semi-arid grassland. Furthermore, we want to discuss how our results can improve future surveys.

Phylogeny Symposium
*Short talk*

# Evolutionary morphology and the phylogeny of chelicerates

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Discussions about chelicerate phylogeny have been going on for decades. And although most scientists would probably agree that a common drive towards a consensually accepted, robustly supported hypothesis is urgently needed in order to understand chelicerate evolution, there is little evidence for a push towards such a consensus.
In my two-sectioned talk I will first review progress in recent chelicerate phylogenetics and analyse the pitfalls in certain of the steps taken in the creation of a phylogenetic hypothesis, and in the second part I will highlight recent advances in the analysis of animal structure as a prerequisite for its evaluation within a phylogenetic context.
Being convinced of a total evidence approach in its broadest sense I would like to promote a common research drive that brings together scientists from as many methodological fields and data from as many data sources as possible to forge a path towards a universally acceptable hypothesis on chelicerate phylogeny.

Ecology
*Short talk*

# Short and long term effects of applying prescribed burn in heathlands on spider and harvestmen assemblages

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Dry heathlands in Poland require active protection. They undergo succession by trees, heather thicket needs regular rejuvenation, of concern is also the competition between *Calluna vulgaris* (common heather) and *Molinia caerulea* (purple moor-grass). One of the methods of heathland management is prescribed burn. It was applied in Poland for the first time in 2015 in a single plot. From this time on a continuous survey of this plot and its reference, the unburnt control is carried out (the whole year round). Two further plots were burnt in 2018, they have also been incessantly monitored until today. In this case the state before burning was also analysed, thus direct impact of fire on arthropod assemblages could be examined.
Two of the focal animal groups in this multi-taxa survey are spiders and harvestmen. The fire had a significant influence on assemblages of these arachnids in changing their composition, species richness, dominance and diversity. The changes seem to be immediate, some pioneer species invade the burnt plot, however some species typical for heather patches persist. The heather regenerates quickly within the years following the burn and slight changes in abundance of selected spider species could be observed, the changes differ between the study plots.
Thus, the main questions of this paper are: how does the spider and harvestmen fauna change in subsequent years following the prescribed burn?; what is the direct impact of fire on spider assemblages?

Evolutionary Biology
*Short talk*

# Repeated evolution of extreme locomotor performance independent of changes in web use in Austral brown spiders (Amaurobioidea/Dictynoidea)

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Many animals utilize self-built structures – so-called extended phenotypes – to benefit or enhance body functions, such as thermoregulation, prey capture or defence. Yet, it is unclear whether the evolution of animal constructions extends or replaces body functions. Using the diverse clade of Austral brown spiders (Austral marronoids) as a model system, we explored if the evolutionary loss and gain of webs as extended prey capture devices correlated with changes in locomotor performance and leg spination – both functional traits associated with prey capture. For this purpose, we combined the inference of the first comprehensive phylogeny of the Austral marronoid clade of spiders using UCE target sequence capture, with the assembly of kinematic, morphological and ecological data. We found that in this group extreme locomotor performance with running speeds of over 100 body lengths per second evolved repeatedly – both in web builders and cursorial spiders. Neither running speed nor leg spination was highly correlated with the use of extended phenotypes – each of these traits showed mosaic, independent evolutionary patterns. This indicates that the use of webs does not reduce the selective pressure on body functions involved in prey capture. Furthermore, our phylogeny is the first step towards a systematic revision of marronoid spiders – one of the most unstable and uncertain parts of spider systematics.

Faunistics & Biodiversity
*Short talk*

# Spiders Diversity (Arachnida: Araneae) in the Northern forests of Armenia

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An exploratory survey and analysis of spider diversity were conducted in five biodiversity hotspots in Armenia. The study was conducted in Dilijan (Tavush province). A total of 97 species of spiders belonging to 20 Families and 67 genera have been sampled from this area. Among these, 13 spp. have been identified as a new to Armenian fauna. Linyphiidae were the most dominant family represented by 27 spp. (or the most studied one). A comparative study of species collected from Northern forests revealed low degrees of endemism. As a result, Armenian forests aren't isolated geographically from the South Caucasus nature in spite of the unique environmental conditions (being upland), thus, this ecosystem contributes to the similar speciation in the area as of neighboring fauna.
These numbers are based on material collected during 2019-2021, collection material of NAS RA Scientific center of Zoology, and the faunistic Database on the Spiders of the Caucasus Ecoregion.

Ecology
*Short talk*

# Ecological aspects of the enigmatic myrmecophile scorpion *Birulatus israelensis* (Arachnida: Scorpiones)

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Myrmecophily, a symbiotic relation between ants and other organism, is an unusual phenomenon that requires special adaptations to survive ant's aggression. While trying to find the rare scorpion *Birulatus israelensis* Lourenço, 2002 we found that they live in close proximity to the harvest ants *Messor ebeninus* Santschi, 1927. A symbiotic interaction between scorpions and ants has never been identified before, and it is not clear what is the nature of this symbiosis. To reveal some of this mystery, we conduct a comprehensive field survey collecting data on scorpion whereabouts and their proximity to harvest ants, as well as laboratory and field experiments. The field survey indicates that *B. israelensis* are found only in or very near to *M. ebeninus* nests. Using laboratory feeding experiment, we found that scorpions consume ant larvae in greater proportions than alternative prey. Using a field experiment we discovered that ants were less aggressive toward scorpions inhabiting their own nest than toward scorpions from other ant nests. Yet, regardless to their origin, ants expressed less aggressiveness to scorpions that kept away from the nests for several weeks than to those kept away from the nest for few hours. Furthermore, we described the scorpion behavior in relation to ant's aggression. Our results suggest that *B. israelensis* is an obligatory exploitative symbiont in *M. ebeninus* colonies. The scorpions benefit protective surrounding and food abundance in the ant's colonies, while many times ignored by the ants, and uses a special set of behaviors to overcome an ant's attack.

# Poster

Poster 40

# Body-size variation in *Nemesia* males and the description of the smallest species thus far recorded (Araneae, Mygalomorphae, Nemesiidae)

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In a famous essay titled “On Being the Right Size” the great J.B. Haldane (1926) explains why different types of animals have body-sizes as a consequence of differential growth ranges between increasing length, surface and volume. This is proverbially illustrated in terrestrial vertebrates with respect to the different body-plans of the mouse and the elephant. However, the expression of “Haldane’s rule” appears to be stronger in large animals (vertebrates) than in small animals (e.g., arachnids). In mygalomorph spiders for instance the largest spiders (fam. Theraphosidae) are approximately 100x larger than the smallest (fam. Micromygalidae) without much difference in body-plan. At the genus level however size ranges in mygalomorphs are usually quite narrow. In the genus *Nemesia* for example over 90% of all 64 nominate species have carapace lengths between 5 and 7 millimetres. Nevertheless, even at the genus level exceptions exist as evidenced by a newly discovered, here only provisionally described, species from the Sfax region in Tunisia that has a carapace length of only 2.9 millimetres.

Poster 01

# A comparison of two widely-used methods for estimating taxonomic and functional diversities of spiders in some temperate grasslands

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Suction sampling is increasingly being used to estimate abundance and diversity of spiders, yet no study quantified its efficiency to simultaneously assess diversity at different taxonomic and functional scales. Here, we evaluated the efficiency of this method (G-Vac) relatively to the long-term used pitfall trapping (Barber), and their possible complementarity. To do that, we compared several diversity metrics of spiders, and using functional traits such as hunting guild and body size. Sampling took place in some coastal back grasslands of Brittany (France) using a spatially-paired design of vacuuming and unfenced pitfall trapping. A total of 1.018 adult spiders were identified down to species. Suction sampling was more efficient (as compared to pitfall trapping) in collecting web-builders and small species living in the vegetation than for large-bodied spiders living near the soil surface. From our results, we conclude that short-term G-Vac suction is more interesting than pitfall trapping to have a 'snapshot' of patterns in taxonomic richness. However, for assessing functional diversity, G-Vac suction and pitfall trapping are complementary sampling methods.

Poster 02

# Natural history and genetic variation of an introduced European ant-mimicking spider, *Myrmarachne formicaria*, in western New York

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The ant-mimicking spider *Myrmarachne formicaria* (Araneae: Salticidae) is a recent arrival to North America from Eurasia, first noted in Ohio in 2001, but little is known about its natural history in its native or invaded range. Most early published accounts of this species in North America are from domestic settings around buildings. To determine if these spiders are associated with ant density or specific habitats, grids of pin flags, a commonly used substrate for their silken shelters, were employed as a sampling method at 18 sites that were visited weekly over summers 2019-20 to check for the presence of *M. formicaria*. Surveys of ant abundance at sites in 2019 revealed no significant association with these spiders, which were rare in older forest with a sparse understory, but frequently found in younger forest, forest edges, and fields. Egg masses were noted in early June, while spiderlings appeared in early July. Females or juveniles were much more common in surveyed sites than mature males, which were not apparent in shelters until August. Species occurrence data from the Global Biodiversity Information Facility (GBIF) provided a means of comparing phenology of M. formicaria in its native range to that observed in North America. Sequencing of a 600-bp mitochondrial DNA gene region in spiders from 14 localities in New York, Pennsylvania, and Ohio yielded very little genetic polymorphism, consistent with a single invasion of *M. formicaria* from one source locality, but data from other molecular markers and more samples are needed to confirm this conclusion.

Poster 03

# A forgotten world: Amber harvestmen as a window into past diversity

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Living harvestmen represent the third largest order of arachnids following mites and spiders. Their modern diversity is, however, not reflected in the fossil record with only a small number of extinct harvestmen described. Most of their evolutionary history is still a mystery. Numerous undescribed harvestman fossils from major amber deposits including Baltic, Bitterfeld, Burmese and Rovno amber have become available for study. Forty-five fossils from all four suborders (Cyphophthalmi, Eupnoi, Dyspnoi and Laniatores) have been examined and twenty-four represent new species. These finds reveal a number of unknown morphological characters, new calibration points for the harvestmen tree of life and new insights into the group's biogeographical history. Notable highlights include the first fossil belonging to the nemastomatid subfamily Ortholasmatinae from Eocene Baltic amber (a group today found in Asia and North America), the first eupnoid from Southeast Asian Burmese amber, a cyphophthalmid showing intriguing adaptations possibly for a partly aquatic lifestyle, and the first fossils of the infraorder Insidiatores (Laniatores) which support the hypothesis of a Gondwanan origin for the Burmese amber fauna.

Poster 04

# Change of mechanical characteristics in spider silk capture threads after contact with prey

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Most spiders rely on specialized capture threads to subdue prey. Cribellate spiders use capture threads, whose adhesion is based on thousands of nanofibers instead of specialized glue. The nanofibers adhere due to van der Waals and hygroscopic forces, but the adhesion is strengthened by an interaction with the cuticular hydrocarbons (CHCs) covering almost all insects. The interaction between CHCs and cribellate threads becomes visible through migration of the CHCs into the thread even far beyond the point of contact. In this study, we were able to show that the migrated CHCs not only influence adhesion but also change the mechanical characteristics of the thread. While adhesion, extensibility and total energy decreased in threads treated with CHCs from different insects, we observed an increasing force required to break threads. Such mechanical changes could be beneficial for the spider: Upon the first impact of the insect in the web, it is important to absorb all the energy without breaking. Afterwards, a reduction in extensibility could cause the insect to stay closer to the web and thus become additionally entangled in neighboring threads. An increased tensile force would additionally ensure that for insects already in the web, it is even harder to free themselves. All in all, these changes make it unlikely that cribellate spiders can reuse their capture threads, if not detangling and subduing the prey rapidly before the CHCs can spread across the thread.

Poster 05

# Body size and short distance mobility are modulated by field farming system and local habitat characteristics

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Body size is one of the most important traits to understand inter and intra-specific interactions and ecosystem functioning. Habitat homogenisation in agroecosystems is a major threat to Biodiversity. In this study, we investigated how the local habitat conditions affect the body size and mobility of spiders. Twenty pairs of spatially-matched CF vs. OF fields were sampled. Local habitat structure and composition have been recorded also. Prosoma width and length and femora length of 950 individuals belonging to 17 wolf spider species (Lycosidae) were measured. As the prosoma length and width were highly correlated, we used prosoma width as a proxy of body size and femora length as a proxy for short distance mobility.
The body size and femora length of spiders was significantly smaller in OF compared to CF and in females compared to males. Both traits were also negatively correlated to vegetation density and femora length was positively correlated to the proportion of bare soil. Our results suggest that the variation of body size and mobility are affected by the local habitat conditions with higher prey availability in OF compared to CF and a more complex habitat in OF but on the other hand more intra and inter-specific competition in OF, as potential drivers. Our results also show that the variation in body size and mobility between males and females depends on the spider species. These results partly stem from, but also have implications for their habitat preferences, food limitation as well as intra and inter-specific interactions.

Poster 06

# Historical collection of Greek spiders (Arachnida: Araneae) in the National Museum in Prague (Czech Republic)

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The collection of historical Greek spiders contains material from three distinct periods. The oldest material originates from zoological expeditions organized by the National Museum before the World War II. Spiders were collected by a herpetologist Otakar Štěpánek (1903–1995), an entomologist Josef Mařan (1905–1978) and a volunteer and later a curator of the Invertebrates Karel Táborský (1906–1988). They were collecting at western Greece – Ioannina, Katarraktis – and the island of Corfu (1927), in the Parnas Mts. and Peloponnesus (1935), Crete (1934–1936, 1938), northern Greece – Nausa cave (1937) and the island of Gavdos (1938). Further material, containing five specimens only, comes from the collection of a Czech arachnologist František Miller (1902–1983). His collection contains *Meta menardi* and *Histopona strinatii* from the Kastria cave (1966). The relatively youngest samples of wolf spiders (Lycosidae) were collected by other Czech arachnologist Jan Buchar (1932–2015) in Thessaly, Thrace, Peloponnesus, Rhodes etc. As he published the material gathered by him (Buchar 2001, 2009; Buchar & Dolanský 2011; Buchar & Thaler 2002; Thaler et al. 2000), we do not treat with it in this contribution. The spiders were identified (or revised) according to current arachnological knowledge and databased. Hence, we provide here yet unpublished faunistic records from 23 localities in Greece. The material includes 298 specimens from 85 species. Among them, *Leviellus stroemi* and *Typhlonesticus* sp. are new to Greek spider fauna.

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Poster 07

# Salt marshes - important habitats for epigeic spider communities

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Inland salt marshes represent grassland formations on very saline soils. They belong to one of the most endangered habitats in the whole of the Europe. They are part of the Habitats Directive and are among the priority habitats of the European Union. Salt marshes are very rare today, especially in the lowlands of southern Slovakia. From the arachnological point of view, the Slovak salt marshes were almost completely unknown. In an effort to fill this gap, from 2017 to 2019 we conducted research on epigeic communities of spiders in 15 habitats located in 8 protected salt marshes of south-western Slovakia included in the Natura 2000 network (Bokrošské salt marsh, Búč, Kamenínske salt marshes, Mostové, Panské lúky - Ráczovo jazierko, Pavelské salt marsh, Síky, Šurianske salt marshes). During this period, we captured more than 10,000 individuals of spiders belonging to more than 200 species and 24 families. We recorded the occurrence of 8 new species for the fauna of Slovakia, the occurrence of many endangered species and the occurrence of several very rare species listed from Slovakia only in the last decade, as well as the occurrence of several rare halophilic spiders. From the studied localities, the Kamenín salt marsh (108 species) and Bokroš salt marsh (102 species) showed the highest species richness. The high species richness and occurrence of rare and endangered species point to the great importance and significance of salt marshes in the landscape in terms of biodiversity conservation and the need to protect them.

Poster 08

# Effect of guano type and cave zoning on the metabolic rate of Mediterranean recluse spider (*Loxosceles rufescens*)

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Variation in basal metabolic rate between species is largely explained by body mass, trophic level, phylogenetic position, and specific adaptations to environmental context. Subterranean organisms are hypothesized to have lower basal metabolic rate, in comparison to their epigean congeners, as a result of physiological adaptations to life in caves. *Loxosceles rufescens* is a prevalent spider in northern Israel caves that inhabit different ecological zones of within (entrance, twilight and dark zones) and outside caves. Our goal was to explore how the different zones and the presence of frugivorous versus insectivorous bats affect the metabolic rate of *L. rufescens*. For this purpose, we collected 44 individuals from three frugivorous bat caves and 36 individuals from three insectivorous bat caves and measured their CO2 respiration rate in a closed chamber system. Spiders from caves inhabited by frugivorous bats had higher metabolic rates compared to spiders from insectivorous bat caves. Metabolic rates of spiders from frugivorous bat caves were higher at the dark zones compared to the cave entrance. However, metabolic rates of spiders from insectivorous bat caves were lower in the dark zones in comparison to the entrance. Our results highlight the importance of ecological context in determining metabolic rates of conspecifics.

Poster 09

# On the alien-invasive spiders (Arachnida, Araneae) from Republic of Kosovo

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Herein we are reporting for the first time three alien species *Parasteatoda tepidariorum* (C. L. Koch, 1841), *Erigone dentosa* O. Pickard-Cambridge, 1894, *Ostearius melanopygius* (O. Pickard-Cambridge, 1880) their distributions and *Pholcus phalangioides* (Fuesslin, 1775) new records and distribution.

Poster 10

# Attraction or repelling effects of commercial plant essential oils on the synanthropic *Cheiracanthium mildei* (Araneae: Cheiracanthiidae)

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The northern yellow sac spider *Cheiracanthium mildei* L. Koch, is expanding its range to Central Europe, especially to synanthropic habitats. The spiders become unwanted companions because of the unreasonable fear – arachnophobia, and esthetic reason – silk retreats in corners, capturing dust. The most commonly used substances against spiders are pesticides, which are, however, toxic. In our work, we tested the attraction or repellence of 15 essential oils (EO) from plants representing eight families to C. mildei. Our research has shown a significant repellent effect of EO from three plants, namely *Syzygium aromaticum* (L.) Merr. et L. M. Perry (Myrtales: Myrtaceae), *Ananas comosus* (L.) Merr. (Poales: Bromeliaceae) and *Musa* sp. (L.) (Zingiberales: Musaceae). In contrast, some EOs appeared to have an attraction effect, particularly *Carum carvi* L. (Apiales: Apiaceae). *Zingiber officinale* Roscoe (Zingiberales: Zingiberaceae) reduced the tendency of spiders to construct the silken retreat. *S. aromaticum*, *A. sativus*, *Musa* sp. and *Z. officinale* have the potential to be used as natural repellents against spiders.

Poster 11

# DNA barcoding of *Oreoneta frigida* (Thorell 1872) individual from Greenland shows close genetic relationship with *O. montigena* from the Alps but is a different species from other barcoded *O. frigida* individuals from Canada, Norway and Russia

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DNA barcoding of COI has revealed a close genetic relationship between *Oreoneta frigid*a found at a glacier foreland in West Greenland and O. montigena from the Alps where this species is supposed to be endemic. The pairwise K2P-distance between *O. frigida* found in Greenland and *O. montigena* from Tyrol in the Alps is 0.9 % while the K2P-distance to *O. frigida* found in Canada (Nunavut), Norway and Russia is 3.3 % which (most likely) makes the barcoded "*O. frigida*" individual from West Greenland and the barcoded "*O. frigida*" individuals from Canada, Norway and Russia different species. There is a clear morfological difference between *O. frigida* found in the North Atlantic region and *O. montigena* while there is no obvious morfological difference between the barcoded "*O. frigida*" from Greenland and the barcoded "*O. frigida*" individuals from Canada (Nunavut), Norway and Russia.
*Oreoneta frigida* was described by Thorell in 1872 from a female collected on Disko Island of Western Greenland. This makes it more likely that Greenlandic specimens indeed are *O. frigida*, while specimens from Canada (Nunavut), Norway and Russia – if belonging to a different species – should be assigned to a valid synonym. We plan to barcode additional "*O. frigida*" individuals from other areas in the North Atlantic region (Iceland and Faroe islands) to get a more precise information of the geographical distribution of this specific genetic variation of "*O. frigida*".

Poster 12

# The tell-tale spider - a new species of *Troglohyphantes* (Araneae: Linyphiidae) from Corsica reveals unexpected biogeographic connections

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Spiders of the genus *Troglohyphantes* (Araneae: Linyphiidae) underwent a remarkable radiation in caves and other subterranean ecosystems across European mountain ranges, with 131 species and 5 subspecies currently described and several more being discovered each year. Recent studies on this genus focused on Italian Alpine species, while information outside the Alps is mostly missing. Despite the potential of *Troglohyphantes* as a biogeographical indicator, no attempt has been made to reconstruct the geological events underlying the current distribution patterns of its species. By coupling traditional taxonomy with time-stamped target gene molecular data and comparative functional trait analyses, we investigated the origins and relationships of the first *Troglohyphantes* species reported in the island of Corsica (France). The undescribed species is characterised by a high level of subterranean adaptation and distinct morphological affinities with geographically distant species. We advanced and tested alternative hypotheses explaining the origin of the species and conclude that the new species diverged in the lower Miocene (approximately 20 Ma) from an ancestral lineage inhabiting the Adrian plate. Given the unique geological history of Corsica, and in the absence of fossil evidence, our findings are noteworthy and represent a major step forward in reconstructing the biogeography and evolutionary history of this remarkable genus.

Poster 13

# The Diversity of Nemastomatidae (Opiliones: Dyspnoi) in Greece

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Nemastomatidae is the most diverse family of Dyspnoi, consisting of 190 species up to now worldwide. Despite the numerous studies within Europe, the nemastomatid fauna in Greece is poorly studied. The aim of this study is to investigate the diversity of this fauna and the species distribution in Greece. The material was obtained mostly from the Opiliones collection of Natural History Museum of Crete, the Collection of Jochen Martens and the arachnological collection of Senckenberg Museum in Frankfurt. The specimens were examined and identified at species level. Fourteen species were found in Greece, from which four are new records for Greece (*Carinostoma ornatum, Histricostoma drenskii, Mediostoma izmiricum, Pyza bosnica*) and three are new species to science (two new species of *Mitostoma* and a new species of *Mediostoma*). Because of the numerous taxonomical issues and the determination difficulties, Paranemastoma specimens were identified up to genus level only and have not been included in the total species number. In total, 29 nemastomatid species have been recorded from Greece. There will be about six species of *Paranemastoma* which are not included in the total Greek record due to unresolved taxonomy. However, 44% of the total number of all Greek species belongs to dubious records (Roewerian references). The large number of the incorrect geographical references and the complicated taxonomy of some genera indicate that further investigation is needed, not only to validate the current species list, but also to discover a pretty large remainder of the fauna, which is still unknown.

Poster 14

# "From childhood's hour I have not been as others were" - On the monotypy of *Vesubia jugorum* (Araneae, Lycosidae)

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*Vesubia jugorum* (Araneae, Lycosidae) was described by Simon in 1881 on the basis of a female specimen collected in high alpine habitat in the nearby of Saint-Martin-Vésubie, (France, Provence-Alpes-Côte d'Azur). It shows a relatively small distribution range, centered in the French and Italian Maritime Alps, where it occurs in rocky environments above 2,300 m of altitude. The species was initially placed in the genus *Trabea* (Simon) and later included in the genus *Lycosa* (Latreille), within the Q group - "Sectio II. Chelarum margo inferior bidentatus" by Simon. The genus was later established in the Lycosinae subfamily by Simon himself and kept monotypic until Roewer added *Arctosa gertschii* Fox, *Tarentula vivax* Thorell, *Lycosa ligata* Cambridge, *Lycosa magallanica* Karsch and *Lycosa caduca* Karsch. Subsequent nomenclatorial revisions lead to the current assignment of three species to the genus: *Vesubia caduca* (Karsch) from Polynesia, *V. vivax* (Thorell) widespread in Russia and Turkmenistan, and *V. jugorum*. After the examination of the type specimens of the tree species we conclude that *V. vivax* is a junior synonym of *Alopecosa aculeata* (Clerck) and, based on the genital morphology we consider to *V. caduca* as not congeneric with *V. jugorum*. Additionally, we perform a molecular analysis using nuclear (28s, H3) and mitochondrial (NADH, COI, 12s) markers to evaluate the position of *Vesubia*. Prelaminar results of such analysis place *Vesubia* well nested inside of Lycosinae, as sister of *Alopecosa*.

Poster 15

# Mate guarding behavior conditionally changed in Phalangium opilio, a phalangiid species with male dimorphism.

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In species with a male dimorphism, the dimorphism is usually concerned with alternative reproductive tactics of the males, such as guarding their mates (or territories) or sneaking. One of the common species of Opiliones, *Phalangium opilio*, shows male dimorphism in sexually dimorphic characters (chelicera size and morphology, and pedipalpal femur length) in Japanese populations. Chelicera length is very important for male-male competitions and larger males always win competitions over mates. However, their reproductive tactics was still unknown.

To understand male reproductive tactics of *Phalangium opilio*, we collected a total of 271 adults of the species at a small grassland in Sapporo, Japan from the end of August to the end of October in 2018. At the laboratory, we introduced 2 males and 2 females in a single 25.5cm × 15cm container and video-recorded their behaviors from 18:00 to 14:00. After they died, we measured lengths of their prosoma (as body length), chelicera, and pedipalp.

In the video experiments, we found that males show a guarding behavior for females over other males in the same container. Males stayed close to a female without mating and sometimes males attacked another male approached to the female. We counted the number of guarding behavior in each video experiment. In all videos in which guard behavior was observed, a male with longer chelicera showed a guard behavior more frequently than other males with shorter chelicera in the container, regardless of the male's actual size. It seems that males change their behavior depending on their opponents.

Poster 16

# The Fauna Portal Australia - a web-based diagnostic platform documenting undescribed species

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The Fauna Portal Australia (www.faunaportal.org) aims to provide a stopgap for the documentation and identification of Australia's undocumented invertebrate fauna. The implementation of the Fauna Portal is based on the web enterprise content management system TYPO3 which allows the creation of an interactive web application that supports an easy and time-efficient input, administration and front-end output of the relevant taxa. Both manual input and automated data import of species and their records are supported. An essential part of the Fauna Portal homepage is represented by an extensive filter-based image selection, which allows a fast parallel access to all species in different selectable systematic hierarchy levels. Using the filters, images can be displayed based on specific morphological characteristics and views with species potentially restricted by a polygon selection in a locality map. For example, one can display the ventral views of a spider pedipalp of a certain genus and only those images are displayed that represent species occurring in a preselected geographic area.
Each species is documented on a webpage that summarizes data on its reference specimen, diagnosis, all illustrations, distribution records, and molecular data. Future implementations may allow for an automated formal description of each species either by export to a web-based journal (such as the Australian Journal of Taxonomy) or the production of archived web-based pdfs into a Fauna Portal Journal.

Poster 17

# Nanofiber processing by cribellate spiders

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Cribellate spiders are a paraphyletic group in the order Araneae. From their eponymous cribellum, a spinning plate on the spider's opisthosoma, they produce nanometer-thick fibers to integrate in their complex capture thread structures. Though other traits are also important to capture prey, the nanofibers stick to all surfaces due to van der Waals forces. The spider, however, has a specialized comb, the calamistrum, which hardly adheres to these fibers despite frequent contact.
This raised the question: why do cribellate spiders not stick to the nanofibers when processing these with their calamistrum? For the feather-legged lace weaver, Uloborus plumipes, a fingerprint-like nanopattern has been identified as a spacer, preventing the nanofibers from smoothly adapting to the surface and, thus, decrease van der Waals forces. Other spiders, however, bear other structural features on their calamistrum the function of which remains unsolved.
By investigating the anti-adhesive properties of three distinct cribellate species, we aim to elucidate the function of the various nanostructures on the calamistra. We found comparable structures in a broad range of cribellate species and, hence, assume that the obtained findings are generally transferable. The findings will provide further insights into how cribellate spiders process their fascinating silk. The biomimetic transfer of these unique structures to artificial surfaces could facilitate the easier processing of artificial nanofibers.

Poster 18

# Conservation status of *Troglohyphantes* (Araneae: Linyphiidae) across the Alps and the North-western Dinarides

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The genus *Troglohyphantes* includes 131 species, mainly distributed across the European mountain ranges. The majority of them, dwell in subterranean habitats including caves, mines, soil litter, rocky debris and other moist and shaded retreats. Despite being intensively studied from a taxonomic, ecological and biogeographic standpoint, knowledge on the conservation and the extinction risk of these spiders is lagging. Only three species were included in the 1996 IUCN Red List, but their status has not been updated since. Here we provided the assessment of the conservation status of the 66 species of *Troglohyphantes* occurring in the Alps and the North-western Dinarides, according to the last version of the IUCN Red List criteria. Among them, 62 had sufficient data to allow the quantification of their Extent Of Occurrence (EOO) and Area Of Occupancy (AOO). Most of the species have a narrow distribution range, meeting the thresholds for the inclusion in the threatened categories. Five species have more widespread distributions. A continuing decline in EOO, AOO and habitat quality was inferred for 30 species, mainly subterranean specialised species with a reduced thermal tolerance and a low dispersal ability. Changes in subterranean microclimatic conditions due to climate change represent a major threat for these species. Land use change and habitat alteration were identified as additional relevant threats. Long-term monitoring programmes, management plans for both the species and their habitats, expansion of the extant protected areas and designation of new ones, should be considered as the most effective approaches to species conservation.

Poster 19

# Niche segregation in *Meta* spiders (Araneae, Tetragnathidae) on Mount Etna (Sicily, Italy)

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The genus *Meta* (Araneae: Tetragnathidae) includes two of the most widespread inhabitants of the twilight zone of hypogean sites across Europe: *Meta menardi* (Latreille) and *M. bourneti* Simon. Both species show broad distribution ranges, which can be explained in light of their life cycle, encompassing an epigean dispersive and a sedentary hypogean phase. Recent observations pointed out the presence of both species in volcanic caves of Mount Etna (Sicily), with *M. menardi* occurring in a small number of sites at higher elevations, where *M. bourneti* is absent. On the basis of the field investigations conducted in 2020-2021, we analyzed the ecological drivers of niche segregation of the two species along an altitudinal gradient ranging from sea level to 2,300 m a.s.l. Results underline a dominant effect of temperature variation in determining the exclusive segregation of the two species along the examined gradient. Despite having an important role for both species, other factors such as the age of the lava in which the cave develops and habitat type outside the cave do not have a differential influence on the species choice. Due to the ongoing increase of global temperatures, the observed segregation pattern of the two species will likely be significantly altered, with possible detrimental effects on the survival of *M. menardi* in this area.

Poster 20

# SEM analysis of chemoreceptors on the mouth parts of two spider species with different lifestyles (*Argiope bruennichi*, *Pisaura mirabilis*)

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The chemosensory organs of spiders have been described as tip-pore sensilla. These tip-pore sensilla occur in legs and pedipalps of males and females. However, there is currently no information on the presence of tip pore sensilla on the mouthparts of spiders although these areas are prone to be involved in contact chemoreception, so-called gustation.
We investigated two spider species with different lifestyles (*Argiope bruennichi*, *Pisaura mirabilis*) using SEM analysis and asked if there are tip-pore sensilla on chelicerae, labium and maxillae (coxa of the pedipalps) and if they differ from those found on the legs. We examined three individuals per sex and species.
Tip-pore sensilla were found on the apical rim of the maxillae in both sexes of both species. We did not detect tip-pore sensilla on the chelicerae and labiae and also no other sensilla that could be involved in chemosensing. In both species, the length of the sensilla on the maxillae was significantly shorter compared to those on the legs whereas the shaft diameter did not significantly differ between species. *A. bruennichi* has more sensilla on the maxillae per area compared to *P. mirabilis*.
Since the tip-pore sensilla are adjacent to the serrulae that are used to cut open the prey and masticate it, they are highly likely gustatory sensilla. Since many behavioural observations demonstrate that spiders are also able to perceive volatile odours, the comparison between gustatory sensilla on the maxillae and those sensilla on the legs that do not contact the substrate might reveal differences that help to classify the sensilla into gustatory and olfactory sensilla.

Poster 21

# Male vibratory performance during courtship of *Pisaura mirabilis*

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Arachnids are especially responsive to vibrations of all types, even cursorial spiders which perceive signals through diverse environmental substrates rather than a stationary web. One such species is the Nursery Web Spider, *Pisaura mirabilis*. This species employs several reproductive tactics which make it especially valuable for study. It is one of only a handful of taxa in which males offer females a nuptial gift during the reproductive process, typically consisting of a prey item wrapped in silk. The male's courtship also includes visual, chemical, and most notably, vibrational stimuli. Courtship vibrations consist of repeated pulses, and advertise the male's condition honestly. My project explores the functional role of vibratory communication within the framework of *P. mirabilis* reproduction. I evaluated the vibratory performance of 150 male spiders by collecting repeated recordings and analyzing the pulse train associated with the courtship. Based on temporal variables shown to influence female choice in *P. mirabilis*, I assessed the variability of vibrational performance within the sample and categorized males as either "high-signaling" or "low-signaling." Female spiders were then mated sequentially with males of both good and poor courtship performance, and their behaviors indicating preference were recorded. These were assessed to determine the effect of male vibratory performance on pre-mating female choice. The newly-developed methods and results from this study will inform future work on the full reproductive consequences (paternity of mixed broods) of male vibratory performance in *P. mirabilis*, as well as the role of vibration within the multimodal courtship signal of these spiders.

Poster 22

# When it gets warm in winter: Phenotypic plasticity in a cold adapted population of a range expanding spider

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The spatial distribution of many species is currently shifting since species track favorable environmental conditions due to climate change. The European wasp spider *Argiope bruennichi* has undergone a rapid latitudinal range expansion from the Mediterranean region into the Baltic states and Scandinavia – however, faster than the climate changed. Previous studies showed that hatched spiderlings from edge populations prefer colder temperatures when given a choice and show higher survival probability under the coldest exposure temperatures, strongly suggesting local adaptation to colder winter conditions. However, edge spiderlings weigh less than core spiderlings, and all lose weight during a warm winter treatment. Populations at the northern edge of the distribution might therefore suffer disproportionately from increasingly warmer winters. To explore the degree and limits of plasticity under warmer winters in a cold-adapted population, we exposed spiderlings from Estonia to cold, moderate, and warm winter conditions. We collected data on temperature effects on 1) survival, 2) lipid content, 3) metabolomics, and 4) gene expression. We can build up on a high-quality reference genome and focus on differential expression of cell repair genes, heat shock proteins, and higher expression of cryoprotectants. Studying the responses to different winter temperature regimes will provide information on the degree and mechanisms of plasticity and help predict responses to climate change of recently cold-adapted populations.

Poster 23

# Comparative genetic structure across co-occurring spiders with contrasting levels of cave adaptation and foraging strategies

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Subterranean ecosystems are fragmented and isolated, compromising connectivity across potential habitats in animals inhabiting them. Additionally, the exceptional environmental and biotic conditions in caves impose strong constraints on organisms that thrive therein, which may result in different levels of morphological, physiological, and other types of adaptations (e.g. depigmentation, reduction of the visual system). Highly adapted cave organisms are most likely not able to use surface to disperse any longer, and often experience population dynamics similar to those of island species. In our study, we compared the population genetic structure of five cave spider species with different foraging strategies—ground-dwellers vs. web-builders—and levels of cave adaptation—troglobionts vs. troglophiles. All species co-occur in the NW Dinarides (Balkans, Europe). Two ground-dwelling, depigmented, and anophthalmic Dysderidae species, *Parastalita stygia* (Joseph, 1882) and *Stalita pretneri* Deeleman-Reinhold, 1971, were never collected outside caves. The other three species belonging to the web-building genus *Troglohyphantes* show different levels of dependency on cave habitats. While *T. excavatus* Fage, 1919, and *T. kordunlikanus* Deeleman-Reinhold, 1978 can be found in surface habitats, *T. croaticus* (Chyzer, 1894), is restricted to caves. Since population sizes of cave organisms are usually small and captures sparse, we applied a hybridization-capture museomic approach (i.e., HyRAD) to extract and capture DNA from 117 historical samples. By comparing population genetic structure among the five species, we unveiled the key role of the specific biotic features of each species on shaping their patterns of spatial genetic diversity. In addition, we detected several common barriers to gene flow, which hint at the existence of common phylogeographic breaks driven by the unique climatic and geological history of the region.

Poster 24

# Competitive exclusion in cave-dwelling spiders

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The coexistence of predators in an ecosystem depends on the balance between their ecological requirements and competitive exclusion dynamics. Disentangling the role of these two factors is not straightforward in complex ecosystems, where confounding effects may hamper the definition and quantification of the niche. Being characterized by highly predictable gradients in their environmental conditions and a simplified habitat structure, hypogean ecosystems represent ideal ecological laboratories in this regard. We here investigated the ecological niche of two medium-sized coexisting troglophile spiders, i.e. *Meta menardi* (Tetragnathidae) and *Pimoa graphitica* (Pimoidae). We monitored monthly their spatial and temporal dynamics over one year in four subterranean sites in the Western Italian Alps and recorded the associated physical and ecological variables. We then quantified the ecological preferences of both species and their competition by means of multi regression techniques and by evaluating the intersection between their multidimensional hypervolumes. Our results pointed out a remarkable overlap between the ecological niches of *M. menardi* and *P. graphitica*. However, the former —being larger in size— resulted the best competitor, causing the latter to readjust its spatial niche towards the inner parts of the cave, where prey availability was scarcer. The niche of the two species was also found to be seasonal dependent, varying over the year in response to the intermittent local availability of food resources. With this work, we could demonstrate that energy-poor environments such as caves maintain the potential for the coexistence of top predators via niches differentiation.

Poster 25

# Influence of habitat conditions and agriculture management on the epigeic spider communities of the Little Carpathian viticulture landscape of Modra region

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Vineyards and other historical landscape structure elements represent very important biodiversity hotspots in agricultural landscape. We evaluated the epigeic spiders' biodiversity in various types of vineyards and other landscape structures in the Modra viticulture landscape. In the years 2018 to 2020, we captured more than 11.000 individuals of spiders, belonging to 186 species and 210 taxa, in 11 study sites. The species *Zodarion rubidum* had the dominant representation in the araneocenosis of the model area and the highest species richness was in the Linyphiidae family. In terms of the environmental requirements, open and very dry habitat species predominated in the araneocenosis of the model area. Ground hunters predominated in the representation of trophic-ecological guilds. We have shown that in addition to the environmental factors that significantly affect the composition of araneocenoses, this composition is also influenced by the human intervention, herbaceous layer cover, type of agriculture and the presence of stone rubble in the study sites. We confirmed the association of species to the presence of a certain factor by determining the indicator species of spiders. We noticed the occurrence of 34 ecosozologically significant species included in the Red List of Spiders of Slovakia, two protected species and a new species for the araneofauna of Slovakia, *Walckenaeria stylifrons*. Our research has demonstrated the importance of diverse habitats in the viticulture landscape for the biodiversity of araneocenoses.

Poster 26

# Potential for use of jumping spiders as pest control agents

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Jumping spiders (Araneae: Salticidae) are a significant part of arachnofauna in many agroecosystems, yet studies of their potential for pest control in these ecosystems are usually limited to general response of spider communities to chemical pest control. I would hereby like to present preliminary results of laboratory experiments with jumping spiders. The experiments tested responses of the spiders in different situations relevant in agroecosystems, most notably pesticide treatment and encounter with different predators. The results are discussed in context of previous studies of jumping spiders' predatory behaviour and compared with responses of different spider families under similar experimental conditions.

Poster 27

# The sublethal effects of neonicotinoids on spiders are independent of their nutritional status

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Spiders were recently shown to be adversely affected by field-realistic concentrations of a broad scale of neonicotinoid insecticides. Among the reported effects of neonicotinoids on invertebrates were declines in lipid biosynthesis and upregulation of β-oxidation, while vertebrate models suggest increased adipogenesis following treatment with neonicotinoids. Therefore, we hypothesized that there exists synergy between the effects of diet and concurrent exposure to field-realistic concentrations of neonicotinoid insecticides. To address this hypothesis, we fed first instars of the large wolf spider *Hogna antelucana* with two types of diets and exposed them to field-realistic concentrations of three formulations of neonicotinoids (thiamethoxam, thiacloprid and acetamiprid). We then measured the growth of the tested spiders; the lipid and protein content of their bodies; and their behavior, including ballooning, rappelling, and locomotor parameters. The two tested diets consisted of casein-treated and sucrose-treated *Drosophila melanogaster*. The dietary treatments affected the lipid and protein content of the spiders, their body weight and carapace length but did not affect any of the measured behavioral parameters. Surprisingly, we did not find any effects of acute exposure to neonicotinoid insecticides on the lipid or protein reserves of spiders. Exposure to neonicotinoids altered the behavior of the spiders as reported previously in other spider species; however, these effects were not affected by dietary treatments. Overall, the dietary treatments did not have any major synergy with acute exposure to field-realistic concentrations of neonicotinoid insecticides.

Poster 28

# Can gap cutting help to preserve forest spider communities?

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Continuous cover forestry is gaining momentum in Europe, because it seems to be a better management system both in mitigating climate change and in preserving biodiversity. The Pilis Gap Experiment has begun in 2018 to investigate gap cutting as a means to achieve large scale continuous forest cover. Between 2019-2021, preceded by a fully sampled pre-treatment year, we investigated spider communities in newly created gaps of two different sizes and of elongated vs. circular shape in a six times replicated complete random block design. Pitfall samples of ca. 5.400 spiders indicated that in all gap types we had a nominally higher species richness and abundance of spiders than in control plots; however, significant increase was observable only in elongated plots. Base abundance and richness increased in control plots over the years investigated, but in gap treatments this increase was significantly higher. As compared to more radical forestry treatments, such as clear cutting, which were investigated in a previous phase of the Pilis Forestry Experiments, the spider communities in control and various gap treatments showed only a moderate change. This indicates that gap treatments are very successful in preserving forest spider communities and suggests that the environmental heterogeneity they create is even beneficial to some degree for the spiders.

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Poster 29

# Dissecting the role of the silk protein MaSp2 in the dragline silk mechanical properties in *Parasteatoda tepidariorum* using CRISPR-Cas9

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Spiders produce different types of silk for different purposes, such as egg sacs, dispersal, food foraging, and safety lines. The Dragline silk is responsible for the last two purposes. Its outstanding mechanical properties and higher toughness exceeding most materials have called the attention of scientists for decades. The mechanical traits of the dragline silk are the product of mechanical, chemical, and genetic factors that change the secondary and tertiary structure of the protein (alfa-helix, β-sheets, and β-turns). In this project, I focus on the MaSp2 protein because it is directly linked to the dragline silk toughness. In this project, I will characterize the function of MaSp2 in the dragline silk by using the CRISPR gene Knock-Out (KO) and by measuring the silk tensile properties. If the MaSp2 protein is responsible for the high extensibility and elasticity of the dragline silk, then I will expect to see a difference in the toughness between mutant and non-mutant spiders.

Poster 30

# From field to museum: Harnessing the power of third generation sequencing to establish a simple and cost-effective multiplex approach for spider taxonomy

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In taxonomy, DNA barcoding has become one of the standard methods for distinguishing and identifying species. Often, a single marker, e.g. COI, is used. However, it has been shown that this is not sufficient in many cases, as the evolutionary history of a single gene does not necessarily reflect the species' precise evolutionary history.
Second- and third-generation sequencing made it possible to greatly increase the number of loci available for DNA barcoding. Molecular taxonomic hypotheses can now be based on hundreds or thousands of loci, even allowing the identification of young species. However, such high-throughput approaches considerably increase the workload and cost for DNA barcoding. In a field like taxonomy, which is facing a funding crisis, it is often impossible to acquire the necessary resources.
Here, we aim to develop a novel DNA barcoding protocol that harnesses the power of whole-genome data to identify standardized marker sets across the spider tree of life, though this approach could potentially be applied to all taxa. We will develop both long amplicons for fresh DNA and short amplicons for degraded DNA, allowing the use of historical collection material. The resultant barcodes will be obtainable via a simple multiplex PCR followed by Nanopore sequencing. Our primary objectives for this protocol are simplicity and cost efficiency, making it accessible to taxonomists all over the world, even those with limited funding and research infrastructure.

Poster 31

# Detection of potential biocontrol agents in cereal fields

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Spiders play an important role in controlling pest populations. However, the detection of concrete biotic interactions with traditional ecological methods cannot be easily achieved. Our aim was to identify natural enemies of potential pests in cereal fields using DNA based techniques. We intended to develop a general COI metabarcode sequencing method to identify prey DNA from a broad range of arthropod predators, both arachnids and insects. We tackle this problem by amalgamating and optimizing several techniques available in the literature, in order to provide reliable solution for each step in the process, such as selection of the right fragment of the metabarcoding locus, decontamination of the sample surface, preventing DNA degradation, relative maximization of prey:predator DNA ratio in the samples. In our trials a 260 bp long fragment of the gene was PCR amplified using the primers of Vamos et al. 2017, which are degenerated primers compatible with the high polymorphism of the COI region in the potential pest species. The amplicons were sequenced on the Illumina NovaSeq platform resulting in 150 bp long paired end reads. Quality filtering, denoising and chimera detection were performed using the dada2 R package, then the amplicon sequence variants (ASVs) were classified with RDP classifier using the CO1 v4 database, followed by downstream analyses to assess taxonomic richness and diversity in the samples. Our preliminary results show that metabarcoding is a sufficient tool to assess the diet of spider species and draft the trophic network involving predatory arthropods.

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Poster 32

# Metabarcoding analysis of different portions of the digestive tract of scorpions (Scorpiones, Arachnida) following a controlled diet regime shows long prey DNA half-life.

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Molecular analysis of gut content is one of the widest used methods to investigate diet in arthropods. Stomach content analysis in some arthropods is particularly difficult, e.g. in arachnids, because they have external digestion and a low foraging frequency. Scorpions have a particularly low feeding frequency, and their diet information is scarce. In this work we explore a DNA-metabarcoding approach to detect prey DNA in Vietnamese forest scorpions (Heterometrus laoticus) under a controlled diet regime. A different type of prey (crickets, mealworms, cockroaches) was offered once every three weeks for a total of nine weeks. To assess the most suitable part of the digestive system and extraction method to use for molecular diet analysis, we separately analyzed three different portions of the digestive tract of scorpions (mid-gut, hepatopancreas and hindgut) using two different extraction methods (salt-out method and a customized beads-based protocol). We calculated the detectability half-life of prey DNA for each digestive tract section. We detected all three targeted prey items, showing that in scorpions multiple predation events can be distinguished in the same specimen within its last nine weeks of foraging activity. The hepatopancreas was the portion of the digestive tract that provided the best prey detection and the longest DNA detectability half-life (51 days), followed by the mid-gut (22 days) and the hindgut (16 days). We found no significant difference between the extraction methods used. However, the salt-out method was less effective in some of the PCRs and is therefore not recommended for molecular diet analysis.

Poster 34

# Evolution of prey specialization in crab spiders (Araneae: Thomisidae)

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Prey specialization can either be an evolutionary dead end or promote species diversification. Species of the family Thomisidae are mostly euryphagous, but few species specialized on ants or other spiders. Our aim in this study was to investigate evolution of myrmecophagy (ant-eating) and araneophagy (spider-eating) in thomisids. We performed a new phylogenetic analysis based on molecular data of 73 genera. We also gathered data on prey using prey acceptance experiments and image-based evidence of prey capture from the internet. Then we projected ant-eating and spider-eating behaviour on the phylogenetic tree and estimated ancestral states. We found that both myrmecophagy and araneophagy are ancestral states, suggesting that common ancestors of Thomisidae were euryphagous predators that included ants and spiders in their diet. Stenophagous myrmecophagy evolved at least three times independently.

Poster 33

# Immature mating in *Parasteatoda tepidariorum*? - Is genital development related to alternative mating tactics?

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In most animal taxa, mating occurs after both male and female individuals reached their adult stage, marked by a final moult in spiders. Moulting into adulthood is associated with a multitude of morphological changes and developments in spider genitalia, providing their functionality for reproduction. However, in several sexual cannibalistic *Latrodectus* species, successful mating with immature (late-subadult) females was observed. Surprisingly, in matings with immature females, copulation results in sperm transfer and fertilization of the egg. Correspondingly, the internal female genitalia are already developed and functional in the late-subadult stage. Moreover, since males mating with immature females are not attacked and cannibalized by the female, immature mating can be considered as an alternative mating strategy, increasing the male´s fitness due to fertilization success and lack of sexual cannibalism.
If early development of the internal female genitalia in *L. geometricus* is an exception in spiders, it might have evolved due to selective benefits of immature mating to the females. If early development is the rule in spiders, it is likely that other species also evolved immature mating, however, as yet undetected. In this study, we aimed to compare early internal genitalia development in *L. geometricus* with another theridiid spider, the common house spider Parasteatoda tepidariorum. We investigated the development of the internal female genitalia using light microscopy, histology and micro-computing tomography in early-, late-subadult and adult females. We found that the copulatory ducts and spermathecae of late-subadult females are fully developed. They differ from the adult genitalia mainly by a thinner cuticle around the copulatory ducts and spermathecae as was found for *L. geometricus*. This implies functionality and would allow successful mating with immature females. Mating trials will reveal if the development of the genitalia of late-subadult females is associated with immature mating in this species. This study will pave the way for understanding to what degree conflict and cooperation between the sexes have shaped the evolution of immature mating.

Poster 35

# Effect of bacteria presence on spider silk mechanical performance

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Spider silk have a great potential to be used in medical purposes as bioink, sutures, burn wound bandages, in tissue and organs regeneration. Spider silk is known to be biodegradable, non-cytotoxic, have no immune response and have some bacteriostatic properties as well. However, little research has been published so far on this topic. It has been discovered that silk surface have few layers: lipid layer, glycoprotein layer, skin and core. It has been hypothesized that those layers are responsible for bacteriostatic properties and locking the nutritious silk protein from bacteria degradation. We have isolated few strains of bacteria from *Nephila clavata* and *Nephila pilipes* web and performed microbiological testing using native silk threads and silk after chemical treatment in aim to wash out silk layers. It appears that two species of bacteria *Microbacterium* sp. and *Novosphingobium* sp. cannot grow on native silk, however, we observed grow on silk without glycoprotein cover. In next step, we performed tensile testing of silk with bacteria on each layers to test presence of bacteria on silk mechanical performance. We noticed that different interactions between silk layers and bacteria broths affect different tensile properties. It seems that only diameter affect maximum stress and strain at the breaking point of silk, but neither of treatment. However, treatment silk with bacteria seems to affect negatively Young's modulus and toughness.

Poster 36

# To sample where no one sampled before: Species composition of dwarf spiders from a pitfall trap project in the northern Swiss alps

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Switzerland is a small country but harbours various habitats and a wide range of environmental conditions. This large habitat diversity on small space allows for a relatively high species diversity, which is also reflected in the approximately 1000 spider species currently found in Switzerland. One of the six major biogeographic regions of Switzerland is the northern flank of the Alps. It is a unique environment shaped by large annual and spatial variations in temperature and precipitation. A part of the northern flank of the Alps is located in the canton of St.Gallen. The spider diversity in St. Gallen is currently understudied in comparison to other taxonomic groups, leading to a gap in the knowledge about alpine spider diversity. We try to fill in this gap by assessing the diversity of spiders in the canton. Additionally, we are interested in the relationship between environmental conditions and species composition at the microhabitat scale. We utilize pitfall traps in the region of Pizol to assess species composition. We set up five traps in August 2021, at different expositions around a 3m boulder at 2300 meters above sea level. Since June 2022 we additionally measured temperature and humidity with data loggers to systematically assess the environmental conditions near the traps. First results suggest an impact of humidity, rather than altitude, on the spider community composition. With this research, we hope to contribute to a better understanding of alpine spider species diversity and community composition in relation to environmental drivers.

Poster 37

# Large-scale prevalence of an endosymbiont in the range expanding spider *Zodarion rubidum* Simon 1914

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Endosymbionts are symbiotic organisms, typically bacteria, living inside the body of other organisms and often inducing parasitic interactions. In the last decades, a large diversity of endosymbiotic micro-organisms has been described in a variety of hosts, especially in terrestrial arthropods that seem to be infected in a considerable extent. Endosymbionts have been reported to cause profound effects on populations structure, for example, manipulation of reproductive phenotypes and skewing sex-ratios via mechanisms like feminization or cytoplasmic incompatibilities. Other documented effects include, for instance, nutrient assimilation or thermal tolerance modifications. It has been also shown that dispersion of a spider species was influenced by the presence of an endosymbiont, with infected spiders showing limited dispersal abilities. In a context of a widely expanding spider species, *Zodarion rubidum* Simon, 1914, we investigated the presence of “Candidatus Cardinium”, one of the most common endosymbionts in spiders, among different populations across Europe. Based on a large-scale dataset, we aimed to determine if this endosymbiont showed a spatial distribution. We screened 147 individuals coming from 43 locations by PCR and detected *Cardinium* in almost every individual in all locations. We conclude that the infection dynamic is not spatially structured and show that Cardinium is widespread in populations of *Z. rubidum* across Europe.

Poster 38

# Cribellate thread production as model for spider's spinneret kinematics

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Spider silk attracts researchers from the most diverse fields, such as material science or medicine. However, still little is known about silk aside from its molecular structure and material strength. Spiders produce many different silks and even join several silk types to one functional unit. In cribellate spiders, a complex multi-fibre system with up to six different silks affects the adherence to the prey. The assembly of these cribellate capture threads influences the mechanical properties as each fibre type absorbs forces specifically. For the interplay of fibres, spinnerets have to move spatially and come into contact with each other at specific points in time. However, spinneret kinematics are not well described though highly sophisticated movements are performed which are in no way inferior to the movements of other flexible appendages. We describe here the kinematics for the spinnerets involved in the cribellate spinning process of Badumna longinqua as an example of spinneret kinematics in general. With this information, we set a basis for understanding spinneret kinematics in other spinning processes of spiders and additionally provide inspiration for biomimetic multiple fibre spinning.

Poster 39

# Harvestmen (Opiliones) in the mires of Poland

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There is very little data on the ecology of harvestmen in Poland. Although this animal group is extremely abundant in some places, thus playing an important ecological role, it is often neglected. The reasons for this are mostly the low harvestmen species richness in temperate zones and methodological problems in analysis of their assemblages. The harvestmen seem not particularly associated with any of mire types, but meanwhile they might also be one of the most abundant groups in the peat bogs or some fens.
We gathered the data sampled over the last one a half decade within the course of different ecological studies. The concerned research lasted at least 6 months and animals were sampled continuously with pitfall traps. The studied mires were situated in different regions of Poland and represented miscellaneous types, i.e. montane bogs and poor fens of the Karkonosze and Izera Mts. (the Sudetes), submontane mire complexes in the Orava-Nowy Targ Basin (the Carpathians), bogs, fens and large mire complexes in the Pomerania (N Poland). In total, we analysed 40 mires or mire complexes, with almost a hundred of sampling plots that represent different mire-associated habitats.
The mire fauna is represented predominately by common species. We measured relative abundance of different harvestmen species in relation to basic environmental factors (e.g. altitude, size of habitat patch, plant structure), summed up their richness and species dominance and discerned the indicator species. As background for our analyses, we used similar data from surrounding habitats or other ecological studies.