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Dear Fellow Arachnologists

We are pleased present another issue of the Early Career Newsletter (EarlCNews) of the European Arachnological Society. This newsletter is a special edition of the regular newsletter of the European Society of Arachnology.
This EarlCNews is intended as a platform for the younger members of our Society, including Bachelor, Master and PhD students. The EarlCNews offers the opportunity to report on one own project and research results. It is a collection of summaries of Bachelor, Master and Doctoral theses that have been defended in the past year. You will see that the abstracts in this volume are sorted according to two three scientific areas: Behavioural Ecology, Ecology and Evolution and Faunistics and Genetic.
In order to facilitate direct communication and discussion between members on the research topics, the e-mail addresses of the early career researchers are provided at the end of each abstract to allow direct contact for discussion and exchange of ideas.

We hope that the EarlyCNews will help to network within the society.

Gabriele Uhl
President of the European Arachnological Society

#BEHAVIOURAL ECOLOGY

Andreas FISCHER | PhD thesis

Chemical communication of the false widow spiders *Steatoda grossa* and *S. triangulosa* (Theridiidae)

The chemical ecology of web-building spiders is poorly understood. Only 12 sex pheromones are known, the side of pheromone production remains elusive, a pheromonal function in female-female conflict has not been described, the effect of male pheromone on male copulatory success has rarely been studied, and there is no report whether female spiders recognize 'self'. Addressing these knowledge gaps, I worked with the false black widow *Steatoda grossa*, and the triangulate cobweb spider, *S. triangulosa*.
I found that subadult female *S. grossa* stay cryptic to mate-seeking adult males, which is likely adaptive to sub-adult females that are in sexual conflict with adult males cohabiting their webs. Working with adult female *S. grossa*, I identified three new contact pheromone components: N-4-methylvaleroyl-O-butyroyl-L-serine, N-4-methylvaleroyl-O-isobutyroyl-L-serine and N-4-methylvaleroyl-O-hexanoyl-L-serine. These compounds originate from the posterior aggregate silk gland, induce courtship by males, and web pH-dependently hydrolyse at the carboxylic-ester bond, giving rise to three corresponding carboxylic acids that attract males. A carboxyl ester hydrolase present on webs likely mediates the functional transition of contact sex pheromone components to the carboxylic acid mate attractant pheromone components.
Non-targeted metabolomics helped reveal the contact pheromone components of *S. triangulosa:* N-4-methylvaleroyl-O-isobutyroyl-L-serine, N-3-methylbutanoyl-O-isobutyroyl-L-serine, and N-3-methylbutanoyl-O-butyroyl-L-serine. Hydrolyses of these serine esters gives rise to butyric and isobutyric acids as mate-attractant pheromone components.
Female *S. grossa* sense intra-sexual competition via their sex pheromones, and respond to sexual, social and natural selection pressures originating from intra-sexual conflict. In settings of high intra-sexual competition, females adjusted their webs to increase prey capture and lower predation risk. To alleviate mate competition, females deposited more contact pheromone components on their webs and accelerated their breakdown to mate-attractant pheromone components, essentially increasing their webs' attractiveness.
Web reduction behaviour by courting *S. grossa* males has no long-range effect on mate-seeking males but functions as an inter-sexual signal. Courting males with functional (silk-releasing) spinnerets were more likely to copulate with the female than males with their spinnerets experimentally occluded. The male's signal likely entails a volatile silk-borne pheromone.
Female *S. grossa* indiscriminately accepted both their own webs and egg sacs and those of conspecific females, likely due to a lack of selection pressure to recognize 'self'.

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Philip O.M. STEINHOFF | PhD thesis

Foraging behavior, neuroanatomy and neuroplasticity in cursorial and stationary hunting spiders

The central nervous system (CNS) is the integration centre for the coordination and regulation of all body activities of animals and the source of behavioural patterns, behavioural plasticity, and personality. Understanding the anatomy and the potential for plastic changes of the CNS not only widens the knowledge on the biology of the respective species, but also enables a more fundamental understanding of behavioural and ecological patterns. The CNS of species with different sensory ecologies for example, will show specific differences in the wiring of their CNS, related to their lifestyle. Spiders are a group of mesopredators that include stationary hunting species that build webs for prey capture, and cursorial hunting species that do not build capture webs. These distinct lifestyles are associated with major differences in their sensory equipment, such as size of the different eyes. In my thesis, I aimed to answer if a cursorial mesopredator would change its behaviour due to different levels of perceived predation risk, and if this behaviour would be influenced by individual differences; how the visual pathways in the brain of the cursorial hunting jumping spider *Marpissa*

muscosa differs from that of the nocturnal cursorial hunting wandering spider *Cupiennius salei*; to what degree the visual systems of stationary and cursorial hunting spiders differ and whether CNS areas that process vibratory information show similar differences; and finally if the CNS in stationary and cursorial hunting spiders shows different patterns of neuroplasticity in response to sensory input and deprivation during development. My dissertation entailed four chapters.
In chapter 1, I found that jumping spiders adjust their foraging behaviour to the perceived level of risk. Interestingly variation in behaviour was largely due to among-individual differences in foraging intensity. Our findings highlight consistent among individual differences in the behaviour of animals that forage under risk. Future studies will address potential fitness consequences that may influence food-web dynamics. In chapter 2, I found that the visual pathways in the brain of the jumping spider *M. muscosa* differ from that in the wandering spider *C. salei*. While the pathway of the principal eyes, which are responsible for object discrimination, is the same in both species, considerable differences occur in the pathway of the secondary eyes, which detect movement. Notably, *M. muscosa* possesses an additional second-order visual neuropil, which is integrating information from secondary eyes, and may enable faster movement decisions. I also showed that the tiny posterior median eye is connected to a first-order visual neuropil which in turn connects to the arcuate body (a higher-order neuropil) and is thus not vestigial as suggested before. In chapter 3, I described all neuropils and major tracts in the CNS of two stationary (*Argiope bruennichi* and *Parasteatoda tepidariorum*) and two cursorial hunting spiders (*Pardosa amentata* and *M. muscosa*). I found major differences in the visual systems of the secondary eyes between species. The neuroanatomy of CNS areas that process mechanosensory information, however, is remarkably similar between cursorial and stationary hunting species suggesting that the same major circuits are used for the processing of mechanosensory information. In chapter 4, I found that developmental neuroplasticity in response to sensory input differs between a cursorial (*M. muscosa*) and a stationary hunting spider (*P. tepidariorum*). While deprivation of sensory input leads to a volume increase in several visual and mechanosensory neuropils *M. muscosa,* neither sensory deprivation nor sensory enrichment had an effect on the volume of neuropils in *P. tepidariorum*. However, exposure to mechanical cues during development affected the scaling slope of the leg neuropils several species. I discuss this pattern in light of the ecology of the species.

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Valeria ARABESKY | Master thesis

Widow spider egg sac defense mechanisms against the egg sac parasitoid wasp *Philolema latrodecti*

Invasive species cause a lot of ecological and economical damage around the world. To properly deal with invasive species, more knowledge about their success relative to native species in their invasion range is needed. I addressed this subject by investigating the interactions between the invasive brown widow spider, *Latrodectus geometricus,* and one of its natural enemies, the egg sac parasitoid wasp *Philolema latrodecti.* This wasp attacks also egg sacs of several other widow spider species, including the native white widow, *Latrodectus pallidus,* in Israel. During preliminary research, I found a higher parasitism rate in the native *L. pallidus* egg sacs than in the invasive *L. geometricus* egg sacs, suggesting that *L. geometricus* has an advantage over *L. pallidus* in dealing with this parasitoid. To investigate the potential mechanisms underlying the observed difference in parasitism rate, I investigated *P. latrodecti* host preference and *L. geometricus* and *L. pallidus* susceptibility to *P. latrodecti.* To test the host preference, I ran choice experiments using an olfactometer and compered between the wasp choice for *L. geometricus* or *L. pallidus* egg sacs. However, while running the experiment I discovered a bias in the olfactometer system and I had to stop the experiment. To test widow spiders' susceptibility, I examined *L. geometricus* and *L. pallidus* defense mechanisms against the parasitoid wasp from behavioral perspective and observed behavioral responses of the widow spiders to *P. latrodecti.* After exposure to wasps, both widow spider species spent more time closer to the egg sac and showed possible

guarding behavior, such as tapping on egg sac with the legs, circling around it and shaking it, which sometimes caused the wasps sitting on the web to drop off it. Nevertheless, more wasps dropped following *L. geometricus* movement and only *L. geometricus* showed a unique behavior of capturing and killing *P. latrodecti* wasps. Moreover, at the end of the experiment L. geometricus egg sacs were parasitized less than *L. pallidus* egg sac. In addition, *L. geometricus* has a unique egg sac with spiky silk structures on the top layer, potentially serving as a physical defense against parasitoids. To test this hypothesis I investigated *P. latrodecti* response *L. geometricus* egg sac with spikes removed from half of it. The wasps showed more interest in the spike-removal side and laid more eggs there. These results suggest that *L. geometricus* has more efficient behavioral and morphological egg sac defense mechanisms against its enemy the parasitoid wasp, *P. latrodecti,* allowing it to avoid egg sac loss. This can give it an advantage over native widow spider species in its invasive range, such as *L. pallidus* in Israel, and may be one of the keys to *L. geometricus* success in establishing around the world.

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Apostolos AGGELAKAKIS | Master thesis

The effect of heatwaves on reproduction and mating behaviors of the common house spider *Parasteatoda tepidariorum*

Our climate is changing, and we are witnessing a substantial increase in the frequency and intensity of extreme climatic events such as heatwaves. A sudden and extreme increase of temperature can potentially affect all the biological functions of an individual, including reproduction. This is particularly true for ectotherms, as they are strongly influenced by temperature variation. Among these, given their important role in ecosystem functioning spiders are a particularly important group for studying thermal responses. In my Msc thesis, I ask if heatwaves impact the reproduction of the common house spider *Parasteatoda tepidariorum.* I exposed spiders of both sexes to experimental heatwaves (5 days at 36C) and maintained a control group (25C), and measured variation in weight, survival and mating behaviour of each sex paired in any possible mating combination. We found that males subjected to elevated temperatures experience a more pronounced loss of body weight and reduced survival rates. These observations suggest the existence of sex-specific responses in life history traits, with size differences between the sexes potentially playing a role as mediators. Heatwaves affected the behavior of both sexes, as females reduced signalling on their webs and males engaged less in courtship. Heat-stressed females experienced decreased mating, possibly as a consequence of their diminished signalling behavior. These findings provide valuable insights into the complex interplay between temperature stress, sexual dimorphism, and behavioural responses in spiders. Given the importance of reproduction for population persistence, understanding how climate change affects survival and mating success is vital for assessing any future biodiversity studies.

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Denise BECKER | Bachelor thesis

Male vibratory courtship performance and mating success in the Nursery Web Spider *Pisaura mirabilis*

In spiders, substrate-borne signaling is particularly prominent and is known to serve various purposes such as species recognition, reducing female aggression, and transmitting information about male quality. Males of the Nursery Web Spider *Pisaura mirabilis* perform such vibrations as a part of courtship, though they are more well-known for offering a prey item wrapped in silk to females as a nuptial gift. The pre-copulatory courtship vibrations are generated by tremulation of the opisthosoma and transfer of pulses onto the substrate via the legs. There is great variability in vibrations within a population of males with regard to pulse rate and the consistency of pulse intervals. However, a male's vibratory courtship performance appears to be individually consistent and can therefore be assumed to transfer honest information on his physical condition and genetic quality. In this study I

assessed the influence of male vibratory courtship performance on female acceptance probability and mating success based on behavioral observations. After screening and ranking 117 P. mirabilis males by the quality of their vibratory performances (high- and low-signaling), I staged 58 double-mating experiments. Each female was mated twice in randomized order: once with a male classified as "high"-signaling and once with a male classified as "low"-signaling, allowing a direct comparison of both. The comparison of courtship and mating behavior in both mating trials revealed that high- and low-signaling males did not differ with regard to the overall courtship performance and obtained a similar mating success in terms of latency to female gift acceptance, latency to copulation, and copulation duration. Linear mixed-effect models exhibited a significant influence of body condition on male mating success despite the same feeding regimen for all spiders, which encourages follow-up studies investigating *P. mirabilis* courtship as a multimodal system. Therefore, this study constitutes a stepping stone for the further analysis of interacting signals in the courtship of the nuptial gift-giving spider *Pisaura mirabilis* and demonstrates the significance and complexity of vibratory communication in the animal kingdom.

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Jindra MROZEK | Bachelor thesis

Myrmecomorphic complex of arthropods in central Europe

Many biological studies have focused their attention on the striking similarity of phylogenetically unrelated organisms, on so called mimicry. Traditionally, mimicry is divided into Batesian mimicry, where a harmless species has warning coloration similar to a dangerous species, and Müllerian mimicry where dangerous species share similar aposematic coloration to deter predators more easily. The above-mentioned dichotomy appears to be quite artificial, as it is not easy to classify individual species unequivocally into one of these groups. This bachelor's thesis therefore focused on the investigation of mimetic complex, specifically the red-black myrmecomorph complex from Central Europe, which has not yet been described. For the purposes of this work, a list of species that potentially belong to this complex was com-piled. The practical part of the work deals with 30 species whose movement, body shape, and coloration were monitored using reflectance analysis. Recorded movements were evaluated in the Ethovision program, body shape in the MimicryMeasurement program, and coloration was measured by photospectrometer. Individual subgroups of the complex were compared with one other using the monitored parameters and it was investigated how accurate mimetics they really are. The analysis results in a detailed description of the similarities and differences and a more comprehensive view on the ways how the mimetics imitate their pattern.

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#ECOLOGY & EVOLUTION

Adrià BELLVERT | PhD thesis

Testing the hypothesis of adaptive radiation and its eco-phenotypic implications

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Without a shadow of a doubt, adaptive radiation processes have played a major role in our current understanding of how species evolved on our planet. Since the original proposal of the theory of evolution by natural selection was published by Charles Darwin and Alfred Wallace more than 150 years ago, examples of adaptive radiations have been extensively studied, particularly in oceanic islands. Because of their well-known geochronology, well defined boundaries, and simpler ecosystems when compared with continental regions, volcanic archipelagos had been referred as natural laboratories to study evolutionary or ecological process. The focus of this thesis is the spider genus *Dysdera*, which has undergone a remarkable diversification in the Canary Islands—a volcanic archipelago situated off the northwestern coast of Africa. The primary objective of this thesis is to test the hypothesis that the great diversification of the group was the result of an adaptive radiation process and

gain insights into the drivers of their eco-phenotypic differentiation.
First, we conducted an integrative taxonomic revision of the group, employing a combination of molecular and morphological data. Our specific objectives were to determine whether DNA barcodes reveal the presence of previously overlooked lineages and help resolve any conflicts that may arise between different datasets. Additionally, we aimed to investigate whether species that are morphologically distinguishable can potentially be identified using DNA barcodes.
Second, using geometric morphometrics, we analysed various morphological structures of the spider body. Our goal was to establish a comprehensive guide for studying variation in the body plan of a non-model system. By integrating different views of similar phenotypic structures, we revealed that the different body parts analysed are interconnected, providing insights into various ecological factors. This research sheds light on the importance of considering multiple morphological characters when studying organismal variation.
Third, we have integrated geometric morphometric tools and experimental approaches with a fully resolved phylogeny. With that we have characterized the different cheliceral morphologies present in the archipelago and unveiled their dietary function. Additionally, we tested if they evolved multiple times independently during the diversification of the group and unveil if trophic specialization could be a case of irreversibility in the *Dysdera* spiders from the Canary Islands. We identified nine different cheliceral morphologies. We confirmed that some of these morphologies were indeed related to either "generalist" or "woodlice-specialized" diets. We provided significant support for the evolutionary convergence of cheliceral morphs in the context of an adaptive radiation. Finally, our results pointed towards the irreversibility of trophic specialization in these spiders.
Four, we investigated the diversification patterns and the role that trophic specialization played in this diversification. Additionally, with the use of climatic variables and occurrence data, we unveiled the underlying mode of speciation in the islands. Our results provide support for the hypothesis of adaptive radiation, showing an initial burst of diversification followed by a deceleration in diversification rates. We also found that trophic specialization played a significant role in shaping the diversification patterns within the group. Furthermore, our analysis suggests that speciation primarily occurred in allopatry, followed by secondary contact events.
Five, we tested whether species underwent an ecological release process following colonization of low competition environments. With that aim, we employed a multidimensional approach to evaluate various aspects of the species' ecological niche. Specifically, we considered trophic breadth, morphological disparity, and climatic and distributional range. Our findings demonstrate that the potential for experiencing an ecological niche release in Canarian *Dysdera* is strongly influenced by their trophic specialization. Specialist species exhibit the ability to expand their spatial range and trophic breadth to a greater extent compared to generalist species.
The present work provides compelling evidence supporting the *Dysdera* genus diversification as a case of adaptive radiation in the Canary Islands, and the ecological and evolutionary effects associated with their cheliceral morphology.
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Irina DAS SARKAR | PhD thesis

Diversity, Assemblage, and Functional Traits of Spiders Along an Elevational Gradient in Himachal Pradesh, India

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Biodiversity patterns and their underlying mechanisms have been focal points in ecology, with elevational gradients serving as natural laboratories for investigating species adaptations to changing environments. While alpha diversity varies locally, understanding assemblage and trait distributions is essential for predicting species responses to stressors like climate change and land-use alterations, particularly in Indian Himalayan ecosystems exposed to rapid land-use transformations due to human activities. Arthropods, especially spiders, are ideal for studying taxonomic and trait-based diversity within mixed-use landscapes, due to their ubiquity and ecological significance. However, they remain poorly studied in the Himalaya, particularly relating to

their community and functional variabilities under changing habitat conditions.
This thesis addressed this gap by assessing spider diversity, assemblage, and trait patterns across three prominent land-use classes (forests, agricultural lands, and human-dominated regions) along a common elevational gradient (1500-4500m) in the Western Himalaya. The study revealed distinct patterns in species diversity and distribution, significantly influenced by land management strategies and landscape characteristics.
The study presented novel insights into spider assemblage structures, with forested areas exhibiting absolute turnovers and specialized species compositions. Agricultural and human-dominated landscapes, despite high species turnovers, displayed structured patterns with higher nestedness, driven by choice of agro-produce and synanthropy respectively. Furthermore, the research highlighted the precedence of land-use affinities over natural elevational affinities in structuring spider assemblages. Select microhabitat characteristics also significantly influenced community variations, with no single factor emerging as a common response variable across different land management classes.
Functional trait analyses revealed directional changes along the elevational gradient, with land-use influenced idiosyncrasies, exhibiting predominantly significant elevational responses within forested and human-dominated regions. Functional declines and deviations within agricultural communities suggested higher functional specialization, raising concerns about ecosystem resilience, particularly in intensively managed orchards. Significant declines in both diversity and functional metrics at the highest elevations indicated a consistent pattern of environmental filtering.
Overall, the study provided novel insights into community and functional patterns of Himalayan spiders, emphasizing the importance of considering land management variabilities and microhabitat heterogeneity for long-term conservation efforts. This understanding can better inform policies designed to mitigate ongoing environmental and land-use pressures in Indian mountain ecosystems.

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Domagoj GAJSKI | PhD thesis

Investigating predator-prey interactions through direct and indirect approaches

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Having accurate knowledge of trophic interactions in ecosystems is crucial for understanding ecosystem dynamics and the behavior of individual species, and communities within them. Traditional dietary analysis methods, like, for instance, direct observation, have limitations that can prevent us from obtaining a complete picture of trophic interactions occurring within an ecosystem. This is especially the case when working with small and cryptic organisms, such as arthropods and reptiles, where observation of trophic interactions in natural conditions is almost unattainable. This is why scientists focused on obtaining information about such interactions through either an indirect approach by observing density relationships of different organisms in a niche or ecosystem, or through direct approaches, by identifying prey remains in the gut content of predators or by using molecular methods such as PCR detection and dietary metabarcoding. This Ph.D. thesis comprises four published scientific papers and one accepted one. The aim of this thesis was to investigate predator-prey interactions through various sets of methods that provide either indirect or direct evidence about predator-prey interactions. These approaches were studied on two different types of predators in Southern Moravia (Czech Republic): arthropods in pear orchards and lizards in limestone hills. The first four manuscripts are focused on arthropods in pear orchards, which were studied for their biological pest control potential by performing a set of methods focused on confirming predation activity, investigating predator-prey density relationships and comparing diet compositions of predators between different seasons and management practices. The last manuscript is focused on the diet of lizards, where we compared the efficacy of macroscopic versus molecular methods for identification of prey remains. Our results show that modern molecular methods can provide a confident amount of information about predator-prey interactions. However, as with every method, they have their limitations, and are still dependent on the traditional methods to obtain a

complete picture of predator-prey interactions. Therefore, only by combining multiple methods together, it allows us to describe complex trophic interactions reliably.

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Filippo MILANO | PhD thesis

Ecology and Conservation of Italian spiders in a climate change scenario

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Despite their ecological importance and diversity, spiders (Arachnida: Araneae) are underrepresented in conservation research in comparison to other groups. The global response of spider species to the environmental variations has been investigated in detail only in the last few decades, but currently is proving to be a stimulating field of research. This thesis aimed at assessing the status of the conservation of different species of spiders occurring in Italy, focusing on their response to climate change. We firstly reviewed the status of spider conservation at the continental scale, and then we focused on several species mainly threatened by global warming. Our review revealed that existing international legislation considering spiders has limited coverage, as well as national and subnational conservation tools. Northern and Central European countries have the highest percentage of species assessed at the regional level, whereas in the Mediterranean basin, despite the highest spider diversity in Europe, conservation efforts are lacking both in terms of assessments and national or subnational legislation. Stemming from this general framework, we provided detailed insights into the conservation status of several emblematic spider species dwelling in habitats that are mostly affected by the impacts of climate change, namely *Argyroneta aquatica* and *Dolomedes plantarius* (wetlands), *Vesubia jugorum* (high-mountain habitats), species of the genus *Troglohyphantes* and *Histopona palaeolithica* (caves). We investigated present, past and future distribution ranges using species distribution models for different integrated emission scenarios. These were combined with knowledge on species' dispersal limitation to account for the possibility that the species will not be able to move beyond the current range in the next decades. In one case, models were integrated with phylogeographic analyses to investigate the effects of past and future climate change on species distribution and genetic diversity. For all species, we assessed the extinction risk according to the global and regional guidelines of the International Union for Conservation of Nature (IUCN), and for one species we explored the relationship between habitat suitability and functional traits related to species performance. Overall, we found a common significant future shift towards higher latitudes and altitudes in the geographic range, and a global future reduction in habitat suitability. Ongoing climate change is predicted to cause relevant future impacts on these species and significant decline in their current distribution range and habitat quality. The application of the IUCN criteria qualifies most of them as threatened, raising concerns for the long-term persistence of these species and suggesting potential high risk of local extinction for the most restricted ones. Considering the current threats to the spider species investigated, the protection of large areas of suitable habitat should be considered as the most effective approach to their conservation. Understanding the conservation status and the level of extinction risk faced by poorly known species is one of the greatest challenges facing conservation biology. In the framework of a general lack of knowledge on the conservation status of spiders, the collection of these works aims at providing a significant contribution to the knowledge of the Italian spiders, from the ecological and especially conservation point of view.

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Tomáš HAMŘÍK | PhD thesis

Local and landscape factors affecting the biodiversity of spiders in temperate deciduous forest and forest-steppe ecosystems

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Open woodlands and forest-steppes are among the biologically richest yet highly endangered ecosystems in the temperate zone. The conservation of open woodlands and forest-steppes requires an understanding of the factors that determine the occurrence of functionally

important organisms closely related to specific environmental conditions. Among these organisms are spiders, constituting the most diverse group of invertebrate predators with distinct environmental requirements. The biodiversity of spiders is influenced by both habitat-related factors (local factors) and landscape-related factors (landscape factors). However, there exists a notable gap in knowledge regarding the effect of these factors on spider biodiversity in temperate deciduous forests and forest-steppe ecosystems. The doctoral thesis comprises four studies. Three of these studies aim to compare the effect of forestry treatments on the biodiversity of ground-dwelling spiders in formerly open woodlands of the Czech Republic. The first study examines the different canopy thinning intensities (Děvín NNR), the second study evaluates different successional stages following canopy thinning (Podyjí NP), and the third study compares the retention forestry using dispersed retention against clear-cutting (Lower Morava Biosphere Reserve). The fourth study investigates the effect of habitat type and landscape-scale heterogeneity on ground-dwelling spider biodiversity in the natural forest-steppes of Kiskunság NP in Hungary. The first study demonstrated a positive effect of canopy thinning on spider biodiversity. The second study indicated the significance of different successional stages for distinct assemblages. Strong thinning and advanced successional stage supported the highest biodiversity of spiders, including species of conservation concern. The third study revealed that both retention forestry and clear-cutting homogenise spider assemblages. However, retention forestry supported higher biodiversity than clear-cutting. The fourth study showed that habitat type plays a more important role than landscape structure in shaping spider assemblages in natural forest-steppes. Each component of the forest-steppes (forest, forest edge, grassland) contributes significantly to the conservation of spider biodiversity. This doctoral thesis presents results that can be practically applied to protect the biodiversity of lowland woodlands and forest-steppes. An effective approach to forest management in protected lowland woodlands involves a combination of various thinning intensities and the maintenance of diverse successional stages. Retention forestry, utilizing dispersed retention, emerges as a suitable alternative to clear-cutting in lowland commercial woodlands. The conservation management strategies for each forest-steppe habitat should be adapted individually.

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Yuri SIMONE | PhD thesis

The effects of an evolutionary trade-off on scorpion diversity and feeding ecology

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This thesis investigates the link between biomechanical trade-off and feeding ecology using scorpions as model organism, and more specifically their pincers (chelae), as model functional traits.
Identifying in which ecological contexts the trait is used and whether there are differences in its usage across the whole morphological gradient is crucial to understand the selective pressures acting on functional traits. In this regard, following the two introductory chapters, the third chapter reviews the multiple selective pressures shaping scorpion chelae, emphasizing their ecological roles in predation, defence, and sexual contests. Particular emphasis is given to the extremes in the differences in morphology or usage between species or higher taxonomic groups, or between sexes, as such cases are most insightful to understand the roles of each of the two distinct weapon systems of scorpions and their evolutionary interactions.
In this thesis, I will mainly focus on the predation as driver of chela morphological diversity. Therefore, understanding the mechanistic basis of the speed-force trade off in chela closing performance is important to possibly infer the following of different evolutionary pathways due or leading to different predatory strategies and possibly diet. Therefore, in the fourth chapter, scorpion species representing the two morphological extremes in the chela architecture were studied. Across scorpions, the chelae showed significant morphological diversity associated with ecology. A biomechanical model of chela closing integrating synchrotron microtomographic data, performance- and muscle architecture data was developed. The main findings reveal a strong integration of muscle architecture and structural elements towards two functional optima of

performance: closing force is optimized in short-fingered species through mechanical advantage of levers and muscles as well as sarcomere length. In long-fingered species closing speed is optimized, e.g., by means of early acceleration. Although other functional demands may be at play, one system seems optimized for prey grasping, and the other for prey crushing. These divergent optima, driven by trade-offs, may have had profound impacts on the trophic range of scorpions, and the evolution of their venom.
To confirm that different chela morphologies with different closing performances might lead to different diet, is necessary to obtain information about which prey do scorpions consume. To this date, traditional methods provided very little information about trophic habits of scorpions. Therefore, in the fifth chapter, a metabarcoding-based technique was developed to retrieve prey DNA from the scorpion digestive system, a task complicated by the low feeding frequency and external digestion in scorpions. Focusing on Vietnamese forest scorpions (*Heterometrus laoticus*), controlled dietary regimes were employed and different portions of the digestive tract were analysed. All the different prey species that were offered were also detected, providing insights into the timing of scorpion digestion. Furthermore, the hepatopancreas was identified as the optimal digestive tract section for prey detection, offering a remarkable 53-day DNA detectability half-life. These findings refined our understanding of scorpion feeding behaviour and offered methodological recommendations for future molecular diet analyses.
Finally, to obtain diet information in scorpions with unknown foraging regime, the developed methodology was employed in a natural population of scorpions showing sexual dimorphism in their chelae to test whether different chela shapes allowed for foraging niche segregation.
This thesis bridges disparate aspects of scorpion biology, elucidating the evolutionary trade-offs that underlie their weaponry, biomechanics, and feeding ecology. By integrating morphological, biomechanical, and molecular approaches, this research provides a comprehensive framework for comprehending the intricate interplay between form and function in scorpion chela diversity.

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Martina BERNATOVÁ | Master thesis

The effect of supporting the occurrence of natural pest enemies on the health and vitality of fruit trees

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Predators (both invertebrates and vertebrates) can have a positive or negative effect on the vitality and physiological processes of woody plants. However, the mutual effect and interaction of several different groups of predators and their influence by different habitat manipulations is still not well known. For this reason, the aim of my work was to find out how biological control, i.e. manipulation to support invertebrate predators, and, conversely, the exclusion of insectivorous predators from vertebrates (birds, bats), or a combination of these two manipulations, will affect the vitality (and health status) of fruit trees, specifically pear. The experiment took place in organic pear orchards in the Zlín and South Moravian Regions. In each orchard (n = 4), 16 trees were selected and divided into groups of 4 trees differing according to the type of manipulation: a) installation of cardboard bands to support invertebrate predators, b) construction with a net to exclude the access of birds and bats, c) combination of cardboard bands and structure with net, d) control tree. The experiment started in the autumn of 2021 with the installation of cardboard bands and in the spring of 2022 with the installation of structures with nets for exclusion of birds. During the season (from May to September 2022), samples were collected to determine and compare leaf biomass and herbivory, fruit biomass and damage, and the efficiency of photosynthesis and the content of chlorophyll in the leaves were also measured, as well as the leaf area index. Overall, the results showed a significant positive effect of the manipulations on pear vitality. The best vitality was recorded for trees with a combination of cardboard bands and exclusion of birds and bats. The results show the importance of supporting natural predators of pests (mainly spiders). On the contrary, it is evident that these interactions could be disturbed by insectivorous birds (bats), which have a significant predation effect on spiders and thus can have a cascading effect on the vitality of fruit trees.

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Andreas FISCHER | Master thesis

Contributions to integrated management of synanthropic spiders

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Arachnophobia, an irrational fear of spiders, is a prevalent anxiety disorder causing harmless synanthropic spiders to be viewed as pests that must be controlled. The objective of my thesis was to explore tactics other than pesticide applications for managing synanthropic spiders. Studying cues that affect settling decisions by cob-web spiders, I found that web architecture, rather than spider silk or silk-borne chemicals, affects settling decisions by females of the false black widow spider, *Steatoda grossa*. Investigating potential natural repellents for spiders in a multi-trophic context, I found that herbivore-induced plant volatiles are deterrent to *S. grossa*, but not to other spiders. As ants prey on spiders, I also explored the effects of ant chemical cues on avoidance responses of spiders. I found that chemical deposits of European fire ants, *Myrmica rubra*, deterred *S. grossa*, Western black widows, *Latrodectus hesperus*, hobo spiders, *Eratigena agrestis*, and – to some extent – cross spiders, *Araneus diadematus.*

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Petra Rychlá HULEJOVÁ | Master thesis

Effect of management intensity during oak restoration in the area of the confluence of the Dyje and Morava rivers on the diversity of spiders (Araneae)

In this thesis, the intensity of management (presence of mechanical soil preparation) of the post-harvest stand and its effect on spider communities was investigated. There were chosen ten locations for the research, which were divided into 5 intensively managed and 5 extensively managed plots. A ground trapping transect was placed in each plot. Samplings were made on the following dates: 18 May 2021, 17 June 2021, 19 July 2021, 19 August 2021, 01 October 2021. A total of 7001 individuals belonging to 16 families and 85 species were captured, of which 12 species were on the Red List of Protected Species in the Czech Republic. *Pardosa lugubris* was the most abundant species and *Trochosa spinipalpis* from the Red List species. The most abundant family found during the survey was the representative of the family Linyphiidae. Primarily individuals with a ground hunting strategy were captured in the ground trapping survey. However, a number of net species were also present. The number of species was significantly higher in areas extensively managed without mechanical soil preparation. The conservation value and abundance of rare and endangered species was also significantly higher in plots under extensive management. It was also found that the effect of management did not affect the overall abundance of spiders. Significant factors influencing spider species composition included vegetation cover and the presence of small wood residues covering the soil surface. According to the results, it can be concluded that extensive management has a positive effect on spiders. Therefore, we recommend this type of management as a positive method that could be further used in the restoration of oak forests in the Soutok Forest Reserve, or in other areas with valuable floodplain forests.

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Helena ROTHOVÁ | Master thesis

The effect of uncut strips on the hay meadows to spider communities

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Until recently, the importance of grasslands in supporting biodiversity in Central Europe has been overlooked. It is only recently that the view that attention needs to be paid to this topic has become more prevalent. Grassland habitats are the most biodiverse places and many organisms have adapted to their traditional management. The post-war intensification of agriculture, associated with the intensive use of fertilizers, pesticides, large-scale mowing and the general homogenisation of production communities, has had a negative impact on overall biodiversity.

The main causes of arthropod mortality include use of chemicals, mechanical destruction, resource and habitat loss. The European Union has therefore introduced a set of so-called agri-environmental-climatic measures (AEKO) to promote biodiversity in agroecosystems. Unfortunately, the partly erroneous and overly technocratic conditions of these measures have often caused them to be ineffective or even counterproductive. There is also a lack of knowledge about the impact of the measures on local communities. At the instigation of the Agency for Nature Conservation of the Czech Republic (AOPK ČR) and the company Envipor s.r.o., we tested the effect of unmown strips on different arthropod groups on 22 production meadows in the vicinity of the Protected Landscape Area Český ráj (CHKO Český ráj) over a period of four years. This thesis focuses on the effect of unmown strips on spider communities. The spiders were caught mainly using ground traps, bump traps and yellow traps (the latter two methods were, however, used primarily for insect trapping). The results show that both spider biodiversity and abundance increase within years in strip grasslands, however the effect is strongest in climatically dry years. Within strip meadows, spiders move evenly and strips were not preferred by spiders over mown vegetation. The spider communities in both strip and control meadows were also analyzed in terms of the ecological functional characteristics (traits) that characterized each community. This analysis showed that the diversity of functional traits was higher in the meadows with unmown strips. The total number of individuals increased each year, but the number of species did not. Thus, it can be said that meadows with unmown strips have a positive effect on spider communities, although they do not increase species diversity.

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Tim HOERRMANN | Bachelor thesis

A Glimpse of the Past: Museum Specimens Reveal Insights into Prey and Microbiome of *Argiope* Spiders (Araneidae) through Historical DNA Metabarcoding

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In ecology, the dynamics of biotic interactions and the underlying processes that shape them is considered a critical area of research. However, it remains difficult to study changes in ecological communities over long periods of time due to a frequent lack of data from the past. Scientific collections worldwide house a wide variety of different species collected at different times and locations. These specimens not only contain morphological information, but also molecular data about their former functions in ecological networks. DNA metabarcoding is a powerful tool that allows low-cost, time-saving identification of species and can potentially decipher the ecological data hidden in museum specimens. In this study, we analysed gut contents of a collection of museum specimens belonging to the spider genus *Argiope* from different geographic locations, covering several decades of collection dates and compared the sequencing success with freshly collected *A. bruennichi* specimens from Germany. Fragments of the target genes cytochrome c oxidase subunit I (COI) and 16S rRNA (16S) were amplified to reconstruct the consumed prey and the gut microbiome. We found that it is possible to get valid sequencing data even from older museum specimens but with a decreased success rate compared to contemporary samples. Moreover, we showed that the gut microbiome of *A. bruennichi* is either dominated by a member of the genus Mesoplasma or a novel, unidentified symbiont. These findings open up new opportunities for future long-term research in ecology to deal with the problem of missing data from the past and allow follow-up questions regarding the role of the two competing microorganisms in the gut microbiome of *A. bruennichi.*

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Lukáš PUCH | Bachelor thesis

Spiders and beetles in discarded beverage cans

Mankind induces rapid change of the environment of many animals. The quality of the resources changes as well as ques formerly linked to the quality of those resources. If the linkage between these ques and the real quality of resources is disrupted, animal can make

suboptimal choice in terms of its fitness. Low quality source preferred over better options is called evolutionary trap. In this thesis I will present the main categories of human influence on fauna and reported cases of evolutionary traps related to these categories. Second part of this thesis is dedicated to the experiment with beverage cans which focuses on spiders (Araneae) and beetles (Coleoptera) inside these cans. Results of this experiment shows higher impact of discarded beverage cans on beetles in comparison with spiders. Furthermore, beverage cans influence rather smaller species of beetles and spiders.

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#FAUNISTICS & GENETICS

Donard GECI | PhD thesis

Faunistic, ecological, and biogeographic features of spider fauna (Arachnida: Araneae) of Kosovo

In this thesis for the first time, data are presented about the ecological, taxonomic and biogeographic features of spiders in Kosovo. This research was carried out in the period July 2020 to 2022 in 50 main localities, which were sampled once every two months, and in some other additional localities, which were sampled only a few times. The material collected earlier, deposited in the Department of Biology, was also identified. The localities in which the faunal material was collected are composed of different types of habitats and are found at altitudes of 426 m to 2066 m above sea level, which indicates the distribution of species at different altitudes and habitats and the influence of ecological and anthropogenic factors on their spread.
In total (together with the samples collected earlier) 2185 individuals, 1454 ♀ and 731 ♂, belonging to 295 species were collected. Sampling was done using entomological nets, pitfall traps, s and by hand. 227 species, 86 genera and 13 families are new findings for Kosovo.
This thesis is the first systematic research on the diversity of spider fauna species throughout Kosovo, the determination of their distribution and certain ecological characteristics in this area. The results from this research will enable to creation of a list of spider species, which was missing earlier, as well as contribute to solving taxonomic problems. The species *Neoscona byzanthina* (Pavesi, 1876) was little known from the Balkans, after analysis, it was re-examined and it is now easier to distinguish it from the species *N. adianta* (Walckenaer, 1802).

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Alireza ZAMANI | PhD thesis

Spiders of Iran – Systematics, diversity and distribution

Spiders (Araneae) are the largest order of Arachnida and the sixth most speciose order of Animalia, comprising more than 50,000 extant species as well as over 1,400 species known from fossils. Despite this immense diversity that has been estimated to comprise 120,000–200,000 species, our knowledge of their systematics and distribution remains rather incipient. While attempts to evaluate the diversity and distribution patterns of spiders have been made for the Neotropical and a few other faunas, most other regions remain historically neglected. The aim of this dissertation is to explore the systematics, diversity and distribution of spiders of Iran, a highly interesting region from a zoological and biogeographical point of view that unfortunately has been poorly investigated regarding its invertebrate fauna. For this purpose, I examined more than 9,000 specimens that were either collected during expeditions to numerous regions and ecosystems across the country or deposited in several natural history collections from around the world. As a result of these efforts, which were initiated in 2013 and mostly carried out in collaboration with researchers from various countries, a total of 11 genera and 147 species of Iranian spiders were described as new to science, and 419 taxa (i.e., 13 families, 87 genera and 319 species) were recorded in Iran for the first time. The total number of newly described and recorded species (i.e., 466 species) constitutes almost half (i.e., 49.83%) of the currently known Iranian species diversity of

this group (i.e., 935 species). Amongst 147 species described, 137 are known only from Iran, representing 63.72% of all species currently considered endemic to this country (i.e., 215 species). These results were published in a total of 87 publications, 38 of which were published after the beginning of my doctoral studies at UTU in 2019. This dissertation, however, is primarily based on only nine taxonomic articles (i.e., I–IX), all published after 2019 and highlighting some of the more important findings.
Because of the newly obtained taxonomic information and an extensive database of all published records, it was possible to conduct a comprehensive review of spatial variation in the diversity patterns of spiders in Iran. This was the main objective of publication X, which also included an evaluation of the effect of sampling bias on the current understanding of the distribution of Iranian spiders. The analyses showed that the diversity of Iranian spiders remains inadequately studied and is heavily affected by the Linnean shortfall (i.e., gaps in taxonomic knowledge), despite a remarkable improvement in taxonomic research on this fauna since the beginning of the 21st century. There are 935 spider species in the 1,648,195 km2 of Iran. Comparing the number of species per area of 171 countries and other political regions indicated that Iran was in position 132, whereas many considerably smaller and less ecologically diverse countries were in lower positions. It was also found that this fauna clearly suffers from a severe Wallacean shortfall (i.e., lack of knowledge of species distributions), as approximately 85% of Iran lacks a single record of spiders. There is a highly uneven distribution of records throughout the country and its provinces and ecoregions, with most of the records situated near large cities. A high correlation was found between the number of records of spiders and the number of records of plants and other animals in Iran, indicating that the noted shortfalls are indeed corroborated by other taxa. Finally, it is suggested that to gain a more complete picture of the diversity of Iranian spiders, future collecting efforts should be primarily in the form of extensive systematic surveys instead of opportunistic sampling, and ideally targeting lesser sampled areas and ecoregions. Once a satisfactory amount of information regarding the taxonomy and distribution of species becomes available, it will be possible to properly assess the conservation status and risk factors that affect these species and to identify areas of higher conservation and management priority.

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Karolína RAUCHOVÁ | Master thesis

Spider fauna of postindustrial sites

This Master thesis presents results of faunistic surveys of the kaolin quarries in Horní Bříza town and their surroundings. Spiders (Araneae) were sampled during a vegetation season in 2022 at ten sites using pitfall traps, a litter reducer, and UV portable light traps. Five sites were characterised by spontaneous vegetation processes, whereas the other five sites were reclaimed by planting of pines (Pinus sylvestris). The recorded species were analysed by Shannon-Wiener´s index and index of dominance. Altogether, 69 species and 338 specimens of spiders were collected – 241 males and 78 females in 19 families.
Among these species, the most important findings are those listed in the Red list of threatened spiders, namely: EN (endangered): *Walckenaeria monoceros, Drassyllus pumilus, Attulus distinguendus*; VU (vulnerable): *Agyneta innotabilis, Pardosa nigriceps, Micaria silesiaca, Sitticus saxicola, Talavera petrensis*; LC (least concern): *Mecopisthes silus, Coriarachne depressa.* Shannon-Wiener´s index indicated slight difference between sites with spontaneous vegetation processes (3,19) and sites reclaimed by pines (3,25). The results of index of dominance indicated that both sites are influenced by mining of kaolin, whereas the subrecedent species prevail and the several species are in higher categories.

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Joshua SUMOGAT | Bachelor thesis

Diversity and Composition of Spider Fauna in Jose Rizal Memorial Protected Landscape in Dapitan, Zamboanga del Norte, Philippines

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Spiders are known to inhabit various microhabitats, and their sensitivity to environmental changes makes them important indicators of ecological conditions. However, there is limited research on the protected landscape in Zamboanga del Norte, with most studies primarily focusing on vertebrates. This study aimed to identify the spider morphospecies diversity in four different sites located at varying elevations in the Jose Rizal Memorial Landscape (JRMPL). The transect method, handpicking, visual searching, ground searching, and sweep netting were utilized to collect data from different microhabitats such as leaf litter, foliage, rocks, and logs. A total of 182 individuals from 66 morphospecies belonging to 10 families were identified, with four of the species being endemic to the Philippines. The highest richness was found in Site 1, near a riparian area, and the lowest in Site 4, which was heavily disturbed due to agricultural activities mainly copra production and logging of trees. The Araneidae family had the highest species richness and abundance, with Leucauge argentina being the most commonly found species from the Tetragnathidae family. All sites showed an even distribution, with Sites 1, 2, and 3 being highly diverse, and Site 4 moderately diverse. Leaf surfaces and plant branches/stems were the most frequently utilized microhabitats by the spiders. Anthropogenic activities in the area, are the primary threat to the spiders could endanger the spider fauna, in particularly to the four considered "threatened species." The results highlight the significance of conservation efforts in the protected landscape, as the JRMPL is relatively high in spider diversity.

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Joel Jair ALCÁNTAR VALENZUELA | Bachelor thesis

The genus *Oecobius* Lucas, 1846 (Araneae: Oecobiidae) in Northwestern Mexico

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The taxonomy and distribution of the genus *Oecobius* Lucas, 1846 (Araneae: Oecobiidae) is reviewed in Northwestern Mexico. Four new species are described, all of them based on both sexes: *O. yoreme* sp. nov., and *O. culichi* sp. nov. from Sinaloa, *O. yaqui* sp. nov. from Sonora, and *O. sudcaliforniana* sp. nov. from Baja California Sur, Mexico. In addition, we provide complementary descriptions or taxonomic remarks and new distributional data of native (*O. concinnus* Simon, 1893, *O. hoffmannae* Jiménez & Llinas, 2005, and *O. isolatoides* Shear, 1970) and introduced species (*O. maculatus* Simon, 1870, *O. navus* Blackwall, 1859, and O. putus O. Pickard-Cambridge, 1876). Furthermore, we provided images of the habitus and copulatory organs, and distributional map of each species.

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Alexandra MAREŠOVÁ | Master thesis

Karyotype differentiation of the harvestmen belonging to the subroder Laniatores from South Africa

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Current cytogenetic knowledge of the suborder Laniatores is only known for 11 species from South and North America. This study presents the first cytogenetic analyses of South African families Biantidae and Triaenonychidae, which belong to the most diverse suborder of harvestmen. After analyzing the karyotype, variability in the diploid chromosome number was found, with Biantidae having 2n = 38-52 and Triaenonychidae having 2n = 28-64. Variability was also observed in the morphology of

chromosomes. While both families predominantly exhibit bi-armed chromosomes, individual species show different representations of various morphological types. In addition to basic cytogenetic analyses, fluorescent in situ hybridization (FISH) was performed, revealing variability in the number and location of gene clusters for 18S rRNA. Using this method, the telomeric motif (TTAGG)n was also localized, which was present only at the ends of chromosomes in all analyzed species from both families.

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Lukáš MARTÍNEK | Bachelor thesis

Searching for the telomeric sequence in the order Araneae

Telomeres are highly conserved throughout taxons. Most of Arthropods share the same telomeric sequence (TTAGG)n. There are some deviations from this motif, but in most cases, the telomeric sequence follows the same pattern. However in spiders, the telomeric motif typical for Arthopoda is not present. The aim of this thesis is to explore the spider telomeric sequence by leveraging available sequencing data and find out, if it is a variation of the classic motif.

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