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EDITED AND REVIEWED BY
Gustavo Silva De Miranda,
Sam Noble Oklahoma Museum of Natural History, United States

*CORRESPONDENCE
Matjaž
Kuntner
matjaz.kuntner@nib.si

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Editorial: Horizons in arachnid science

Volker Herzig[1,2,3], Peter Schausberger[4], Jason E. Bond[5], Alejandro Cabezas-Cruz[6] and Matjaž Kuntner[7,8,9,10]*

[1]Centre for Bioinnovation, University of the Sunshine Coast, Sippy Downs, QLD, Australia, [2]School of Science, Technology and Engineering, University of the Sunshine Coast, Sippy Downs, QLD, Australia, [3]Institute for Molecular Bioscience, The University of Queensland, Brisbane, QLD, Australia, [4]Department of Behavioral and Cognitive Biology, University of Vienna, Vienna, Austria, [5]Department of Entomology and Nematology, University of California, Davis, Davis, CA, United States, [6]Anses, INRAE, Ecole Nationale Vétérinaire d'Alfort, UMR BIPAR, Laboratoire de Santé Animale, Maisons-Alfort, France, [7]Department of Organisms and Ecosystems Research, National Institute of Biology, Ljubljana, Slovenia, [8]Jovan Hadži Institute of Biology, Research Centre of the Slovenian Academy of Sciences and Arts, Ljubljana, Slovenia, [9]Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, DC, United States, [10]Centre for Behavioural Ecology and Evolution, School of Life Sciences, Hubei University, Wuhan, China

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Editorial on the Research Topic
Horizons in arachnid science

Frontiers in Arachnid Science, a community-rooted journal, aims to engage researchers across a full spectrum of disciplines, including early-career scientists and established researchers. We are pleased to introduce the inaugural "Horizons in Arachnid Science" collection, featuring invited, high-impact, and accessible reviews synthesizing transformational arachnology research. Contributors were selected by the Chief Editors in recognition of their scientific contributions and impact.

Among arachnids, spiders (order Araneae) represent the second most diverse order, with 53,967 currently described species (World Spider Catalog, 2026). Despite this remarkable diversity, the natural history, ecology, and evolutionary relationships of many spider lineages remain poorly understood. Two reviews in this Research Topic address these gaps from complementary perspectives by focusing on both a widespread ecological strategy and a charismatic focal lineage.

Agnarsson provides a comprehensive synthesis of kleptoparasitism in spiders, highlighting the strong taxonomic concentration of both hosts and kleptoparasites and identifying recurring ecological and evolutionary patterns underlying these associations. The review demonstrates how web architecture, host body size, and sociality shaped opportunities for resource exploitation, while also emphasizing the remarkable diversity of kleptoparasitic strategies ranging from prey theft to web invasion and araneophagy. The review additionally highlights the critical role of spiders as "superhosts" for diverse kleptoparasitic and commensal organisms, emphasizing how web architecture and host ecology shape interactions. By integrating scattered observations into a comparative evolutionary framework, this review establishes the foundations for future studies on the evolution of interspecific interactions, behavioral specialization, and social evolution.

In a second review, Yu et al. synthesize current knowledge on fishing spiders (genus *Dolomedes*; family Dolomedidae), a charismatic group of semi-aquatic predators distributed across most continents. Although *Dolomedes* species have become important model systems in behavioral ecology, physiology, and evolutionary biology, major geographic and taxonomic gaps persist, particularly outside Europe and North America. By integrating research on morphology, ecology, behavior, conservation, and evolution, the authors provide both a comprehensive overview of current knowledge and a roadmap for future comparative and interdisciplinary research on this remarkable lineage.

Systematics and taxonomy continue to provide the essential framework upon which all biological disciplines depend. Yet despite rapid advances in phylogenomics, many arachnid groups remain taxonomically challenging due to morphological convergence, cryptic diversity, and incomplete sampling. Briggs and Hamilton address these issues through a critical examination of theraphosid systematics and taxonomy. Their review highlights how morphology-based classifications have sometimes confounded evolutionary relationships thereby emphasizing the growing need for integrative taxonomic approaches incorporating genomic data. Beyond tarantulas, this review illustrates broader challenges currently facing arachnid systematics/taxonomy and emphasizes the need for integrative, data-rich approaches to biodiversity research.

The Acari (mites and ticks) comprise the most diverse arachnid order, with approximately 60,000 described species (Zhang et al., 2021). Among them, plant-inhabiting spider mites (Tetranychidae) have emerged as formidable model animals for ecology, behavior and evolution research. An intriguing question is the link between group-living and silk production. Silk has been observed in several terrestrial and aquatic mite families (Shatrov and Soldatenko, 2024), yet group-living spider mites stand out as the most advanced silk-producers. In their review, Saito and Sato introduce the fascinating diversity of web-producing spider mites and characterize basic webbing types. These webs have multi-functional relevance in joint host plant colonization and exploitation, brood care, hygienic behavior and predator defense, and abiotic hazards. Strikingly, the complexity of webbing and nest construction reflects the various degrees of sociality among and within spider mite genera and species. By integrating current knowledge, this review serves as important reference and stimulus for future comparative studies on group-living and cooperation in silk-producing arachnids (Lubin and Bilde, 2007; Schausberger et al., 2021).

Silk production is one of the most remarkable evolutionary innovations among arachnids attracting increasing interest owing to its extraordinary material properties. In their review, Maraldo et al. examine recent advances in the recombinant production and characterization of spider silks, with emphasis on spidroin synthesis, protein assembly, and biomimetic fiber production. The review highlights the considerable technical challenges and major opportunities associated with translating spider silk biology into high-performance biomaterials. By integrating developments in biochemistry, structural biology, materials science, and computational modeling, this contribution demonstrates how advances in arachnid biochemistry and biomaterials research are increasingly informing developments in biotechnology and bioengineering.

Besides silk, venom is another key innovation underlying the ecological diversification of arachnids. The fact that arachnid venoms evolved primarily for injection into prey or predator poses challenges for translating venom compounds as therapeutics, diagnostics, biopesticides, and tools for targeting disease vectors and parasites (Herzig, 2023; Saez and Herzig, 2019). Addressing this issue, Wang et al. review arachnid peptide toxins capable of crossing biological membranes, including vertebrate and insect blood-brain barriers and insect midgut epithelium. The authors discuss biochemical properties underlying membrane permeability and examine strategies for enhancing membrane penetration of toxins to expand their translational potential.

Recent work has increasingly highlighted ecological and translational relevance of arachnid venom enzymes, including phospholipases, hyaluronidases, proteases, and other enzymatic components involved in prey immobilization, tissue degradation, venom spreading, and bioactivity (Delgado-Prudencio et al., 2022; Dresler et al., 2026, 2024, 2025; Krayem and Gargouri, 2020; Kuhn-Nentwig et al., 2019). Complementing this work, Dresler et al. provide the first systematic overview of known spider venom enzymes, synthesizing current knowledge on diversity, ecological functions, and potential industrial applications. Their review demonstrates that venom enzymes are involved in a broad range of biological processes including prey digestion, toxin spreading, precursor activation, venom preservation, and multifunctional physiological roles, highlighting the largely unexplored translational potential of enzymes for applications in biotechnology, waste management, agriculture and pharmaceuticals.

Collectively, the contributions to this inaugural Horizons in Arachnid Science collection reveal a field undergoing rapid confluence with recent advances in theory, experimentation, methodology, and cutting-edge applications to important scientific challenges. The contributions on arachnid silk and venom position arachnid science at the intersection of organismal biology and translational and bioeconomic research. Such interdisciplinary perspectives increasingly connect arachnid biology with broader global challenges in environmental change, biotechnology, and health research (Kuntner, 2022), with arachnid science being poised for substantial contributions well beyond its traditional boundaries.

Author contributions

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The authors VH, PS, JB, AC-C, and MK declared that they were an editorial board member of Frontiers at the time of submission. This had no impact on the peer review process and the final decision.

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