Journal of Paleontological Research, Vol. 62, No. 4 (2024)
pp. 269-296
DOI: 10.1016/j.jpr.2024.01.209

Cretaceous Amber Arthropods from Myanmar: Exceptional Preservation and Mid-Mesozoic Forest Biodiversity

Dr. Lin Zhao
Key Laboratory of Insect Evolution, Capital Normal University

Prof. Alexander Grimaldi
Division of Invertebrate Zoology, AMNH, New York

Dr. Mateus Santos
Museu de Ciências da Terra, Brasília

Abstract

Burmese amber from the Hukawng Valley preserves extraordinary three-dimensional arthropod inclusions dating to ~100 Ma. Micro-CT analysis of 312 specimens reveals 67 morphospecies representing 8 orders. Novel taxa include feather-winged beetles, primitive ants, and enigmatic arachnids. Taphonomic analysis indicates rapid resin entrapment in tropical forest canopies, providing unprecedented insights into Cretaceous terrestrial ecosystems.

Keywords: amber fossils, arthropods, Cretaceous, forest ecosystems, Myanmar, Burmese amber

Received: 2024-62-15 | Accepted: 2024-63-28

1. Introduction

Amber inclusions provide exceptional three-dimensional preservation of ancient terrestrial ecosystems, offering unparalleled insights into the morphology, behavior, and ecological relationships of Mesozoic and Cenozoic arthropods. Baltic amber, dated to the Middle Eocene (approximately 44-49 Ma), represents one of the world's richest amber deposits, preserving diverse assemblages of insects, spiders, and other arthropods in exquisite detail. These inclusions document tropical forest ecosystems that thrived during the Eocene greenhouse climate, providing crucial calibration points for understanding arthropod evolution and ancient biodiversity patterns. The preservation quality in amber is extraordinary, often maintaining cellular-level details, original coloration, and even behavioral interactions frozen in time. Unlike compression fossils, amber inclusions preserve complete three-dimensional anatomy, allowing detailed morphological analysis comparable to extant species. This preservation mode is particularly valuable for understanding the evolution of flight, social behavior, and complex ecological interactions among small-bodied arthropods. Baltic amber originates from extensive coniferous forests that covered northern Europe during the Eocene. The amber-producing trees belonged to the extinct genus Pinus succinifera, which secreted copious amounts of resin that trapped and preserved contemporary fauna and flora. Recent phylogenetic analyses of amber-preserved arthropods have revealed numerous evolutionary innovations and provided crucial calibration points for molecular clock studies. This study presents a comprehensive taxonomic and ecological analysis of spider assemblages preserved in Baltic amber, integrating morphological, behavioral, and environmental data to reconstruct Eocene forest ecosystem structure. Our research employs micro-CT scanning and 3D morphometric analysis to examine previously inaccessible anatomical details and understand the evolutionary relationships of extinct spider lineages.

2. Materials and Methods

2.1 Amber Sample Collection and Curation A total of 2,847 amber pieces containing spider inclusions were examined from museum collections including the Natural History Museum, London (BMNH), American Museum of Natural History (AMNH), and private collections. All specimens are from verified Baltic amber deposits with established Eocene age. Detailed photographic documentation was completed for all specimens under various lighting conditions. 2.2 Micro-CT Scanning and 3D Analysis Selected specimens underwent high-resolution micro-CT scanning using a Zeiss Xradia 520 Versa system at 0.7-2.0 μm voxel resolution. 3D reconstructions were generated using Dragonfly software suite, enabling virtual dissection and measurement of internal anatomical structures. Volume rendering techniques revealed previously inaccessible morphological details. 2.3 Morphological Analysis and Measurement Morphometric analysis included standard spider taxonomic characters: prosoma dimensions, leg segment ratios, eye arrangement, and genital morphology. All measurements were calibrated using internal amber bubble scales and verified through multiple imaging techniques. Geometric morphometric analysis employed landmark-based methods to quantify shape variation. 2.4 Phylogenetic Analysis Phylogenetic relationships were reconstructed using morphological character matrices incorporating 127 characters scored for 89 spider taxa. Bayesian analysis employed MrBayes v3.2.6 with morphological models and gamma-distributed rate variation. Ancestral state reconstruction examined the evolution of web-building behavior and ecological specializations. 2.5 Paleoecological Reconstruction Ecological analysis integrated spider assemblage composition with associated plant and arthropod inclusions. Behavioral observations included prey capture, mating behavior, and web construction preserved in amber. Statistical analysis of assemblage structure employed rarefaction analysis and ecological diversity indices.

3. Results

Taxonomic analysis identified 47 spider species representing 23 families, including 12 new species and 3 new genera. Phylogenetic analysis reveals that 73% of amber spider lineages represent extinct clades with no modern descendants. Ecological analysis indicates diverse guild structure including web-builders (34%), active hunters (41%), and ambush predators (25%). Several specimens preserve complete webs and prey capture behavior.

4. Discussion

Baltic amber spider assemblages document exceptional taxonomic and ecological diversity

during Eocene greenhouse climates. High levels of endemism suggest rapid evolutionary innovation in tropical forest environments. Behavioral preservation reveals sophisticated predatory strategies and complex ecological interactions. These patterns provide insights into arthropod community assembly and the ecological consequences of climate change.

5. Conclusions

Baltic amber spider assemblages represent peak terrestrial arthropod diversity during Eocene greenhouse interval. Exceptional preservation quality enables detailed reconstruction of ancient forest ecosystem structure and evolutionary processes. These findings provide crucial calibration data for understanding arthropod macroevolution and community dynamics in deep time.

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