

Researchers close knowledge gap on the evolutionary history of Polyneoptera

From grasshoppers to roaches and stoneflies: Polyneoptera was the only major lineage of winged insects with an unresolved evolutionary history concerning important phenotypic traits like external shape, social behavior and lifestyle. These ambiguities have far-reaching consequences for the understanding of the early evolution of winged insects in general. Researchers from Wageningen University & Research closed this knowledge gap.

Polyneoptera represent one of the major lineages of winged insects (Pterygota), comprising around 40,000 extant species in ten traditional orders. "Origin of insect wings is a major macro-evolutionary event. Wings are one of the reasons why insects are so successful. But many important aspects of polyneopteran evolution, such as their phylogenetic relationships, changes in their external appearance, their habitat preferences and social behavior were unresolved and a major enigma in the scientific study of insects," says Assistant Professor Sabrina Simon.

Evolution of winged insects

These ambiguities also had direct consequences for the understanding of the evolution of winged insects in general, for example, with respect to the ancestral habitats of adults and juveniles. Researchers from Wageningen University & Research addressed these issues with a large-scale phylogenomic analysis, a genomic study of the evolutionary history and relationships among organisms. They used the reconstructed phylogenetic relationships to trace the evolution of 112 characters associated with the external appearance and the lifestyle of winged insects.

Biting mouthparts and hardened forewings

Sabrina Simon: "Our inferences suggest that the last common ancestors of Polyneoptera and of the winged insects were terrestrial throughout their lives, implying that wings did not evolve in an aquatic environment. We were able to reconstruct how it may have looked like. The appearance of the first polyneopteran insect (>300 million years ago) was mainly characterized by ancestral traits, such as long segmented abdominal appendages and biting mouthparts held below the head capsule." This ancestor lived in association with the ground, which led to various specializations, including hardened forewings and unique tarsal attachment structures.

Life on plants

However, within Polyneoptera several groups switched separately to a life on plants. In contrast to a previous hypothesis, the researchers found that social behavior was not part of the polyneopteran ground plan. In other traits, such as the biting mouthparts, Polyneoptera shows a high degree of evolutionary conservatism unique among the major lineages of winged insects.

"It's important to know how Polyneoptera evolved and this research is taking us closer to solving the mysteries of insect evolution", Simon says. "Only with a reliable phylogenetic reconstruction, we can study how insect species influence ecosystems and sustain or endanger our natural resources. This is becoming even more important and urgent considering the increase in so-called 'pest-species' but also the dramatic decline of other insects caused by human impact."

The publication was a international collaborative study within the 1KITE project (1,000 Insect Transcriptome Evolution, <http://www.1kite.org>) and published on PNAS in their online Latest Articles.

Notes for editors:

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An abstract of the publication "Evolutionary history of Polyneoptera and its implications for our understanding of early winged insects" by Benjamin Wipfler, Harald Letsch, Paul B. Frandsen, Pashalia Kapli, Christoph Mayer, Daniela Bartel, Thomas R. Buckley, Alexander Donath, Janice S. Edgerly-Rooks, Mari Fujita, Shanlin Liu, Ryuichiro Machida, Yuta Mashimo, Bernhard Misof, Oliver Niehuis, Ralph S. Peters, Malte Petersen, Lars Podsiadlowski, Kai Schütte, Shota Shimizu, Toshiki Uchifune, Jeanne Wilbrandt, Evgeny Yan, Xin Zhou, and Sabrina Simon is accessible at:

<https://www.pnas.org/content/early/2019/01/08/1817794116>.