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DIGITALVISION

PHYLOGENOMICS

Building the insect tree-of-life

> "novel approaches were used to produce a robust phylogenomic tree of insects"

The transcriptomes of 144 insect species representing all extant taxonomic insect orders have been used to construct a detailed phylogenomic tree and to date major insect evolutionary innovations. The results of this collaborative effort of >100 researchers indicate that insects first colonized land alongside the first terrestrial plants ~479 million years ago, a date far earlier than previously thought.

In an attempt to better understand insect evolutionary history, the team sequenced 2.5 Gb of cDNA from 103 species and combined this with previously published transcript data. A graph-based approach was then used to identify orthologous genes. "We show that only 1,478 orthologous genes can be identified among all arthropods using nuclear genome sequences," explains Bernhard Misof, one of the lead authors of the study. "This is therefore the maximal number of genes which can be used in phylogenomic studies dealing with arthropods, including hexapods." The team then generated maximum-likelihood phylogenetic trees with both nucleotide and amino acid data. To increase the plausibility of their models, they developed a new approach that uses protein domain partitions instead of gene partitions.

Notably, the data indicate that insect flight first occurred ~406 million years ago and that diversification within modern winged insects started in the Paleozoic Era. This diversification generated three large groups of related forms: Polyneoptera, true bugs and Holometabola. "Flies, beetles, moths, bees, ants and wasps originated in the Paleozoic," says Misof, "but they really started to diversify only after the Cretaceous," which is around the same time as the emergence of flowering plants.

"Scientists have proposed every conceivable relationship among insect orders, based on morphological data or molecular data, or both, but a robust consensus did not emerge from these efforts," comments Misof. In this research, novel approaches were used to produce a robust phylogenomic tree of insects, which will now serve as a reference point for future research.

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ORIGINAL RESEARCH PAPER Misof, B. *et al.* Phylogenomics resolves the timing and pattern of insect evolution. *Science* **346**, 763–767 (2014)

WEB SITE

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