Team reveals new findings about insect diversification

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Biologists from the University of York have compiled two new datasets on insect evolution, revealing that metamorphosing insects diversify more quickly than other insects and are therefore the biggest contributors to the evolution of insect diversity.

Both funded by the Natural Environment Research Council (NERC), the first dataset is a complete fossil catalogue showing timescales of origination and extinction of different families of insects. Working with the Natural History Museum and National Museums Scotland, former PhD student Dr David Nicholson collated a database of 1500 fossil families, a third of which are entirely new to the record since 1993.

Using this updated fossil record, the researchers found that families of insects that undergo metamorphosis, a pupal stage separating two different juvenile and adult stages, are less prone to extinction than other insects. Insects that have metamorphosis include moths and butterflies (Lepidoptera), beetles (Coleoptera), wasps, bees, ants (Hymenoptera) and true flies (Diptera).

This finding is supported by a second dataset compiled by PhD student James Rainford. Producing the biggest and most detailed family tree of insects displaying all living groups, the distribution of numbers of species across time is shown in minute detail, demonstrating which insect groups have achieved diversity. Again, this shows that insects that undergo metamorphosis display a greater turnover of species and therefore have a higher rate of diversification. The research is published

in the Royal Society's journal *Proceedings of the Royal Society B*.

Dr Peter Mayhew, Senior Lecturer in the Department of Biology and Supervisor to both PhD projects, said: "I have been working on the evolutionary reasons for insect diversity for over a decade. An important task is to pin down in which groups of insects the rates of diversification or extinction have changed, and which are therefore responsible for most of their richness.

"Intuitively, people have long suspected that insects with metamorphosis have experienced different rates of diversification, because the richest insect orders mostly have metamorphosis. However there has been little hard evidence to back this up. These two new datasets are comprehensive, detailed tools in confirming our intuitions and will pave the way for further research into why metamorphosis is important for insect evolution."

James Rainford said: "Early family trees were not very finely resolved, and could not easily pin down the groups where diversification rates changed. In putting together a dated family tree for the entire group we can, for the first time, view patterns of diversification in a truly global context and test long-standing ideas regarding the processes involved. These two analyses, one based only on the living groups and the other on the fossil record, agree about the importance of metamorphosis in the diversification of insect groups. This provides a strong basis for further explorations into the origin of this key part of modern ecosystems."

These two new datasets will now pave the way for future research into why metamorphosis is important for insect evolution. Dr Mayhew adds: "Metamorphosis might reduce extinction, and promote speciation, in a number of different ways. It might reduce competition between larvae and adults, it might promote dietary specialisation, it might reduce development times, it might improve survival in times of hardship, or

something else. Future work needs to address this question."

More information: Fossil evidence for key innovations in the evolution of insect diversity, Published 27 August 2014 DOI: 10.1098/rspb.2014.1823

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