

## **The Middle Triassic insect radiation revealed by isotopic age and iconic fossils from NW China**

Daran Zheng (1,2), Su-Chin Chang (2), He Wang (1), Yan Fang (1), Jun Wang (2), Chongqing Feng (2), Guwei Xie (3), Edmund A. Jarzembowski (1,4), Haichun Zhang (1), Bo Wang (1,5)

(1) State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Nanjing, China, (2) Department of Earth Sciences, The University of Hong Kong, Hong Kong Special Administrative Region, China, (3) Changqing Research Institute of Petroleum Exploration and Development, Changqing Oilfield Company, PetroChina, Xi'an, China, (4) Department of Earth Sciences, The Natural History Museum, London, UK, (5) Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, Beijing, China

Following the end-Permian mass extinction, the Triassic represented an important period witnessing the recovery and radiation of marine and terrestrial ecosystems. Terrestrial plants and vertebrates have been widely investigated; however the insects, the most diverse organisms on earth, remain enigmatic due to the rarity of Early–Middle Triassic fossils. Here we report new fossils from a Ladinian deposit dated at  $\sim 238$ – $237$  Ma and a Carnian deposit in northwestern China, including the earliest definite caddisfly cases (Trichoptera) and water boatmen (Hemiptera), diverse polyphagan beetles (Coleoptera) and scorpionflies (Mecoptera). Our findings suggest that the Holometabola, comprising the majority of modern-day insect species, experienced an extraordinary diversification in the Middle Triassic and was already been dominant in some Middle and Late Triassic insect faunas, after the extinction of several ecologically dominant, Paleozoic insect groups in the latest Permian and earliest Triassic. This turnover is perhaps related to notable episodes of extreme warming and drying, leading to the eventual demise of coal-swamp ecosystems, evidenced by floral turnover during this interval. The forest revival during the Middle Triassic probably stimulated the rapid radiation and evolution of insects including some key aquatic lineages which built new associations that persist to the present day. Our results provide not only new insights into the early evolution of insect diversity and ecology, but also robust evidence for the view that the Triassic is the “Dawn of the Modern World”.

Besides, LA-ICP-MS U-Pb dating initially gave a late Ladinian age for the Tongchuan entomofauna after the results:  $237.41 \pm 0.91$  Ma and  $238 \pm 0.97$  Ma. The age is in agreement with that of the marine Ladinian-Carnian boundary, representing a novel age constraint for the terrestrial strata near this boundary. This age can provide a calibration for marine and terrestrial correlation near Ladinian-Carnian boundary, and also for the correlation of the contemporaneous biotas.