
The fossil insect assemblage of Alderton Hill, Gloucestershire, UK and its link to the Toarcian Oceanic Anoxic Event

Emily Swaby*¹, Angela L. Coe¹, Bryony A. Caswell², Scott A. L. Hayward³, Luke Mander¹, and Jörg Ansoerge⁴

¹School of Environment, Earth and Ecosystem Sciences, The Open University, Walton Hall, Milton Keynes, Buckinghamshire, MK7 6AA, UK – United Kingdom

²Department of Geography, Geology and Environment, Faculty of Science and Engineering, University of Hull, Cottingham Road, Hull, HU6 7RX, UK – United Kingdom

³School of Biosciences, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK – United Kingdom

⁴Institut Für Geologische Wissenschaften, Ernst-Moritz-Arndt-Universität Greifswald, Friedrich-Ludwig-Jahn Str. 17a, D-17489 Greifswald, Germany – Germany

Abstract

Strata in Western Europe representing the Toarcian Oceanic Anoxic Event (T-OAE, ~183 Ma ago) contains several horizons with abundant fossilised insect, suggesting that it is highly likely that the severe climatic change at this time led to high insect mortality. It is now well established that the T-OAE was a time of environmental change, driven by changes in the carbon cycle, and that it led to increased global palaeotemperatures, enhanced global chemical weathering rates, widespread marine anoxia, eustatic sea-level rise, a crisis in marine taxa and increased atmospheric CO₂ levels. More recently it has been noted that on land, global warming, wildfires and acid rain associated with the T-OAE resulted in a decrease in diversity and richness of land plant assemblages, which then had significant effects on the rest of the trophic web including extinction of all basal sauropodomorph dinosaurs. However, the influence of the event on insects has not previously been investigated in detail. There are seven primary locations in western Europe that have yielded fossil insects from the T-OAE, including two in the UK. We present the first comprehensive taxonomic and taphonomic review and analysis of one of these locations: Alderton Hill, Gloucestershire (UK). All insect material was collected in the mid-19th century from a single layer of early diagenetic calcareous nodules within the Whitby Mudstone Formation and is now held with six museum and institutional collections.

Through the examination of 366 known individuals, we have established that there is a diverse palaeoentomofauna assemblage of 13 insect orders, 28 families, 30 genera and 24 species. This diversity is comparable with the ordinal diversity of present-day insect assemblages from equivalent latitudes (30°–40°N), indicating that the entomofauna of Alderton Hill provides a representative reflection of the insect community during the Toarcian and can therefore be used to draw conclusions about the assemblage. Hemiptera (true bugs),

*Speaker

Coleoptera (beetles) and Orthoptera (dragonflies) are the most common orders, constituting ~ 55% of the total assemblage. Coleoptera and Hemiptera also dominate insect assemblages at similar palaeolatitudes today. Hemiptera is the most taxonomically diverse order in the Alderton Hill insect assemblage, supporting the interpretation that they are likely to have diversified in response to the warm, humid conditions of the T-OAE. In particular, the family Progonocimicidae (Hemiptera: Coleorrhyncha) identified within the insect assemblage is characteristic of much warmer and humid conditions and would have most likely inhabited drought-resistant flora including conifers, which were dominant during the T-OAE. Preservation of highly sclerotised taxa including Coleoptera most likely reflects that their exoskeleton was favourable under the environmental fluctuations, but preservation may have been enhanced by a taphonomic bias towards more robust elements. Highly disarticulated compression fossils dominate the assemblage, ~ 68% of which are isolated wings or wing fragments. In comparison, the coeval insect assemblage from the only other major UK site at Strawberry Bank (Ilminster, Somerset) is less diverse, generally less well-preserved and taphonomically biased towards Coleoptera.

Our results indicate that the Alderton Hill insect assemblage is the most well-preserved and representative record of insect diversity ever reported from Toarcian strata in the UK. Furthermore, the results of this comprehensive analysis of the Alderton Hill insect assemblage now allows for an in-depth comparison with the rich entomofaunas of Germany and Luxembourg, in order to assess the diversity and distribution of insect taxa during the T-OAE.

Keywords: Alderton Hill, Gloucestershire, Lower Jurassic, Toarcian, Insects