FossilsX3

INSECTS • ARTHROPODS • AMBER

Programme and Abstracts

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preserved in an authigenic mineral, c) as a mould of the insect exoskeleton, d) as a cast, replicate in a secondary mineral, e) in a travertine, f) in a concretion.

Leptogastrinae in the fossil record (Insecta: Diptera: Asilidae) – evaluation of minimum age, biogeographical implications and morphological characteristics

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Fossil species play an important role in phylogenetic research projects as they serve as the only definitive evidence to hypothesise the minimum age of a taxon. However, fossils are often difficult to assign to a clade based on the few morphological details preserved or the morphological divergence of extant clades from stem-lineage members. The fossil species of Leptogastrinae (Diptera: Asilidae, robber flies) are reviewed, based on all available material and in light of the aforementioned difficulties when dealing with past and recent lineages. The two oldest fossil species of Asilidae are Cretaceous in origin, from the Santana Formation in Brazil (110 Million years ago) and from New Jersey Amber (94-90 Million years ago). Both species can be unambiguously assigned to the Asilidae, but the relationships to recent taxa are difficult to hypothesise because no comprehensive morphological phylogenetic hypothesis for Asilidae exists. The unnamed species from New Jersey Amber was postulated to belong to the Leptogastrinae and a re-examination supports this hypothesis, which provides a minimum age for this taxon. Newly available fossil specimens, primarily preserved in Dominican Amber (approximately 30 Million years ago), of species of Leptogastrinae are presented. These undescribed species are important as they exhibit combinations of character states unknown in extant species or provide insight into the historical biogeography of the Leptogastrinae. The three formerly described species of *Leptogaster* Meigen, 1803 from Oligocene and Miocene deposits (Florissant of Colorado, USA; Radoboj, Croatia; central and south-central France) will be reviewed and their generic combinations will be re-evaluated.

Planthoppers: from the Permian to Cenozoic

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Fulgoroidea is the oldest extant hemipteran superfamily. This lineage is traceable back from Cixiidae (Late Jurassic–Recent) via Jurassic Fulgoridiidae to Surijokocixiidae (Late Permian–Triassic). Putative ancestors of these latter, Permian Coleoscytoidea show such planthopper features as claval Y-vein, small postclypeus, lateral ocelli close to eyes (plesiomorphies), short basal cell in forewings, and disc of mesonotum separated (by furrows).

Surijokocixiids developed carinae on the head and pronotum and also on the mesonotum (first, two laterally along the furrows, then, two submedian and one median). They had the venation cixiid-like (rarely polymerized) and a wide precostal area (sometimes with crossveins) in the forewings. Fulgoridiids were like cixiids, with a pentacarinate mesonotum and incipient extravenal pterostigma, but with a deeper CuA fork.

Metatarsal pectens are setigerous or (1st or both) asetigerous in cixiids and achilids, whereas the metatibial pecten is always asetigerous. However, the latter could likewise be either setigerous or asetigerous in Early Cretaceous Lalacidae (otherwise indistinguishable from Cixiidae) and presumably in other extinct families.

First (earliest Cretaceous) Achilidae had a plectoderine-like venation. Achilids are common in some ambers, because their mycetophagous nymphs lived under the bark.

Late Cretaceous *Netutela* (related to extant *Protachilus*) is the earliest member of the (Dictyopharidae + Fulgoridae) lineage, the oldest of extant planthopper groups with long-legged, adult-like nymphs (the first such nymphs are found in the Early Cretaceous). Most nymphs of pre-Cretaceous fulgoroids probably lived in soil or rotten wood.

Other extant planthopper families have at most a Cenozoic fossil record. No tettigometrid-like forms are known from the Mesozoic. The stem of the fulgoroid family tree consists of cixiid-like forms, and Delphacidae could be their direct descendants. Fossil fulgoroids seem to be more common in warmer palaeoenvironments and absent from some cooler faunas.

Evolutionary implications of insect radiations and extinctions in the Cretaceous

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The Cretaceous was a period of great significance in the evolution of terrestrial life, and we present abundant new fossil evidence and interpretations of this period regarding insects. The appearance of abundant amber in the Early Cretaceous provides a unique archive for extinct insect life 140-120 mya, as did the formation of major Plattenkalke deposits. Major groups that radiated during the Cretaceous were various Dictyoptera (especially mantises and termites), phytophagan beetles, aculeate Hymenoptera, cyclorrhaphan Diptera, and glossatan Lepidoptera. Several of these groups are the largest lineages of phytophagous and pollinating animals, radiations of which coincide with that of the angiosperms. An evolutionary mechanism as to how phytophagy and anthophily promotes insect diversification, however, remains obscure. The fragmentation of Gondwana created the vast rain forests of the Amazon and Congo River basins, and separated areas of temperate forest that were once contiguous in Antarctica, southern Africa, Chile, Australia, New Zealand, and surrounding islands (the Austral Region). Numerous living austral disjuncts suggest a pervasive effect of Gondwanan drift, but northern-hemisphere fossils of many presently austral groups indicate these were widespread in the Cretaceous and probably into the early Oligocene. Insects seem to have barely been affected at the family level by the K/T extinctions, but appear to have been profoundly affected by climatic change. The importance of phylogenetics in addressing evolutionary patterns like radiations and extinctions is stressed.

The palaeontological significance of insect trace fossils in palaeosols

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Insect trace fossils in palaeosols have been studied systematically since the eighties, contributing to different extents to geological, biological and palaeontological disciplines. In ichnology, new ethological categories, ichnofacies, and principles have been created to accommodate them. Stratigraphy and sedimentology have been benefited because of their importance in the recognition of palaeosols and for extracting palaeoenvironmental inferences. In contrast, the integration of this new information with palaeoentomology for reconstructing evolutionary histories of insects has still been scarce.

Insect ichnofossils are dominant in palaeosols from the Paleocene to the Recent. The key is that these structures, such as breeding and pupation chambers, are produced for larval development. In insect nests, larvae are confined to chambers that are provisioned with different kinds of organic matter. Chambers need to maintain very precise environmental conditions internall to avoid the destruction of provisions and larvae. These conditions are achieved by constructing walls, linings, and particular architectures, in order to isolate them from soil. These morphological devices increase the complexity of the structures. The incorporation of organic matter in the constructions is important for the formation of soils, but also because it increases the potential for preservation of these traces. Nests of bees, dung beetles and termites are the most common