

Froghoppers, leafhoppers, planthoppers and their allies (Hemiptera: Cicadomorpha and Fulgoromorpha) from the Mesozoic of Northeastern China

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Mesozoic volcanic activity in eastern China commenced in the Late Triassic, gradually increased in intensity during the Early and Middle Jurassic. During the Late Jurassic the volcanism was very strong, while in the Early Cretaceous it was weaker and nearly terminated in the Late Cretaceous (XU Z. 1990). The Northeast China, especially Jiulongshan Formation of Middle Jurassic and Yixian Formation of Late Jurassic to Early Cretaceous, yield a mass of notable fossils including abundant insects which provide important evidence for study of the origin and early evolution of insects.

Among these abundant insect fossils, the record of fossil of Fulgoromorpha and Cicadomorpha are not only abundant, but also diverse and well preserved. Last published summary comprised at least representatives of nearly 50 species placed in 20 genera (WANG Y. et al. 2006), but this number vastly increased since then. Representatives of various families are present in Northeastern China deposits, both extinct and extant.

Representatives of extinct lineage Palaeontinoidea, i.e. Palaeontinidae were huge, moth-like insects, resembling a little, but not related to singing cicadas, which witnessed the rise and fall of dinosaurs. Their wing span ranges 10-36 mm; wings are very often disruptive patterned (WANG Y. & REN D. 2009), and body is often covered with scales or dense hairs. A combination of cryptic coloration and disruptive marking enhanced their camouflage. Palaeontinids existed from the Triassic to the Mid Cretaceous. They constitute 14% of specimens in the fossil record of Northeastern China.

The lineages of Cicadomorpha present in nowadays faunas are united under Clypeata, comprising a number of extinct and extant families. Synapomorphies of Clypeata are: postclypeus enlarged, presumably xylem-feeders; ocelli close to each other; forewings with radial and medial cells always closed, and commissural space reduced distally (A₂ secondarily free); nymphs probably cryptobiotic.

The most abundant group present in both Jurassic and Cretaceous strata is Procercopidae (Cercopoidea). These fossils comprise about 40% of all specimens collected. However, the known taxonomic diversity of these froghoppers is relatively low, with 7 genera reported from the Daohugou (Middle Jurassic) and Beipiao (Lower Cretaceous) strata. Another group related to Procercopidae is under investigation now.

Tettigarctidae (Cicadoidea) is the most ancient lineage still present in recent fauna, recorded since terminal Triassic (SHCHERBAKOV 2009). Ancient tettigarctids are ancestors of recent singing cicadas (Cicadidae), known in fossil record since the Late Cretaceous. Tettigarctidae were morphologically diverse and quite abundant in the Jurassic and Cretaceous, like Cicadidae in the Cenozoic and nowadays. The pronotum concealing major of mesonotum seems to be an autapomorphy of Tettigarctinae (WANG B. & ZHANG H. 2009). In the fossil material from the Northeastern China they constitute 23%, but so far, only 4 definitive species of Tettigarctidae are known.

Hylcellidea, the common ancestors of the three living superfamilies, i.e. Cicadoidea, Cercopoidea and Membracoidea, evolved from Prosboloidea by the Middle Triassic. The

extinct family Hylcellidae had the first appearance in the Middle Triassic (Anisian) of Vosges, France. It was abundant in the Jurassic and became extinct by the Mid-Cretaceous (SHCHERBAKOV & POPOV 2002). Hylcellidae are quite common in the insectiferous deposits from the Northeastern China, often very well preserved and presenting distinct morphological disparity. They constitute at least 7% of the known specimens, but their taxic diversity is still weakly recognised and needs further investigations.

The knowledge on the other groups is virtually lacking; a few weakly preserved specimens could be ascribed to Karajassidae or their descendants Cicadellidae. Some others seems to be related to Archijassidae, however the taxonomic status of this family is still under debate.

The 2% remaining include some uncertain taxa and only a few Fulgoromorpha. The study of fossil Fulgoroidea from China is still at the debut stage, but the number of new outcrops and specimens is increasing. Single specimen which could be ascribed to the paraphyletic 'Fulgoridiidae' was identified in the late Middle Jurassic deposits of Daohugou. However, it clearly differs from all forms known from Europe and Asia.

The family Lalacidae, widely differentiated in the South America is reported from a single genus *Cretocixius* Zhang Z., 2002 from the Lower Cretaceous of Beijing.

Another group of taxa including genera *Lapicixius* Ren, Yin et Dou, 1998, *Yanducixius* Ren, Lu et Ji, 1995 and another not yet described genus superficially resembles Cixiidae, but in details of venation pattern, head capsule and leg structures clearly differs from it and deserve familial placement.

The increment of number of specimens collected and examined is bringing a number of new taxa described. The known taxa are under revisionary studies as well. These allows further comparisons. By analyzing the record of animals and associated plants fossil, palaeoclimatic data and palaeoecological data the processes of evolution of Cicadomorpha and Fulgoromorpha could be traced and analyzed. Also the co-evolutionary processes of insects and plants could be reconstructed, as well as particular insectiferous biota.

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