



New Fulgoridiidae genus from Upper Jurassic Karatau deposits, Kazakhstan (Hemiptera: Fulgoromorpha: Fulgoroidea)

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Abstract

Aulieezidium karatauense, a new genus and species of the extinct planthopper family Fulgoridiidae is described from the Upper Jurassic deposits of Karabastau Formation of Aulie, Karatau (Southern Kazakhstan Province, Kazakhstan). The characters of the new genus in respect to other genera placed in Fulgoridiidae are reviewed. The palaeoecological and palaeogeographical data concerning *Aulieezidium* gen. n. and other genera of Fulgoridiidae are also discussed.

Key words: *Aulieezidium* gen. n., *Aulieezidium karatauense* sp. n., taxonomy, phylogeny

Introduction

The hemipteran suborder Fulgoromorpha is a very old and highly diverse suborder of the Hemiptera. It comprises three superfamilies: Permian Coleoscytoidea Martynov, 1935 (Coleoscytidae Martynov, 1935), Permian and Triassic Surijokocixioidea Shcherbakov, 2000 (Surijokocixiidae Shcherbakov, 2000) and Fulgoroidea Latreille, 1807, known since the Jurassic. Over 20 families of Fulgoroidea, extinct and extant, are recognized (Szwedo *et al.* 2004; Bourgoin & Szwedo 2007, 2008, 2009). Extinct families of Fulgoroidea are: Jurassic Fulgoridiidae Handlirsch, 1906 and Cretaceous ones – Lalacidae Hamilton, 1990, Neazoniidae Szwedo, 2007, Perforissidae Shcherbakov, 2007 and Mimarachnidae Shcherbakov, 2007 (Hamilton 1990; Szwedo 2007, 2008, 2009; Shcherbakov 2007a, b). The monophyly, relationships, range and content of several families (both extant and extinct) is under discussion. The recently recognised extant Fulgoroidea families are: Achilidae Stål, 1866 + Achilixiidae Muir, 1923, Caliscelidae Amyot et Serville, 1843, Cixiidae Spinola, 1838, Delphacidae Leach, 1815, Derbidae Spinola, 1839, Dictyopharidae Spinola, 1838, Eurybrachidae Stål, 1862 + Gengidae Fennah, 1949, Flatidae Spinola, 1838 + Hypochthonellidae China et Fennah, 1952, Fulgoridae Latreille, 1807, Issidae Spinola, 1838 + Acanaloniidae Amyot et Serville, 1843, Kinnaridae Muir, 1925 + Meenoplidae Fieber, 1872, Lophopidae Stål, 1866, Nogodinidae Melichar, 1898, Ricaniidae Amyot et Serville, 1843, Tettigometridae Germar, 1821 and Tropiduchidae Stål, 1866. Despite a great interest in studying phylogenetic relationships of Fulgoroidea the taxonomy of this unit is still not stable. Morphology-based hypotheses had been presented by Asche (1988), Emeljanov (1990, 1999) and Bourgoin (1993). Several studies tested relative placement of particular families, e.g. Tettigometridae, Tropiduchidae, Caliscelidae or Achilixiidae (Bourgoin *et al.* 1997; Yeh *et al.* 1998; Liang 2002, Gnezdilov & Wilson 2006). Another attempt to present fulgoroid relationships (Bourgoin & Campbell 2002) is based on combined morphology, molecular sequences and palaeontological data. Some of the so called higher Fulgoroidea, e.g. subunits of the families Nogodinidae, Issidae and Tropiduchidae are related, but their relationships are unclear in respect to morphological, palaeontological and molecular data and interpretations, and the limits of the families are not strict. More recently, molecular phylogenetic studies of the recent Fulgoroidea were presented

by Yeh & Yang (1999), Yeh *et al.* (2005) and Urban & Cryan (2007, 2009). The results obtained are unfortunately still inconclusive, depending on the set of taxa and features selected.

Materials and methods

Karatau fossil site (Karatau Lagerstätte) is the famous locality of fauna and flora from the Jurassic. It is situated in the Karatau Mountain Range (the northwestern spur of the Tian Shan Mountains), Southern Kazakhstan. The Karatau Range stretches over 400 km from southeast to northwest. It is subdivided into the Greater and Lesser Karatau, the latter being subparallel to, and to the east of, the Greater Karatau. The Karatau Range is composed of rocks of almost all geological ages, beginning with the Lower Proterozoic. Jurassic deposits form a narrow belt between Lesser Karatau and the southern and central parts of the Greater Karatau. This belt, 2–8 km wide, stretches over 200 km from the Chokpak pass in the southeast to the valley of the Bala Turlan river in the northwest (Doludenko & Orlovskaya 1976). The locality known as Karatau comprises several sites, of which those in the vicinity of villages Galkino (now Uspenovka) and Aulie outcrop (according to Hecker 1948, 'Aulie' meaning 'holy' is an aboriginal name for the outcrop) near the village of Mikhaïlovka, Chimkent (now Shymken) Region, are the most rich in fossils. Unfortunately, Galkino with Jurassic insects, vertebrates and plants has vanished completely (Anon. 1999). The exposures of the facies in the village Aulie, Karabastau, Chugurchak and their vicinities are the first geological reserve in the former Soviet Union. Now the reserve is a part of the Aksu-Dzhabagly Nature Reserve (Doludenko *et al.* 1990).

The continental deposits of the Karabastau Formation have yielded more than 18,000 remains of diverse insects, a lot of plants, fishes, and conchostracans. Gastropods, ostracods, and spiders are not common. A salamander, five species of reptiles, and a feather belonging to a bird or a dinosaur have been described from the same beds (Doludenko *et al.* 1990). Numerous plant remains are represented in Karatau mainly by bennettites, conifers, pteridophytes, and cycadophytes as well as Equisetales, Caytoniales, Ginkgoales, Cycadales, and Czekanowskiales. Judging from the plant assemblage and a spore-pollen complex analysis, the age of the Karabastau Formation may be assigned to the Callovian – Kimmeridgian (Kirichkova & Doludenko 1996). The age of the deposit is estimated as Late Jurassic (Kimmeridgian – Oxforidian), i.e. *circa* 158–152 Mya. Pollen data demonstrates that *Classopolis* pollen is dominant with a low amount of spores with the smooth exine of *Leiotriletes*-type and spores with *Klukisportites* microrelief, as well as single *Disaccites* spores (Doludenko *et al.* 1990).

The Aulie profile is composed of grey, laminate aleurolites, marls, limestones and dolomites. The layers are separated by grey or black aleurolites, with inclusions of sandstones, conglomerates and gravels. Within the Aulie profile, two cycles with 4 series can be recognized. The basement of the profile is characteristic of sandstones series. The lower cycle is finished with series of aleurolites with interbeddings of limestones and marls. The upper cycle begins with series composed of conglomerates with alternate interbeddings of clays, aleurolites, marls, limestones and dolomites. The cycle ends with a series of alternate layers of aleurolites, marls, limestones and dolomites. There are also layers of sandstones among them. Almost all organic remains are associated with the uppermost layers of this series (Doludenko *et al.* 1990).

During the Jurassic it was an area with a dry climate, proved by the findings of xeromorphic and xerothermophilous plants. On the other hand, the presence of meso- and hygrophilous *Bibionomorpha* (Diptera: Nematocera) contrasts with the general xeromorphic landscape reconstructions for the area, and with the other insects, also characteristic for dry habitats. This contradiction could be explained by the presence of rotting plant debris on the shores of the lakes (Ponomarenko *et al.* 2005). According to Hecker (1948), the sediments of the upper portion of the profile have lacustrine origins. The most common statement is that Karatau Lake originated in the inner-mountain basin and relatively rapidly was filled with proluvial sediments. Therefore, in a short time a large and shallow reservoir with small differences in depth was formed. The shores of the lake were flat and marshy. The deposition of the sediments was seasonal, in the changing sequence of carbonates (summer season) and sediments enriched with silt (winter season). These

sequences are interpreted as varves but their annual cycle is not proven. The water in the lake was characterized by high hardness and relatively high salinity (Ponomarenko *et al.* 2005).

The most common animals among Karatau fossils are fish and insects. Most fish described from this locality represent the families Palaeoniscidae and Coccolepidae of the extinct order Palaeonisciformes (Chondrostei). The other specimens represent Pholidophoriformes (Teleostei) of the families Pholidophoridae and Galkiniidae, but in distinctly lower numbers (Doludenko *et al.* 1990). Also Gastropoda, Crustacea, Aranea as well as vertebrates – amphibians and reptiles – are known from this locality. A single spider species of the family Archeidae has been described – *Jurarchaea zherikhini* Eskov, 1987, the other fossils representing the other 4–5 families of spiders. Among vertebrates, excluding fish, the salamander *Karaurus sharovi* Ivachnenko, 1978 has been found as well as a few remnants of turtles and a small, probably terrestrial, crocodile *Karatausuchus sharovi* Efimov, 1976. Also known are the remnants of two species of pterosaurs from the suborder Rhamphorhynchoidea – *Batrachognathus volans* Riabinin, 1948 and *Sordes pilosus* Sharov, 1971, while the Pterodactyloidea have not been recorded (Ponomarenko *et al.* 2005).

The insect diversity is incomparably higher than all the other animals taken into account together. There are representatives of 19 insect orders, with true bugs (Hemiptera: Heteroptera), beetles (Coleoptera), true flies (Diptera) and cockroaches (Blattodea) predominating (Panfilov 1968; Doludenko *et al.* 1990, Rasnitsyn & Zherikhin 2002). Heteroptera are from the infraorders Nepomorpha, Pentatomomorpha and Cimicomorpha. Corixidae (Nepomorpha) are the most numerous among true bugs, constituting $\frac{3}{4}$ of all heteropterans collected, and a single species *Karataviella brachyptera* Becker-Migdisova, 1949 is known from over 550 imprints. The other families known are Naucoridae (three species), Notonectidae (1 species) and Scaphocoridae (1 species) – all Nepomorpha and Mesoveliidae (1 species) of Gerromorpha. Cimicomorpha are represented by two species of Miridae, while Pentatomomorpha by Coreidae (2 species), single species of Mesopentacoridae and Pachymeridiidae (Popov 1968, 1971, Popov & Bechly 2007). The suborder Coleorrhyncha is also recorded, with representatives of the families Progonocimicidae and Karabasiidae known (Popov & Shcherbakov 1991). Sternorrhyncha: Aphidomorpha are represented by single species of Genaphididae and unplaced Aphidoidea (Shaposhnikov 1979, Heie & Wegierek 1998), while Psyllomorpha by Protopsyllidiidae (10 species), Malmopsyllidae (8 species) and 3 species of Neopsylloididae (Becker-Migdisova 1985). Among Cicadomorpha the families Palaeontinidae (2 species), Tettigarctidae (1 species), Hylcellidae (1 species) and Karajassidae (1 species) are known (Becker-Migdisova 1968, Shcherbakov 1988, 1992). The only representative of Fulgoromorpha known up to the present was *Elasmoscelidium rotundatum* Martynov, 1927 (Szwedo *et al.* 2004).

The specimen described below was collected during the joint expedition of the Institute of Palaeobiology, Polish Academy of Sciences, and Department of Zoology, University of Silesia, in the year 2006. The specimens collected are deposited in the collection of the Institute of Palaeobiology, Polish Academy of Sciences, Warsaw, Poland.

Systematics

Order Hemiptera Linnaeus, 1758

Suborder Fulgoromorpha Evans, 1946

Superfamily Fulgoroidea Latreille, 1807

Family Fulgoridiidae Handlirsch, 1939

Genus *Aulieezidium* gen. n.

Type species *Aulieezidium karatauense* sp. n.; here designated.

Diagnosis. Differs from the similar genera *Eofulgoridium* Martynov, 1939 (Lower Jurassic of Kyrgyzstan and China) and *Fulgoridium* Handlirsch, 1906 *s. str.* (Lower Jurassic of Europe) by the following combination of characters: tegmen with thickened costal margin, uniformly narrow costal area with a few terminals in apical portion (costal area with transverse veinlets developed in *Eofulgoridium*; costal margin thickened and narrow at base and widened in distal portion with a few apical terminals present in *Fulgoridium s. str.*); costal cell with distinct, oblique and sigmoid veinlets (only a few transverse veinlets in *Eofulgoridium*; no veinlets in *Fulgoridium s. str.*); stem ScR forked basad of stem CuA forking (stem ScR forked apicad of stem CuA forking in *Fulgoridium s. str.* and *Eofulgoridium*); stem M forked slightly distad of claval apex (similarly as in *Fulgoridium s. str.*, tegmen with stem M forked distinctly basad of claval apex in *Eofulgoridium*); stem CuA multibranched (three main branches in *Fulgoridium s. str.*, three main branches in *Eofulgoridium*, with branch CuA_1 forked slightly apicad of claval apex), branch CuA_{2b2} with 4 terminals, first terminal shifted from claval apex (CuA_{2b} not forked or if forked, the first branch close to apex of clavus in *Fulgoridium s. str.*; CuA_{2b} not forked in *Eofulgoridium*) tegmen with two elongately sigmoid veinlets *m-cua*, imitating longitudinal veins, the second vein about 4 times as long as width posterior discal cell at level of CuA stem forking (no such developed veinlets in *Eofulgoridium* and *Fulgoridium s. str.*); cell C5b developed, narrowed in apical portion, cell C5c developed (additional cells C5b and C5c not developed in *Fulgoridium s. str.*; other pattern of cubital veins branching in *Eofulgoridium*).

Description. Lateral margins of frons continued on postclypeus as lateral carinae, converging but not fused, not reaching apex of postclypeus. Mesonotum with 5 carinae. Tegmen about 3 times as long as wide, not narrowed at base; with costal margin thickened and somewhat widened, stems CA and Pc+CP merely shifted, costal area narrow, less than half of costal cell width, a few terminals of Pc+CP in apical portion of costal area. Costal cell with sigmoid, oblique veinlets, costal cell wider than cell C1 (outer anteapical cell). Stem Sc+R forked basad of stem CuA first branching. Branch RP not forked to the level of claval apex. Stem M forked at level of claval apex, branch M_{1+2} not forked, branch M_{3+4} forked on membrane. Stem CuA multibranched. Cell C4 with two oblique veinlets *m-cua* basad of claval apex, and straighter veinlet *m-cua* apicad of claval apex; the second veinlet *m-cua* partly parallel to longitudinal veins.

Etymology. The genus name is derived from the name of the locality – Aulie, the name of the important category of spirits from the Central Asian mythology – taika eezi (“the master of the mountain”) combined with the ending ~idium. Gender: neuter.

Composition. Only the type species is included so far.

Aulieezidium karatauense sp. n.

(Figs. 1–9)

Diagnosis. Tegmen 3.1 times as long as wide. Cell C5b narrowed in apical portion, closed with a very short *icu* veinlet, cell C5c with a few veinlets; cell C3 about twice as long as adjoining apical cell; second (apical) veinlet *r-m* oblique, veinlet *im* between M_{1+2} and M_3 placed apicad. Other features as for the genus, as it is the only included species.

Description. Total length *c.* 14 mm. Head of general Fulgoroidea type, lateral margins of frons distinct, postclypeus with lateral carinae being continuation of lateral margins of frons, converging, but not reaching apical portion of postclypeus. Length of head (upper line, lateral view) *c.* 1.05 mm, length of frons (lateral view) *c.* 1.87 mm, postclypeus *c.* 1.35 mm long, anteclypeus *c.* 1.5 mm long. Rostrum very long (*c.* 8.3 mm), subapical segment *c.* 4.3 mm long, apical segment 3.8 mm long, not exceeding length of body.

Pronotum (upper line, lateral view) *c.* 0.75 mm long, with transverse (postocular) carina present. Mesonotum (upper line, lateral view) *c.* 1.75 mm long, probably with five longitudinal carinae.

Fore and mid legs normally developed, not flattened. Fore femur 2 mm long, fore tibia 2.75 mm long, fore tarsus *c.* 0.83 mm long, basitarsomere slightly longer, *c.* 0.33 mm, mid and apical tarsomeres subequal, *c.* 0.26 mm long. Mid femur 2 mm long, mid tibia 2.75 mm long, mid tarsus *c.* 0.83 mm long.

Length of tegmen 11.4 mm, width of tegmen 3.7 mm. Costal margin slightly thickened, stems CA and Pc+CP merely shifted, costal area very narrow, less than half of width of costal cell. Basal cell not distinctly visible but it seems that stems Sc+R and M leave basal cell at same point. Stem Sc+R forked distinctly basad of stem CuA first forking, branch Sc+RA subparallel to costal margin, branch RP forked apicad of stem M branching. Stem M forked at level of claval apex, branch M_{3+4} forked slightly basad of branch M_{1+2} forking. Stem CuA forked slightly apicad of stem Sc+R forking, branch CuA_1 not forked, branch CuA_2 forked basad of claval apex, at level of second veinlet *m-cua* connection with branch CuA_1 ; branch CuA_{2a} not forked to the tegmen margin; branch CuA_{2b} forked slightly basad of level of M forking, branch CuA_{2a1} forked again at level of claval apex. Clavus long, exceeding $\frac{2}{3}$ of tegmen length, claval veins Pcu and A_1 fused in apical portion of clavus, slightly apicad of branch CuA_2 forking. Costal cell with number of elongately sigmoid veinlets. Cell C1 (outer anteapical cell) long, narrower than costal cell, without transverse veinlets basad of claval apex. Anterior discal cell very long without transverse veinlets. Cell C3 twice as long as adjoining apical cell. Posterior discal cell widest, cell C4 long, delimited by two elongately sigmoid veinlets *m-cua*, the first more oblique, the second partly parallel to longitudinal veins another veinlet *m-cua* present apicad of claval apex. Cell C5d with a few veinlets, cell C5c narrowed in apical portion, closed with a very short *icu* veinlet.

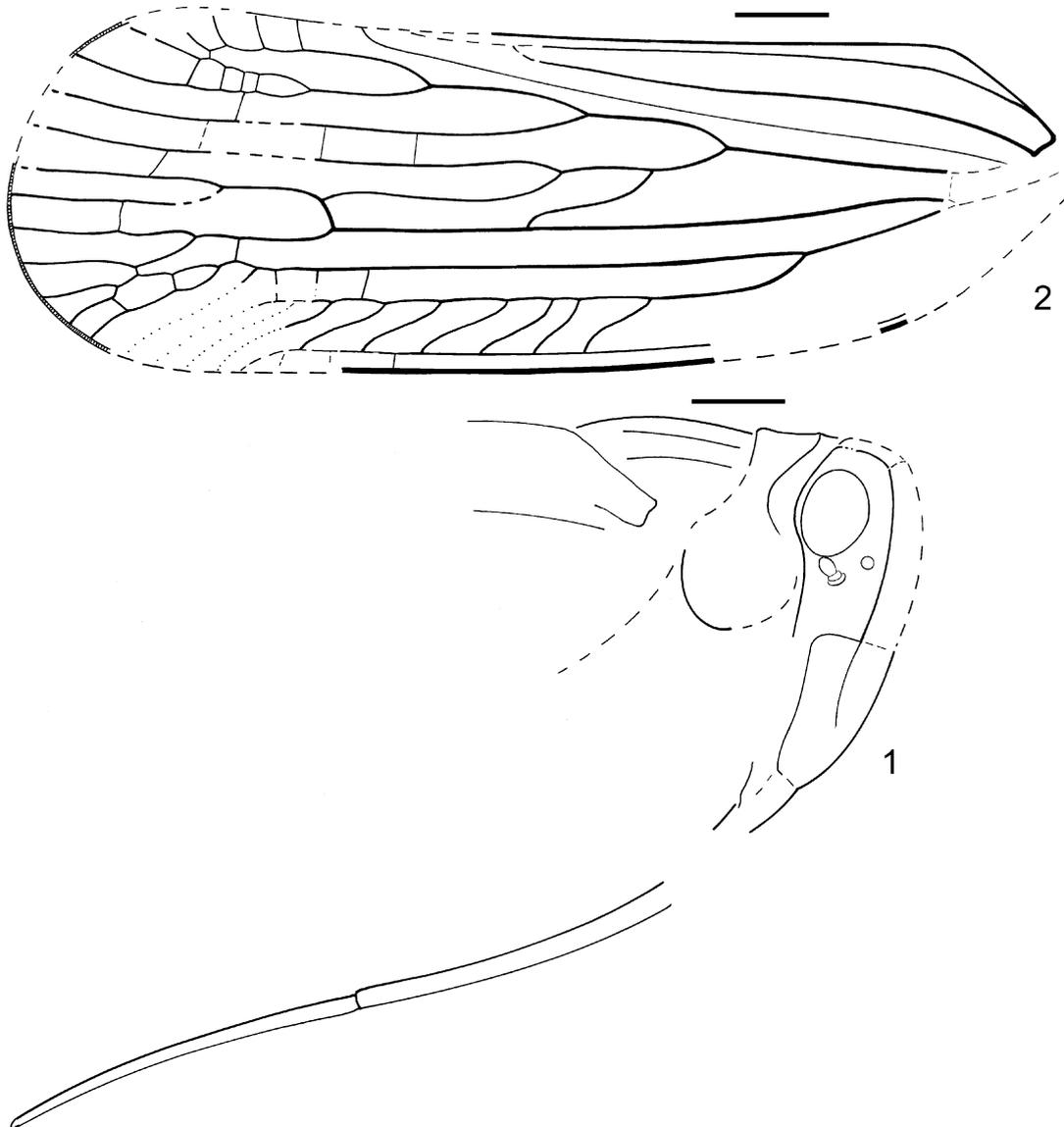


FIGURE 1, 2. *Aulieezidium karatauense* gen. sp. n. 1—anterior part of body, lateral view; 2—tegmen venation (partly reconstructed). Scale bar 1 mm.

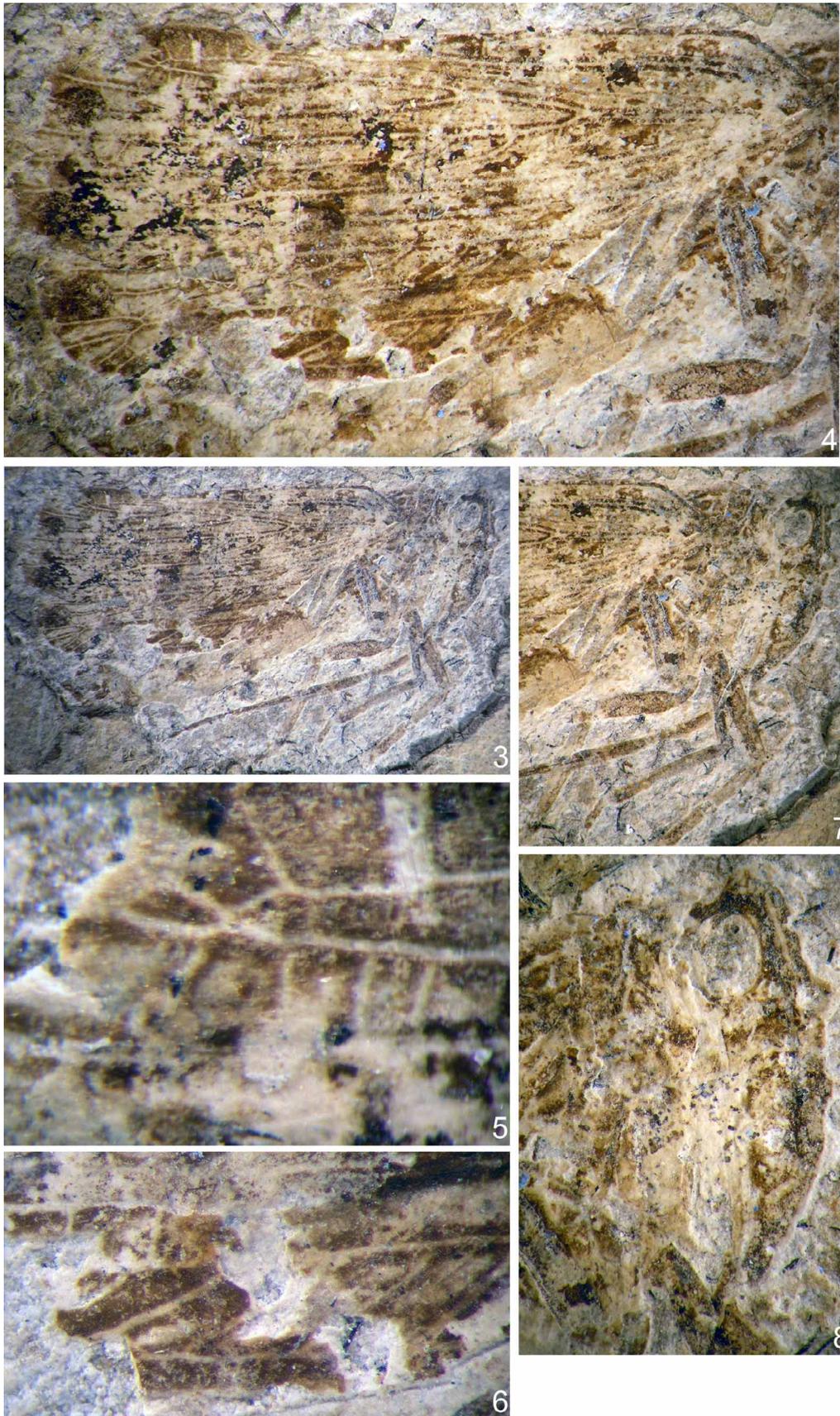


FIGURE 3–8. *Aulieezidium karatauense* **gen. sp. n.** 3—holotype; 4—tegmen; 5—apical portion of cells C5b and C5c; 6—fragment of costal area and costal cell; 7—anterior portion of body; 8—head.

Two round spots in apical portion of tegmen, darker marking portion on membrane, two darker markings in median portion of tegmen. Veins light, with darker emarginations.

Etymology. The specific epithet is derived from the name of the Karatau Lagerstätte.

Age and occurrence. Upper Jurassic, Oxfordian–Kimmeridgian, Karabastau Formation. Aulie near Mikhailovka village, Karatau Range, Southern Kazakhstan province, Kazakhstan.

Type material. Holotype, male (?). Specimen number ZPAL V32.354, deposited in the Institute of Palaeobiology, Polish Academy of Sciences, Warsaw, Poland. Collected by Piotr Wegierek.

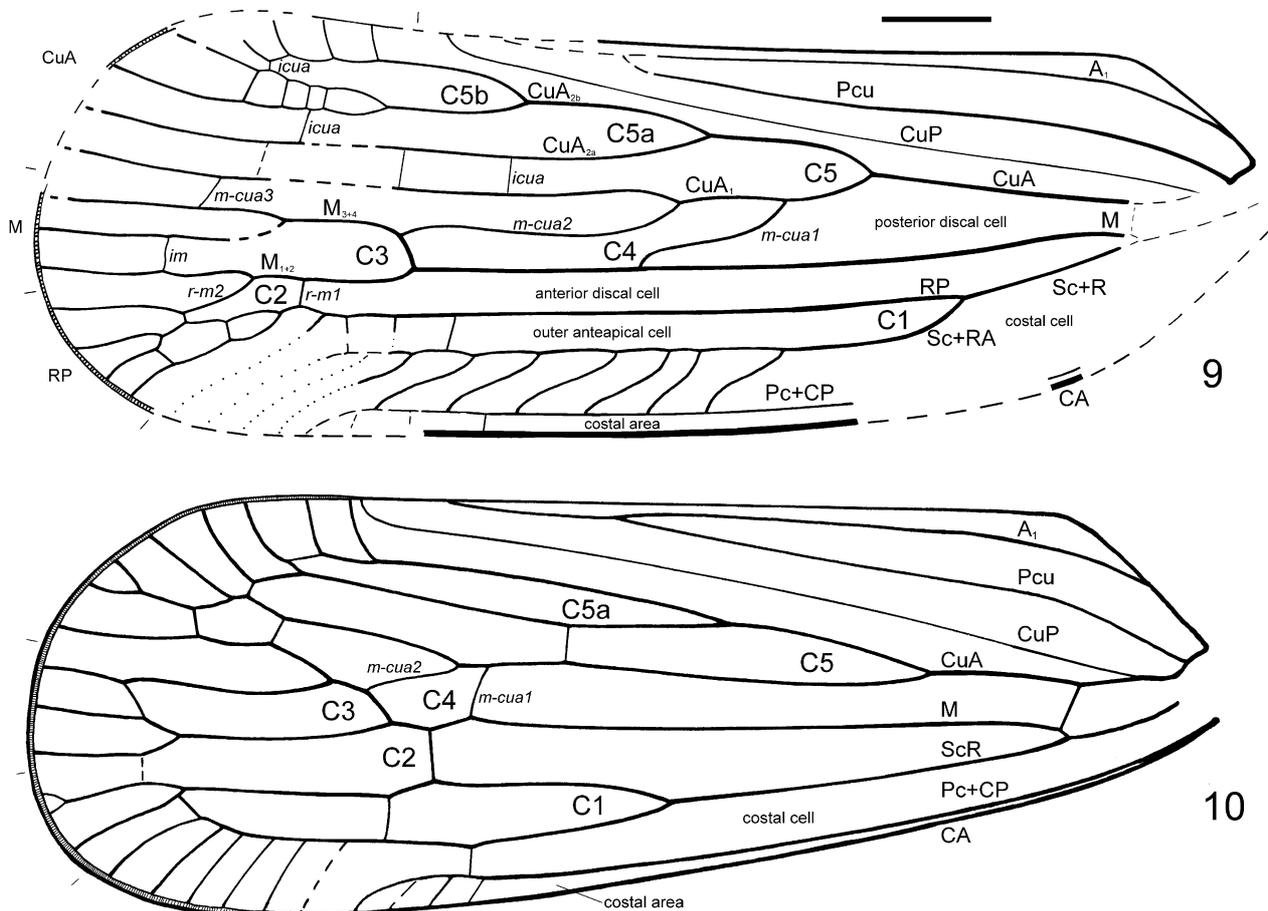


FIGURE 9. *Aulieezidium karatauense* gen. sp. n.—nomenclature of tegmen veins and cells (modified after interpretations of Emeljanov 1977, Mead & Kramer 1982, Dworakowska 1988, Anufriev & Emeljanov 1988, and Bourgoïn 1993).

FIGURE 10. *Fulgoridium balticum* (Geinitz, 1880)—tegmen venation pattern based on photograph of the specimen from Dobbertin, specimen LDA958.

Discussion

The extinct family Fulgoridiidae seems to be a paraphyletic unit but is believed to be ancestral to the other families of the superfamily Fulgoroidea (Shcherbakov & Popov 2002, Bourgoïn & Szewdo 2007, 2008). It needs a full revision as numerous taxa described by Geinitz (1880), Handlirsch (1906, 1939), Bode (1907, 1953), Martynov (1927, 1939) and Becker-Migdisova (1962), as well as more recently described by Lin (1986) and Zhang *et al.* (2004) must be re-analyzed and the characters of genera and species redefined. Fulgoridiidae has to be seen now as a paraphyletic assemblage from the Jurassic strata of Europe and Asia and needing revisionary studies. The number of species recognized seems to be reduced after revision of the materials (Ansoerge 1996). ‘True’ Fulgoridiidae share a long basal RP and a short CuA due to its early double

forking (= long cell C5) before the nodal line level. *Fulgoridium* and *Eofulgoridium* (which differs from the former by numerous crossveins in the basicostal area and a multibranching RP) have a long C1 and an uncommon early forking of CuA₂. The genus *Elasmoscelidium* is to be placed in this group but represents subbrachypterous forms. It seems also that the genus *Margaroptilon* should be placed there. In reverse, *Fulgoridulum* exemplifies a long ScP+R stem (= short C1, short outer anteapical cell), closed cells C2, C3 and C4 short, less than twice as long as wide and an unforked CuA₂.

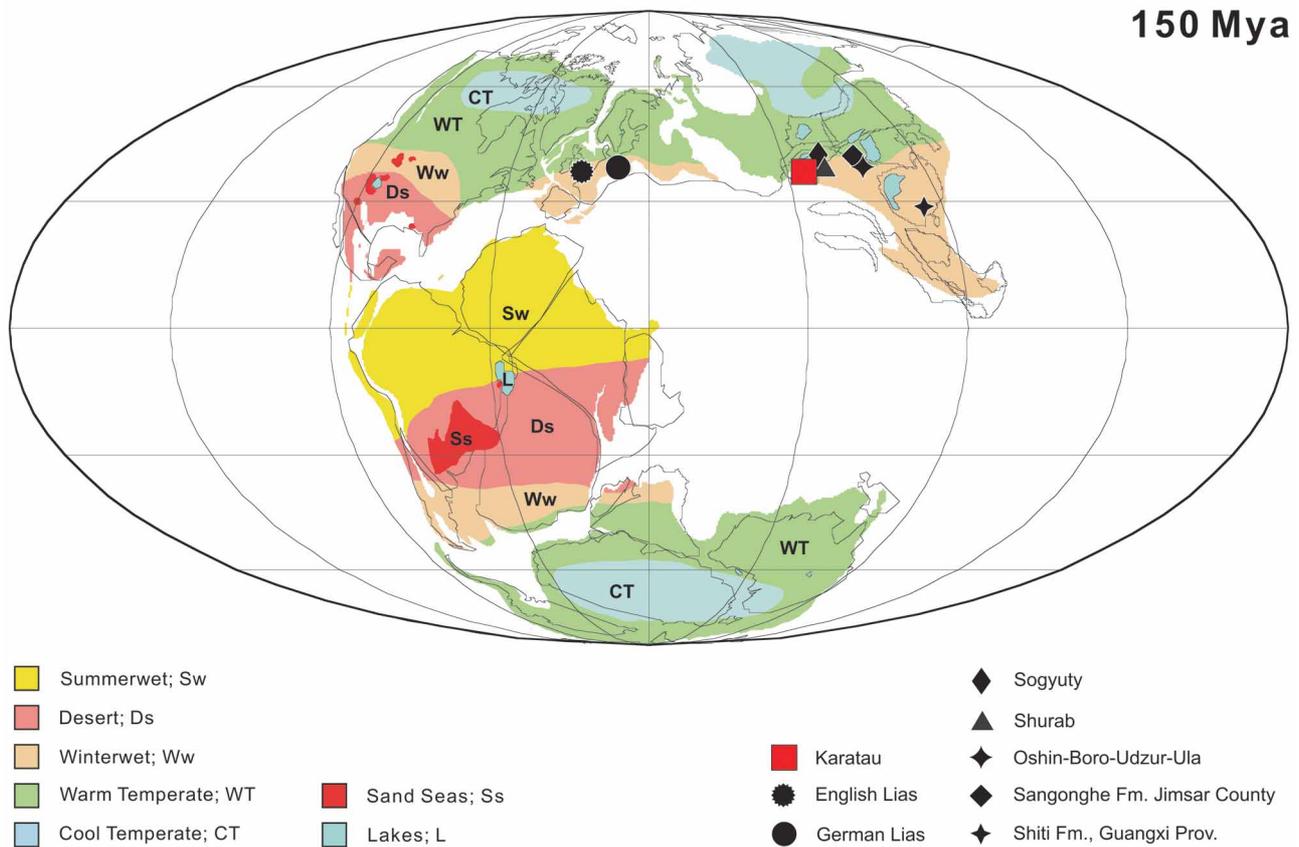


FIGURE 11. Localities of Fulgoridiidae on the background of climatic belts 150 Mya. Distribution of climatic belts and landmasses after Rees *et al.* 2000.

The genus *Fulgoridium* Handlirsch, 1906 *sensu lato* comprises a large number of weakly defined species from the Liassic of Europe (Szwedo *et al.* 2004). Several ill-defined subgenera of *Fulgoridium sensu lato* have also been recognised, and sometimes treated as genera. The subgenera erected by Bode (1953) are based on body characters, not venation making the situation more unclear, with dozens of species described but of unclear position. The genus *Fulgoridium* Handlirsch and related genera of the paraphyletic Fulgoridiidae await revision. The diagnostic characters of *Fulgoridium sensu stricto* based only on its type species, i.e. *Fulgoridium balticum* (Geinitz, 1880) are as follows (Fig. 10): tegmen about 3 times as long as wide, narrow at base than widened, costal margin thickened, costal area narrow at base then slightly widening basad of nodal line level, at least with a few terminals in apical portion; costal field without transverse veinlets; stem ScR leaving basal cell slightly basad of stem M, forked basad of half of tegmen length, but apicad of stem CuA forking, branch ScRA with a few terminals, branch RP usually with 2-3 terminals; stem M forked distinctly apicad at level of nodal line; stem CuA first forking very basad, second forking (branch CuA₁ forking) about at level of stem ScR forking, branches CuA₁ and CuA₂ not forked basad of claval apex, but forked in apical portion; prenodal veinlets sometimes present, transverse; nodal veinlet *m-cua* variable, sometimes strongly oblique and long, but no longer than twice of posterior discal cell width; postnodal veinlets present, but not forming distinct subapical or apical lines; clavus long, its apex about 0.7 of tegmen

length; claval veins united in apical 1/3 of clavus length.

Aulieezidium differs from the European species of “Fulgoridiidae”. These species are exclusively from the Lower Jurassic, Liassic deposits of Germany and England, and they are placed in the genera *Fulgoridium* Handlirsch, 1906 *s. l.*, *Fulgoridulum* Handlirsch, 1939, *Margaroptilon* Handlirsch, 1906, *Metafulgoridium* Handlirsch, 1939, *Parafulgoridium* Handlirsch, 1939 and *Tetragonidium* Bode, 1953. There are some similarities between *Aulieezidium* and some species ascribed to the genus *Fulgoridium* Handl. A few terminals of stem Pc+CP are present i.e. in ‘*Fulgoridium*’ *obtusum* Handlirsch, 1939 and ‘*Fulgoridium*’ *grave* Handlirsch, 1939, but both species differ from *A. karatauense*. in the pattern of ScR forking (apical of CuA forking) and branch CuA_{2b} without additional forkings basad of claval apex. Stem M forked at level of claval apex is found e.g. in ‘*Fulgoridium*’ *multipunctatum* Handlirsch, 1939, ‘*Fulgoridium*’ *debile* Handlirsch, 1939 or ‘*Fulgoridium*’ sp. 2 figured by Ansoerge (1996: Fig. 37; Pl. 7, Fig. 9), but two former differs in stem ScR forking, and the latter in the lack of distinguished costal area. ‘*Fulgoridium*’ *pallidum* Handlirsch, 1906 and ‘*Fulgoridium*’ *breve* Handl. present long and oblique veinlet *m-cua*, but it is shorter than these in *A. karatauense*; in any of above mentioned species prenodal veinlet *m-cua* is found and it seems it is rather normal condition, not an aberration.

The new species described above differs distinctly from *Elasmoscelidium rotundatum* Martynov, 1927, the only species of Fulgoromorpha described so far from the Karatau deposits. The placement of *Elasmoscelidium* is dubious. The species described from Karatau seems to be a brachypterous form. The other species ascribed to the genus, *Elasmoscelidium boreale* (Bode, 1907), *E. promotum* Bode, 1953, *E. rectemarginatum* Bode, 1953 and *E. venulosum* Bode, 1953 (all from the Lower Jurassic of Germany), must be revised and their characters re-examined. *Aulieezidium* differs from *Elasmoscelidium* in the tegmen length/width ratio – the tegmen is about 3.1 times as long as wide, while in *Elasmoscelidium* the tegmen is about twice as long as wide. Also the venation pattern is different, a costal cell with veinlets is present in *Aulieezidium*, and no veinlets in costal cell are in *Elasmoscelidium*; the stems Sc+R and CuA are forked about at same level in *Elasmoscelidium*, and stem Sc+R is forked more basad in *Aulieezidium*; branch CuA₂ is single in *Elasmoscelidium*, while branched several times in *Aulieezidium*. The length/width ratio of *Aulieezidium* tegmen differs a little from this ratio recorded in Lower Jurassic *Eofulgoridium tenellum* Zhang, Wang et Zhang, 2004 (Sangonghe Formation, Junggar Basin, Jimsar County, Xinjiang, China), and *Eofulgoridium kisylikiense* Martynov, 1939 (Kyzyl-Kiya, Uch-kungurskoe coal quarry near Kyzyl-Kiya town, Oshskaya oblast’, Kirghizia; length/width ratio 3.3 : 1). The latter species is also characteristic of the relatively short cell C5a tapered in apical portion, which is a feature similar to that found in *Aulieezidium* (here the cell C5b is short and tapered), but *Eofulgoridium kisylikiense* Mart. differs in the model of forking of stems Sc+R, M, and CuA, and the presence of a quite wide costal area with transverse veinlets along. The other Lower Jurassic genera *Fulgoropsis* Martynov, 1939 (Kyzyl-Kiya; known only from the hind wing) and *Valvifulgoria* Lin, 1986 (Shiti Formation, Guangxi Province, China) are too poorly known for any conclusive remarks. The pattern of forking of stem M of *Aulieezidium* could be interpreted in two ways. The branch M₁₊₂ separates from stem M and is forking again in apical portion. The second interpretation is that the branch M₁₊₂ is not forked, i.e. stem M ends with three terminals. Both interpretations are of equal possibility as this portion of the tegmen is not very clearly preserved. The presence of two strongly sigmoid veinlets *m-cua* on the tegmen is worthy of special attention. It is unique that the second veinlet *m-cua* imitates the longitudinal vein and for a long portion it is parallel to the longitudinal stem M and branch CuA₁. Long and strongly oblique veinlets *m-cua* on the tegmen are known among some other “Fulgoridiidae” as well, however not in such a developed form. The other interpretation that it is an offshoot of branch CuA₁ suggests that there is a fused long portion of terminals M and CuA. It seems less probable, as among other Fulgoridiidae the branch CuA₁ is not secondarily forked basad of claval apex and stem M is forked in apical portion of tegmen at the level of claval apex. Placement of *Cixiites* Handlirsch, 1906 within Fulgoridiidae seems to be dubious, and the status of Lower Cretaceous ‘*Fulgoridium*’ *matsuoii* Fujiyama, 1978 was recently clarified – this taxon is placed in the genus *Nipponoridium* Szwedo, 2008 of the recently described family Mimarachnidae (Shcherbakov 2007,

Szwedo 2008). In comparison with the Lower Jurassic Fulgoridiidae genera, *Aulieezidium*, differs by numerous characters of the venation. It seems also that the basal cell of *Aulieezidium* is narrower than in typical “Fulgoridiidae”; in the latter it is usually twice as long as wide. The short cell C5a1 tapered in apical portion resembles some taxa ascribed to the family Lalacidae Hamilton, 1990. It seems that in respect to venation patterns of tegmina and hind wings a few models are present among “Fulgoridiidae” and the taxa included in this group could be distributed among separate units after revision of the material available. The head of *Aulieezidium* is of general Fulgoroidea type and, similarly to other known Fulgoridiidae, the rostrum is very long, exceeding the hind leg coxae. The lateral margins of the frons are well developed, carinate, and prolonged onto the postclypeus. Unfortunately this character has not been studied among other Fulgoridiidae and it is not clear if it is a plesiomorphic condition; it is present also among various taxa of other Fulgoroidea families, developed to various extents. The narrow, collar-like pronotum is found also among other representatives of “Fulgoridiidae” and also among some representatives of extant families, e.g. Cixiidae and Delphacidae. The five-carinate mesonotum is present also among some other fossil Fulgoromorpha (e.g. Lower Cretaceous *Lapicixius* Ren, Yin et Dou, 1998) as well as among extinct and extant Cixiidae (the tribes Pentastirini Emeljanov, 1971 and Mnemosynini Emeljanov, 1993) and Delphacidae.

The Jurassic was the time of drastic tectonic differentiation of the land masses. The Tethys Ocean separated Laurasia (more or less corresponding to modern Eurasia) from the block of southern continents, i.e. Gondwana. The newly formed Indian and Atlantic Oceans had divided the Southern continental block into Western Gondwanaland (South America, Antarctica, Australia, New Zealand) and Eastern Gondwanaland, which began further dividing into Africa, Hindustan and Madagascar. Numerous groups of insects originated during the Jurassic in the equatorial belt, and subsequently appeared at higher latitudes (in Siberia and Gondwana). On the other hand, it was the time when apparent movement occurred also in the opposite direction, from high to low latitudes. During the Early and Middle Jurassic, however, there are a whole series of taxa which had originated in the temperate Siberian region (including Mongolia and northern China) and some time later penetrated into the Equatorial region (Eskov 2002). Due to this reason Zherikhin (1980a) notes that the Siberian entomofaunas of the Early Jurassic are very advanced and seem to be more similar to the Late Jurassic ones than to the equatorial (Indo-European) faunas of the Early Jurassic. Both the above trends can be regarded as departures from the operating regime of the “equatorial pump”; they can be directly attributed to the establishment of a less contrasting world climate in the geologic time under consideration (Eskov 2002). The presumed ancestors of Fulgoridiidae – the Surijokocixiidae, are known since Upper Permian to Upper Triassic. During the Late Triassic, the climatic zonality was not strongly pronounced and a frostless climate prevailed at this time (Meyen 1987, Ziegler *et al.* 2001). The Lower Jurassic representatives of Fulgoridiidae (Fig. 11) appear in the fossil record in the warm temperate zone (Rees *et al.* 2000). The Upper Jurassic genus *Aulieezidium* described above was found in the warm temperate/winterwet zone, but according to locality conditions reconstructions it was an area with a dry climate. Karatau lake was a large and shallow reservoir with the shores flat and marshy, but surrounded by mountains, which influenced the climatic conditions. Plant remains represented near the Karatau lake were bennettites, conifers, pteridophytes and cycadophytes as well as Equisetales, Caytoniales, Ginkgoales, Cycadales and Czekanowskiales. It seems that some of the gymnosperms listed above could be host plants for Fulgoridiidae. A very long rostrum (as found in *Aulieezidium*) was common in various Mesozoic Fulgoromorpha indicating that sucking from trunks and thick branches was more widespread than nowadays. Distractive colour pattern, e.g. dark ‘false eye’ spots near the apex of the tegmen attracting predator’s attention to the rear end of prey instead of to its head seems to be common among Jurassic Fulgoridiidae, e.g. *Margaroptilon* (Shcherbakov & Popov 2002). A distinct colour pattern, including two spots in the apical portion of the tegmen is found in *Aulieezidium* as well. The other probable possibility is that already in the Early Jurassic some planthoppers (some Fulgoridiidae) mimicked their visual predators, maybe some spiders, as suggested by Shcherbakov (2007b). The assumption that *Aulieezidium* presents also this kind of coloration, simple spider patterns with dark bands and 1–2 apical eyespots on the tegmen (as known e.g. in some extant Cixiidae) seems to be reasonable, however it is too poorly preserved on the specimen available for description. *Aulieezidium karatauense* lived near the Karatau

lake, feeding on gymnosperm plants growing in its vicinity, disrupting its enemies with false eyes or spider mimicking. Some other representatives of planthoppers from this locality await description but it could be assumed that Fulgoromorpha fauna of this fossil site was quite differentiated.

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