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New Lacewings (Neuroptera) from the Terminal Permian and Basal Triassic of Siberia

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Abstract—*Permorapisma gori* sp. nov. (Permithonidae; Tunguska Basin, Kureika River; Upper Permian, Pelyatka Formation), *Permantispa emelyanovi* gen. et sp. nov. (Permithonidae?; Tunguska Basin, Ilimpeya River; terminal Permian or basal Triassic, Limptekon Formation), and *Babykamenia eskovi* gen. et sp. nov. (Archeosmylidae; Kuznetsk Basin, Babii Kamen' locality; basal Triassic?, Maltseva Formation) are described on the basis of isolated wings. *Osmythone* gen. nov. (Permithonidae) is created for *Permithone neoxenus* Riek, 1953 from the terminal Permian of Australia.

INTRODUCTION

It is well known that the greatest biosphere reorganization in the Phanerozoic took place near the Permian/Triassic boundary and was accompanied by a maximal decrease in diversity. Therefore, any data on the biota that existed near this boundary are quite interesting. The present paper describes three neuropteran insect fossils that have been found in the strata close to the boundary. One specimen is from the Babii Kamen' locality (Tom' River, Kuznetsk Basin), which has been known since the beginning of the 20th century. Paleoentomologists long considered this locality to be Lower Triassic; now, however, opinions differ widely on the age of these insect beds: either all of them are Permian, or all of them are Triassic, or they include the Paleozoic/Mesozoic boundary (see Durante and Mogucheva, 1998). In any case, the locality is close to the boundary. Until recently, no neuropterans had been found there; the first specimen was collected by an expedition of the Paleontological Institute of the Russian Academy of Sciences in 2001.

Two more specimens are from the Tunguska Basin, Krasnoyarsk region. Upper Permian and Triassic deposits of the Tunguska Basin have long been a widely debated topic, and different researchers draw the Permian/Triassic boundary there differently. One wing has been found in the Pelyatka Formation (Kureika River), which is considered to be Permian (Upper Tatarian). The second specimen was collected from the Limptekon Formation, Ilimpeya River, attributed to the Dvurogino Horizon of the intertrappean deposits; these strata are variously dated either to the basal Triassic or to the terminal Permian (Shcherbakov, 2000).

It is indicative that all three specimens belong (or are closely related) to taxa known from the terminal Permian of Australia. Evidently, the insect faunas of Angaria and Gondwana were quite similar at the end of the Permian and about the Permian/Triassic boundary.

The relationships between the extant neuropteran families are currently determined mainly on the basis of genital and larval characters (Aspöck *et al.*, 2001), whereas the only possible classification of fossil neuropterans is based on wing structure, mostly that of the forewing. Permian Neuroptera were formerly described in eight extinct families, only four of which were accepted in the latest treatise on fossil insects (Carpenter, 1992). Venation in Permian forms is more uniform than in living ones; therefore, almost all (except for Archeosmylidae; Novokshonov, 1996) or all Permian Neuroptera (Makarkin and Archibald, 2003) were recently united into one family, Permithonidae. However, even some extant families retaining generalized venation (e.g., Sisyridae and Dilaridae) fit the forewing diagnosis of these broadly understood Permithonidae given by Novokshonov (1996). To avoid taxonomic continuum from the Permian to Recent forms, a more elaborate suprageneric system of Permian Neuroptera is necessary. Thus, it is appropriate to retain Archeosmylidae as a separate family, although the two genera established below partly fill the gap between this family and Permithonidae. In addition, some other formerly accepted families (especially Palaemerobiidae Martynov, 1928) seem to merit subfamily status within Permithonidae s.l.

For the vein nomenclature, see Novokshonov (1996): MA is associated with RS and appears as its most proximal branch, M_5 is a basal crossvein between MP and CuA, and interradial space separates R from the RS stem. Contrary to Novokshonov (1996), SC does not invariably terminate on R in Permian neuropterans, and some show SC terminating on C and connected to R by a crossvein, as in Hemerobiidae. This character is not easy to trace in some fossils, and it may be obscured by a fold in the subcostal space (Ponomarenko, 1995).

MATERIAL

The specimens that were studied are stored at the Paleontological Institute of the Russian Academy of Sciences (PIN).

SYSTEMATIC PALEONTOLOGY

Key to Permian families of Neuroptera (forewing)

1. Nine to ten principal RS+MA branches close-set, with limited end-twigging, posterior ones nearly parallel to longitudinal wing axis, MA stem running posterior to the wing midwidth; R beyond junction with SC arched parallel to wing margin; CuP forked about as deep as CuA............................Archeosmylidae

If principal RS+MA branches close-set, then MA stem running anterior to the wing midwidth; R beyond SC apex usually not parallel to wing margin; if forked, CuP normally less deep than CuA.........
....Permithonidae

Family Permithonidae Tillyard, 1922, s.l.

Genus *Permorapisma* Tillyard, 1926

Permorapisma gori **Ponomarenko et Shcherbakov, sp. nov.**

E t y m o l o g y. In memory of paleobotanist Yu.G. Gor, who found the specimen.

H o l o t y p e. PIN, no. 1830/1, left hindwing lacking anal area, slightly folded along anterior MP branch (negative impression); northern Krasnoyarsk region, Tunguska Basin, Kureika River; Upper Permian, Upper Tatarian, Pelyatka Formation.

D e s c r i p t i o n (Fig. 1). The hindwing elongate, not widened toward the base, about three times as long as it is wide, widest near the midlength, with the anterior margin weakly convex, slightly concave near pterostigma, curved just before the wing apex. The crossveins are few; between the RS+MA branches, there is one distal gradate series of weakened (flexible) crossveins. The costal area is narrow, with forked, moderately inclined veins that become sparser, simple, and associated pairwise toward the base. The pterostigma is weakly separated, consisting of very dense, forked veins. The trichosors are developed near the wing apex and absent in the MP region; nygmata have not been found. The subcostal space is very narrow in the proximal half. SC is connected to R with a crossvein in the apical wing quarter; R+SC is weakly curved backward and then forward before entering the anteapical wing margin. The interradial space is slightly widened toward the base, with seven crossveins, all long and reclined except for the distal one. RS is markedly gradate, so that some of its sections appear to be a continuation of the interradial crossveins. RS+MA bears nine principal branches. MA is forked beyond the wing midlength. MP is forked slightly more proximally than RS+MA, and both its branches fork late (anterior one slightly later) and with pronounced end-twigging. CuA is concave (a convex furrow runs anterior to it) and pectinate, with no less than four branches (posterior one forked). The space between CuA and CuP is wide. 1A bears no less than four branches. The wing membrane is slightly suffused, with several indistinct dark spots near the pterostigma. The veins are strewn with small granules (bases of setae).

M e a s u r e m e n t s, mm: hindwing length, 20.

C o m p a r i s o n. Distinct from two other species in the fewer interradial crossveins. It differs from the type species, *P. biseriale* Tillyard, 1926 (= *triseriale* Tillyard, 1926), known from several forewings from the terminal Permian of Australia (Belmont), in having much less numerous crossveins. From the second species, *P. fragmentatum* Vilesov et Novokshonov, 1994, described based upon a hindwing from the terminal Permian of Kazakhstan (Karaungir), it differs in addition in its more elongated wing shape, forked pterostigmal veins, absence of reticulate venation between CuA and CuP, and larger size.

R e m a r k s. In the extant genus *Rapisma* McLachlan, 1866 (Ithonidae) and in the type species of the genus *Permorapisma*, the crossveins between the SC branches and two or three cell series between CuA and CuP are developed in the forewings. In the hindwing of *Rapisma*, these crossveins and cell series are absent, and, by analogy, their absence in the hindwing could be considered normal for *Permorapisma*.

The new species is assigned to the genus *Permorapisma* on account of its narrow subcostal space, interradial space being somewhat widened basally and with many crossveins, nine principal RS+MA branches, MA forking distal to anterior MP branch, widened space between CuA and CuP, pronounced end-twigging over the distal wing half, very large size, elongate wing shape, and forked pterostigmal veins (the two latter characters are absent in *P. fragmentatum*). In some of these characters, the new species is similar also to the genus *Permithonopsis* Martynov, 1933, being distinct in its more elongated hindwing with an anterior margin concave near pterostigma, absence of unforked veins in pterostigma, longer SC, and more pronounced end-twigging.

The hindwings of neuropterans somewhat differ from their forewings and have been described (in addition to the two above-mentioned genera) only in the following few Late Permian genera: *Permithone* Tillyard, 1922: *Permopsychops* Tillyard, 1926; and *Sialidopsis* M. Zalessky, 1926. Thus, allocation of the isolated hindwings to the genera established for forewings is more or less tentative, and both the new species and *P. fragmentatum* may belong to separate genera.

The species in question seems to represent the largest Permian lacewing known, since its forewings were probably somewhat longer than 20 mm (for *P. biseriale*, a forewing length of 19–20 mm has been cited).

The generic name *Permorapisma*, as well as *Rapisma*, is of neutral gender.

M a t e r i a l. Holotype.