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A NEW FOSSIL GREEN LACEWING (NEUROPTERA: CHRYSOPIDAE) FROM THE EOCENE TADUSHI FORMATION, EASTERN SIKHOTE-ALIN

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Asiachrysa tadushiella **gen. et sp. n.** (Neuroptera: Chrysopidae: Nothochrysinæ) is described as a new genus and species from the Eocene Tadushi Formation (Russia, Primorye). The venation of the new genus is most similar to that of the early Eocene genus *Cimbrochrysa* Schlüter from Denmark, but is easily distinguished from it by a strongly zigzagged pseudocubitus (Psc); the crossveins which in part form this are confidently identified.

KEY WORDS: Neuroptera, Chrysopidae, Nothochrysinæ, new genus, Eocene, Tadushi Formation.

В. Н. Макаркин. Новая ископаемая златоглазка (Neuroptera: Chrysopidae) из эоцена Тадушинской свиты, восточный Сихотэ-Алинь // Дальневосточный энтомолог. 2014. N 272. С. 1-7.

Asiachrysa tadushiella **gen. et sp. n.** (Neuroptera: Chrysopidae: Nothochrysinæ) описан как новый род и вид из эоцена Тадушинской свиты (Россия, Приморье). Жилкование нового рода наиболее сходно с жилкованием раннеэоценового рода *Cimbrochrysa* Schlüter из Дании, но легко отличается от него очень изви-

листой ложнокубитальной жилкой (Psc) с хорошо определяемыми в ней всеми поперечными жилками.

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INTRODUCTION

Nothochrysinæ was the dominant chrysopid subfamily in the Eocene, unlike today, when it is a minor, sporadically distributed element within the family. Fossil Nothochrysinæ include 11 named genera and 22 species from the Cenozoic of Europe and North America. However, only one unnamed species of Nothochrysinæ has been reported in Asia and Russia, from the late Miocene of the Botchi Formation, southern Khabarovskii Krai (Makarkin, 1998).

Here, a new genus and species *Asiachrysa tadushiella* gen. et sp. n. is described from the Uglovoi Stream locality of the Tadushi Formation (eastern Sikhote-Alin). There is another chrysopid specimen from that locality, a probably nothochrysinæ; however, it is a fragmentary and crumpled hind wing whose taxonomic affinity is obscure below this level.

The Tadushi Formation is distributed in the basin of the Zerkalnaya [=Tadushi] River, Kavalerovskii Raion [=Kavalerovo District], eastern Primorskii Krai [=Primorye], Russian Far East. A number of outcrops of this formation are known within the river valley and lower reaches of its tributaries. At least six localities are known: (1) the lower reaches of the Sadovaya [=Yushangou] River, a right tributary of the Zerkalnaya River [=‘Petrushka’ River: Ablaev, 1974; Ablaev *et al.*, 2005; =‘Petrushka’ River: Zherikhin, 1978]; (2) the lower reaches of the Uglovoi Stream [=‘Ugol’nyi’: Zherikhin, 1978], in the vicinity of Suvorovo Village, a right tributary of the Zerkalnaya River; (3) a quarry in 900 m upstream the mouth of ‘Petrushka’ [=Sadovaya] River; (4) the left bank of the Kurchumka [=Dalisyagou] River, a right tributary of the Zerkalnaya River (? the same as “near Suvorovo Village”: Bersenev *et al.*, 1969); (5) a quarry near Ustinovka Village at the right bank of the Zerkalnaya River; and (6) near Bogopol Village (Ablaev 1974; Zherikhin, 1978; Krassilov, 1989; Mikhailov *et al.*, 1989).

The Tadushi Formation is thought to represent deposits of a montane stratified lake (Akhmetiev, 1973; Zherikhin, 1978; Krassilov, 1989). It contains an abundant flora (e.g., Ablaev, 1974; Krassilov, 1989; Ablaev *et al.*, 2005) and numerous insects, collected mainly at an outcrop about one kilometer upstream from the mouth of the Sadovaya River and at another in the lower reaches of the Uglovoi Stream (Zherikhin, 1978). Insects have been recovered from tuffaceous mudstones of the upper part of the formation (Zherikhin, 1978; Rasnitsyn & Zherikhin, 2002). The number of neuropteran fossils is low. Only seven specimens may be identified with certainty as belonging to Neuroptera (two Chrysopidae, three Hemerobiidae and two Osmylidae), i.e., approximately 0.2 % of all insect specimens. However, such a low percentage of the order is generally characteristic of Cenozoic lacustrine deposits (Archibald & Makarkin, 2006).

The age of the Tadushi Formation is controversial. It is usually considered to be Paleocene: late Paleocene, possibly Thanetian (Rasnitsyn & Zherikhin, 2002); middle Paleocene (Selandian – earliest Thanetian) (Pavlyutkin & Petrenko, 2010); or even early Danian (Akhmetiev, 2010), based on its insects and flora. However, radiometric dating of volcanic rocks of the underlying Bogopol Formation and basalts of the overlying Suvorovo Formation shows that the Tadushi Formation is Eocene. The age of samples from the Bogopol Formation determined by K-Ar dating within Zerkalnaya River valley are 48 Ma (vicinity of Bogopol Village: Bykovskaya *et al.*, 1960) and 57±3 Ma (near Ustinovka quarry: Arakelyants *et al.*, 1982). The age of upper horizons of this formation from nearby regions is thought to be late Paleocene to early Eocene, from 59.68 ± 1.59 to 52.92± 1.0 Ma by Rb-Sr dating (Popov & Grebennikov, 2001), and 52.6±1.3 Ma – 50.6±1.2 Ma by K-Ar dating (Otofuji *et al.*, 1995). The age of basalts of the Suvorovo Formation is middle Eocene, from 41±3 Ma to 47.3±1.2 Ma (Arakelyants *et al.*, 1982; Otofuji *et al.*, 1995, 1998, 2002; Martynov, 1999). Basalts of the Suvorovo Formation conformably overlay the Tadushi Formation, whereas the latter rests unconformably on volcanic rocks of the Bogopol Formation, at least on the left bank of the Kurchumka River, probably in the vicinity of the village of Suvorovo (Mikhailov *et al.*, 1989). Therefore, a late early Eocene age of the Tadushi Formation is most probable (see also Popov & Grebennikov, 2001).

The specimen described here was collected in 1972 during an expedition of the Paleontological Institute, Russian Academy of Sciences, Moscow (PIN) under the guidance of Dr. V. V. Zherikhin, and deposited in PIN.

Abbreviations: AA1–AA3, first to third branches of the anterior anal vein; CuA, anterior cubitus; CuP, posterior cubitus; *im*, intramedian cell; MA and MP, anterior and posterior branches of the media; Psc, pseudocubitus; Psm, pseudomedia; RA, anterior radius; RP, posterior sector; ScP, subcosta posterior. Crossveins are designated after the longitudinal veins which they connect and are numbered in sequence from the wing base, e.g., 1scp-r, first (proximal-most) crossvein connecting ScP and R/RA; 1im, first (proximal-most) crossvein between MA and MP.

ORDER NEUROPTERA LINNAEUS, 1758

Family Chrysopidae Schneider, 1851

Subfamily Nothochrysinæ Navás, 1910

Genus *Asiachrysa* Makarkin, gen. n.

Type and only species. *Asiachrysa tadushiella* gen. et sp. n.

DIAGNOSIS. Origin of RP and basal crossvein between ScP and RA (1scp-r) shifted distally; M forked distally to origin of RP; intramedian cell broad, trapezoid in shape; crossvein 1r-m short connecting RP and intramedian cell at its proximal part; crossvein 2m-cu distad crossvein 1r-m, nearly in mid-point of intramedian cell; MA simple; pseudocubitus strongly zigzagged; anal veins simple.

ETYMOLOGY. Asia- (from the continent of Asia) + -chrysa (a traditional ending of chrysopid genera, from *Chrysopa*, a genus-group name). Gender feminine.

DISCUSSION. The shape of the intramedial cell of this genus is most similar to that of the genera *Cimbrochrysa* Schlüter, *Danochrysa* Willmann and *Stephenbrooksia* Willmann from the early Eocene Fur Formation of Denmark (Schlüter, 1982; Willmann, 1993). The position of 2m-cu in mid-point of the intramedial cell in *Cimbrochrysa* and *Stephenbrooksia* is also similar to that of *Asiachrysa* gen. n. In general, the venation of the new genus is most similar to that of *Cimbrochrysa*. The new genus is easily distinguished from these genera by its strongly zigzagged pseudocubitus, whose crossveins are confidently identified. The Psc of latter genera directly continues CuA, not zigzagged, and its crossveins are mostly lost or are more difficult to identify as such. These Danish genera also have at least AA1 forked (in *Danochrysa* AA2 is also forked), and their branches of RP are more closely spaced.

Asiachrysa gen. n. more or less resembles also some North American genera described from the Eocene of Okanagan Highlands (south-western Canada and north-western U.S.A.) and Florissant (Colorado): *Palaeochrysa* Scudder, *Tribochrysa* Scudder, *Archaeochrysa* Adams, and *Dyspetochrysa* Adams. It may be distinguished from these by the much more distal position of the crossvein 2m-cu. This crossvein is positioned against a proximal portion of the intramedial cell, even proximad 1r-m in most species of these American genera (see Carpenter, 1935; Adams, 1967). 2m-cu is located in nearly mid-point of the intramedial cell only in *Archaeochrysa profracta* Makarkin et Archibald from the early Eocene locality at McAbee (British Columbia, Canada) (Makarkin & Archibald, 2013). However, the origin of RP is shifted far proximad in all species of this genus, so that it is placed much proximad the fork of M. Other fossil and extant chrysopid genera strongly differ from *Asiachrysa* gen. n.

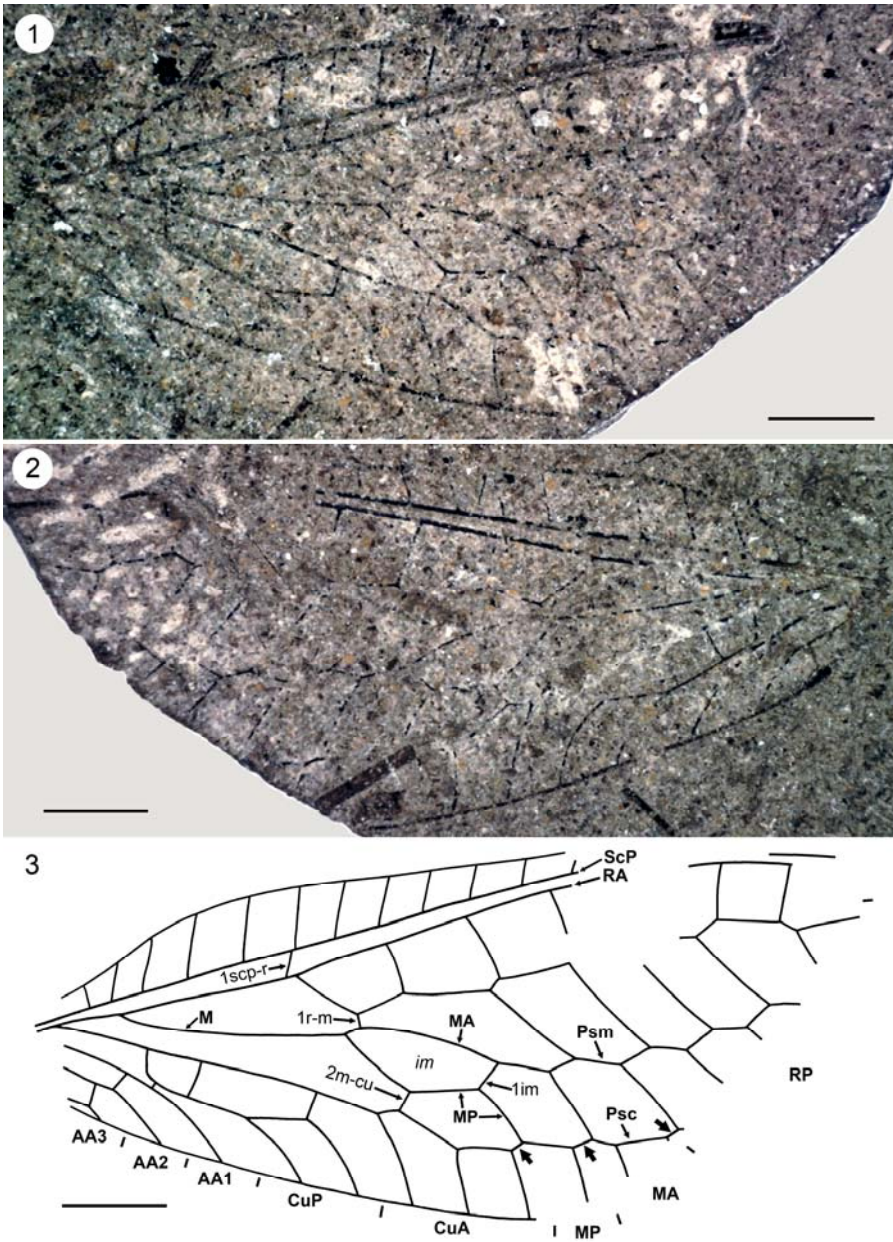
***Asiachrysa tadushiella* Makarkin, sp. n.**

Figs 1–3

MATERIAL. Holotype – PIN, No. 3364/3755 (part and counterpart); a rather well-preserved proximal two-thirds of a forewing with black veins (probably a result of coalification), in brown tuffaceous mudstone.

LOCALITY AND HORIZON. Uglovoi Stream, a right tributary of the Zerkalnaya River, Primorskii Krai, Russian Far East. Tadushi Formation, Eocene.

DESCRIPTION. Forewing 8.0 mm long as preserved (estimated complete length ca. 10–11 mm), 3.5 mm wide. Costal space moderately broad; most dilated slightly proximad 1psc-r. Subcostal veinlets simple, rather widely spaced. Subcostal space moderately broad; basal crossvein 1scp-r located slightly proximad origin of RP. RA space broad, with six crossveins preserved. Stem of RP originates at relatively obtuse angle, zigzagged, with four preserved widely spaced branches. Basal crossvein between RP and M very short, connecting stem of R and MA within intramedial cell. M dividing into MA and MP far distal to origin of RP. MA ached, deeply forked at Psc; MP strongly zigzagged, simple. MA and MP not divergent toward Psc. Crossvein



Figs 1–3. *Asiachrysa tadushiella* gen. et sp. n. (holotype PIN, No. 3364/3755). 1 –part; 2 – counterpart; 3 – forewing venation. Crossveins of pseudocubitus (Psc) are shown by bold arrows. Scale bar: 1 mm.

between MA and MP before Psc (1im) long. Intramedian cell rather broad, trapezoidal. Psm weakly developed, strongly zigzagged. Crossvein 2m-cu (between intramedian cell and CuA) placed nearly in mid-point of intramedian cell. CuA with two simple branches. Psc weakly developed; continuing into outer gradate series of crossveins. CuP deeply forked. Two intracubital crossveins: 1icu connecting CuA and CuP well proximad fork of CuP; 2icu connecting CuA and anterior branch of CuP. CuP and AA1 connected by short crossvein. All three anal veins simple; each connected with other by long crossvein. Two gradate series of crossveins in radial space; inner series with four preserved crossveins distal to MA; outer series not preserved except those crossveins that belongs to Psc.

ETYMOLOGY. Tadushi- (from the Tadushi River, former name of the Zerkalnaya River) + -ella (from the Latin diminutive suffix *-ellus*).

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