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A new species of *Sympherobius* Banks (Neuroptera: Hemerobiidae) from the late Eocene Rovno amber

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Abstract

Sympherobius irinae **sp. nov.** (Neuroptera: Hemerobiidae: Sympherobiinae) is described from the late Eocene Rovno amber, Ukraine. It differs from other species of the genus by small details in the forewing venation: (1) crossvein 3rp1-rp2 is not strongly shifted distally relative to neighboring crossveins in the third gradate series, and (2) the humeral veinlet has only two branches. All four late Eocene species form a distinctive species group, which is named here the *completus* species group, distinguished from other species of the genus by the presence of the crossvein 3rp2-rp3 in the forewing in distal position, connecting RP2 and RP3. The neuropteran assemblages of the Bembridge Marls and succinites (particularly Baltic and Rovno ambers) are briefly compared. The assemblages of some families are relatively similar, but there are obvious differences in others. It is impossible to draw conclusions about the age of Baltic or Rovno ambers based on this weak similarity.

Keywords: Neuroptera, Hemerobiidae, Sympherobiinae, Rovno amber, Bembridge Marls, Eocene

Introduction

The genus *Sympherobius* Banks, 1904 is rather speciose in the family Hemerobiidae, comprising ca. 50 extant species (Oswald, 2020). It is today widely distributed throughout Europe, Asia, Africa and America. Fossils of the genus are known from the late Eocene Baltic amber (*Sympherobius completus* Makarkin & Wedmann, 2009 and *S. siriae* Jepson *et al*., 2010) and latest Eocene Bembridge Marls of the Isle of Wight, England (*S. yulei* Nel & Jarzembowski, 2019), and the Miocene Dominican amber (an unnamed species: Engel & Grimaldi, 2007).

The genus belongs to the subfamily Sympherobiinae together with three other genera: the extant *Nomerobius* Navás, 1915a and *Neosympherobius* Kimmins, 1929, and the late Eocene *Prolachlanius* Krüger, 1923 (Makarkin *et al*., 2019).

In this paper, we describe a new species of *Sympherobius* from the late Eocene Rovno amber, Ukraine.

Material and methods

The piece of amber with the embedded specimen of *Sympherobius* was collected near Voronki in the Vladimirets District of the Rovno Region, Ukraine. It is triangular in shape (26.2 × 28.7 × 41 mm), concave, with a maximum thickness 4 mm (similar in shape in lateral view to the bowl of a spoon). Syninclusions: a large male Chironomidae (Diptera) and rare stellate hairs near the specimen of *Sympherobius*. The strongly concave inner surface of the amber piece implies its trunk origin.

Information on Rovno amber and its biota was reported by Perkovsky *et al*. (2010), Perkovsky & Makarkin (2019), Martynova *et al*. (2019 and references therein).

Venational terminology follows Makarkin *et al*. (2016).

Abbreviations: AA1–AA3, first to third anterior anal vein; CuA, cubitus anterior; CuP, cubitus posterior; hp, humeral plate; hv, humeral veinlet; MA and MP, anterior and posterior branches of media; ORB1–ORB3, first and third oblique radial branches; RA, radius anterior; RP, radius posterior; RP1–RP4, first (proximal-most) to fourth branches of RP; ScP, subcosta posterior.

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Institutional abbreviations: SIZK, Schmalhausen Institute of Zoology, National Academy of Sciences of Ukraine, Kiev, Ukraine.

Systematic palaeontology

Order Neuroptera Linnaeus, 1758
Family Hemerobiidae Leach, 1915
Subfamily Sympherobiinae Comstock, 1918
Genus *Sympherobius* Banks, 1904

***Sympherobius irinae* sp. nov.**
(Figs 1–3)

Holotype. Specimen No. SIZK L-118, collected by Nikolai R. Khomich, currently deposited in his collection, but will be ultimately deposited in SIZK. A nearly complete specimen, partly obscured by a milky covering.

Etymology. The species is named in memory of Evgeny Perkovsky's mother.

Diagnosis. Forewing venation is most similar to that of three other species of the genus from the Eocene, distinguished from these by 3rp1-rp2 not strongly shifted distally relative to neighboring crossveins in the third gradate series, and humeral veinlet having two branches.

Type locality and horizon. Rovno amber (Voronki locality). Late Eocene.

Description. Head mostly obscured by a milky covering. Terminal segments of maxillary and labial palps long, dark with apical semi-segment acute, pale. Antennae moderately long; scapus relatively large, longer than wide; pedicellus distinctly stouter than first flagellomeres; flagellum *ca*. 42/43-segmented (basal flagellomeres not clearly visible).

Pronotum poorly visible. Mesonotum: narrow transversal medial ridge well developed (see Makarkin & Perkovsky, 2020: fig. 3). Legs of usual morphology for the genus, with hind tibia swollen. Abdomen mostly obscured by a milky covering, especially its genital segments.

Forewing oval with rounded apex, 5.4 mm long, 2.3 mm (right wing) to 2.7 mm (left wing) wide. Trichosors prominent along entire wing margin. Costal space broad, dilated in proximal part. Seven to eight proximal subcostal veinlets branched once (one in left wing twice), other subcostal veinlets simple. Humeral veinlet (*i.e*., basal-most subcostal veinlet) recurrent, pectinately branched, with two simple branches. Crossveins absent in costal space. Subcostal space moderately broad for entire length, with two crossveins (basal, distal). RA apically dichotomously forked twice (left wing) or pectinate forked with three branches (right wing). Two (right wing) to three (left wing) separate stems [ORBs] of RP originated on RA. Configuration of RP in left wing is normal: ORB1[= RP1], ORB2 [= RP2] very similar, not forked proximal to fourth gradate series; ORB3 [= RP proper] possesses two branches, originating proximad fourth gradate series (RP3, RP4 respectively). Configuration of RP in right forewing is anomalous, with two ORBs: RP1 to RP3 fused forming ORB1; ORB2 representing RP proper with one distal branch (RP4) (Fig. 3B), and 4rp-rp3 abnormally long. M appears fused basally with RA for some distance, forked lightly distad origin of RP1; MA, MP sub-parallel before terminal branching. Anterior trace of CuA terminally shallowly forked, pectinately branched, with two (right wing) to three (left wing) branches, all of which have marginal forks except for one distal in left wing. CuP with only one marginal fork. AA1 with two (left wing) to three (right wing) simple pectinate branches. AA2 deeply forked: anterior branch with short pectinate branches (three in right wing, four in left wing); posterior branch with one to two very short simple pectinate branches. AA3 simple. Four gradate series of crossveins (series 1–4 of Oswald, 1993) posterior to RA. First series consists of four crossveins: 1m-cu, 1cu-aa, 1aa1-aa2, 1aa2-aa3. Second series consists of three crossveins: 2r-m, 2m-cu, 2icu. Third ('inner') series with six crossveins (from RA to CuA); 3rp1-rp2 not strongly shifted distally relative to next crossveins in the series. Fourth ('outer') series incomplete, with four crossveins (from RA to RP1). Crossveins absent between branches of CuA. Wing hyaline, yellowish; crossveins 3ra-rp and 3rp2-rp3 in right wing darker than other, narrowly margined with a brownish color; crossvein 3ra-rp in left wing and all crossveins in fourth series of both forewings (except 4rp-rp3 in right wing) slightly (indistinctly) margined with a brownish color.

Hind wing *ca*. 4.6 mm long; width impossibly to measure. Trichosors prominent along entire margin. Humeral plate with two very long setae (frenulum) and numerous shorter setae. One short crossvein (1ra-rp) in RA space. Basal crossveins 1r-m connects M, RP1. RP with three dichotomously forked branches. M forked slightly proximad origin of RP2. MA dichotomously forked; MP with only two terminal short branches. CuA with at least four branches (poorly visible); two distal-most simple. Two crossveins in inner gradate series, none in outer.

Discussion

The new species is assigned to *Sympherobius* as its venation fully corresponds to the diagnosis of the genus, *i.e*., crossveins 2scp-r, 4r-m, 4im, 4m-cu in the forewing and all crossveins in outer gradate series of the hind wing are absent (Makarkin & Wedmann, 2009).

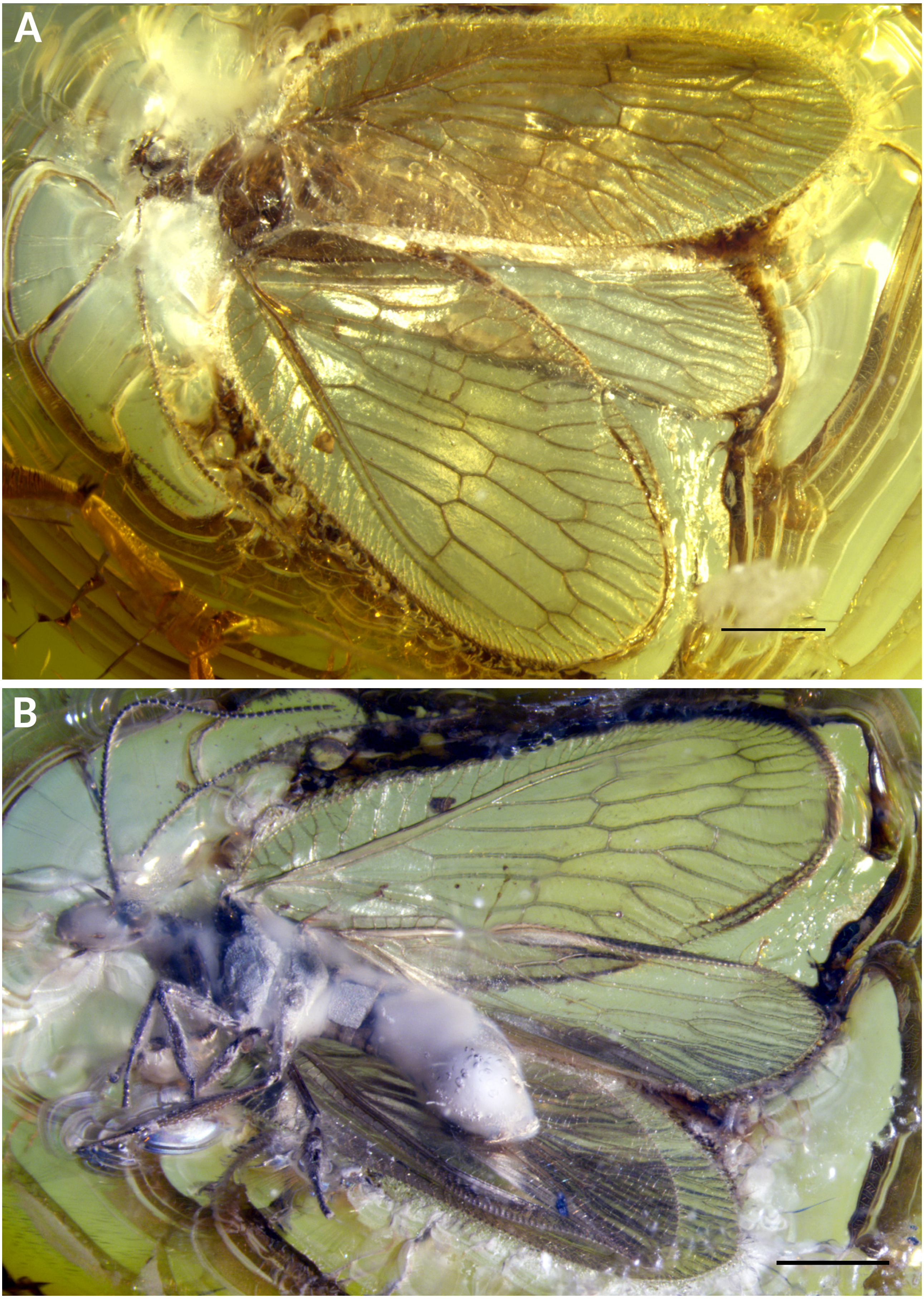

FIGURE 1. *Sympherobius irinae* **sp. nov.**, holotype SIZK L-118. **A**, Dorsal view. **B**, Ventral view. Scale bars = 1 mm.

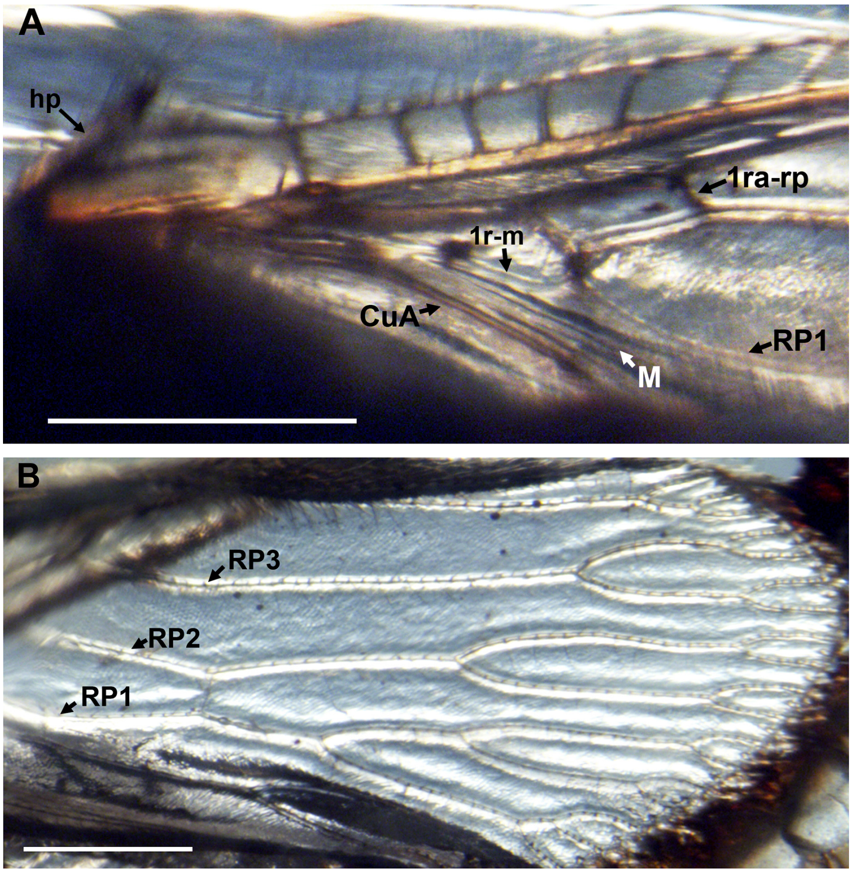

FIGURE 2. Left hind wing of *Sympherobius irinae* **sp. nov.**, holotype SIZK L-118. **A**, Basal portion. **B**, Distal portion. Scale bars = 0.5 mm.

Sympherobius irinae differs from the other three Eocene species (*i.e*., *S. completus*, *S. siriae*, *S. yulei*) by two character states (see Diagnosis). The crossvein 3rp1-rp2 in the forewing is strongly shifted distally in all known specimens of *Sympherobius* from Baltic amber (14 specimens of *S. completus* and/or *S. siriae*), while it is placed markedly proximad relative to neighboring crossveins in the gradate series in *S. irinae*. This is distinctly visible when comparing the relative position of 3rp1-rp2 and 3rp2-rp3 in *S. irinae* and *S. completus* (see Fig. 3A, C). The crossvein 3rp1-rp2 is not preserved in *S. yulei*, however the visible venation suggests its distal position. Also, the forewing humeral veinlet usually possesses four branches (rarely three) in these Baltic amber specimens, and never two as in *S. irinae*. The humeral veinlet also has three to six branches in extant species.

The configuration of RP in the right forewing of *Sympherobius irinae* is anomalous (Fig. 3B). However, similar venational aberrations are rather normal in this family, and sometimes occur in both fossil and extant species of Hemerobiidae and other families of Neuroptera (see Makarkin *et al*., 2016).

The venation of all four late Eocene species of *Sympherobius* is very similar, in particular the possession of three ORBs and the distal ORB3 bearing one long branch. The vast majority of extant species of the genus possess two ORBs, with ORB1 being deeply forked (see *e.g*., Oswald, 1993: fig. 82). The following extant species have three ORBs with branching of ORB3 similar to that of the Eocene species: *Sympherobius fuscescens* (Wallengren, 1863), *S. pellucidus* (Walker, 1953), *S. riudori* Navás, 1915b, *S. klapaleki* Zelený, 1963, *S. wuyianus* Yang, 1981, and *S. mirandus* Navás, 1920 (= *S. molinarii* Nakahara, 1960). However, these lack the crossvein 3rp2-rp3 in the forewing (see Fig. 3D), which is present in the Eocene species, located in a distal position, connecting RP2 and RP3. Moreover, this crossvein is absent or strongly shifted proximally connecting RA/RP proper and RP2 in all other extant species of the genus (*e.g*., Klimaszewski *et al*., 1988: fig. 17; Oswald, 1988: fig. 4, 1993: fig. 82; Makarkin & Wedmann, 2009: figs 5–9).

These four Eocene species form a distinctive species group in the genus *Sympherobius*, which might be named the *completus* species group. The group occurred in the late Eocene throughout Europe, from present-day England (Bembridge Marls) to the Ukraine (Rovno amber). Generally, to what extent are the neuropteran assem-

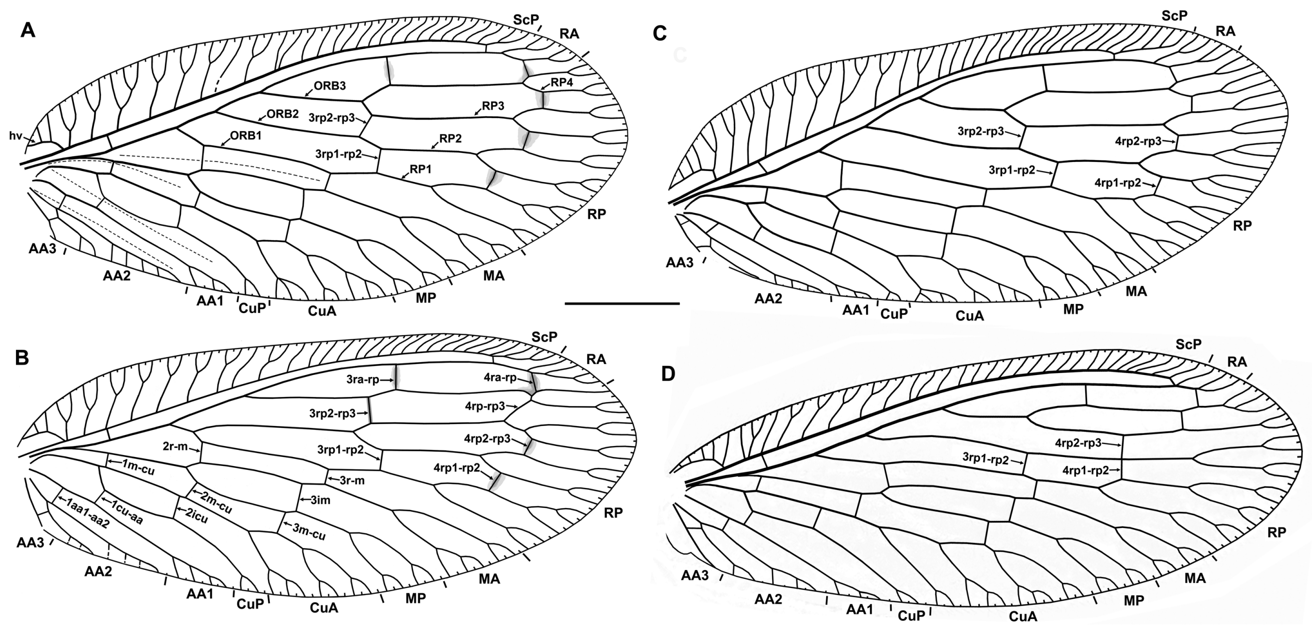

FIGURE 3. Forewing venation of *Sympherobius*. **A**, *S. irinae* **sp. nov.**, holotype SIZK L-118, left forewing. **B**, Same, right forewing. **C**, *S. completus* (Baltic amber; revised drawing of the holotype). **D**, *S. fuscescens* (extant). Scale bar = 1 mm (**A**–**C** to same scale; **D** not to scale).

blages of the Bembridge Marls and succinites (particularly Baltic, Bitterfeld, and Rovno ambers) similar? This question is important as the age of succinites (primary Baltic amber) remains debatable (*e.g*., Perkovsky *et al*., 2007; Perkovsky, 2016; Bukejs *et al*., 2019 and references therein), while the age of the Insect Bed of the Bembridge Marls has been determined more or less accurately, *ca*. 34 Ma (Ross & Self, 2014). In particular, one Baltic amber species of Braconidae (Hymenoptera) was recorded in the Bembridge Marls (Antropov *et al*., 2014), although the conspecifity of the lost holotype from Baltic amber and an incomplete forewing from the Bembridge Marls should be considered as preliminary. Also, it is thought that the fossil record of the two subfamilies of Ichneumonidae (Townesitinae and Hybrizoninae) present only in the Bembridge Marls and succinites confirms the close relation of the faunas (Tolkanitz *et al*., 2018 and references therein).

Besides *Sympherobius yulei*, other Hemerobiidae from the Bembridge Marls are mostly fragmentary, except for a small (5 mm long) forewing of '*Hemerobius*' *tinctus* Jarzembowski, 1980, fig. 31. Its taxonomic affinity has been previously discussed (Makarkin, 1991; Makarkin *et al*., 2016), and it is theoretically possible that this species could be placed in both *Megalomus* and *Proneuronema*. The latter occurs in Baltic and Rovno amber, and in the early Eocene of northern Europe, North America and probably the Russian Far East. The Bembridge Marls species strongly differs from all known species by its smaller size and RP1 being deeply forked once (RP1 with at least two anteriorly-directed branches in other species). So, if this is a species of *Proneuronema*, it is most distantly related to other species of the genus.

The taxonomic affinity of an incomplete specimen of Sisyridae (see Jarzembowski, 1980: fig. 27) from the Bembridge Marls was discussed in Perkovsky & Makarkin (2015). Here we concluded that it most probably belongs to the genus *Paleosisyra* Nel *et al*., 2003, three species of which occur in Baltic amber and the early Eocene Oise amber (Wichard *et al*., 2016).

Chrysopidae of the Bembridge Marls are too incomplete to draw detailed conclusions from them (see Jarzembowski, 1980: fig. 42; Nel & Jarzembowski, 2019: figs 2C, 3). Only one thing is certain: the specimen IWCMS.2006.103 from the Bembridge Marls belongs to Chrysopinae like the Baltic amber *Pseudosencera baltica* Makarkin *et al*., 2018. This subfamily is unknown from horizons older than the late Eocene.

Mantispidae are represented in the Bembridge Marls by two specimens of *Vectispa relicta* (Cockerell, 1921): a small wing fragment (see Cockerell, 1921: fig. 46; Jarzembowski, 1980: fig. 29), and a nearly compete forewing (see Jarzembowski, 1980: fig. 30). *Vectispa* Lambkin, 1986 is usually considered as belonging to Mantispinae (*e.g*., Jepson, 1915; Makarkin, 2019), although Lambkin (1986) preliminary assigned it to Drepanicinae. One undescribed specimen of Mantispidae is found in Baltic amber (see Gröhn, 2020: fig. on p. 263). Its forewing venation is very similar to that of *Mantispa* s.l. (Mantispinae), and dissimilar to that of *V. relicta*.

Two taxa of family level are found in the Bembridge Marls but not in succinites: these are Nemopteridae and Gumillinae (Osmylidae). Nevrorthidae, however, are diverse and very abundant in succinites, but not detected in the Bembridge Marls.

Nemopteridae are represented in Bembridge Marls by an incomplete forewing (Nel & Jarzembowski, 2019: figs 1, 2A, B), whereas neither larvae nor adults of this family have been found in succinites.

Osmylidae are represented in Baltic amber only by Protosmylinae; in particular, *Protosmylus pictus* (Hagen in Pictet-Baraban, 1856), which is rather common. At least two specimens from the Bembridge Marls (*i.e*., the incomplete NHMUK II.2989 and the fragmentary NHMUK II.2981) may be rather confidently assigned to Gumillinae, although the former was incorrectly placed in "?Chrysopidae" by Nel & Jarzembowski (2019). The distal fusion of ScP and RA together with the long antennae, the faintly-dilated costal space, and widely-spaced simple subcostal veinlets are present only in Gumillinae (see Nel & Jarzembowski, 2019: figs 4A, C, D).

Therefore, the neuropteran assemblage of the Insect Bed of the Bembridge Marls is indeed relatively similar to those of succinites, but this similarity is weak. There are obvious differences, which may be partly explained by taphonomic reasons. It is impossible to draw conclusions on the age of Baltic or Rovno ambers based on the weak similarity of their faunas except that it is not too different from the age of the Insect Bed of the Bembridge Marls, probably within Priabonian.

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