

New lacewings from the Insect Bed (late Eocene) of the Isle of Wight (Neuroptera: Nemopteridae, Chrysopidae, Hemerobiidae)

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ABSTRACT: New fossils of the families Nemopteridae and Chrysopidae are recorded and a new species of Hemerobiidae, *Symphorobius yulei* sp. nov., is described from the late Eocene Insect Bed of the Isle of Wight. The new nemopterid belongs to the tribe Stenonemiini and is very similar to a specimen already recorded from the Early Oligocene of Alsace (France), suggesting that these warm-climate insects were not affected by the 'Oi-1 Glaciation' cooling.

KEY WORDS: Cenozoic, Insecta, sp. nov., UK.

Neuroptera are uncommon insects in nearly all Cenozoic lacustrine deposits, usually comprising less than 1% (and never more than 5%) of the insects found (Archibald & Makarkin 2006). This is also the case for the late Eocene lagoon setting of the Isle of Wight where this order is represented by nine species distributed in four families in the Insect Bed (Bembridge Marls: Jarzembowski 1980). The family Hemerobiidae (brown lacewings) is represented by '*Megalomus tinctus*' (Jarzembowski 1980, pp. 254, 257, 259, fig. 31; Makarkin 1991, pp. 57, 60), two unnamed ?*Neuronema* species (Jarzembowski 1980, pp. 258–259, figs 39, 40) and three species in undetermined genera. Furthermore, Mantispidae (mantis flies) are represented by *Vectispa relicta* (Cockerell 1921, pp. 477–478, fig. 46; Jarzembowski 1980, pp. 254–255, 257, fig. 29; Lambkin 1986, pp. 16, 23; Wedmann & Makarkin 2007), Sisyridae (spongilla flies) by unnamed Species A (Jarzembowski 1980, pp. 254, 261, fig. 27) and Chrysopidae (green lacewings) by another Species A (Jarzembowski 1980, pp. 258, 260–261, fig. 42). This could appear a rather low count, but it is higher than what has been found in the fossiliferous Oligocene deposits of the palaeolake Céreste: one ascalaphid and one undescribed chrysopid (Nel 1991). New acquisitions at the Isle of Wight County Museum and Natural History Museum have added the family Nemopteridae (spoon-winged lacewings), another species of Chrysopidae and a new species of Hemerobiidae to the Isle of Wight Eocene entomofauna and are described herein. Nemopterids are weakly flying insects no longer found in the UK, with distinctly elongate hindwings used in courtship display. The adults rest on flowers where they feed on small insects and pollen, whereas the larvae are ground predators.

The insects are preserved in concretions or tabular bands of very fine-grained micrite, known as Insect Limestone. The unit



in which these concretions/bands occur is known as the Insect Bed, which lies towards the base of the Bembridge Marls Member (Solent Group: Bouldnor Formation). The Bembridge Marls are currently considered to be late Eocene in age (Ross & Self 2014). The specimens described herein are from the coastal outcrop on the W of Burnt Wood behind Saltmead Ledge (National Grid Reference SZ 439928). Repositories of specimens are the Natural History Museum, London (NHMUK) and the Isle of Wight County Museum Service (IWCMS).

1. Systematic palaeontology

Order Neuroptera von Linnaeus, 1758

Family Nemopteridae Burmeister, 1839

(spoon-winged lacewings)

Subfamily Nemopterinae Burmeister, 1839

Tribe Stenonemiini Orfila, 1954

Genus and species undetermined A

(Figs 1, 2a, b)

Material. Specimen no. IWCMS.2006.102a,b (Yule 28a, b). Insect Bed, NW Isle of Wight. A. Yule collection.

Taphonomy. Incomplete wing in a fossiliferous parting associated with other insect remains (Odonata, formicid Hymenoptera and Diptera inc. *Dixa*-like species), ostracods and a seed.

Description. Part and counterpart of the costo-basal one-third of a hyaline forewing, 23.6 mm long, 7.7 mm wide; costal area narrow, 0.8 mm wide with 30 preserved simple

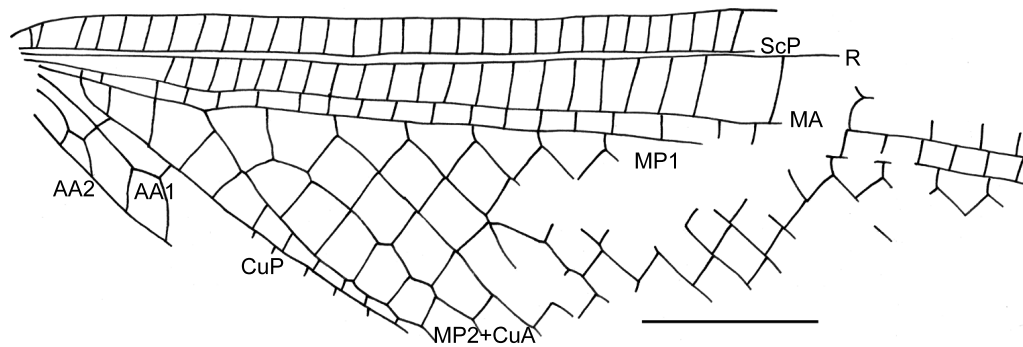


Figure 1 Nemopteridae Stenonemiini species A, specimen IWCMS.2006.102a, b (field no. 28a, b), drawing of forewing. Scale bar = 4 mm.

crossveins; subcosta posterior (ScP) and radius anterior (RA) very close, straight and parallel; radial sector (Rs) + media anterior (MA) emerges from radius (R) 19.5 mm from wing base; area between R and media posterior (MP)₁ narrow with more than 22 simple crossveins basal of Rs + MA; area between MP₁ and MP₂ + cubitus anterior (CuA)₁ very narrow with about 28 preserved crossveins; CuA₂ and CuA₁ separating 4.6 mm from wing base; area between MP₂ + CuA₁ and CuA₂ very broad, with more than 13 parallel branches of MP₂ + CuA₁; area between CuA₂ and cubitus posterior (CuP) very narrow distally; 1A short, 5.3 mm long, with only two posterior branches; 2A very short, 2.6 mm long.

Discussion. This fragment belongs to the Nemopteridae in the tribe Stenonemiini (=Stenorrhachiini *sensu* Tjeder 1967) because of the following typical features: MP₁ and MP₂ + CuA₁ closely parallel, very long and nearly straight; area between MP₂ + CuA₁ and CuA₂ very broad, with more than 13 parallel branches of MP₂ + CuA₁; base of Rs + MA in a very distal position; and 1A short with only two posterior branches (Orfila 1954).

Affinities with the Cretaceous family Roeslerianidae Martins-Neto are excluded because the costal crossveins are simple and not dichotomous (Martins-Neto 2000). The Mesozoic nemopterid genus *Cratonemopteryx* Martins-Neto, 1992 differs from the Bembridge Marls fossil in having a narrower area between MP₂ + CuA₁ and CuA₂ and the base of Rs + MA in a more basal position (Martins-Neto 1992).

The forewing venations of numerous genera of the extant tribe Stenonemiini are very similar to that of this fossil, *viz.* *Nemopistha* Navás, 1910; *Sicyoptera* Navás, 1910, *Nemeura* Navás, 1910, *Brevistoma* Tjeder, 1967, *Semirhynchia* Tjeder, 1967, etc. (Tjeder 1967; Navás 1912). Thus, it is not possible to attribute this fossil to an extant genus.

Fossil Nemopteridae belonging to the same tribe are also represented by the fossil genus *Marquettia* Navás, 1913, with two species – *M. americana* (Cockerell, 1907) and *M. metzeli* Pierce & Kirkby, 1959 – from the late Eocene of the USA (Carpenter 1960). Our fossil differs from *Marquettia* in the organisation of the veins in the area between MP₂ + CuA₁ and CuA₂; that is, the branches of MP₂ + CuA₁ are more regularly spaced. Nel (1991) described a unnamed fossil belonging to the same tribe from the early Oligocene of the ‘Potasse d’Alsace’, Haut-Rhin, France, which could well belong to the same genus, if not the same species as our one, based on the similar wing proportions and venation.

The UK fossil is the second record of this tribe in the European Cenozoic. Recent Stenonemiini are known from Africa, South America and Asia, and are represented by one species in Europe (from Bulgaria). The new find confirms the previous inference of a rather warm palaeoclimate in Western Europe during the late Eocene (Nel 1991) corresponding to the

cooling associated with the 33.5 mya ‘Oi-1 Glaciation’ (*sensu* Van Simaey *et al.* 2005). This cooling is perceptible through the proportions of the bionid genera in the Insect Bed (Collomb *et al.* 2008; Krzeminski *et al.* 2019), but it did not affect several taxa whose recent relatives live in warm climates, e.g., these Nemopteridae, the Isoptera: Mastotermitidae and the leaf-mimicking Orthoptera: Tettigoniidae: Pseudophyllinae (Nel *et al.* 2008).

Family Chrysopidae Schneider, 1851

Genus undetermined species B

(Figs 2c, 3)

Material. Specimen no. IWCMS.2006.103a, b. Insect Bed, NW Isle of Wight.

Taphonomy. Specimen preserved in weathered ‘rind’ of the insect limestone.

Description. A body with the fore- and hindwings preserved but twisted and deformed. Forewing only partly preserved and only the basal part of the costal area is clearly visible and rather broad, up to 1.1 mm wide; hindwing 14.5 mm long, width unknown; costal area narrow, 0.4 mm wide, with about 14 simple crossveins; pterostigmal area not well preserved; veins subcosta (Sc) and RA fused apically; vein pseudo-median vein (psm) straight with five branches of Rs + MA ending on it; Rs + MA with eight branches ending on the posterior wing margin; six inner gradate veins regularly spaced; only the apical outer gradate veins are preserved.

Discussion. Jarzembowski (1980) has already recorded the family Chrysopidae from the Insect Bed. The new fossil confirms the presence of this family supported by the characteristic vein psm, and inner gradate (i.g.) and outer gradate (o.g.) crossveins (Brooks & Barnard 1990; Nel *et al.* 2005). Like the previous records, affinities with the Apochrysinæ seem unlikely because the o.g. veins are few and not well aligned, and this fossil could well be related to Chrysopinæ *sensu stricto* or Nothochrysinæ. It is not possible to give a more precise attribution because the forewing intramedian cell is not preserved.

Jarzembowski’s chrysopid species A is based on a small fragment of wing apex (specimen NHMUK I.8643). The new find differs from it in that Sc and RA are fused distally, suggesting a generic difference. The new fossil is more intact, also suggesting less transportation than the previous record. Chrysopidae are well known from the Palaeogene of continental Europe (Nel *et al.* 2005); future fieldwork may well yield critical material.

Remark. Another specimen (NHMUK II.2989a, b, A. Yule collection) could be attributed to the Chrysopidae on the basis of the apparent presence of a straight vein psm, but this is uncertain (Fig. 4a). This last fossil is remarkable by its very

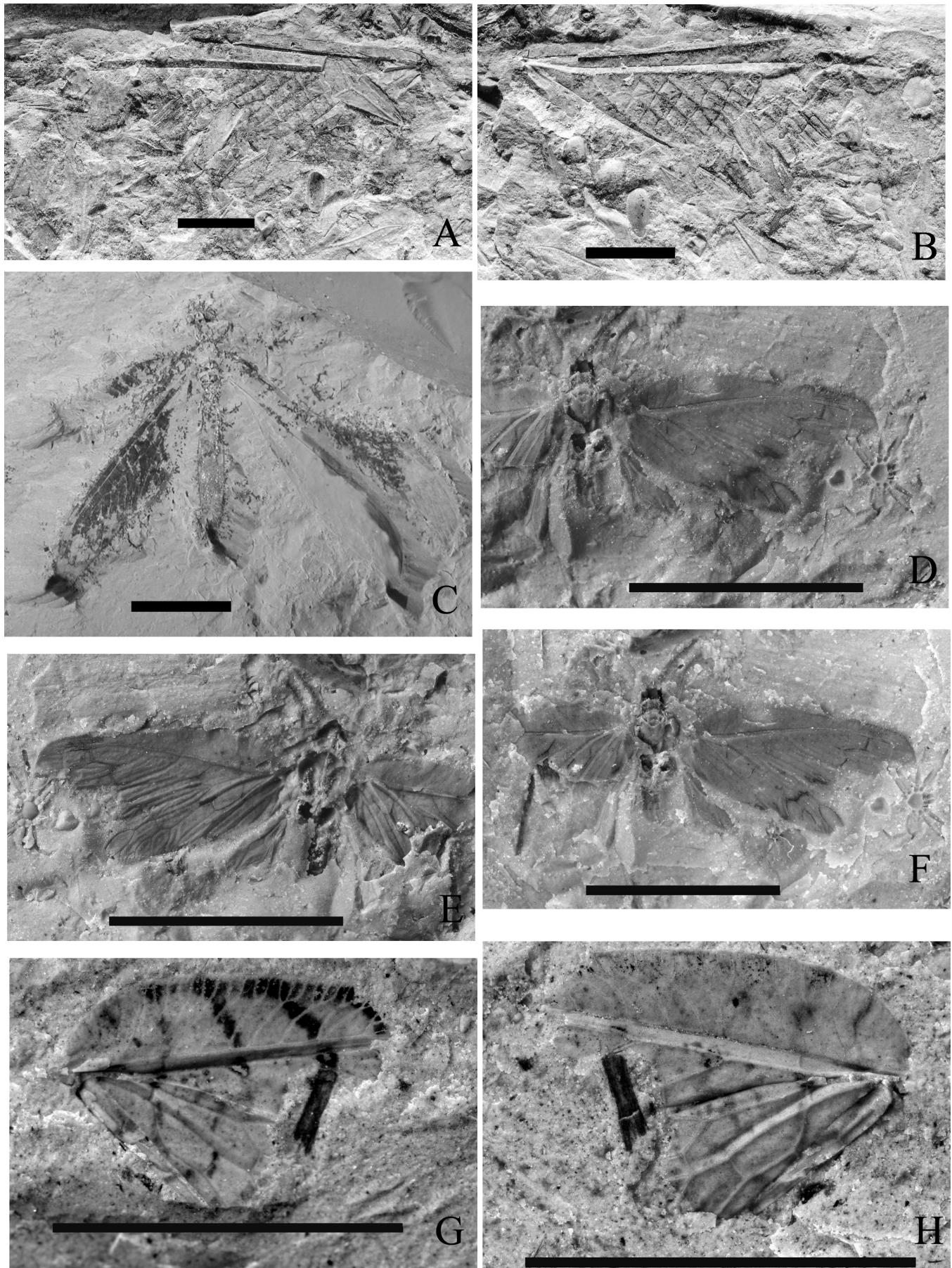


Figure 2 (A) Nemopterinae *Stenonemiini* genus and species undetermined A, no. IWCMS.2006.102a (part). (B) Counterpart of (A). (C) Chrysopidae genus undetermined species B, no. IWCMS.2006.103a (part). (D) *Sympherobius yulei* sp. nov., holotype NHM II.2973a (print), left wings. (E) Counterpart of (D). (F) Part of (D), general habitus. (G, H) Specimen NHMUK II.2979b, part and counterpart of the base of a forewing, coll. Andy Yule, NHM. Scale bars = 4 mm (A, B, D, E); 5 mm (C); 3.5 mm (F); 4 mm (G, H).

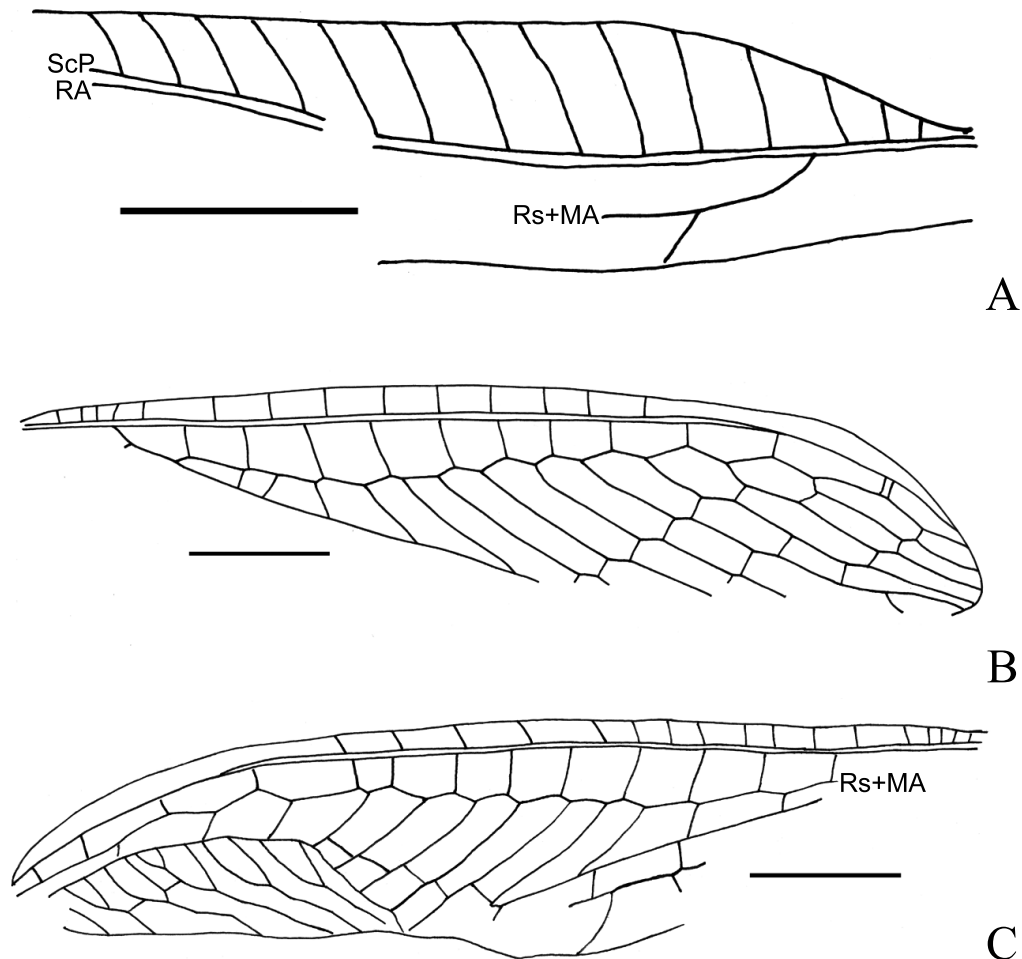


Figure 3 Chrysopidae species B, specimen IWCMS.2006.103a,vb. (A) Drawing of forewing costal area. (B) Drawing of left hindwing. (C) Drawing of right hindwing. Scale bars = 2 mm.

long antennae, a character present in Chrysopidae but also in some other neuropteran families, e.g., Osmylidae.

Family Hemerobiidae Latreille, 1802

Genus *Sympherobius* Banks, 1904

Sympherobius yulei sp. nov.
(Figs 2d–f, 5)

Holotype. NHMUK II.2973a, b. Insect Bed, Saltmead Ledge, Isle of Wight. A. Yule collection.

Diagnosis. Fossil species of *Sympherobius* with forewing crossvein 3 intercalary radial vein (ir) just distal of first fork of branches of radial sector (ORB) 3; ORB3 with only one fork; 1 median-cubital (m-cu) crossvein nearly aligned with base of CuP.

Etymology. Named after Andy Yule who found and donated the type specimen to the NHM.

Taphonomy. Part and counterpart of a body, a forewing with apical fifth missing, base of the opposite forewing and fragments of a hindwing; legs and antennae not visible; spider on same bedding plane.

Description. We follow the wing venation nomenclature of Oswald (1993a). The body is probably complete, but shows no taxonomically useful characters, unlike the forewing. Forewing 4.4 mm long (the complete length of the wing was certainly only slightly longer than what is preserved), 2.3 mm wide as preserved; costal area very broad near its base, 0.5 mm wide, trichosors of anterior wing margin present;

humeral marginal silhouette convex; prestigmal width of subcostal space narrow but broader than adjacent Sc throughout; subcostal crossvein 2 subcosta-radial (sc-r) present; radial vein with three ORBs and ORB1 shallowly forked; ORB3 with only one fork; radial veins straight, not sinuate; pre-3ir1 intraradial crossveins absent; crossvein 3ir1 just distal of first fork of ORB3; posterodistal marginal silhouette convex; anterior border of third intercalary radial-median cell (c3r-m) straight; radiomedial crossvein 3 radial-median crossvein (r-m) present, 3r-m connecting ORB1 and MA; intersection of 2m-cu with MP located more than the crossvein's length distal to fork MA/MP; cell c2m-cu narrow distally; intramedial crossvein 2 intercalary median cell (im) absent; three mediocubital crossveins present; mediocubital flexion line present; intercubital crossvein 1 cubital crossvein (cua-cup) absent; proximal forks of CuP and A1 absent.

Discussion. Based on the phylogenetic analysis of the hemerobiid genera by Oswald (1993a, b), the pre-3ir1 intraradial crossvein is a synapomorphy of the Hemerobiidae, even if reversed in the two genera *Neuronema* and *Gayomyia*. *Sympherobius yulei* sp. nov. differs strongly from the 'basal' subfamily Adelphomerobiinae Oswald, 1994 in the structure of the radial sector (Oswald 1994). Following the key to genera of Oswald (1993a), it would fall near the genera *Hemerobiella*, *Hemerobius*, *Wesmaelius* or *Sympherobius* (in part), because of the presence of three prestigmal 'radial sectors', forewing humeral vein narrow and forewing with three m-cu veins. *Wesmaelius* differs from *Sympherobius yulei* sp. nov. in ORB3 possessing three forks and 2r-m displaced

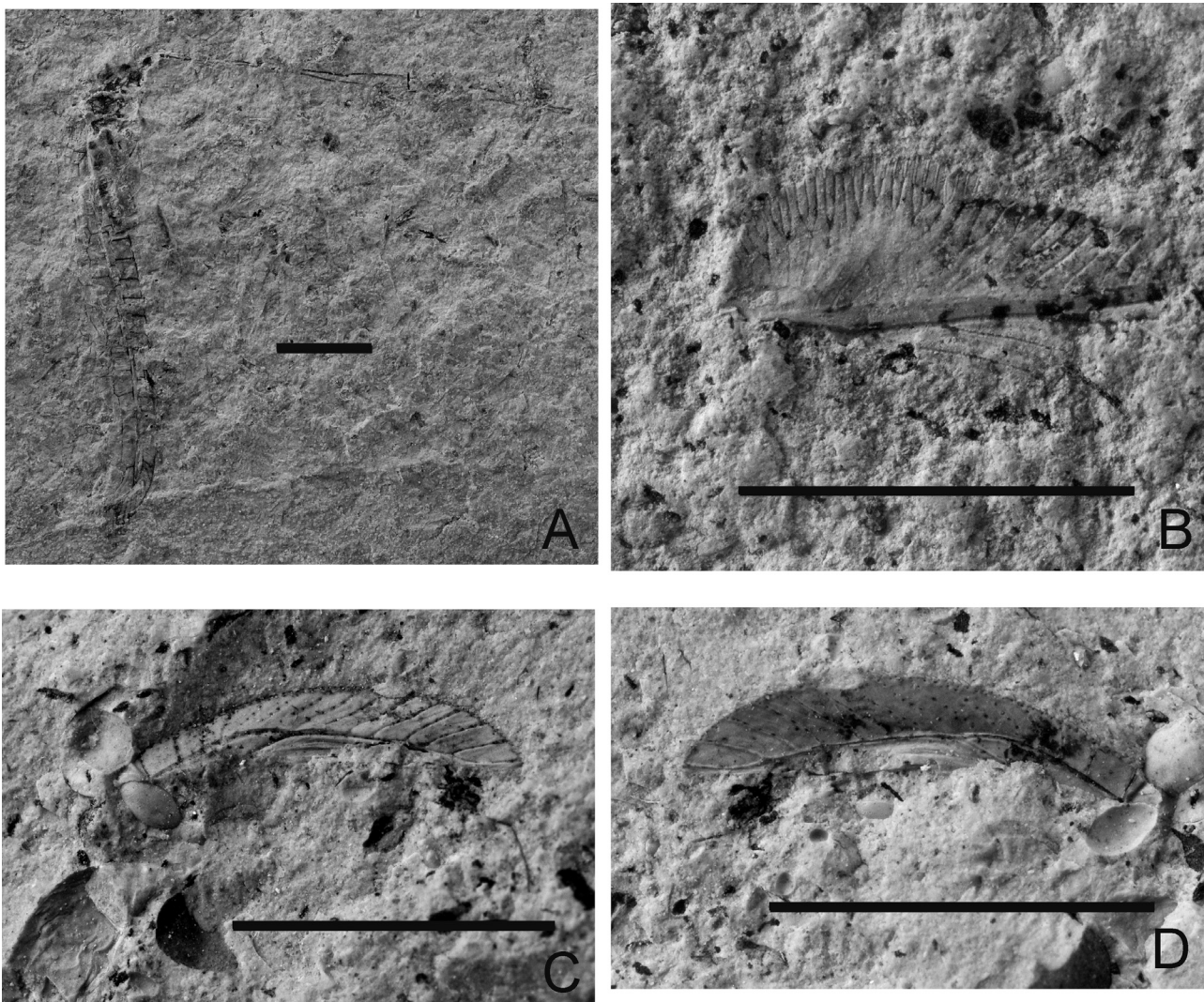


Figure 4 (A) ?Chrysopidae genus and species undetermined, NHMUK II.2989a, A. Yule collection. (B) Hemerobiidae genus and species undetermined, NHMUK II.2988, A. Yule collection. (C, D) NHMUK II.2981a, b part and counterpart of Neuroptera family, genus and species undetermined, II2981a, A. Yule collection. Scale bars = 4 mm.

proximad of crossvein 2m-cu; the latter feature is an apomorphy of *Hemerobius*. Also, the anterior border of cell c3r-m being straight and the radial veins not sinuate exclude the fossil from *Hemerobiella*. *S. yulei* sp. nov. differs from the extant *Hemerobius* species in the position of the crossvein 3ir1, just distal of the first fork of ORB3 (Aspöck *et al.* 1980). Also in *Hemerobius*, 2r-m is either lost or located much proximal to the fork of median vein (M) and ORB1. The fossil shows more similarities with *Symphorobius* (Oswald 1988). Thus, we tentatively place the fossil in this genus, even if the absence of the body and hindwing characters renders its attribution uncertain.

Among the fossil *Symphorobius* species, *Symphorobius yulei* sp. nov. differs from the Baltic amber *Symphorobius completus* Makarkin & Wedmann, 2009 in its ORB3 with only one fork (although some uncertainty remains about this character as the wings are not completely preserved), and more proximal position of crossvein 1m-cu (Makarkin & Wedmann 2009). *Symphorobius yulei* sp. nov. differs from the Baltic amber *Symphorobius siriae* Jepson *et al.*, 2010 in the shorter forewing (ca.4.4 mm instead of 5.9 mm long; Jepson *et al.* 2010). The *Symphorobius* sp. described by Engel & Grimaldi (2007) from the Dominican amber has retained the crossvein 4m-cu.

Symphorobius yulei sp. nov. differs from all fossil Hemerobiidae already described and figured from the Isle of Wight,

except Hemerobiidae species B in the few branches of Rs separated by broad intercalary areas (Jarzembowski 1980); the latter is based on a rather fragmentary specimen but is possibly congeneric with the new fossil, even if they are not conspecific, *S. yulei* having an ORB3 with a distinct angle near its base while this vein is straight in species B. *Symphorobius yulei* sp. nov. also differs from '*Hemerobius*' *tinctus* Jarzembowski, 1980, from the Isle of Wight Eocene – later transferred to the genus *Megalomus* by Makarkin (1991) – in the presence of the crossvein 2r-m, simple ORB1 and only two forks of ORB3. We agree with Oswald (1993a), who considered that the wing venation of '*Megalomus*' *tinctus* resembles more that of *Psychobiella* than *Hemerobius* and *Megalomus*, especially in the structure of the radial sector.

Among the fossil hemerobiid genera, *Symphorobius yulei* differs from the Early Eocene *Cretomerobius* Makarkin *et al.*, 2003 in the organisation of the radial sector (Makarkin *et al.* 2003). *Symphorobius yulei* sp. nov. also differs from the enigmatic Baltic amber *Prolachlanius* Krüger, 1923 and *Prophlebonema* Krüger, 1923 in the position of the crossvein 1r-m, and from *Prospadobius* Krüger, 1923 and *Promegalomus* Panfilov, 1980 in the organisation of the radial sector (Pictet & Hagen 1856; Krüger 1923; Panfilov 1980; Oswald 1993a). The forewing venation of the Canadian genus *Bothromicromus*

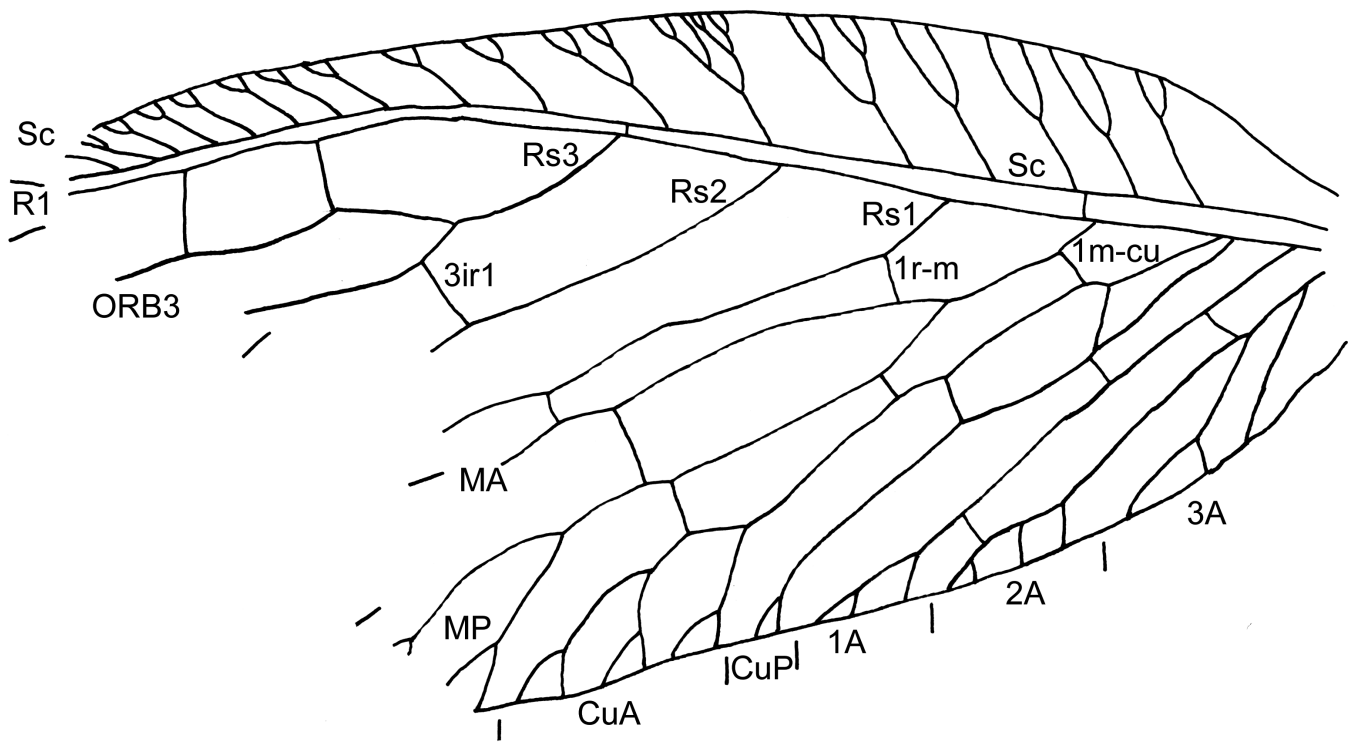


Figure 5 *Sympherobius yulei* sp. nov. Holotype, NHMUK II.2973a, b, drawing of forewing. Scale bar = 4 mm.

Scudder, 1878 resembles that of *Drepanopteryx* (Scudder 1890; Oswald 1993a). *Mesohemerobius* Ping, 1928 is a very enigmatic and incomplete wing differing from *S. yulei* sp. nov. in its very numerous radial branches (Ping 1928).

In addition, Rumbucker (1995) described two Lower Cretaceous genera *Brasilopsychopsis* and *Cratopsychopsis*, but Makarkin *et al.* (2003) indicated that they should be revised.

Remark. A new specimen (NHMUK II.2979a, b, part and counterpart of the base of a forewing, A. Yule collection) has its preserved veins similar to those of the type specimen of *Sympherobius yulei*. It is larger than this fossil, and has five dark coloured bands in the subcostal space (Fig. 2g, h), not present in the type specimen of *S. yulei*, but this could be due to variation or a problem of taphonomy, or it could be a different species, maybe in the same genus.

A further specimen (NHMUK II.2988, A. Yule collection) can also be attributed to the Hemerobiidae, but as only the basal part of costal area is preserved with traces of dark bands, it is impossible to attribute it to a precise genus or subfamily, although the dense venation would suggest some similarities with the ?*Neuronema* species already known from the same bed. We consider it as a Genus undetermined species C (Fig. 4b).

For another Neuroptera specimen (NHMUK II.2981a,b, A. Yule collection), it is impossible to suggest a family attribution because the organisation of the radial area is not preserved, although an aberrant osmylid affinity cannot be ruled out, due to the long distal fusion of R and Sc with a series of long, parallel, anterior branches (Fig. 4c, d).

Note. Makarkin (1998) described the Oligocene–Miocene genus *Oligogetes* and attributed it to the Jurassic family Solenoptilidae Handlirsch, 1906. However, *Oligogetes relictum* Makarkin, 1998 is based on fragments of wing apices that do not show any character, which is typical of Neuroptera. In particular, the holotype specimen (PIN 3429/305) is much more likely to be a hindwing apex of an orthopteran (*cf.* Carpenter 1992; Makarkin 1998, text-fig. 4a; Makarkin &

Archibald 2003). The attribution of *Oligogetes* to the Solenoptilidae is very doubtful.

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