

Lacewings (Insecta: Neuroptera) from the Lower Cretaceous Purbeck Limestone Group of southern England

James E. Jepson^{a,*}, Vladimir N. Makarkin^b, Robert A. Coram^c

^a School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Williamson Building, Oxford Road, Manchester M13 9PL, UK

^b Institute of Biology and Soil Sciences, Far Eastern Branch of the Russian Academy of Sciences, Vladivostok 690022, Russia

^c 6 Battlemead, Swanage, Dorset BH19 1PH, UK

ARTICLE INFO

Article history:

Received 24 February 2011

Accepted in revised form 5 October 2011

Available online 13 October 2011

Keywords:

Neuropterida
Kalligrammatidae
Psychopsidae
Osmylidae
Chrysopidae
Prohemerobiidae
Nymphidae
Berothidae

ABSTRACT

Eight new genera and 12 new species are described from the Lower Cretaceous Purbeck Limestone Group, southern England. *Sophogramma wimbledoni* sp. nov. (Kalligrammatidae) is described from the Purbeck of Wiltshire. *Pterinoblattina peverilensis* sp. nov., *Pterinoblattina fasciata* sp. nov., *Purbepsychoptis parallela* gen. et sp. nov. (Psychopsidae), *Ovalorobius edmondsi* gen. et sp. nov. (Prohemerobiidae), *Mes-osmylidus vulgaris* gen. et sp. nov., *Osmylochrysa anomala* gen. et sp. nov., *Osmylochrysa fragilis* gen. et sp. nov., *Stenochrysa gradata* gen. et sp. nov. (Osmylidae), *Mesypochrysa minuta* sp. nov. (Chrysopidae), *Purbemerobius medialis* gen. et sp. nov. (?Hemerobiidae), *Epimesoberothena parva* gen. et sp. nov. (Berothidae) and *Pseudocorydasialis alleni* (Neuroptera familia incertae sedis) are described from Durlston Bay, Dorset. The species *Pterinoblattina penna* Scudder, *Pterinoblattina pluma* (Giebel) (Psychopsidae) *Sialium sipylus* (Nymphidae) and *Osmylopsis duplicata* (Osmylidae) are re-examined, described and figured. The genus *Valdipsychoptis* Jepson et al. has been synonymized with *Pterinoblattina*.

© 2011 Elsevier Ltd. All rights reserved.

1. Introduction

Neuroptera along with the orders Raphidioptera and Megaloptera make up the superorder Neuropterida. Neuropterida are holometabolous insects, undergoing complete metamorphosis (Grimaldi and Engel, 2005). Neuropteran (lacewing) adults are mostly predators with biting mouthparts; some also consume pollen or honeydew. The generally terrestrial larvae are sucking predators in foliage, leaf litter and soil or, rarely, parasitic. There are approximately 6000 described species of extant Neuroptera in 17 families (Aspöck, 2002). In Britain today there are six families: Chrysopidae, Osmylidae, Coniopterygidae, Hemerobiidae, Myrmeleontidae and Sisyridae, and 66 species (Plant, 1997). British Mesozoic Neuroptera are known from the Upper Triassic (Tillyard, 1933), Lower Jurassic (Prohemerobiidae, Mesopolystoechotidae, Brongniartiellidae, and Kalligrammatidae) (Whalley, 1988), and the Lower Cretaceous Purbeck Limestone Group (this paper) and overlying Wealden Supergroup (Kalligrammatidae, Psychopsidae, Osmylidae, Ithonidae and two genera of uncertain family affinity) (Jarzembowski, 2001; Jepson et al., 2009b). Previously only four species of Neuroptera have been formally described from the

Purbeck Limestone Group: *Sialium sipylus* Westwood, *Pterinoblattina pluma* Giebel, *Pterinoblattina penna* Scudder and *Osmylopsis duplicata* Giebel (Westwood, 1854; Giebel, 1856; Scudder, 1885b; Whalley, 1988). Herein we revise these species and describe eight new genera and 12 new species.

2. Geological setting

The predominantly lagoonal deposits of the Purbeck Limestone Group of southern England are divided into a lower Lulworth Formation and upper Durlston Formation, attributed here to the Lower and Upper Berriasian respectively (c. 146–140 Ma; Ogg et al., 2008), although the precise position of the Jurassic/Cretaceous boundary is not resolved, and may lie within the Lulworth Formation (Allen and Wimbledon, 1991; Ensom, 2002; W. A. Wimbledon, pers. comm. 2009). Insect fossils are common and diverse in fine-grained fissile micrites in both the Lulworth and Durlston formations, comprising mainly disarticulated remains of terrestrial taxa.

With the exception of one specimen collected from a quarry near Teffont, in the Vale of Wardour, Wiltshire (National Grid Reference ST 991 310), all material described herein was collected from the coastal outcrop at Durlston (Durdlestone) Bay, near Swanage, Dorset (NGR SZ 035 780), the type section of the Purbeck

* Corresponding author.

E-mail address: james.jepson@manchester.ac.uk (J.E. Jepson).

Limestone Group and most prolific source of Purbeck fossil insect material. Fossil insects from this site were first studied and named in the mid 19th Century, principally by Prof. J. O. Westwood (1854). It remains highly productive and has provided the holotypes of approximately 200 insect species to date.

Fossils of Neuropterida are relatively uncommon in the Purbeck Limestone Group, comprising 1.4 per cent of identifiable insect wings from Durlston Bay (Coram, 2005). Approximately three-quarters of these are Neuroptera, described below; the remainder are Raphidioptera, recently described by Jepson et al. (2009a).

3. Material and methods

The neuropteran material is deposited in the following collections: DZSWS, Wiltshire Heritage Museum, Devizes; MANCH, The Manchester Museum; NHMUK, the Natural History Museum, London; and CAMSM, the Sedgwick Museum of Earth Sciences, Cambridge.

The material was studied using an Olympus SZH stereomicroscope with a camera lucida attachment for producing drawings. Some drawings are composite, merging the part and counterpart to establish a more complete venation; this was achieved using a light box. Some of the specimens were submerged in 10% ethanol to enhance vein detail. Photographs were taken using a Canon EOS 450D digital SLR camera mounted on a rostrum stand, except the Natural History Museum, London, specimens, which were photographed by Phil Crabb (NHM).

We follow the traditional (*sensu* Wootton, 2003) venational terminology of Comstock (1918) with the recent interpretation of Oswald (1993) and Archibald and Makarkin (2006). Wing vein abbreviations are as follows: C, costa; Sc, subcosta; R, radius; R1, first branch of R; Rs, radial sector; Rs1, most proximal branch of Rs; M, media; MA, media anterior; MP, media posterior; Cu, cubitus; CuA, cubitus anterior; CuP, cubitus posterior; 1A–3A, first to third anal veins.

4. Systematic palaeontology

Order: Neuroptera Linnaeus, 1758

Family: Kalligrammatidae Handlirsch, 1906

Genus *Sophogramma* Ren and Guo, 1996

1996 *Sophogramma* Ren and Guo, p. 461.

Type species. *Sophogramma papilionaceum* Ren and Guo, 1996, by original designation.

Revised diagnosis. Eye-spots absent in both wings; in forewing, Rs1 profusely branched distally; both MA and MP arched, not forked until terminal branching; in hind wing, costal space very broad; CuA divides near wing base into 2 long branches; CuP appears to originate proximal to fork of CuA.

Included species. Six species (one unnamed) from the Lower Cretaceous of Eurasia: *Sophogramma wimbletoni* sp. nov., Lower Berriasian of England (new record); *Sophogramma* sp., Valanginian/Barremian of Transbaikalia, Asian Russia (Makarkin, 2010); and *Sophogramma eucallum* Ren and Guo, *S. papilionaceum* Ren and Guo, *S. plecophlebium* Ren and Guo, *Sophogramma lii* Yang et al., Barremian of the Yixian Formation, NE China (Ren and Guo, 1996; Yang et al., 2009).

Sophogramma wimbletoni gen. et sp. nov.
Fig. 1A and B

1996 Kalligrammatidae; Ross and Jarzembowski, p. 113, text-fig. 5.
2010 Kalligrammatidae; Jarzembowski and Palmer, p. 192, fig. 4.54.

Derivation of name. After William Wimbledon, Jurassic/Cretaceous stratigrapher.

Holotype. DZSWS: NH2008.9015.21 [No.15 of Revd. W. R. Andrews collection]. A fragmentary hind wing, collected by W. R. Andrews.

Type locality and horizon. Teffont Evias, Wiltshire; mid-part of Purbeck, Mid-Berriasian.

Diagnosis. Absence of proximal branching of anterior branch of CuA in hind wing (in *S. lii* proximal branching of this vein is present, at level of the origin of third fork of MP).

Description. Hind wing, 44 mm preserved length (estimated complete length about 60 mm), 36.8 mm preserved width. C not preserved; costal space incomplete, 11–12 subcostal veinlets (including perhaps humeral veinlet) and several crossveins preserved between them. Sc, R1 incomplete with many regularly spaced crossveins between them. Space between R1 and Rs nearly equal in width, with 16 r1-rs crossveins preserved. Rs originates very near to wing base, with nine branches preserved, some forked

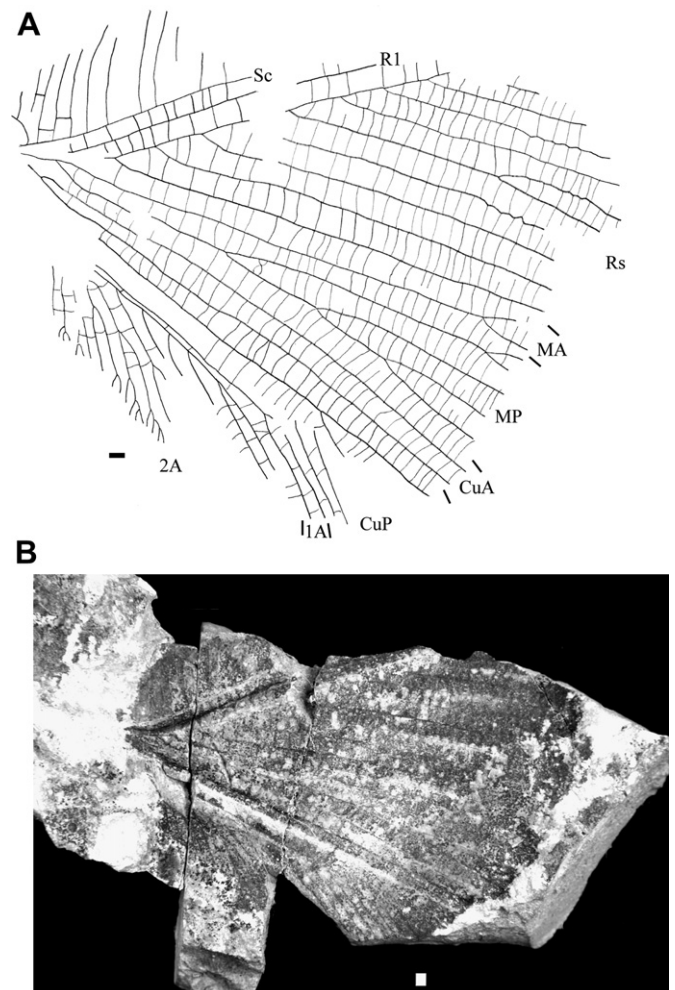


Fig. 1. *Sophogramma wimbletoni* sp. nov., holotype DZSWS NH2008.9015.21. A, drawing of hind wing venation. B, photograph. Scale bar represents 1 mm.

distally. MA and MP appear to originate separately from Rs (or M divides into MA and MP very close to wing base). MA concave, simple for most of length. MP with three anteriorly directed branches. Cu origin not preserved. CuA forked near wing base, anterior branch slightly concave, posterior branch strongly convex; both running parallel to each other, not branched before terminal branching. CuP strongly concave, pectinately branched distally. 1A very long, with few distal branches. 2A long, running very close to 1A, pectinately branched. 3A poorly determinable, perhaps pectinate. Numerous closely spaced crossveins throughout wing. Wing membrane appears brown; eye-spot not detected.

Remarks. Four species of the genus *Sophogramma* are known only from forewings (Ren and Guo, 1996; Makarkin, 2010), but the fifth (*S. lii* Yang et al., 2009) is based on a beautifully preserved complete specimen with open wings (Yang et al., 2009). *S. wimbletoni* sp. nov. has been interpreted as a hind wing on the basis of its broad triangular wing shape and structure of M and Cu. The fact that most of the representatives of this genus are known from forewings makes comparison with the hind wing of the Purbeck specimen difficult. However, using the size difference of the fore- and hind wing of *S. lii* (its forewing is approximately 1.24× larger than the hind wing), it is possible to estimate the forewing length of *S. wimbletoni* sp. nov., which is potentially 74 mm long. This wing length tentatively separates it from *S. plecophlebium* (62 mm) and *S. lii* (57 mm); it is however close in size to *S. papilionaceum* (75 mm) and *S. eucallum* (78 mm), but can be separated on the radial space being wider than subcostal space in *S. wimbletoni* sp. nov., and the branches of Rs being deeply forked in *S. papilionaceum* and *S. eucallum* (this is reflected in the hind wing venation, e.g. *S. lii*) and simple in *S. wimbletoni* sp. nov. The preserved hind wing venation of *S. wimbletoni* sp. nov. is very similar to that of *S. lii*, particularly in the structure of the M and Cu systems, but differs as shown in the diagnosis. Cu of the new species has three long branches beginning near the wing base; CuA is deeply forked whereas CuP is not. Previously, only two genera were known in which Cu has three long branches, these being *Limnogramma* Ren, 2003 (Makarkin et al., 2009) and *Kalligrammula* Handlirsch, 1919 (i.e., *Kalligrammula senckenbergiana* Handlirsch, 1919). The latter requires restudy, and the venation in figure 1 of Handlirsch (1919) does not allow the basal forking of Cu to be determined. In *Limnogramma*, CuP is deeply forked, and CuA is not (Makarkin et al., 2009). If our interpretation of the venation is correct, *S. wimbletoni* sp. nov. can be quite confidently assigned to *Sophogramma*, although since the holotype is incomplete and poorly preserved, future revision may be necessary.

Kalligrammatidae gen. et sp. indet.

Fig. 2A and B

Material. NHMUK Pal. I.3958. An incomplete wing.

Locality and horizon. Durlston Bay, Swanage, Dorset.

Description. Wing fragment, 18.7 mm preserved length, 13.8 mm preserved width. Six branches of Rs partially preserved, two-forked; numerous crossveins present throughout.

Remarks. A small fragment of a kalligrammatid wing, which unfortunately has no preserved features that allow identification to a lower taxonomic rank. It differs, however, from the other Purbeck kalligrammatid, particularly in its larger size.

Family: Psychopsidae Handlirsch, 1906

Genus *Pterinoblattina* Scudder, 1885b, sit. nov.

1885b *Pterinoblattina*; Scudder, p. 105.

2009b *Valdipsychops* Jepson, Makarkin and Jarzembowski, p. 1330, syn. nov.

Type species. *Blatta pluma* Giebel, 1856, by subsequent designation (Handlirsch, 1906–08: 607).

Revised diagnosis. In both wings, Rs dichotomously branched; several short gradate series of crossveins in radial space; CuA pectinately branched; CuP non-pectinate.

Included species. Nine–eleven Lower Cretaceous species from the Purbeck Limestone Group (Berriasian) and Wealden Supergroup (Hauterivian and Barremian) of southern England: *P. pluma* (Giebel), *P. penna* Scudder, *Pterinoblattina peverilensis* sp. nov., *Pterinoblattina fasciata* sp. nov., *Pterinoblattina* sp. B (all from the Purbeck; this paper), *P. logunovi* Jepson et al., comb. nov., *P. brigidae* Jepson et al., comb. nov., *P. maculosa* Jepson et al., comb. nov., *P. proudlovei* Jepson et al., comb. nov., *P. minima* Jepson et al., comb. nov., *Pterinoblattina* sp. A (= *Valdipsychops* sp. of Jepson et al., 2009b) (all from the Wealden; Jepson et al., 2009b).

Remarks. Due to the incomplete preservation of all specimens, the assignment of some species to the genus *Pterinoblattina* is preliminary. Examination of the type specimens of the previously described Purbeck species of this genus (*P. pluma* and *P. penna*) establishes with confidence that the genera *Pterinoblattina* and *Valdipsychops* are synonyms. The features of the type species are too vague to determine the family assignment with certainty, but other species of the genus having similar size, colour pattern and venation allow

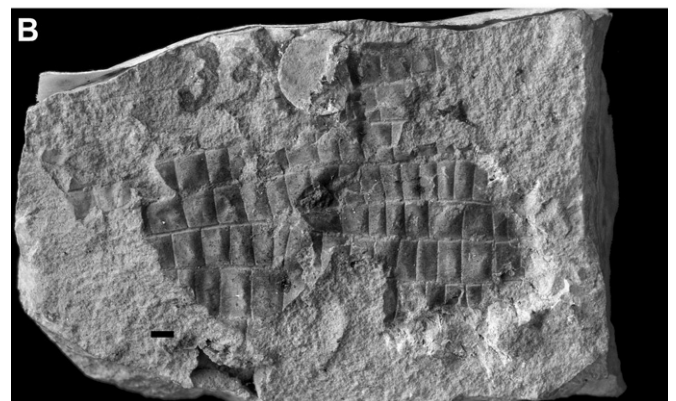
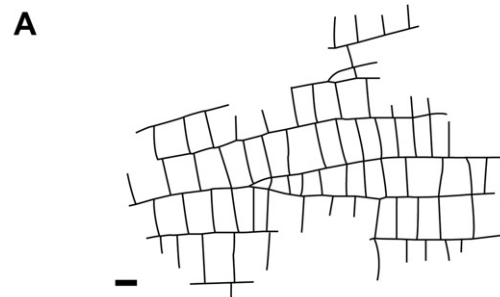


Fig. 2. Kalligrammatidae gen. et sp. indet., NHMUK Pal. I.3958. A, drawing of wing venation. B, photograph (taken by Phil Crabb, NHM). Scale bar represents 1 mm.

a confident placement within Psychopsidae. Previously, *Pterinoblattina* has usually been placed within the family Brongniartiellidae. However, examination of photographs of the type species of the type genus of the family (i.e., *Brongniartiella gigas* (Weyenbergh)) indicates that its venation is quite different from that of *Pterinoblattina* (see Makarkin and Archibald, 2005; Makarkin, 2010).

The wings of many species of *Pterinoblattina* have an extremely broad costal space. Based on this feature they are tentatively considered to be forewings, and accordingly the convex vein is interpreted as CuA (it is concave in relation to MP in the hind wings: Makarkin et al., 2009). However, the costal space in the well-preserved Jurassic species *Cretapsychops decipiens* Peng et al. from China (preserved with wings open) is also extremely broad and markedly broader in the hind wing than in the forewing (Peng et al., 2010). Therefore, the wings which show a distinct concave CuA may well be hind despite their broad costal space. Unfortunately, all psychopsid wings, from both the Purbeck and Wealden, are very incomplete with the basal forking of M and Cu not being preserved, which hinders confident identification of the veins.

The assignment of *Pterinoblattina kobdoensis* Ponomarenko, 1986 (Lower Cretaceous of Mongolia) to this genus is in our opinion doubtful.

Pterinoblattina pluma (Giebel, 1856)

Fig. 3A and B

- 1854 Unnamed neuropteran; Westwood, p. 394, pl. 15, fig. 14.
 1856 *Blatta pluma* Giebel, p. 322 (Blattoptera).
 1864 *Blattidium pluma*; Heer, p. 289 (Blattoptera).
 1880 *Blatta pluma*; Geinitz, p. 520 (Blattoptera).
 1885a *Pterinoblattina pluma*; Scudder, p. 755, fig. 935 (Blattoptera).
 1885b *Pterinoblattina pluma*; Scudder, p. 105, 106 (Blattoptera).
 1886 *Pterinoblattina pluma*; Scudder, p. 469, 470, pl. 48, figs 7, 8 (Blattoptera).
 1906–08 *Pterinoblattina pluma*; Handlirsch, p. 608, pl. 48, fig. 7 (Prohemerobiidae).
 1988 *Pterinoblattina pluma*; Whalley, p. 48, 56, 58, fig. 9 (Brongniartiellidae).
 1993 *Pterinoblattina pluma*; Jarzembowski, p. 178 (Neuroptera).
 1993 *Pterinoblattina pluma*; Ross and Jarzembowski, p. 418 (Brongniartiellidae).

Holotype. NHMUK Pal. I.3968 (Brodie collection, 1898). An incomplete ?forewing.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Durlston Formation; Upper Berriasian.

Revised diagnosis. Presence of several transverse costal gradate series of costal crossveins (one longitudinal series in *P. fasciata* sp. nov.).

Description. Incomplete ?forewing, 8.8 mm preserved length (estimated length 20 mm), 5.2 mm preserved width. Costal space incomplete; 26 subcostal veinlets preserved, some forked near margin; costal gradate series present. Sc, R1, Rs incomplete. Subcostal and R1 spaces equal in width. Nine sc-r1 crossveins preserved. Rs with 10 branches preserved, majority dichotomously forked, forming 30 branches distally. Few crossveins preserved in radial space. M, Cu and anal veins not preserved.

Remarks. *Pterinoblattina pluma* is represented by a very fragmentary specimen and as such there are very few diagnostic characters

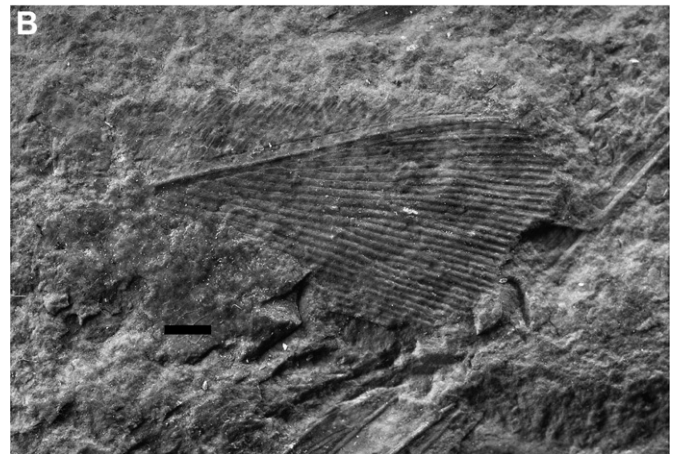
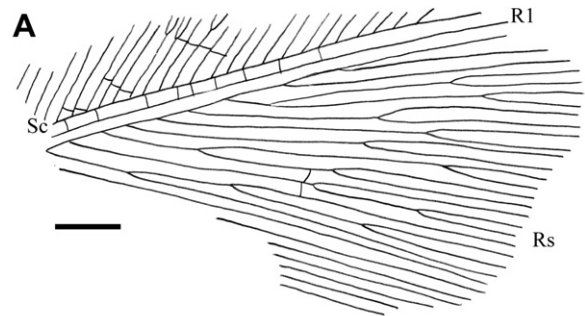


Fig. 3. *Pterinoblattina pluma* (Giebel, 1856), holotype NHMUK Pal. I.3968. A, drawing of ?forewing venation. B, photograph (taken by Phil Crabb, NHM). Scale bar represents 1 mm.

preserved to allow a confident separation from the other species of *Pterinoblattina*. The main diagnostic character of *P. pluma* is the presence of several gradate series of costal crossveins.

Pterinoblattina penna Scudder, 1885b

Fig. 4A and B

- 1885b *Pterinoblattina penna* Scudder, p. 106, 108 (Blattoptera).
 1886 *Pterinoblattina penna*; Scudder, p. 470, pl. 48, fig. 14 (Blattoptera).
 1906–08 *Pterinoblattina penna*; Handlirsch, p. 608 (Prohemerobiidae).
 1949 *Pterinoblattina penna*; Martynova, p. 168 (Brongniartiellidae).
 1988 *Pterinoblattina penna*; Whalley, p. 48, 58, fig. 10 (Brongniartiellidae).
 1993 *Pterinoblattina penna*; Jarzembowski, fig. 4 (Brongniartiellidae).

Holotype. NHMUK Pal. I.12324 (Brodie colln). An incomplete forewing.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Lulworth Formation; Lower Berriasian.

Revised diagnosis. Combination of absence of costal gradate series, narrow R1 space and partial mottled colour pattern.

Description. Forewing, preserved length 10.4 mm (estimated length 19 mm), preserved width 7.7 mm. C not preserved. Costal space wide, about three times wider than 'vena triplica', with 38 subcostal veinlets preserved, many forking towards anterior wing margin.

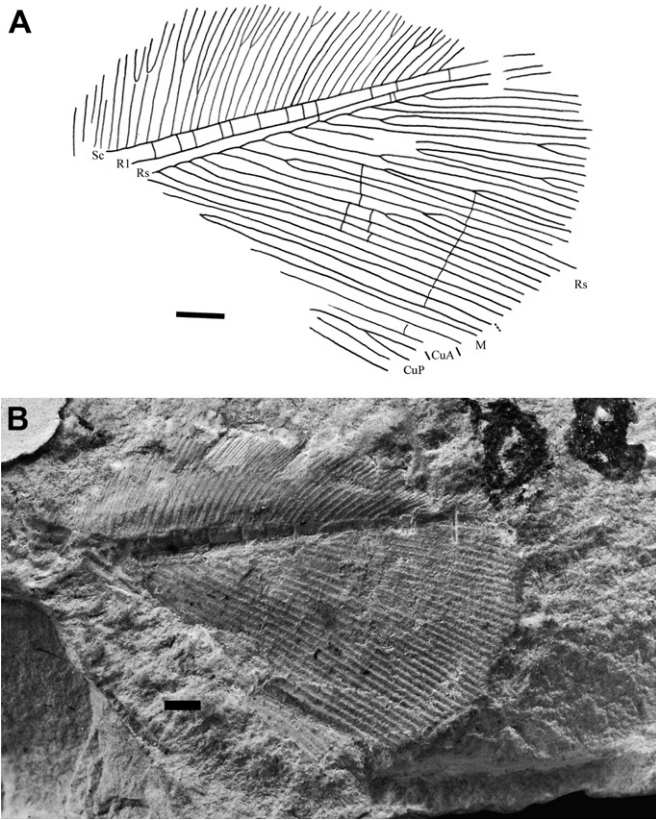


Fig. 4. *Pterinoblattina penna* Scudder, 1856, holotype NHMUK Pal. I.12324. A, drawing of forewing venation. B, photograph (taken by Phil Crabb, NHM). Scale bar represents 1 mm.

'Vena triplica', formed by Sc, R1 and Rs, runs parallel and straight, with 12 sc-r1 crossveins and three r1-rs crossveins preserved. Rs with 18 branches, many forked; some dichotomously, forking to 31 distally. Several crossveins preserved in radial space, forming two small gradate series. Fork of M not preserved; configuration of M unknown. CuA (convex) fragmentary, no branching preserved; CuP fragmentary, apparently pectinately branched. Anal veins not preserved.

Pterinoblattina peverilensis sp. nov.

Fig. 5A and B

Derivation of name. After Peveril Point, Durlston Bay, Swanage, Dorset, UK.

Holotype. MANCH LL.16083.a-b [DB175/NEUR 11]. An incomplete hind wing, collected by R. A. Coram.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Clements' (1993) Bed DB175, Corbula beds, Durlston Formation; Upper Berriasian.

Diagnosis. Combination of short Sc; possibly terminating on R1 and mottled colour pattern over entire wing.

Description. Hind wing, 15 mm preserved length (estimated length 19 mm), 10 mm preserved width. C not preserved, costal space with 35 subcostal veinlets preserved. Sc, R1 and Rs forming 'vena triplica'. Sc rather short, curving, possibly terminating on R1 distally (not clearly visible). Eight sc-r1 branches preserved. Rs with 14 branches, many branches heavily forked. Crossveins preserved in radial space

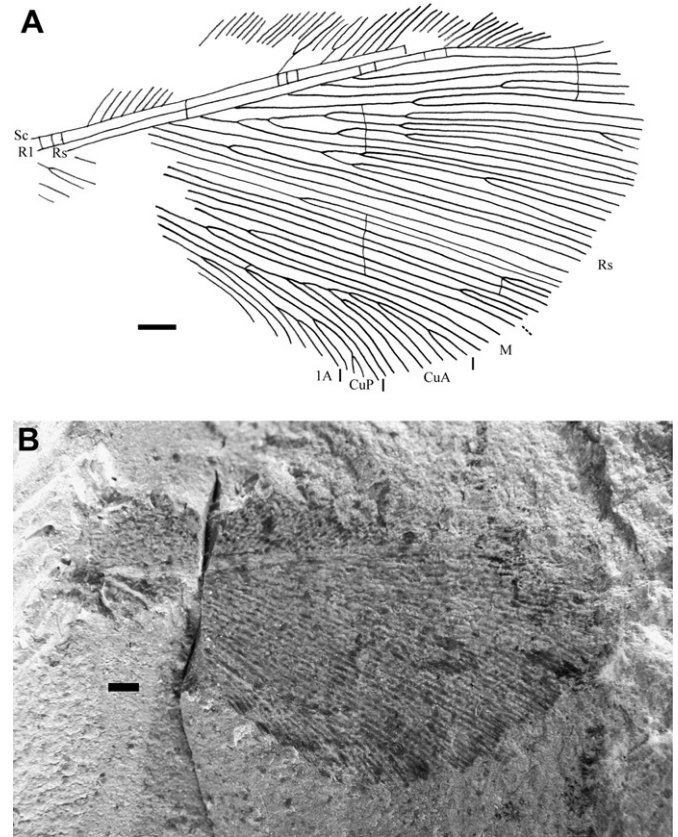


Fig. 5. *Pterinoblattina peverilensis* sp. nov., holotype MANCH LL.16083.a-b. A, drawing of hind wing venation. B, photograph. Scale bar represents 1 mm.

forming a few gradate series. Fork of M not preserved; apparently deeply forked, each branch forked at one-third of vein length, all terminal branches appear simple. CuA concave, pectinately branched, with six branches. CuP non-pectinately branched with two primary branches, forking to four at posterior wing margin. 1A forked, with two primary branches, forking to four at posterior wing margin. 2A incomplete, with two branches. Mottled colour pattern preserved on wing similar to that of *P. penna* and *P. pluma*.

Remarks. The three species *P. penna*, *P. pluma* and *P. peverilensis* sp. nov. appear to be closely related, but all are incompletely preserved, preventing detailed comparison.

Pterinoblattina fasciata sp. nov.

Fig. 6A and B

Derivation of name. Latin *fascia*, band, in reference to the presence of a pale band over fuscous forewing.

Holotype. MANCH LL.16091.a-b [DB59/NEUR 1]. An incomplete forewing, collected by R. A. Coram.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Clements' (1993) Bed DB59, Soft Cockle beds, Lulworth Formation; Lower Berriasian.

Diagnosis. Combination of short Sc and colour pattern with pale band over fuscous wing.

Description. Forewing, preserved length 12.5 mm (estimated length about 18 mm), preserved width 11 mm. C not preserved, costal space

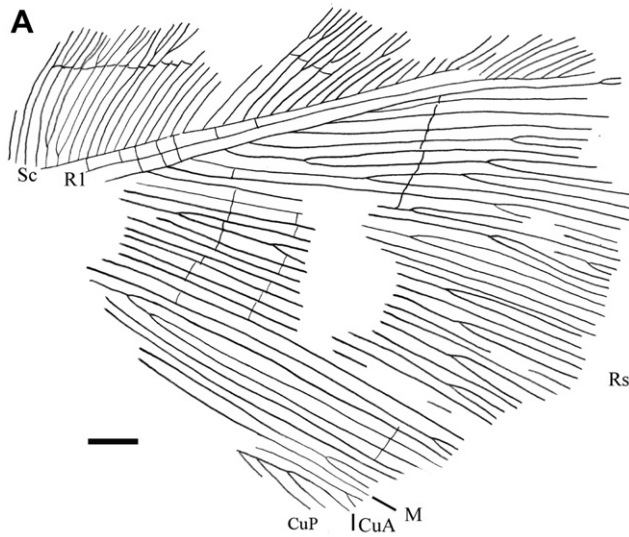


Fig. 6. *Pterinoblattina fasciata* sp. nov., holotype MANCH LL16091.a-b. A, drawing of forewing venation. B, photograph. Scale bar represents 1 mm.

with 36 subcostal veinlets preserved, majority forked, some dichotomously, closely spaced. One longitudinal costal gradate series of crossveins. Sc, R1 and Rs partially preserved; origin and termination not seen. Seven sc-r1 crossveins and three r1-rs crossveins preserved. Rs pectinately branched, many-forked dichotomously. Configuration of M unknown. CuA convex, with terminal forking. CuP incomplete, concave, pectinately branched. Anal veins not preserved.

Remarks. This species is tentatively placed in *Pterinoblattina* on the basis of similar venation with other species of the genus (i.e., dichotomously branched Rs), and colour pattern. The colour pattern is most similar to that of the Wealden species *P. logunovi* and *P. proudlovei*.

Pterinoblattina sp. B
Fig. 7A and B

Material. NHMUK Pal. I.12311. A fragmentary forewing.

Locality and horizon. Durlston Bay, Swanage, Dorset. Horizon unknown.

Description. Forewing, preserved length 10.5 mm (estimated length about 20 mm), preserved width 7.1 mm. C, Sc, R1 not preserved. Rs

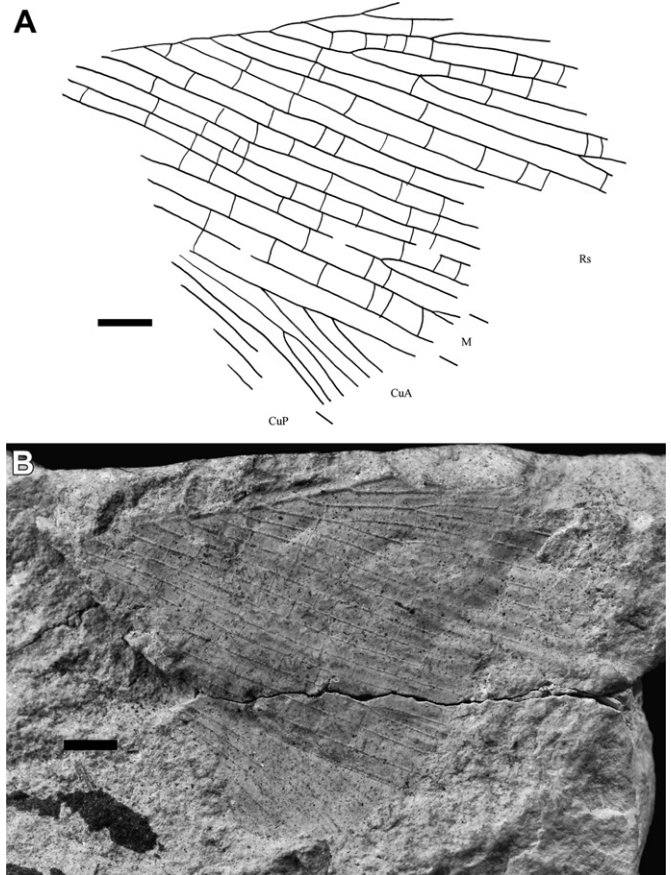


Fig. 7. *Pterinoblattina* sp. B., NHMUK Pal. I.12311. A, drawing of forewing venation. B, photograph (taken by Phil Crabb, NHM). Scale bar represents 1 mm.

partially preserved, 12 branches visible, some forked. Crossveins in radial space randomly arranged. M apparently two-branched, origin not preserved. CuA convex, pectinately branched with approximately six branches. CuP partially preserved (two–four branches), apparently not pectinate. Anal veins not preserved.

Remarks. This species is assigned to *Pterinoblattina* because the Rs branching is similar to that of some of the other species in the genus (e.g., *P. penna*, but not as multi-forked as in the majority of species placed in *Pterinoblattina*) and the radial crossveins are numerous, forming irregular short series (with additional randomly arranged crossveins).

Genus *Purbepsychoptis* gen. nov.

Type and only species. *Purbepsychoptis parallela* gen. et sp. nov.

Derivation of name. From Purbeck and *Psychoptis*, a genus-group name. Gender feminine.

Diagnosis. Elongate wing; parallel, mostly simple branches of Rs; heavy distal forking of MA and MP; CuA dichotomous (pectinate in *Epactinophlebia* Martynov) and CuP pectinate.

Remarks. This genus has been tentatively placed in *Psychoptidae* because its venation is similar to that of some other fossil genera confidently ascribed to this family (especially *Cretapsychoptis*: Peng et al., 2010; fig. 3A) although no crossveins were detected. *Purbepsychoptis* gen. nov. resembles *Epactinophlebia* from the Upper

Jurassic of Karatau, Kazakhstan (Martynov, 1927) and several undescribed species from the Lower Cretaceous locality of Baissa (East Siberia) in general venational configuration and in the absence of crossveins, particularly in the radial space (VM, pers. obs.). The latter feature is possibly an artefact of preservation in the case of the Purbeck specimen, but is more likely to be an autapomorphy of this genus (or genus-group).

Purbepsychopsis parallela sp. nov.

Fig. 8A and B

Derivation of name. Latin *parallelus*, parallel, in reference to the parallel branches of Rs.

Holotype. CAMSM J.58307. A nearly complete forewing, collected by Rev. O. Fisher.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Soft Cockle Beds, Lulworth Formation (interpreted from rock by RAC), Lower Berriasian.

Diagnosis. As for genus.

Description. Forewing, preserved length 15 mm (estimated length about 16–17 mm), preserved width 6.8 mm. C not preserved, costal space with 30 subcostal veinlets preserved. Subcostal and R1 spaces relatively narrow, equal in width. Rs with 26 parallel branches, vast majority not forked until end-twigging. M forked well distal to origin of Rs1. MA concave, pectinately branched distally with six branches. MP convex, pectinately branched distally with four branches. Cu forked near wing base. CuA strongly convex proximal to distal dichotomous branching. CuP concave, pectinately branched with ten simple branches. 1A pectinately branched with three branches. 2A dichotomously forked. 3A incomplete, pectinately branched, with three branches preserved. No crossveins detected.

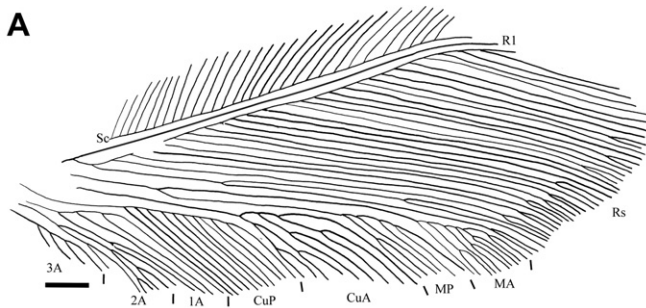


Fig. 8. *Purbepsychopsis parallela* gen. et sp. nov., holotype CAMSM J.58307. A, drawing of forewing venation. B, photograph. Scale bar represents 1 mm.

Family: Prohemerobiidae Handlirsch, 1906

Genus *Ovalorobius* gen. nov.

Type and only species. *Ovalorobius edmondsi* gen. et sp. nov.

Derivation of name. Latin *ovalis*, oval, and *robustus*, a traditional ending of hemerobiid-like genera (from *Hemerobius*, a genus-group name), in reference to the oval shape of the type species forewing. Gender masculine.

Diagnosis. Differs from other prohemerobiids in that CuA is dichotomously branched.

Remarks. The family Prohemerobiidae is strongly in need of a revision, and *Ovalorobius edmondsi* gen. et sp. nov. has been placed within it provisionally, on the basis of Sc not being fused distally and general agreement of its venation with that of this family (including the type genus). The venation of this species appears to be most similar to that of *Actinophlebia anglicana* Tillyard known from the Lower Jurassic of England (see Tillyard, 1933: fig. 2) and *Actinophlebioides valdensis* Jepson et al. from Hauterivian of the Wealden. The latter genus is monotypic and treated as Neuroptera *familia incertae sedis* (Jepson et al., 2009b). The genus *Actinophlebia* Handlirsch, 1906 (with five–six species from the Lower Jurassic of Europe) is currently considered as belonging to Brongniartellidae (e.g., Whalley, 1988; Carpenter, 1992; Ansorge, 1996) or Osmylopsychopidae (e.g., Ponomarenko, 1996; Makarkin and Archibald, 2005). These families have similar venation, but it is unlike that of *Actinophlebia* and *Actinophlebioides*. Probably, these two genera may also belong to Prohemerobiidae. On the other hand, the assignment of the genera *Liassopsychops* Bode and *Stenoteleuta* Bode to Prohemerobiidae (Ponomarenko, 1996) is very doubtful. The type species of these genera are represented by fragmentary wings with uncertain family affinities.

Ovalorobius edmondsi sp. nov.

Fig. 9A and B

Derivation of name. After Richard Edmonds, Earth Science Manager for the Jurassic Coast World Heritage site.

Holotype. MANCH LL.16088.a-b [DB175/NEUR 4]. An almost complete forewing, collected by R. A. Coram.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Clements' (1993) Bed DB175, Corbula beds, Durlston Formation; Upper Berriasian.

Diagnosis. As for genus.

Description. Forewing, preserved length 10.9 mm (estimated length 12.2 mm), width 7.3 mm. C preserved, costal space with over 26 subcostal veinlets preserved, many forked near anterior wing margin. Trichosors present on anterior margin. Sc not fused with R1 distally. Rs with 12 primary branches, many of which are forked, producing over 20 branches. M forked before mid-point. MA simple most of length, forking distally. MP simple for most of length, forking more proximally than fork of MA. One ma-mp crossvein preserved. Cu deeply forked. CuA dichotomously forking at mid-point of vein forming nine branches, majority with end-twigging. CuP forking at mid-point of vein, forming three primary branches. 1A with four primary branches, first branch dichotomously forked, others with end-twigging. 2A multibranching, deeply forked near wing base, producing 12 branches at posterior wing margin. 3A incomplete.

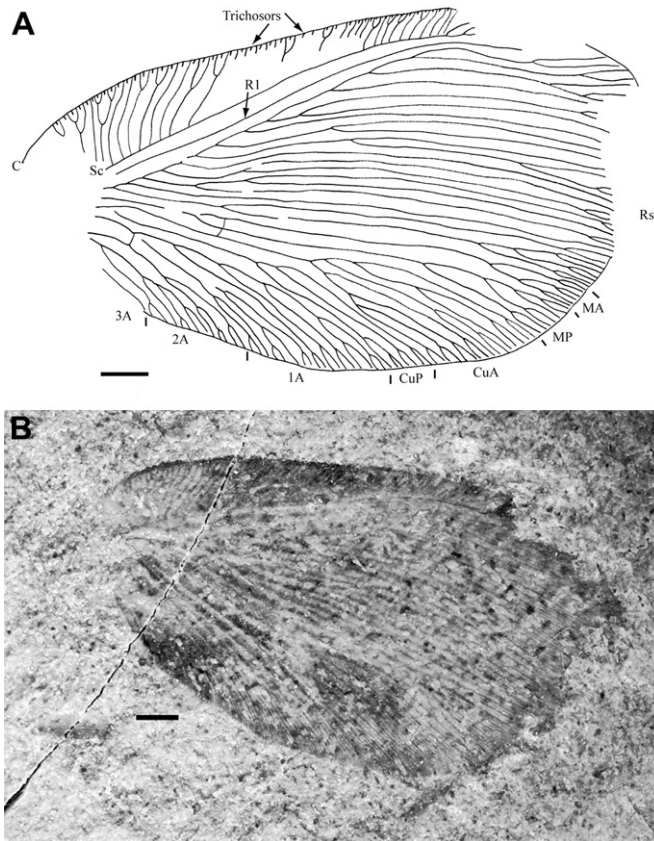


Fig. 9. *Ovalorobius edmondsi* gen. et sp. nov., holotype MANCH LL16088.a-b. A, drawing of forewing venation. B, photograph. Scale bar represents 1 mm.

Remarks. The interpretation of the venation (especially in the cubital and anal areas) is preliminary because of indistinctly visible veins.

Family: Osmylidae Leach, 1815

Subfamily: ?Mesosmylininae Bode, 1953

Genus *Mesosmylidus* gen. nov.

Type and only species. *Mesosmylidus vulgaris* gen. et sp. nov.

Derivation of name. From the Mesozoic and Osmylidae. Gender masculine.

Diagnosis. Long, pectinately branched CuP in forewing, with up to ten branches (three–four in *Mesosmylina* Bode and *Jurosmylus* Makarkin and Archibald).

Remarks. Most closely related to *Mesosmylina* and *Jurosmylus*. The subfamily classification of the fossil Osmylidae has not been studied. Mesosmylininae was created in Prohemerobiidae to include *Mesosmylina exornata* Bode, 1953 from the Lower Jurassic of Germany. In later work, Ponomarenko (1996) adequately redescribed this species and confirmed its osmylid affinity. Three other species were included in this genus: *M. mongolica* Ponomarenko (Lower/Middle Jurassic of Mongolia), *M. sibirica* Ponomarenko (Middle Jurassic of Siberia) and *M. falcifera* Ansoerge (Lower Jurassic of Germany) (Ponomarenko, 1984, 1985; Ansoerge, 1996). *M. sibirica* Ponomarenko is based on a poorly preserved specimen; its congeneric relationship with other species is impossible to confirm. The other three species

may indeed belong to one genus. In particular, they share the few-pectinate CuP. The genus *Jurosmylus* (= *Mesosmylus* Panfilov) from the Upper Jurassic of Kazakhstan has similar venation, such as the structure of CuP (this genus is probably not synonymous with *Mesosmylina*, being distinguished by other characters). These two genera may constitute the subfamily Mesosmylininae. Recently, however, *Jurosmylus* was included in the subfamily Protosmylinae (Wang et al., 2010). In general, the status and composition of Mesosmylininae and its relationships with Protosmylinae are in need of revision. It is unclear if *Mesosmylidus* gen. nov., as well as *Stenosmylina* Jepson et al. from the Wealden Supergroup, belong to Mesosmylininae, because they both possess a very long CuP.

Mesosmylidus vulgaris gen. et sp. nov.

Fig. 10A and B

Derivation of name. Latin *vulgaris*, usual, in reference to generalised venation.

Holotype. MANCH LL.16084.a-b [DB175/NEUR 9]. An incomplete forewing, collected by R. A. Coram.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Clements' (1993) Bed DB175, Corbula beds, Durlston Formation; Upper Berriasian.

Diagnosis. As for genus.

Description. Forewing, preserved length 8.5 mm (estimated length 11–12 mm), preserved width 3.2 mm. Costal space rather broad, with 15 simple subcostal veinlets preserved, closely spaced. Subcostal space narrow, no sc-r1 crossveins detected. Rs originating from R near wing base; seven r1-rs crossveins in proximal R1 space. Rs zigzagged, with four branches preserved; branches of Rs zigzagged. M deeply branched; MA simple for most of its length, forked distally; MP forking many times distally, forming eight branches. Cu forked near wing base. CuA simple for most of its length, forking to four branches distally. CuP pectinately branched with 10 branches, some distal branches forked. Numerous

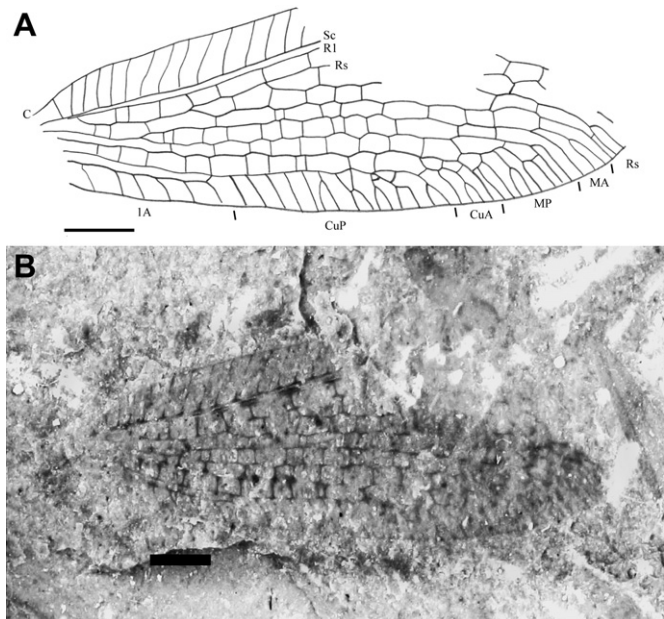


Fig. 10. *Mesosmylidus vulgaris* gen. et sp. nov., holotype MANCH LL16084.a-b. A, drawing of forewing venation. B, photograph. Scale bar represents 1 mm.

crossveins throughout radial to cubital spaces. One cup-1a crossvein preserved. 1A pectinately branched with five branches. Colour pattern consists of fuscous patches at ends of some crossveins proximally and fully dark-shaded crossveins distally.

Subfamily: ?Gumillinae Navás, 1912
(=Epiosmylinae Panfilov, 1980)
Genus *Osmylochrysa* gen. nov.

Type species. Osmylochrysa anomala gen. et sp. nov.

Included species. Type species and *Osmylochrysa fragilis* gen. et sp. nov.

Derivation of name. *Osmylo-* (from *Osmylus*, a genus-group name), and *-chrysa*, a traditional ending of chrysopoid genera [from *Chrysopa*, a genus-group name (from Greek *chrysos*, gold, and *opa*, eyes)], in reference to osmylid affinity and superficial resemblance to chrysopids. Gender feminine.

Diagnosis. Presence of only one crossvein between R1 and Rs before origin of Rs1 (many more in other genera of Gumillinae).

Included species. Two species described below.

Remarks. The forewing venation of this genus is similar to that of Gumillinae in having a distally shifted origin of Rs1. Within this subfamily, the venation and wing size most resemble those of the genus *Epiosmylus* Panfilov. Unfortunately, the diagnosis of Gumillinae includes such features as very long antennae and enlarged scapus, which are not preserved in the Purbeck material. Therefore, the subfamily affinity of the genus is preliminary.

Osmylochrysa anomala gen. et sp. nov.
Fig. 11A and B

Derivation of name. Latin *anomalus*, anomalous, in reference to the presence of subcostal crossveins in the forewing.

Holotype. MANCH LL.16093.a-b [DB175/NEUR 18]; a proximal half of the forewing, collected by R. A. Coram.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Clements' (1993) Bed DB175, Corbula beds, Durlston Formation; Upper Berriasian.

Diagnosis. Presence of subcostal crossveins and more proximal branching of 1A (proximal to the origin of Rs).

Description. Forewing, preserved length 5.4 mm (estimated length 11–12 mm) preserved width 3.1 mm. Costal space relative narrow, dilated at basal one-fifth, narrowed basally, with 12 simple, widely spaced subcostal veinlets preserved. Subcostal space narrow, with five sc-r crossveins preserved. Three widely spaced rs-r1 crossveins preserved. Rs zigzagged, apparently pectinate with two branches partially preserved; one crossvein preserved between these. Origin of Rs1 distant from origin of Rs. One rs-m crossvein and two rs-ma crossveins preserved. M deeply forked; MA and MP simple for most of preserved length, distal part of vein not preserved. Two ma-mp crossveins, four m-cua and mp-cua crossveins. Cu divides into CuA and CuP close to base (not preserved). CuA pectinately branched distally with three simple branches. Four cua-cup crossveins. CuP pectinately branched with two branches. 1A pectinately branched with three branches. 2A partially preserved.

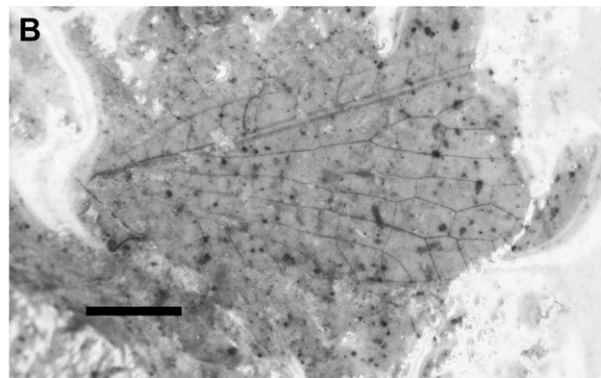
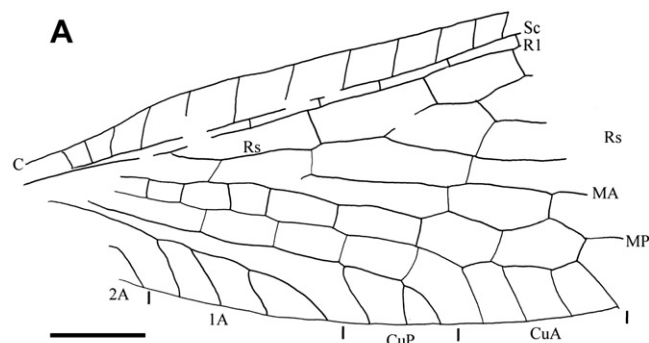


Fig. 11. *Osmylochrysa anomala* gen. et sp. nov., holotype MANCH LL.16093.a-b. A, drawing of forewing venation. B, photograph (submerged in ethanol). Scale bar represents 1 mm.

Remarks. The venation of this species is somewhat 'chrysopoid-like', especially in posterior portions of the wing (e.g., short CuA with simple, widely-spaced branches). In particular, it slightly resembles the chrysopoid family Mesochrysopidae, but the configuration of the venation is very different between them.

Osmylochrysa fragilis gen. et sp. nov.
Fig. 12A and B

Derivation of name. Latin *fragilis*, fragile, in reference to delicate and damaged condition of the holotype.

Holotype. MANCH LL.16090 [DB175/TM1096]. An incomplete forewing, collected by Mr A. A. Mitchell.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Clements' (1993) Bed DB175, Corbula beds, Durlston Formation; Upper Berriasian.

Diagnosis. More distal branching of 1A (distal to the origin of Rs). No subcostal crossveins.

Description. Forewing, 12.7 mm preserved length (estimated length 13 mm), 3.3 mm preserved width. Costal space relatively narrow; 25 subcostal veinlets, all simple, rather widely spaced proximally, closely spaced distally. Trichosors present on anterior wing margin, towards apex. Sc and R1 fused distally; 10 Sc + R1 veinlets, mostly forked, closely spaced. Six r1-rs crossveins. Rs pectinately branched, partially preserved; Rs1 origin well distal of origin of Rs. M partially preserved; its fork not visible. Four m-cua crossveins preserved. Cu forked near wing base; CuA and CuP incomplete, forking not preserved. One cua-cup. 1A pectinately branched, with simple branches. One 1a-2a crossvein preserved. 2A incomplete, with one branch preserved.

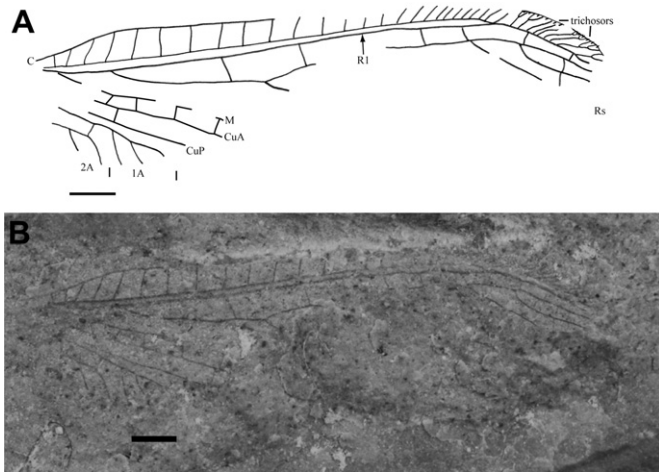


Fig. 12. *Osmylochrysa fragilis* gen. et sp. nov., holotype MANCH LL.16090 A, drawing of forewing venation. B, photograph. Scale bar represents 1 mm.

Remarks. This species is somewhat tentatively assigned to *Osmylochrysa* since it does not possess subcostal crossveins.

Subfamily: Uncertain

Genus *Stenochrysa* gen. nov.

Type and only species. *Stenochrysa gradata* gen. et sp. nov.

Derivation of name. Greek *stenos*, narrow, and *-chrysa*, a traditional ending of chrysopoid genera (from *Chrysopa*, a genus-group name), in reference to the evidently narrow forewing of the type species. Gender feminine.

Diagnosis. Much narrower R1 space (almost as narrow as subcostal space) with widely-spaced crossveins together with a narrow costal space.

Remarks. This genus may belong to Gumillinae, but the fragmentary nature of the wing does not allow a confident placement. On the other hand, the preserved venation is similar to that of the chrysopoid family Mesochrysopidae. However, Cu is forked very close to the wing base, and CuP is long in *Stenochrysa* gen. nov.; both conditions are not characteristic of that family, but are characteristic of Osmylidae.

Stenochrysa gradata gen. et sp. nov.

Fig. 13A and B

Derivation of name. Latin *gradatus*, gradate, in reference to the presence of a gradate series of crossveins in the radial space of the forewing.

Holotype. MANCH LL.16085.a-b [DB175/NEUR 12], a fragmentary anterior portion of the forewing. Collected by R. A. Coram.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Clements' (1993) Bed DB175, Corbula beds, Durlston Formation; Upper Berriasian.

Diagnosis. As for genus.

Description. Forewing, preserved length 27 mm (estimated length about 35 mm); preserved width 6.2 mm. Costal space relatively

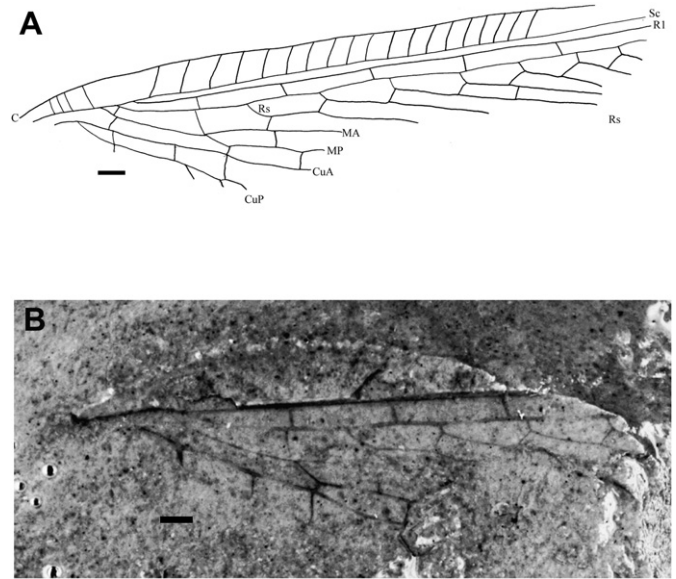


Fig. 13. *Stenochrysa gradata* gen. et sp. nov., holotype MANCH 16085.a-b. A, drawing of forewing venation. B, photograph (submerged in ethanol). Scale bar represents 1 mm.

narrow; 23 simple subcostal veinlets preserved. Subcostal space narrow, no subcostal crossveins detected. R1 space very narrow; five very widely spaced r1-rs crossveins preserved. Rs pectinately branched, with seven preserved branches. Seven crossveins in radial space. One rs-ma crossvein and one rs-m crossvein. M deeply forked, MA and MP incomplete, one ma-mp crossvein preserved. One m-cua and two mp-cua crossveins preserved. Cu deeply forked, CuA and CuP incomplete; CuP pectinately branched, with two branches preserved. Four cua-cup crossveins preserved (distal-most very incomplete); one cup-a1 crossvein. Anal veins not preserved.

Genus *Osmyloopsis* Handlirsch, 1906, sit. nov.

1906–08 *Osmyloopsis* Handlirsch, p. 614.

Type and only species. *Abia duplicata* Giebel, 1856, by monotypy.

Diagnosis. Distinguished by falcate hind wing and distal-most veinlets of Sc + R1 being forked.

Remarks. The family affinity of this genus was hitherto unclear because of an inadequate original description. It was usually considered as Neuroptera *incertae sedis* (e.g. Handlirsch, 1906–08; Martynova, 1949, 1962; Carpenter, 1992). Handlirsch (1939) thought that *Osmyloopsis* might be assigned to Epigambridae, a very poorly-defined family of Neuroptera. The hind wing of *O. duplicata* is poorly preserved but examination shows that it most probably belongs to the family Osmylidae (unknown subfamily).

Osmyloopsis duplicata (Giebel, 1856)

Fig. 14A and B

1854 Unnamed orthopteran; Westwood, p. 390, 396; pl. 18, fig. 42.

1856 *Abia duplicata* Giebel, p. 264, 416 (Sialidae).

1886 *Pterinoblattina? binneyi* Scudder, p. 472, 473 (Blattoptera).

1887 *Pterinoblattina? binneyi*; Geinitz, p. 200 (Blattoptera; as a synonym of *Abia duplicata*).

1906–08 *?Osmyloopsis duplicata*; Handlirsch, p. 614; pl. 48, fig. 15 (Neuroptera *incertae sedis*).

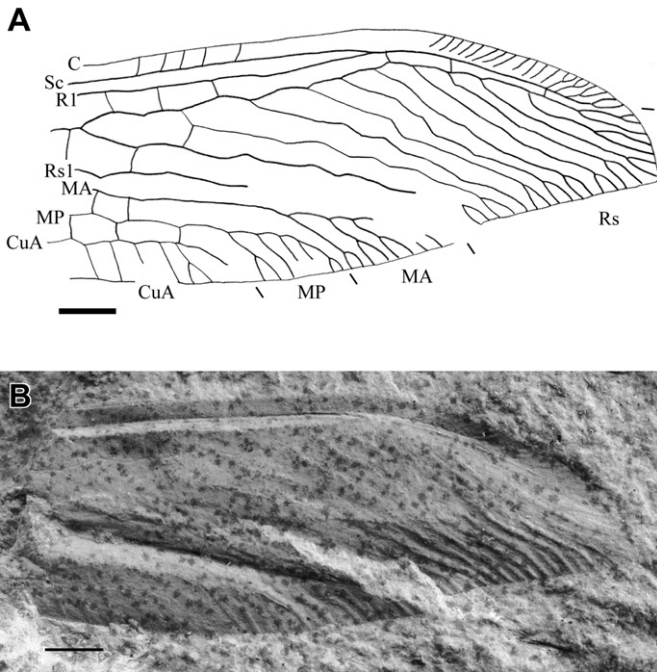


Fig. 14. *Osmyloopsis duplicata* (Giebel, 1856), holotype NHMUK Pal. I.3954. A, drawing of hind wing venation. B, photograph (taken by Phil Crabb, NHM). Scale bar represents 1 mm.

- 1939 *Osmyloopsis duplicata*; Handlirsch, p. 76 (?Epigambriidae).
 1949 *Osmyloopsis duplicata*; Martynova, p. 169 (Neuroptera incertae sedis).
 1988 *Osmyloopsis duplicata*; Lambkin, p. 450, 453 ('osmylid-like' neuropteran).
 1993 *Osmyloopsis duplicata*; Jarzembowski, p. 178 (Neuroptera).
 2003 *Osmyloopsis duplicata*; Makarkin and Archibald, 176 (Neuroptera familia incertae sedis).

Holotype. NHMUK Pal. I.3954. An incomplete hind wing.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Lulworth Formation; Upper Berriasian.

Diagnosis. As for genus.

Description. Hind wing 10.4 mm preserved length (estimated length about 14 mm), width about 4.0 mm. C preserved; trichosors not detected. Costal space narrow; slightly dilated apically. Subcostal veinlets widely spaced proximally, more closely spaced distally; Sc + R1 veinlets closely spaced, three distal-most forking. Sc fused with R1 very proximally of wing apex; Sc + R1 entering margin well before wing apex. Subcostal space rather broad. Origin of Rs not preserved. Rs strongly zigzagged medially, smoother distally, with 11 branches, majority with terminal forking. R1 space (between R1 and Rs) narrow medially, very narrow distally; six r1-rs crossveins preserved. Crossveins in radial space poorly preserved, apparently sparse. M incomplete, origin and fork of MA and MP not preserved. MA strongly concave; pectinately branched, with four–five branches, most (or all) with terminal forking. MP slightly convex; pectinately branched, with five branches, some with terminal forking. Two ma-mp and three mp-cua crossveins preserved. CuA pectinately branched, with five simple branches preserved. CuP and anal veins not preserved.

Remarks. *Pterinoblattina? binneyi* is based on the same specimen as *A. duplicata* (see Scudder, 1886, p. 473).

Family: Chrysopidae Schneider, 1851

Subfamily: Limaiinae Martins-Neto and Vulcano, 1988

Genus *Mesypochrysa* Martynov, 1927

Type species. *Mesypochrysa latipennis* Martynov, 1927 (Upper Jurassic of Karatau, Kazakhstan), by monotypy.

Diagnosis. Distinguished from all other genera of the subfamily by the complete fusion of the basal portion of MA and R, then stem of Rs, so that MA has the appearance of a proximal branch of Rs.

Included species. Sixteen species from Upper Jurassic (Oxfordian/Kimmeridgian) to Lower Cretaceous (Upper Aptian): *Mesypochrysa polyclada* Panfilov, *M. reducta* Panfilov, *M. intermedia* (Panfilov), *M. latipennis* Martynov, *M. makarkini* Nel et al., Oxfordian/Kimmeridgian of Kazakhstan (Martynov, 1927; Panfilov, 1980; Nel et al., 2005); *Mesypochrysa minuta* sp. nov., Upper Berriasian of England (new record); *Mesypochrysa angustialata* Makarkin, *M. chrysopa* Makarkin, *M. curvimedia* Makarkin, *M. falcata* Makarkin, *M. magna* Makarkin, *M. minima* Makarkin, Valanginian/Barremian of Transbaikalia, Asian Russia (Makarkin, 1997); *Mesypochrysa* cf. *chrysopoides* Ponomarenko, Barremian of China (Nel et al., 2005); *Mesypochrysa chrysopoides* Ponomarenko, Hauterivian/Aptian of Mongolia (Ponomarenko, 1992a), and *Mesypochrysa confusa* (Martins-Neto and Vulcano), *M. criptovenata* (Martins-Neto and Vulcano), Upper Aptian of Brazil (Martins-Neto and Vulcano, 1989).

Mesypochrysa minuta sp. nov.

Fig. 15A and B

Derivation of name. Latin *minutus*, meaning minute, small.

Diagnosis. Broad mediocubital space in hind wing, and distinctively small size.

Holotype. MANCH LL.16086.a-b [DB175/NEUR 28]. A small poorly preserved wing, collected by R. A. Coram.

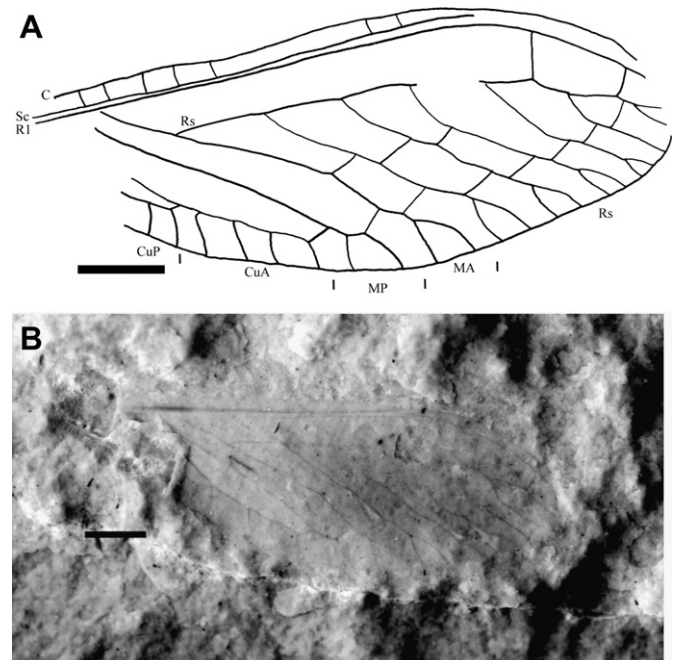


Fig. 15. *Mesypochrysa minuta* sp. nov., holotype MANCH LL.16086.a-b. A, drawing of hind wing venation. B, photograph (submerged in ethanol). Scale bar represents 1 mm.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Clements' (1993) Bed DB175, Corbula beds, Durlston Formation; Upper Berriasian.

Description. Hind wing, preserved length 6.7 mm (estimated length about 7 mm), width 2.7 mm. Costal space narrow, with seven preserved subcostal veinlets. Sc termination not visible. R1 long, termination not preserved. Two distal r1-rs crossveins preserved. Rs with five branches, most with terminal forks. Two gradate series of crossveins in radial to mediocubital spaces: inner with three crossveins and outer with eight crossveins, both nearly parallel to each other and hind margin. M fork absent; MA basally fused with Rs, giving it the appearance of a proximal branch of RS; MP appears fused with R basally; both simple most of length, forking terminally. Cu origin and fork not preserved. CuA pectinately branched with three simple branches. Distal portion of CuP partially preserved with one pectinate branch preserved. Mediocubital space (between MP and CuA) very broad. Distal cua-cup crossvein short. Anal veins not preserved.

Remarks. The specimen is very poorly preserved, with veins just visible when submerged in ethanol. Some features are not detectable; for example, the dense veinlets of R1 near the wing apex, although these may have been present. It has been confidently placed within the genus *Mesypochrysa* on the basis of the basal fusion of MA with R and then Rs in the hind wing. This is the smallest known fossil species of Chrysopidae, and the first record of the family from the Mesozoic of Europe.

Family: ?Hemerobiidae Leach, 1815

Genus *Purbemerobius* gen. nov.

Type and only species: *Purbemerobius medialis* gen. et sp. nov.

Derivation of name. From Purbeck, and *Hemerobius*, a genus-group name. Gender masculine.

Diagnosis. Multibranched M in the hind wing.

Remarks. The placement of this genus in the family Hemerobiidae is somewhat tentative due to the poor preservation of the hind wing, but seems very likely judging from the venation, which conforms to that of that family (e.g., narrow costal space with simple subcostal veinlets; stout Sc; few subcostal and radial crossveins; Sc and R1 not fused distally, joined by distal crossvein; configuration of CuA, CuP, and 1A characteristic of hemerobiid hind wings). A single character that occurs very rarely in the extant genera of Hemerobiidae is the Media having several (four) deep forks. In the majority of hemerobiids M in the hind wing has only one deep fork, and extant *Gayomyia* Banks from southern South America is probably the only exception, having a similar structure of M to *Purbemerobius* gen. nov. (see Oswald, 1993, fig. 175).

Fossil hemerobiids are rare in the Mesozoic with only two confirmed taxa: *Promegalomus anomalus* Panfilov from the Upper Jurassic of Karatau, Kazakhstan, and *Cretomerobius disjunctus* Ponomarenko from the Lower Cretaceous of Mongolia (Panfilov, 1980; Ponomarenko, 1992a). A hemerobiid-like species, *Protohemerobius perexiguus* Jepson et al., that has been described from the Wealden most likely represents an undescribed family (Jepson et al., 2009b). *Mesohemerobius jeholensis* Ping, from the Lower Cretaceous of China, was previously placed in Hemerobiidae, but was removed from the family by Makarkin et al. (2003) and placed as Neuroptera *incertae sedis*. Two species of hemerobiids have been described from the Lower Cretaceous Crato Formation of Brazil;

however these are in need of redescription to confirm their placement in the family (Makarkin et al., 2003).

Purbemerobius medialis gen. et sp. nov.

Fig. 16A and B

Derivation of name. From *Media*, a median vein, in reference to the structure of the Media of the hind wing.

Holotype. MANCH LL.16092.a-b [DB175/NEUR 5]. An incomplete hind wing, collected by R. A. Coram.

Diagnosis. As for genus.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Clements' (1993) Bed DB175, Corbula beds, Durlston Formation; Upper Berriasian.

Description. Hind wing, preserved length 8.8 mm (estimated length 9.5 mm), width 4.5 mm. C preserved. Costal space narrow; 44 subcostal veinlets, majority simple. Subcostal space relative broad, with two distal crossveins detected. Sc long, forking before termination on wing margin. R1 long, dichotomously forked distally 1.3 mm before wing apex. Sc and R1 not fused distally. R1 space broad basally, and narrow distally, with two long oblique basal r1-rs crossveins, and one short medial r1-rs crossvein. Rs with nine branches; Rs1 deeply forked; few crossveins preserved between branches. Rs2, Rs3 simple most of length, dichotomously forked distally. Other seven branches

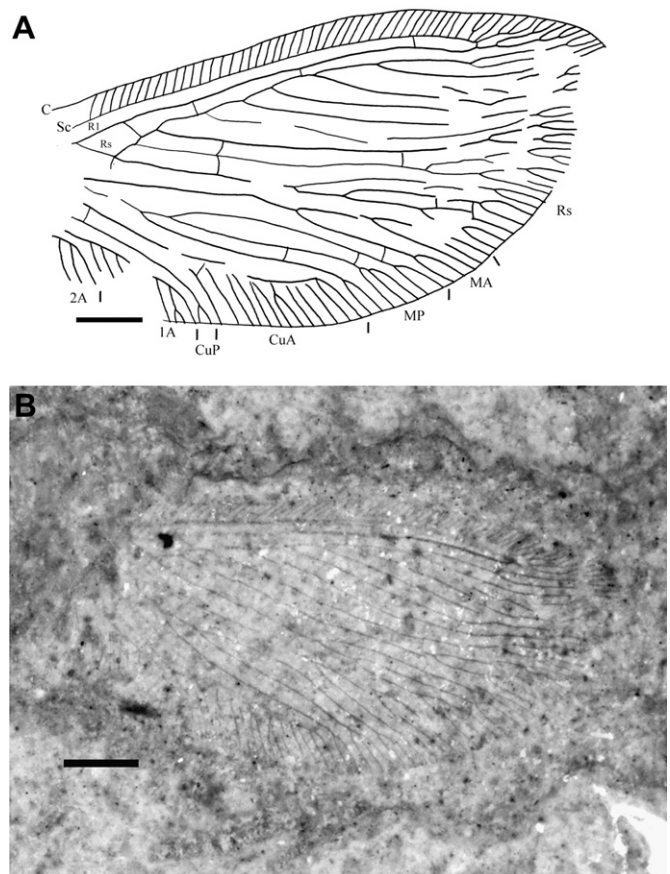


Fig. 16. *Purbemerobius medialis* gen. et sp. nov., holotype MANCH LL.16092.a-b. A, drawing of hind wing venation. B, photograph (submerged in ethanol). Scale bar represents 1 mm.

heavily damaged, simple most of length, forking distally. Basal crossvein r-m not completely preserved; its shape not clear. M deeply forked, proximal to origin of Rs1, its origin not preserved. MA forked just after mid-point of vein, dichotomously branched, heavily damaged. MP deeply forked twice, all three branches simple most of length, forking before termination at posterior wing margin. Few crossveins preserved in medial space. CuA origin not preserved, pectinately branched with 11 long branches, mostly simple, some forked. One crossvein preserved between branches of CuA. CuP simple most of its length, forking near termination at posterior wing margin. 1A pectinately branched, five branches preserved, one forked. 2A partially preserved, apparently pectinately branched, two branches partially preserved.

Remarks. The wing appears to have been damaged prior to fossilization, with many veins being broken. This is observed especially around the mid-point of the wing, affecting mainly the lower half, towards the posterior wing margin. *Purbemerobius medialis* gen. et sp. nov. possibly represents the first record of a British Mesozoic hemerobiid.

Family: Berothidae Handlirsch, 1906

Genus *Epimesoberotha* gen. nov.

Type and only species. *Epimesoberotha parva* gen. et sp. nov.

Derivation of name. Greek *epi*, near, and *Mesoberotha*, a genus-group name, in reference to mesoberothid appearance. Gender feminine.

Diagnosis. Lack of recurrent humeral vein and a pectinately branched CuA.

Remarks. The forewing venation and size of the new genus are rather similar to those of the Burmese amber berothids (Engel and Grimaldi, 2008), except for the pectinately branched CuA. In the latter genera, CuA is rather few-branched. A pectinately branched CuA similar to that of *Epimesoberotha* gen. nov. is seen in the berothid *Plesiorobius* Klimaszewski and Kevan from the Lower to Upper Cretaceous of North America and Siberia (Klimaszewski and

Kevan, 1986; Makarkin, 1994), but the latter has a recurrent humeral vein.

Epimesoberotha parva gen. et sp. nov.

Fig. 17A–D

Derivation of name. Latin *parvus*, little, in reference to the small size of the species.

Holotype. MANCH LL.16089.a-b [USCDB/TM432]. A nearly complete forewing, collected by Mr A. A. Mitchell.

Paratype. CAMSM X.50165.1.1a and CAMSM X.50165.1.2a (part and counterpart). An incomplete forewing, collected by Rev. O. Fisher.

Type locality and horizon. Holotype and paratype: Durlston Bay, Swanage, Dorset; Upper Soft Cockle beds, Lulworth Formation; Lower Berriasian.

Diagnosis. As for genus.

Description of the holotype. (Fig. 17A and B). Forewing, length 3.7 mm, width 1.7 mm. Trichosors present on distal part of anterior margin. C complete. Costal space narrows towards wing base, is most dilated at one quarter wing length, and gradually narrows towards wing apex. Subcostal veinlets simple, nearly straight. Sc incomplete, terminating on R1. Sc + R1 with five simple branches. Subcostal space broad for entire length; crossveins not detected. R1 space slightly narrower than subcostal space, with two r1-rs crossveins detected. Rs with six branches; Rs1, Rs2 dichotomously forked distally, others not forked before marginal branching. Few crossveins in radio-media space detected. M deeply forked, much distal to origin of Rs; MA and MP mostly dichotomously forked distally, 0.4 mm from posterior wing margin. Cu deeply forked proximal to origin of Rs. CuA pectinately branched, with five branches, majority simple except for proximal-most branch. CuP deeply forked. Anal veins not preserved.

Description of the paratype. (Fig. 17C and D). Forewing, preserved length 3.8 mm (estimated length 4.5 mm), preserved width

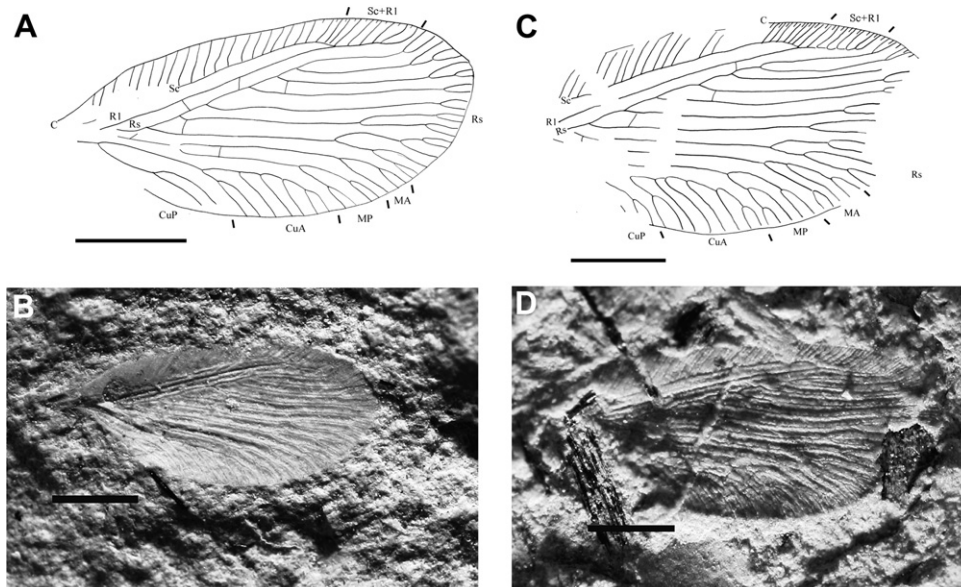


Fig. 17. *Epimesoberotha parva* gen. et sp. nov. A, drawing of forewing venation of holotype MANCH LL.16089.a-b. B, photograph of the holotype. C, drawing of forewing venation of paratype CAMSM X.50165.1.1a. D, photograph of paratype. Scale bar represents 1 mm.

2.1 mm. Trichosors present on anterior wing margin. C incomplete. Costal space narrowed to base, most dilated at one quarter, gradually narrowed towards apex. Subcostal veinlets simple, nearly straight. Sc terminates on R1. Sc + R1 with seven simple branches. Subcostal space broad for entire length; crossveins not detected. R1 space narrower than subcostal space; one rs-rs1 crossvein detected. Rs with seven branches, three proximal-most dichotomously forked distally. Two crossveins preserved in radial space. One rs-m crossvein in proximal portion of wing. M deeply forked (fork not preserved). MA and MP dichotomously branching distally to give five branches extending to posterior wing margin. CuA pectinately branched with five–six branches, majority simple. CuP poorly and incompletely preserved. Anal veins not preserved.

Remarks. The paratype's locality and horizon have been inferred by RAC, from the characteristic nature of the sediment (the light 'chalky' nature of the matrix, the abundant charcoal fragments and the small cubical halite (salt crystal) moulds), because no detailed locality information was present with the specimen.

Family: Nymphidae Rambur, 1842

Genus *Sialium* Westwood, 1854, sit. nov.

Type and only species. *Sialium sipylus* Westwood, 1854, by monotypy.

Diagnosis. Differs from other Mesozoic genera in having eight MP branches in the hind wing.

Remarks. Examination of the type species shows that the hind wing venation is typical for the family Nymphidae (e.g. Sc and R1 distally fused; Sc + R1 entering margin after wing apex; trichosors present; Rs originating very near wing base). In general, it is most similar to that of *Mesonymphes* Carpenter, two species of which are known from the Upper Jurassic of Germany and Kazakhstan (Carpenter, 1929; Panfilov, 1980). The latter and other nymphid genera are distinguished from *Sialium* by the number of MP branches in the hind wing (five in *Mesonymphes*; four in *Liminymphe* Ren and Engel and *Cretonymphes* Ponomarenko; three in *Nymphites* Haase (Haase, 1890; Ponomarenko, 1992b; Ren and Engel, 2007)).

Sialium sipylus Westwood, 1854

Fig. 18A and B

- 1854 *Sialium Sipylus* Westwood, p. 390, 396, pl. 18, fig. 24 (Neuroptera, allied to *Sialis*).
- 1856 *Abia sipylus*: Giebel, p. 263, 416 (*Sialidae*).
- 1862a *Sialium Sipylus*; Hagen, p. 104 (Neuroptera).
- 1862b *Sialium sipylus*; Hagen, p. 10 (Neuroptera).
- 1884 *Syalium* [sic] *Sipylus*; Geinitz, p. 571 (?Orthoptera).
- 1886 *Pterinoblattina* ? *Sipylus*; Scudder, p. 472 (Blattoptera).
- 1887 *Pterinoblattina* ? *Sipylus*; Geinitz, p. 200 (Blattoptera).
- 1891 *Sialium sipylus*; Scudder, p. 130 (Blattoptera).
- 1906–08 *Sialium sipylus*; Handlirsch, p. 609, pl. 48, fig. 10 (*Nymphitidae*).
- 1939 *Sialium sipylus*; Handlirsch, p. 159 (*Nymphitidae*).
- 1949 *Sialium siphylus* [sic]; Martynova, p. 167 (*Nymphitidae*).
- 1988 *Sialium sipylus*; Lambkin, p. 451, 454 (*Nymphitidae*).
- 1988 *Sialium sipylus*; Whalley, p. 46 (*Nymphitidae*).
- 1993 *Sialium sipylus*; Jarzembowski, p. 178 (Neuroptera).

Holotype. NHMUK Pal. I.13951ab. An almost complete hind wing.

Type locality and horizon. Durlston Bay, Swanage, Dorset; Lulworth Formation; Lower Berriasian.

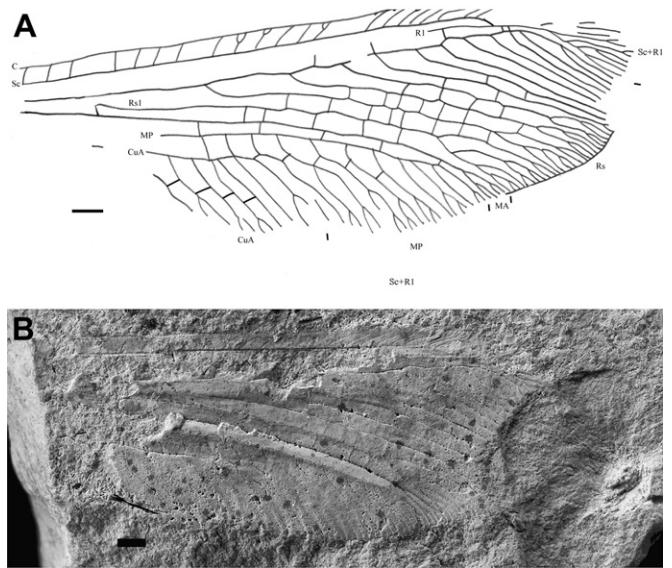


Fig. 18. *Sialium sipylus* Westwood, 1854, holotype NHMUK Pal. I.13951. A, drawing of hind wing venation. B, photograph (taken by Phil Crabb, NHM). Scale bar represents 1 mm.

Diagnosis. As for genus.

Description. Hind wing, preserved length 21 mm (estimated length about 25 mm), preserved width 6.8 mm. C partially preserved, trichosors preserved apically. Subcostal space narrow, 21 subcostal veinlets preserved, becoming densely spaced distally. Sc curves towards R1 distally, and is fused with it. R1 preserved only in distal part. Sc + R1 with five forked branches preserved. Five r1-rs crossveins preserved. Rs pectinately branched with 11 branches, forking close to posterior wing margin; Rs1 relatively profusely branched. Numerous randomly arranged crossveins preserved in central part of radial space. MA simple for most of its length, dichotomously forking very close to posterior wing margin to give four branches. Six ma-rs crossveins and five ma-mp crossveins preserved. MP pectinately branched, with eight branches, majority forked distally to give more than 20 branches at posterior wing margin. Four crossveins preserved within MP. Two mp-cua crossveins preserved. CuA pectinately branched with six branches forking to 11 distally and at least four preserved crossveins. CuP and anal veins not preserved.

Remarks. Although the gender of *Sialium* is neuter (according to Article 30.1.3 of ICZN), the species epithet should be spelt *sipylus* because it was most probably derived from Mount Sipylus in Lydia (according to Greek mythology), i.e., this is a noun (Article 31.2.1).

Family: Neuroptera familia incertae sedis

Genus *Pseudocorydasialis* gen. nov.

Type and only species. *Pseudocorydasialis alleni* gen. et sp. nov.

Derivation of name. Greek *pseudos*, false, and *Corydasialis*, a genus-group name, in reference to superficial resemblance to the megalopteran family Corydasialidae.

Diagnosis. Costal space basally dilated; Sc and R1 not fused distally; CuA, CuP and 1A few-branched, not pectinate.

Remarks. The systematic position of *Pseudocorydasialis alleni* gen. et sp. nov. is uncertain. Superficially, its venation resembles that of the megalopteran family Corydasialidae, known from the Eocene Baltic amber (Wichard et al., 2005). However, the basal portion of the forewing costal space in all megalopterans (including Corydasialidae) is never so strongly dilated; this is characteristic of Neuroptera. Among neuropterans, the venation of this genus is similar to that of the somewhat younger Cretaceous genera *Tachymerobius* Ponomarenko from the Bon-Tsagan locality, Mongolia, and *Cratochrysa* Martins-Neto from the Crato Formation, Brazil (Ponomarenko, 1992a; Martins-Neto, 1994; Nel et al., 2005). The position of these genera is also not entirely understood, although *Tachymerobius* was preliminarily referred to the Prohemerobiidae (Ponomarenko, 1992a), and the latter was placed as basal with respect to Chrysopoidea (Nel et al., 2005), and recently in its own family Cratochrysidae (Martins-Neto and Rodrigues, 2009), although this family name is unavailable according to Article 13.1 of ICZN (no description or definition). The actual systematic position of this new genus will become clearer when more complete and better preserved specimens are found. It may turn out to be con-familial with *Cratochrysa* or/and *Tachymerobius*.

Pseudocorydasialis alleni gen. et sp. nov.

Fig. 19A and B

Derivation of name. After the late Professor Perce Allen.

Holotype. MANCH LL.16087.a-b [HCSD NEUR 1]. An almost complete forewing, collected by R. A. Coram.

Diagnosis. As for genus.

Type locality and horizon. Durlston Bay, Swanage, Dorset; probably Hard Cackle Beds, Lulworth Formation; Lower Berriasian.

Description. Forewing, preserved length 23.3 mm (estimated total length 24.5 mm), width 8.3 mm. Costal space strongly widened basally; subcostal veinlets proximal to pterostigmal region

moderately spaced, forked; closely spaced, simple in pterostigmal region and apically. Gradate series of crossveins (seven preserved) in costal space near base of wing. Sc long. R1 enters margin near wing apex, distally with several veinlets; Sc and R1 not fused apically. Subcostal space narrow; three crossveins preserved: one at mid-point of wing and two in distal part of wing (basal portion of space not preserved). Rs originates from R at acute angle, 5.0 mm distant from base of the wing, with four pectinate branches. Origin of Rs1 shifted distally. Nine widely spaced crossveins present between R1 and Rs. Crossveins in radial space scarce, four detected. M forked distal to origin of Rs; MA and MP incompletely preserved. M and R not fused basally. Origin of Cu not preserved; Cu probably dividing into CuA and CuP close to wing base. CuA incomplete; CuP long, not pectinate, forking approximately 4 mm from posterior wing margin. Cubital space broad, with four cua-cup crossveins preserved. Three cup-1a crossveins. 1A long, straight, rather deeply forked in same manner as CuP, 4.0 mm from posterior wing margin; 2A long, pectinate, with four branches preserved. Four 1a-2a crossveins preserved. 3A not preserved.

A small portion of the underlying other forewing is exposed, but provides no further information.

5. Discussion

Prior to this study only four species of neuropterans were known from the Purbeck Limestone Group of southern England, all of which were described in the 19th Century and poorly illustrated. These species, *O. duplicata*, *S. sipylus*, *P. pluma* and *P. penna* have now been thoroughly redescribed and figured. The family affinities of these species have also been confirmed, with *O. duplicata* being placed in Osmylidae, *S. sipylus* in Nymphidae and *P. pluma* and *P. penna* in Psychopsidae. The redescription of *Pterinoblattina* has shown the psychopsid genus *Valdipsychops* from the Wealden to be a synonym. The new families recorded within the Purbeck include Osmylidae, Chrysopidae, Berothidae, Kalligrammatidae, Prohemerobiidae, and possibly Hemerobiidae. The psychopsoid neuropterans (Psychopsidae and Kalligrammatidae) make up the majority of the neuropteran fauna in terms of number of species and most of the undescribed fragmentary material is also of psychopsoid affinity (JEP pers. obs.). Osmylidae are the next dominant group after the psychopsoids. The chrysopids, nymphids, ?hemerobiids, berothids and prohemerobiids are represented by a single species each.

The first records of Chrysopidae, Berothidae and possibly Hemerobiidae have been recorded in the British Mesozoic. The chrysopid is the smallest known representative of the family with an estimated hind wing length of 7 mm. The presence of Berothidae in England during the Lower Cretaceous extends the family's geographical range, it previously being known from Lebanon, China, Brazil, Burma, Russia, USA, Canada and Baltic amber (Engel and Grimaldi, 2008).

The geographical ranges of the genera *Sophogramma* and *Mesypochrysa* have been extended with their discovery in the Purbeck. *Sophogramma* was previously only known from Asian Russia and China (Ren and Guo, 1996; Makarkin, 2010). *Mesypochrysa* was more globally widespread, with previous occurrences documented from Kazakhstan, Asian Russia, Mongolia, China and Brazil (Makarkin, 1997; Nel et al., 2005).

The neuropteran fauna of the Purbeck is more diverse than that of the younger Wealden, having a higher number of families present: Wealden four (Jepson et al., 2009b) and Purbeck seven (herein). There are, however, similarities between the two faunas; for example, the psychopsoids dominate in each, with Osmylidae being sub-dominant. The family Brongniartiellidae is not known from the Purbeck or Wealden; specimens previously thought to

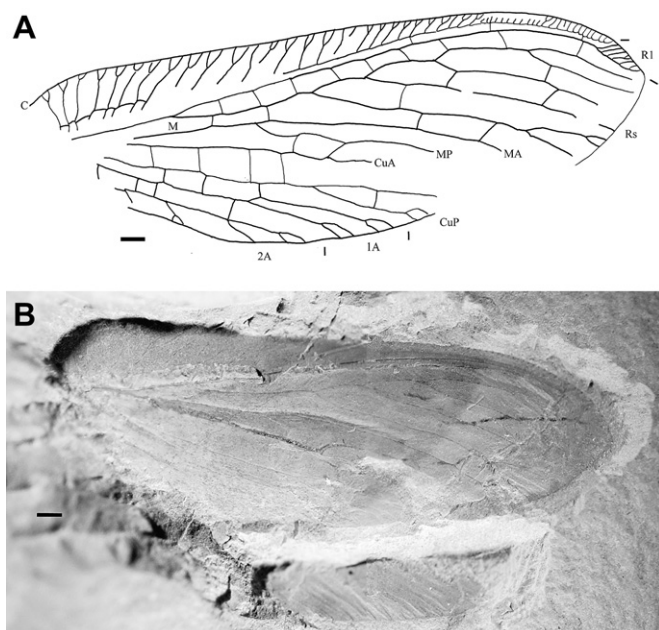


Fig. 19. *Pseudocorydasialis alleni* gen. et sp. nov. MANCH LL.16087.a-b. A, drawing of forewing venation. B, photograph. Scale bar represents 1 mm.

belong to this family are now known to be psychopids. Both the Purbeck and Wealden have genera which are present in the younger (Aptian) Crato Formation of Brazil: *Principiala* Makarkin et Menon (Ithonidae) in the Wealden (Jepson et al., 2009b) and *Mesypochrysa* (Chrysopidae) in the Purbeck (herein).

Modern Neuroptera are found in a variety of habitats, with many being observed in and around woodland (Duelli et al., 2002). Sedimentological evidence, along with the relative scarcity of plant macrofossils, indicates that the Purbeck insect-bearing beds were deposited in hypersaline or brackish water bodies separated from the nearest well-vegetated ground by wide (up to several km) beaches or mudflats (Coram, 2003). Transport over such distances would account for the disarticulated nature of the neuropteran, and most other terrestrial insect, remains.

The Purbeck climate is interpreted to have been seasonally semi-arid, ameliorating somewhat midway through Purbeck times (Allen, 1998). Charcoal and evaporites, indicative of wildfires and hypersalinity respectively, are conspicuous in the Lulworth Formation and less so in the overlying Durlston Formation. Osmyloid neuropterans, present in both formations, mostly have semi-aquatic larvae today, which tend to prefer damp conditions close to fresh water. This suggests that despite the general semi-aridity, such conditions were locally present throughout Purbeck times.

Acknowledgements

Thanks to the Natural History Museum (London), Sedgwick Museum (Cambridge), Wiltshire Heritage Museum (Devizes) and The Manchester Museum (Manchester) for loan of specimens; Phil Crabb (NHM) for photography of the NHMUK specimens; Claire Mellish (NHM) for help with the NHMUK loan and Bill Wimbledon (Research Fellow, Dept. of Earth Sciences, University of Bristol) for help with the specimen of *Sophogramma wimbledonii* sp. nov. Thanks also to David Gelsthorpe (MANCH), Dan Pemberton and Matt Riley (CAMSM) for their help with the loan of specimens, and to Bruce Archibald (Simon Fraser University, Canada) for providing photographs of *Brongniartiella gigas* and Qiang Yang (Capital Normal University, Beijing, China) for photographs of *Sophogramma lili*. Thanks to Antonio Arillo and one anonymous reviewer for their useful comments. JEJ acknowledges a Wingate Scholarship and the University of Manchester Alkins Fund.

References

- Allen, P., 1998. Purbeck-Wealden (early Cretaceous) climates. *Proceedings of the Geologists' Association* 109, 197–236.
- Allen, P., Wimbledon, W.A., 1991. Correlation of NW European Purbeck-Wealden (nonmarine Lower Cretaceous) as seen from the English type-areas. *Cretaceous Research* 12, 511–526.
- Ansorge, J., 1996. Insekten aus dem oberen Lias von Grimmen (Vorpommern, Norddeutschland). *Neue Paläontologische Abhandlungen* 2, 1–132.
- Aspöck, U., 2002. Phylogeny of the Neuropterida (Insecta: Holometabola). *Zoologica Scripta* 31, 51–55.
- Archibald, S.B., Makarkin, V.N., 2006. Tertiary giant lacewings (Neuroptera: Polystoechotidae): revision and description of new taxa from western North America and Denmark. *Journal of Systematic Palaeontology* 4, 119–155, 307 (errata).
- Bode, A., 1953. Die Insektenfauna des ostniedersächsischen oberen Lias. *Palaeontographica*, Abt. A 103, 1–375.
- Carpenter, F.M., 1929. A Jurassic Neuropteran from the lithographic limestones of Bavaria. *Psyche* 36, 190–194.
- Carpenter, F.M., 1992. Treatise on invertebrate paleontology. Part R. Arthropoda 4. In: *Superclass Hexapoda*, vol. 4. The Geological Society of America and University of Kansas, pp. 338–356.
- Clements, R.G., 1993. Type-section of the Purbeck Limestone Group, Durlston Bay, Swanage, Dorset. In: *Proceedings of the Dorset Natural History and Archaeological Society* 114 (for 1992), pp. 181–206.
- Comstock, J.H., 1918. *The Wings of Insects*. Comstock Publication Company, Ithaca, 430 pp.
- Coram, R.A., 2003. Taphonomy and ecology of Purbeck fossil insects. *Acta Zoologica Cracoviensia* 46 (Suppl. Fossil Insects), 311–318.
- Coram, R.A., 2005. Palaeoecology and Palaeoenvironmental Significance of Early Cretaceous Fossil Insects from the Purbeck Limestone Group, Dorset, UK. Unpublished PhD thesis, Reading University.
- Duelli, P., Obrist, M.K., Flückiger, P.F., 2002. Forest edges are biodiversity hotspots – also for Neuroptera. *Acta Zoologica Academiae Scientiarum Hungaricae* 48, 75–87.
- Ensom, P.C., 2002. The Purbeck Limestone Group of Dorset, southern England: a guide to lithostratigraphic terms. *Special Papers in Palaeontology* 68, 7–12.
- Engel, M.S., Grimaldi, D.A., 2008. Diverse Neuropterida in Cretaceous amber, with particular reference to the paleofauna of Myanmar (Insecta). *Nova Supplementa Entomologica* 20, 1–86.
- Geinitz, F.E., 1880. Der Jura von Dobbertin in Mecklenburg und seine Versteinerungen. *Zeitschrift der Deutschen Geologischen Gesellschaft* 32, 510–534.
- Geinitz, F.E., 1884. Ueber die Fauna des Dobbertiner Lias. *Zeitschrift der Deutschen Geologischen Gesellschaft* 36, 566–583.
- Geinitz, F.E., 1887. Beitrag zur Geologie Mecklenburgs. *Archiv des Vereins der Freunde der Naturgeschichte in Mecklenburg* 41, 143–216.
- Giebel, C.G., 1856. *Fauna der Vorwelt mit steter Berücksichtigung der lebenden Thiere*. Monographisch dargestellt von Dr. C. G. Giebel. Zweiter Band: Gliederthiere. Erste Abtheilung: Insecten und Spinnen. Brockhaus, Leipzig, xviii + 511 pp.
- Grimaldi, D., Engel, M.S., 2005. *Evolution of the Insects*. Cambridge University Press, New York, 755 pp.
- Haase, E., 1890. Bemerkungen zur Palaeontologie der Insecten. *Neues Jahrbuch für Mineralogie. Geologie und Palaeontologie* 1890 (2), 1–33.
- Hagen, H.A., 1862a. Ueber die Neuropteren aus dem lithographischen Schiefer in Bayern. *Palaeontographica* 10 (2), 96–145.
- Hagen, H.A., 1862b. A comparison of the fossil insects of England and Bavaria. *Entomologist's Annual* for 1862, 1–10.
- Handlirsch, A., 1906–08. Die fossilen Insekten und die Phylogenie der rezenten Formen. Ein Handbuch für Paläontologen und Zoologen. Engelmann, Leipzig, ix + 1430 pp., 51 pls.
- Handlirsch, A., 1919. Eine neue Kalligrammide (Neuroptera) aus dem Solnhofener Plattenkalk. *Senckenbergiana* 1 (3), 61–63.
- Handlirsch, A., 1939. Neue Untersuchungen über die fossilen Insekten mit Ergänzungen und Nachträgen sowie Ausblicken auf phylogenetische, palaeogeographische und allgemein biologische Probleme. II. Theil. *Annalen des Naturhistorischen Museums in Wien* 49, 1–240.
- Heer, O., 1864. Ueber die fossilen Kakerlaken. *Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich* 9 (4), 273–302.
- International Commission on Zoological Nomenclature, 1999. *International Code of Zoological Nomenclature*, fourth ed. International Trust for Zoological Nomenclature, London, 306 pp.
- Jarzewowski, E.A., 1993. A provisional checklist of fossil insects from the Purbeck Beds of Dorset. In: *Proceedings of the Dorset Natural History and Archaeological Society* 114 (for 1992), pp. 175–179.
- Jarzewowski, E.A., 2001. A new Wealden fossil lacewing, pp. 56–58. In: Rowlands, J.L.J. (Ed.), *Tunbridge Wells and Ruxhall Commons: A History and Natural History*. Tunbridge Wells Museum and Art Gallery, Tunbridge Wells, 126 pp.
- Jarzewowski, E.A., Palmer, D., 2010. Mesozoic fossil arthropods. In: Jarzewowski, E.A., Siveter, D.J., Palmer, D., Selden, P.A. (Eds.), *Fossil Arthropods of Great Britain*. Geological Conservation Review Series, No. 35. Joint Nature Conservation Committee, Peterborough, pp. 151–208.
- Jepson, J.E., Coram, R.A., Jarzewowski, E.A., 2009a. Raphidioptera (Insecta: Neuropterida) from the Lower Cretaceous Purbeck Limestone Group, Dorset, UK. *Cretaceous Research* 30, 527–532.
- Jepson, J.E., Makarkin, V.N., Jarzewowski, E.A., 2009b. New lacewings (Insecta: Neuroptera) from the Lower Cretaceous Wealden Supergroup of southern England. *Cretaceous Research* 30, 1325–1338.
- Klimaszewski, J., Kevan, D.K.M., 1986. A new lacewing fly (Neuroptera, Planipennia) from Canadian amber, with an analysis of its forewing characters. *Entomological News* 97 (3), 124–132.
- Lambkin, K.J., 1988. A re-examination of *lithosmylidia* Riek from the Triassic of Queensland with notes on Mesozoic 'osmylid-like' fossil Neuroptera (Insecta: Neuroptera). *Memoirs of the Queensland Museum* 25, 445–458.
- Leach, W.E., 1815. Artikel entomology, pp. 57–172. In: Brewster, D. (Ed.), *Edinburgh Encyclopaedia* 9(1) Edinburgh.
- Linnaeus, C., 1758. *Systema Naturae per Regna Tria Naturae, Secundum Classes, Ordines, Genera, Species, cum Characteribus, Differentiis, Synonymis, Locis*, tenth ed., Laurentius Salvius, Holmiae, 824 pp.
- Makarkin, V.N., 1994. Upper Cretaceous Neuroptera from Russia and Kazakhstan. *Annales de la Société Entomologique de France (NF)* 30, 283–292.
- Makarkin, V.N., 1997. Fossil Neuroptera of the Lower Cretaceous of Baissa, East Siberia. Part 3. Chrysopidae. *Spixiana* 20, 107–118.
- Makarkin, V.N., 2010. New psychopoid Neuroptera from the Lower Cretaceous of Baissa, Transbaikalia. *Annales de la Société Entomologique de France (NS)* 46, 254–261.
- Makarkin, V.N., Archibald, S.B., 2003. Family affinity of the genus *Palaeopsychops* Andersen with description of a new species from the Early Eocene of British Columbia (Neuroptera: Polystoechotidae). *Annals of the Entomological Society of America* 96, 171–180.
- Makarkin, V.N., Archibald, S.B., 2005. Substitute names for three genera of fossil Neuroptera, with taxonomic notes. *Zootaxa* 1054, 15–23.
- Makarkin, V.N., Archibald, S.B., Oswald, J.D., 2003. New Early Eocene brown lacewings (Neuroptera: Hemerobiidae) from western North America. *Canadian Entomologist* 135, 637–653.

- Makarkin, V.N., Ren, D., Yang, Q., 2009. Two new species of Kalligrammatidae (Neuroptera) from the Jurassic of China, with comments on venational homologies. *Annals of the Entomological Society of America* 102, 964–969.
- Martins-Neto, R.G., 1994. Neuropteros da Formação Santana (Cretáceo Inferior), Bacia do Araripe, Nordeste do Brasil. 9. Primeiros resultados da composição da fauna e descrição de novos taxons. *Acta Geologica Leopoldensia* 17, 269–288.
- Martins-Neto, R.G., Rodrigues, V.Z., 2009. New Neuroptera (Insecta, Osmylidae and Mesochrysopidae) from the Santana Formation, Lower Cretaceous of northeast Brazil. *Gaea* 5, 15–20.
- Martins-Neto, R.G., Vulcano, M.A., 1988. Neuropteros (Insecta: Planipennia) da Formação Santana (Cretáceo Inferior), Bacia do Araripe, Nordeste do Brasil. I – Família Chrysopida. *Anais da Academia Brasileira de Ciências* 60, 18–201.
- Martins-Neto, R.G., Vulcano, M.A., 1989. Neuropteros (Insecta: Planipennia) da formação Santana (Cretáceo Inferior) Bacia do Araripe, Nordeste do Brasil. IV Complemento partes I & II, com descrição de novos taxa. *Anais da Academia Brasileira de Ciências* 61, 312–318.
- Martynov, A., 1927. Jurassic fossil insects from Turkestan. 7. Some Odonata, Neuroptera, Thysanoptera. *Bulletin de l'Académie des Sciences de l'URSS* 21, 757–768.
- Martynova, O.M., 1949. Mesozoic lacewings (Neuroptera) and their bearing on concepts of phylogeny and systematics of the order. *Trudy Paleontologicheskogo Instituta* 20, 150–170 (in Russian).
- Martynova, O.M., 1962. Order Neuroptera. Lacewings, pp. 272–282. In: Rohdendorf, B.B. (Ed.), *Fundamentals of Palaeontology. Arthropoda, Tracheata and Chelicerata*. Akademiya Nauk SSSR, Moscow, 560 pp. (in Russian).
- Navás, L., 1912. Insectos Neuropteros nuevos o poco conocidos. *Memorias de la Real Academia de Ciencias y Artes de Barcelona* 10, 135–202.
- Nel, A., Martínez-Delclòs, X., Hutin, A., 2005. Mesozoic chrysopid-like Planipennia: a phylogenetic approach (Insecta: Neuroptera). *Annales de la Société Entomologique de France* 41, 29–68.
- Ogg, J.G., Ogg, G., Gradstein, F.M., 2008. *The Concise Geologic Time Scale*. Cambridge University Press, Cambridge, 177 pp.
- Oswald, J.D., 1993. Revision and cladistic analysis of the world genera of the family Hemerobiidae (Insecta: Neuroptera). *Journal of the New York Entomological Society* 101, 143–299.
- Panfilov, D.V., 1980. New representatives of lacewings (Neuroptera) from the Jurassic of Karatau, pp. 82–111. In: Dolin, V.G., Panfilov, D.V., Ponomarenko, A.G., Pritykina, L.N. (Eds.), *Fossil Insects of the Mesozoic*. Naukova Dumka, Kiev, 135 pp., 21 pls. (in Russian).
- Peng, Y.Y., Makarkin, V.N., Yang, Q., Ren, D., 2010. A new silky lacewing (Neuroptera: Psychopsidae) from the Middle Jurassic of Inner Mongolia, China. *Zootaxa* 2663, 59–67.
- Plant, C.W., 1997. A key to the adults of British lacewings and their allies (Neuroptera, Megaloptera, Raphidioptera and Mecoptera). *Field Studies* 9, 179–269.
- Ponomarenko, A.G., 1984. Neuroptera from the Jurassic of eastern Asia. *Paleontologicheskii Zhurnal* 1984(3), 64–73 (in Russian). [English translation: *Paleontological Journal*, 1985, 18(3), 59–69].
- Ponomarenko, A.G., 1985. Neuroptera from the Jurassic of Siberia and western Mongolia, pp. 91–95. In: Rasnitsyn, A.P. (Ed.), *The Jurassic Insects of Siberia and Mongolia*. *Trudy Paleontologicheskogo Instituta* 211, 192 pp. (in Russian).
- Ponomarenko, A.G., 1986. Lacewings. Myrmeliontida [sic] (=Neuroptera Planipennia), pp. 108–109. In: Rasnitsyn, A.P. (Ed.), *Insects in the Early Cretaceous Ecosystems of West Mongolia*. *Transactions of the Joint Russian-Mongolian Paleontological Expedition*, vol. 28. Nauka, Moscow, 214 pp. (in Russian).
- Ponomarenko, A.G., 1992a. New lacewings (Insecta, Neuroptera) from the Mesozoic of Mongolia, pp. 101–110. In: Grunt, T.A. (Ed.), *New Taxa of Fossil Invertebrates of Mongolia*. *Transactions of the Joint Soviet-Mongolian Paleontological Expedition*, vol. 41. Nauka, Moscow, 142 pp. (in Russian).
- Ponomarenko, A.G., 1992b. Neuroptera (Insecta) from the Lower Cretaceous of Transbaikalia. *Paleontologicheskii Zhurnal* 1992(3), 43–50. Moscow (in Russian). [English translation, *Paleontological Journal* 26(3), 56–66].
- Ponomarenko, A.G., 1996. Upper Liassic neuropterans (Insecta) from Lower Saxony, Germany. *Russian Entomological Journal* 4 (for 1995), 73–89.
- Rambur, J.P., 1842. *Histoire Naturelle des Insectes, Néuroptères*. Librairie encyclopédique de Roret. Fain et Thunot, Paris, 534 pp.
- Ren, D., 2003. Two new Late Jurassic genera of kalligrammatids from Beipiao, Liaoning (Neuroptera, Kalligrammatidae). *Acta Zootaxonomica Sinica* 28, 105–109.
- Ren, D., Engel, M.S., 2007. A split-foot lacewing and two epiosmylines from the Jurassic of China (Neuroptera). *Annales Zoologici (Warszawa)* 57, 211–219.
- Ren, D., Guo, Z.G., 1996. On the new fossil genera and species of Neuroptera (Insecta) from the late Jurassic of northeast China. *Acta Zootaxonomica Sinica* 21, 461–479.
- Ross, A.J., Jarzembowski, E.A., 1993. *Arthropoda (Hexapoda; Insecta)*, pp. 363–426. In: Benton, M.J. (Ed.), *The Fossil Record 2*, second ed. Chapman and Hall, London, 845 pp.
- Ross, A.J., Jarzembowski, E.A., 1996. A provisional checklist of the fossil insects of the Purbeck Group of Wiltshire. *Wiltshire Archaeological & Natural History Magazine* 89, 106–115.
- Schneider, W.G., 1851. *Symbolae ad monographiam generis Chrysopae*, Leach, Apud Ferdinandum Hirt, Vratislaviae, 178 pp.
- Scudder, S.H., 1885a. *Classe Insecta. Insecten*, pp. 747–831. In: Zittel, K.A. (Ed.), *Handbuch der Palaeontologie*. Bd. 1. Abt. 2. R. Oldenbourg, München und Leipzig, 893 pp.
- Scudder, S.H., 1885b. Notes on mesozoic cockroaches. *Proceedings of the Academy of Natural Sciences of Philadelphia* 37, 105–115.
- Scudder, S.H., 1886. A review of mesozoic cockroaches. *Memoirs of the Boston Society of Natural History* 3 (13), 439–485.
- Scudder, S.H., 1891. Index to the known fossil insects of the world including myriapods and arachnids. *Bulletin of the United States Geological Survey* 71, 1–744.
- Tillyard, R.J., 1933. The panorpoid complex in the British Rhaetic and Lias. *British Museum (Natural History). Fossil Insects* 3, 1–79.
- Wang, Y.J., Liu, Z.Q., Ren, D., Shih, C.K., 2010. A new genus of Protosmylinae from the Middle Jurassic of China (Neuroptera: Osmylidae). *Zootaxa* 2480, 45–53.
- Westwood, J.O., 1854. Contributions to fossil entomology. *Quarterly Journal of the Geological Society of London* 10, 378–396.
- Whalley, P.E.S., 1988. Mesozoic Neuroptera and Raphidioptera (Insecta) in Britain. *Bulletin of the British Museum of Natural History (Geology)* 44, 45–63.
- Wichard, W., Chatterton, C., Ross, A., 2005. Corydasialidae fam. n. (Megaloptera) from Baltic amber. *Insect Systematics and Evolution* 36, 279–283.
- Wootton, R.J., 2003. Wings, pp. 1186–1192. In: Resh, V.H., Cardé, R.T. (Eds.), *Encyclopedia of Insects*. Academic Press, London, 1266 pp.
- Yang, Q., Zhao, Y.Y., Ren, D., 2009. An exceptionally well-preserved fossil Kalligrammatid from the Jehol Biota. *Chinese Science Bulletin* 54, 1732–1737.