**A Remarkable New Family of Jurassic Insects (Neuroptera) with Primitive Wing Venation and its Phylogenetic Position in Neuropterida**

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Table S1. Description of morphological character states.

**LARVA:**

**Character 1:** *mouthparts*

(0) masticatory (as in Corydalidae: Figure 2b in [1]); (1) suctorial (as in Berothidae: Figure 8b in [1]).

Comments. State (1) is an autapomorphy of Neuroptera.

**ADULT:**

**Character 2:** *palpi*

(0) moderately short (as in Parakseneuridae; Fig. 28A); (1) clearly elongate (as in Kalligrammatidae: Figure 249 in [2]).

Comments. State (1) is derived and probably a synapomorphy of Kalligrammatidae and Aetheogrammatidae, although the present analysis did not reveal sister relationships of these families.

**Character 3:** *palpi*

(0) all segments nearly equal in thickness (as in Parakseneuridae; Fig. 28A); (1) terminal segment clearly enlarged (as in Coniopterygidae: Figure 7 in [3]).

Comments. State (1) is derived.

**Character 4:** *coronal suture*

(0) distinct, long (as in Berothidae: Figure 34 in [4]); (1) indistinct, short (as in Sisyridae: Figure 8 A in [5]); (2) absent.

Comments. The coronal suture is the longitudinal median arm of the epicranial suture on posterior part of the head [6]. Coniopterygidae, Hemerobiidae, and probably Mesochorysopidae (maybe other families) are polymorphic for this character. In Coniopterygidae, the coronal suture is distinct from the posterior margin of the head to the labrum in Brucheiserinae (i.e., the coronal suture is continued in the mid-frontal suture), and indistinct or absent in other taxa [3,7]. In Hemerobiidae, the coronal suture is absent in many genera, but vestigial at least in *Micromus* Rambur and *Psectra* Hagen [8]. In Mesochorysopidae, this suture is detected only in one genus, *Longicellochrysa* Ren *et al.* [9].

**Character 5:** *ocelli*

(0) present (as in Corydalidae: Figure 3A in [10]); (1) absent.

Comments. Osmylidae is polymorphic for this character; the ocelli are absent in the extant genus *Gumilla* Navás and present in the others.

**Character 6:** *forelegs*

(0) walking; (1) raptorial (as in Mantispidae).

Comments. Berothidae are polymorphic for this character; the forelegs are raptorial in Rhachiberothinae, Paraberothinae, and probably Mesithoninae, and in the others.

**Character 7:** *articulation of forelegs to prothorax*
(0) posteriorly (as in Berothidae: Figure 33 in [4]); (1) anteriorly (as in Mantispidae: Figures 10, 25 in [11]).

Comments. State (1) is an autapomorphy of Mantispidae.

**Character 8: long ovipositor in female**

(0) absent; (1) present (as in Dilaridae: Figures on reverse of back wrapper in [12]).

Comments. A long hose-like ovipositor is the most spectacular apomorphic transformation of the female gonocoxites in Neuropterida occurring in all Raphidioptera and two families of Neuroptera (Mantispidae and Dilaridae) [13]. Mantispidae is polymorphic for this character: Symphrasinae possess an ovipositor, other subfamilies not. The ovipositor might be evolved independently in all three groups of Neuropterida; this is obvious concerning Raphidioptera and Neuroptera, and most probable concerning Mantispidae and Dilaridae as these families are not closely related as previously supposed.

**Character 9: gonostyli of the 9th gonocoxites in female**

(0) present (as in Hemerobiidae: Figure 26 in [14]); (1) lost (as in Chrysopidae: Figures 127, 128 in [13]).

Comments. The presence of terminal gonostyli on the female ninth gonocoxites is a plesiomorphic condition in Neuropterida. It is believed that the loss of gonostyli have occurred several times independently in Neuroptera [13].

**WINGS**

**Character 10: spinules (‘microtrichia’) on wing membrane**

(0) present (as in Hemerobiidae: Figure 12B in [15]); (1) absent.

Comments. Spinules (known also as ‘microtrichia’) are minute cuticle processes that are non-innervated and non-articulated in sockets [16]. Chrysopidae, Nymphidae and Berothidae are polymorphic for this character. The spinules cover the whole wing membrane in only one species of Chrysopidae (i.e., *Leptochrysa prisca* Adams et Penny [17]), and occur in reduced form only in *Nesydrion* Gerstaecker among Nymphidae [18]. State (1) is used for the analysis for these families. State (0) is used for Berothidae as the spinules are present in some genera [18].

**Character 11: long hairs on wing membrane**

(0) absent; (1) present (as in Parakseneuridae; Fig. 29).

Comments. In Sialidae, both long true sensilla (setae, ‘macrotrichia’) and minute spinules (‘microtrichia’) occur on wing membrane [19], whereas in Ascalaphidae (some Hoplogleniinae) only scarce sensilla are present [20]. In fossils, long hairs (where present) are impossible to study in detail, and it is unknown yet if these are long spinules or true sensilla. The presence of long hairs on a restricted area of the hind wing of one species of the Eocene genus *Palaeopsychops* Andersen (Ithonidae s.l.) is here considered as species autapomorphy.

**Character 12: trichosors**

(0) present (as in Parakseneuridae); (1) absent (as in Chrysopidae).

Comments. The trichosors are small setigerous swellings along the wing margin between the tips of veins and veinlets [15]. These structures are characteristic of only Neuroptera. Mantispidae is polymorphic for this character; the trichosors are present in Mesomantispinae, Symphrasinae and some Drepanicinae, and absent in Calomantispinae and Mantispinae. It is believed that their presence is a plesiomorphic condition in the order.

**Character 13: nygmata**
Comments. The nygmata (‘facetic organs’ [22], ‘corneous spots’ [23]) are small, thickened sensory spots on the wings. Their presence is a plesiomorphic condition as they occur in several orders of Holometabola (at least). Prohemerobiidae is possibly polymorphic for this character. The nygmata are not detected in Prohemerobius dilaroides Handlirsch, the type species of the genus and family, but present in some other species of this genus (e.g., Figure 2 in [24]).

Character 14: distal ScP and RA
(0) separated (as in Parakseneuridae; Fig. 24C); (1) fused (as in Parakseneuridae; Fig. 1).

Comments. Many families of Neuroptera are polymorphic for this character (i.e., Berothidae, Chrysopidae, Hemerobiidae, Ithonidae, Kalligrammatidae, Panfiloviidae, Parakseneuridae, Permithonidae and Psychopsidae). ScP and RA are distally fused in some Mesozoic representatives of Limaiae (Chrysopidae) [25; VM, QY, pers. obs.], and a few genera of Hemerobiidae [26,27]. The vast majority of genera of these families have these veins to be separate distally. ScP and RA are distally widely separated in only one genus of Kalligrammatidae (i.e., Kalligrammina Panfilov); this genus is thought to be “incertae sedis in regard to family assignment” [28, p. 318]. In many extant Psychopsidae, the distal ScP abruptly terminates at RA or these veins are connected by a strong crossvein that closes distally so-called vena triplica. The majority fossil psychopsids have no vena triplica, and ScP and RA are distally clearly separated. In Osmopsychoptera, ScP and RA approach each other distally, but their fusion is not clearly visible because of poor preservation.

In Coniopterygidae, ScP and RA appear widely separated distally. However, based on a study of the pupal tracheation, Withycombe [29] considered ScP deeply forked distally, whose anterior branch continues stem of ScP, and the posterior branch is basally crossvein-like and distally continues RA. Therefore, in fact both conditions occur on the same wing, ScP and RA are fused and separate. This unusual relationship of these veins needs more detailed examination. State (0) is used for this analysis.

FOREWING
Character 15: length
(0) 0-5 mm; (1) 5-15 mm; (2) 15-35 mm; (3) >35 mm.

Comments. Mean forewing length in Mantispidae is approximately 15 mm; State (2) is used for this analysis.

Character 16: length/width ratio
(0) <3.5; (1) >3.5.

Character 17: humeral veinlet
(0) crossovein-like, simple (as in Chrysopidae; Figure 1 in [30]); (1) recurrent, branched (as in Parakseneuridae; Fig. 1).

Comments. The recurrent and branched humeral veinlet is characteristic of several families of Neuroptera. It has occurred (probably independently) in the hemerobiid, berothid, psychopsid and ithonid clades. Berothidae, Mantispidae, Prohemerobiidae and Hemerobiidae are polymorphic for this character. The berothid subfamily Mesithoninae possesses the strongly recurrent and branched humeral veinlet, whereas numerous other Mesozoic taxa have state (0) which is used here for the analysis. Some species of Prohemerobiidae have only a slightly recurrent and single forked humeral veinlet. In a few genera and species of Hemerobiidae (e.g., Micromus Rambur, Zachobiella Banks) the humeral veinlet is also only slightly recurrent and simple, or single forked. A few taxa of Mantispidae (e.g., Plega Navás
among Symphrasinae, Mesomantispinae) have state (1), but the majority of other genera (including the Early Jurassic *Liassochrysa* Ansorge et Schlüter) have state (0) which is used for the analysis.

**Character 18: costal space**

(0) narrowed basally, moderately dilated some distance from base (as in Osmylidae: Figure 2A in [21]); (1) dilated in proximal part (as in Hemerobiidae: Figure 17 in [14]); (2) strongly dilated for entire length (as in Psychopsidae: Figure 32 in [31]); (3) equally slightly dilated for entire length (as in Palaeoleontidae: Figure 4B in [32]); (4) narrow for entire length (as in Coniopterygidae: Figure 8 in [3]).

Comments. Nymphidae, Prohemerobiidae, Ithonidae and Psychopsidae are polymorphic for this character. In Nymphidae, state (2) occurs in the most species of Myiodactylinae, and state (3) in the most species of Nymphinae and the vast majority of fossil taxa. In Prohemerobiidae, state (1) occurs in a few species that possess the strongly recurrent and branched humeral veinlet; state (0) in other species. The same situation is in Ithonidae. State (0) is used for the analysis in these families. In Psychopsidae, some fossil genera (e.g., *Undulopsychopsis* Peng et al.: Figure 2 in [33]) have state (1), whereas all extant and some fossil genera (e.g., *Baisopsychops* Makarkin: Figure 1 in [34]) possess state (2), which is used for the analysis.

**Character 19: width of subcostal space in its middle part**

(0) narrow (as in Hemerobiidae: Figures 24, 66, 90 in [14]); (1) moderately broad (as in Parakseneuridae: Fig. 1); (2) broad (as in Grammolingiidae: Figure 3 in [35]).

Comments. Osmylidae is polymorphic for this character. The subcostal space is narrow in most extant genera (state 0), and very broad in an undescribed Jurassic subfamily (state 2). However, the most primitive fossil taxa (including Protosmylinaea, *Archaeosmylidia* Makarkin *et al.*: [36]) possess state (1) which is used here for the analysis.

**Character 20: ScP**

(0) long, reaching pterostigmal region (as in Parakseneuridae; Fig. 1); (1) short, enters costal margin not reaching pterostigmal region (as in Raphidiidae).

Comments. Some Mesozoic taxa of Chrysopidae appear to possess state (1) (see e.g. Figure 2G in [37]). However, this is likely a derived condition within the family as ScP reaches the pterostigmal region in the vast majority of the other taxa (including Mesozoic forms).

**Character 21: subcostal veinlets**

(0) all (or mostly) forked (as in Parakseneuridae: Fig. 1); (1) all (or mostly) simple (as in Ascalaphidae: Figures 36, 38 in [20]).

Comments. Nevorthidae, Osmylidae, Nymphidae and Berothidae are polymorphic for this character. The subcostal veinlets in some species of Nevorthidae are mostly forked (e.g., some *Nipponeuworthus* Nakahara; one undescribed species from Baltic amber), whereas in others they are mostly simple; state (0) is used for the analysis. State (1) is used for the analysis in Osmylidae, although some subcostal veinlets in many genera are forked. In some Nymphidae (e.g. *Myiodactylus* Brauer: [38]) the majority of subcostal veinlets are forked. In some Berothidae (e.g., the Burmese amber genera: Figures 19, 24, 25 in [39]) all subcostal veinlets are simple.

**Character 22: subcostal crossveins (sc-r)**
few (1-4, as in Hemerobiidae: Figures 33, 90, 166 in [14]); (1) many (>4, as in Parakseneuridae: Fig. 1); (2) very numerous (as in Kalligrammatidae: Figure 5 in [40]).

Comments. Dilaridae, Osmylidae and Nymphidae are polymorphic for this character. In Dilaridae, the genus Dilar Rambur possesses many subcostal crossveins (state 0), whereas Nallachius Navás and Neonallachius Nakahara have few crossveins; the latter are considered here as having secondarily simplified venation, and state (0) is used for the analysis. The vast majority of the Osmylidae genera have state (0), a few others have the states (1) (i.e., Archaeosmylidia Makarkin et al. [36], Osmylochrysa Jepson et al. (Figure 11 in [42]), and Porismus McLachlan (Figure 1 in [41]) and (2) (i.e., an undescribed genus of the Jurassic Daohugou; VM, QY, pers. obs.). This character varies in the extant Nymphidae, e.g., state (0) in Nolfolius Navás and some Nymphes Leach, and state (1) in other species of Nymphes and Myiodactylus [38]. However, there are few subcostal crossveins in almost all fossil Nymphidae.

Character 23: RA (or ScP+RA) termination
(0) well before wing apex (as in Parakseneuridae); (1) at or near wing apex (as in Mesochrysopidae; [43] Makarkin & Menon 2005, fig. 3) (2) well after wing apex (as in Ascalaphidae; [20] Tjeder 1992, figs. 36, 38).

Comments. State (2) is a synapomorphy of Myrmeleontoidea.

Character 24: RP origin
(0) near wing base (as in Palaeoleontidae: Figure 4B in [32]); (1) distant from wing base (as in Mesochrysopidae: Figure 3 in [43]); (2) far from wing base (as in Ascalaphidae: Figures 36, 38 in [20]); (3) very far from wing base (as in Babinskaiidae: Figure 8A in [44]).

Character 25: RP1 branching
(0) shallow (as in Parakseneuridae; Fig. 1); (1) deep (as in Hemerobiidae: Figures 74, 140 in [14]).

Comments. Prohemerobiidae, Psychopsidae and Hemerobiidae are polymorphic for this character. RP1 varies in the extant genera of Hemerobiidae from simple for the most length (e.g., Hemerobius Linnaeus) to deeply pectinate branched (e.g., Conchopterella Handschin) [14]. The most Mesozoic and Palaeogene taxa, however, possess state (1) (see Figure 4 in [45]; Figure 31 in [46]; Figures 4, 5 in [27]). In a few species of Prohemerobiidae and Psychopsidae, RP1 is deeply forked (see e.g. Figure 3 in [33]), but the majority of taxa have state (0).

Character 26: crossoveins in radial space
(0) very rare (as in Sisyridae: Figures 10A, 11A in [5]); (1) rare (as in Nevrothidae: Plate 7, Figures 1, 2 in [47]); (2) dense (as in Parakseneuridae: Fig. 1); (3) very dense (as in Kalligrammatidae: Figure 5 in [40]).

Comments. Berothidae, Dilaridae, Osmylidae and Mesochrysopidae are polymorphic for this character. The crossveins in most genera of Berothidae (including most ancient ones) are rare, but dense in the subfamilies Nyrminae and Berothimerobiinae. The crossveins in small-sized Dilaridae (Nallachius, Neonallachius) are very rare, but this is a derived condition within the family. The crossveins in most genera of Osmylidae are quite dense to very dense (e.g., an undescribed genus of the Jurassic Daohugou; VM, QY, pers. obs.); but state (1) is characteristic of most putative primitive taxa (i.e., Archaeosmylidia Makarkin et al., Mesosmylininae, Protosmylinae) and is used for the analysis. The crossvein number in Mesochrysopidae is quite variable between taxa (see Figures 198, 110 in [48]; Figures 6, 7, 9
Character 27: arrangement of crossveins in radial space
(0) all crossveins sporadically distributed, not arranged in series (as in Ascalaphidae: Figures 36, 38 in [20]); (1) most crossveins sporadically distributed but some form gradate series (as in Brongniartiellidae: Figure 3B in [49]); (2) most crossveins arranged in gradate series, but there are some sporadically distributed crossveins (as in Osmylidae: Figure 2 in [50]); (3) all crossveins arranged in one or more gradate series (as in Hemerobiidae: Figures 33, 41, 50 in [14]).

Comments. Berothidae, Osmylidae, Mesochrysopidae are polymorphic for this character. In Berothidae, all four conditions are found but the majority of genera possess state (3) which is used in the analysis. In Osmylidae, states (0) to (2) occur; state (2) characteristic of most primitive taxa (Archaeosmylidia Makarkin et al., Mesosmylininae, Protosmylininae) is used for analysis. The crossvein arrangement in Mesochrysopidae is highly variable between taxa (see Figures 108, 110 in [48]; Figures 6, 7, 9 in [30]). State (2) characteristic of Mesochrysopa is used for the analysis.

Character 28: aligned basal oblique crossveins r-m and m-cu
(0) absent; (1) present (as in Ascalaphidae: Figures 36, 38 in [20]).

Comments. The presence of aligned basal oblique crossveins r-m and m-cu is probably synapomorphy of the advanced Myrmeleontoidea (Myrmeleontidae, Ascalaphidae). Nymphidae is polymorphic for this character; in the Mesozoic taxa, these crossveins are not aligned.

Character 29: M and R
(0) separate for entire length; (1) fused basally for considerably distance (as in Mantispidae: Figure 5A in [51]).

Character 30: MP termination
(0) after wing mid-point; (1) before or at wing mid-point.

Character 31: MP branching
(0) dichotomous, or deeply forked (as in Parakseneuridae: Fig. 1; Permithonidae: Figure 3b in [52]); (1) pectinate (as in Ithonidae: Figures 2B-D in [54]); (2) strongly pectinate (as in Saucrosmylididae: Figure 3A in [55]).

Comments. Coniopterygidae and Kalligrammatidae are polymorphic for this character. In Coniopterygidae, all three states appear occur if assumed that MA is reduced. State (1) is used for the analysis as it is characteristic of the most genera of Aleuropteryginae, a more ancient subfamily and more diverse in the fossil record than Coniopteryginae (see Table 1 in [56]). Most genera of Kalligrammatidae have a pectinate branched MP with branches anteriorly directed, clearly a derived condition within the family; state (0) is characteristic of Protokalligramma Yang et al. and an undescribed genus from Karatau [40] and is used for the analysis. In Sialidae, state (0) is used for the analysis, but some species have the simple MP.

Character 32: m-cu arculus (‘M5’)
(0) distinct (as in Nevrotidae: Plate 7, Figure 1 in [47]); (1) lost or not discernible from crossveins (as in Ascalaphidae: Figures 36, 38 in [20]).

Comments. A convex oblique vein connecting the stem of M and CuA is plesiomorphically present in almost all Neoptera (see for example Figures 1A, B in [57] for
this vein in the forewing of a basal blattinopsidaean from Carboniferous). In Neuroptera, this
vein is well developed in the Permian Permithonidae (see Figures 2, 3, 6 in [58]) and
Mesozoic Mesithoninae (Berothidae) (see Figures 1, 2 in [59]). The families Ithonidae and
Osmylidae are polymorphic for this character. The m-cu arculus is not discernible from
crossveins in most Osmylidae, but distinct in some Jurasssic taxa (e.g. Archaeosmylidia
Makarkin et al., and an undescribed genus from Daohugou [36], VM, QY, pers. obs.),
especially in the latter taxon. The same situation is in Ithonidae where the m-cu arculus is
distinct in some genera (e.g., Platystoechotes Carpenter), and not discernible from crossveins
in the others (e.g., Rapisma Walker), see Figure 2 in [54].

Character 33: M and CuA
(0) separate for entire length; (1) fused for some distance (as in Sialidae: Figure 1 in [19]).
Comments. The partial fusion of M and CuA occurring in all Raphidioptera (including
Priscaenigmatidae) and Sialidae probably evolved independently.

Character 34: MP and CuA
(0) separate; (1) fused (as in Ascalaphidae: Figures 36, 38 in [20]).
Comments. The fusion of MP and CuA in the forewing is a synapomorphy of
Myrmelontooidea (but it is unclear concerning Babinskaiidae due to small examined
specimens). The similar character state found in some genera of other families (e.g., some
Nallachius among Dilaridae: Figure 1 in [60]) undoubtedly evolved independently.

Character 35: CuA branching
(0) dichotomous, or deeply forked (as in Parakseneuridae; Fig. 1); (1) pectinate (as in
Hemerobiidae: Figure 33 in [14]); (2) strongly pectinate (as in Nymphidae: Figures 1, 24 in
[38]); (3) simple (as in Coniopterygidae: Figure 8 in [3]).
Comments. Berothidae, Dilaridae, Grammolingiidae, Kalligrammatidae and Mantispidae
are polymorphic for this character. Some genera or species of Berothidae, Mantispidae
Mantispidae and Dilaridae have CuA not pectinate (dichotomous or so). In the most genera of
Kalligrammatidae, CuA is usually weakly pectinate; state (0) characteristic of
Protokalligramma and an undescribed genus from Karatau [40] is used for the analysis.
The pectinate branches of the Grammolingiidae species are long and dichotomously branched.

Character 36: CuP branching
(0) simple or with terminal fork (as in Permithonidae: Figures 1b, 2 in [52]); (1) dichotomous
or deeply forked (as in Parakseneuridae; Fig. 1); (2) few pectinate (as in Mesochrysopidae:
Figure 9.3 in [30]); (3) strongly pectinate (as in Nymphidae: Figures 1, 24 in [38]).
Comments. Kalligrammatidae, Mantispidae, Nymphidae and Psychopsidae are
polymorphic for this character. In the most genera of Kalligrammatidae, CuA is usually
weakly or strongly pectinate; state (1) is characteristic of Protokalligramma and an
undescribed genus from Karatau [40] is used for the analysis. Some taxa of Mantispidae have
CuP dichotomously branched (e.g., Mesomantispa Makarkin) or with terminal fork (e.g.,
some Symphrasinae). In some species of Nymphidae, CuP is only weakly pectinate. Some
genera of Psychopsidae have CuP to be strongly dichotomously branched (e.g.,
Undulopsychopsis: Figures 2 in [33]; Baisopsychops: Figure 1 in [34]).

Character 37: AA3+4 branching
(0) simple or with terminal fork (as in Chrysopidae: Nothochrysinae: Figures 1-5 in [61]); (1)
dichotomous or deeply forked (as in Parakseneuridae: Fig. 1); (2) pectinate (as in Osmylidae:
Figures 1-3 in [50]).
Comments. Berothidae, Ithonidae, Kalligrammatidae and Nymphidae are polymorphic for this character. In some genera or species of Berothidae and Ithonidae, AP1+2 is pectinate. Most species of Kalligrammatidae have AA3+4 more or less pectinate; state (1) characteristic of Protokalligramma and an undescribed genus from Karatau [40] is used for the analysis. In the genera of Myiodactylinae, AA3+4 is pectinate, in the other genera of Nymphidae it is deeply or shallowly forked; state (1) is used for the analysis.

**Character 38: AP1+2 branching**
(0) simple or with terminal fork (as in Chrysopidae: Nothochrysinae: Figures 1-5 in [61]); (1) dichotomous or deeply forked (as in Parakseneuridae: Fig. 1); (2) pectinate (as in Osmylidae: Figures 1-3 in [50]).

Comments. Kalligrammatidae and Sisyridae are polymorphic for this character. In some genera of Kalligrammatidae (e.g., Sophogramma Ren et Guo), the AP1+2 is deeply forked, not pectinate. In Sisyridae, this vein is few-pectinate or has terminal fork; state (2) is used in the analysis.

**Character 39: jugal lobe**
(0) distinct (as in Chrysopidae: Nothochrysinae: Figures 1-5 in [61]); (1) absent or reduced (as in Ascalaphidae: Figure 38 in [20]).

Comments. The full reduction of the anal lobe occurs probably only in families of the myrmeleontoid clade (except Chrysopidae). However, it evolved also independently within some other families in advanced genera (e.g., in Coniopterygidae, Berothidae).

**HIND WING**
**Character 40: hind wings**
(0) normally developed; (1) very narrow and long (as in Nemopteridae: Figures 1987, 2023 in [62]).

Comments. Neuroptera normally bear well-developed hind wings more or less similar in size to forewing, but there are a few brachypterous, micropterous or apterous species, found in the following extant families: Hemerobiidae, Coniopterygidae, Ithonidae, Dilaridae, Berothidae, and Nemopteridae [63,64]. Such reduction is usually associated with flightlessness, and obviously derived within genera or generic groups. The highly modified hind wings of Nemopteridae are an autapomorphy of this family.

**Character 41: humeral veinlet**
(0) crossvein-like, simple; (1) recurrent, branched (as in Parakseneuridae: Fig. 31).

Comments. The humeral veinlet of Psychopsidae is recurrent but not branched; state (1) is used for the analysis.

**Character 42: basal r-m brace**
(0) long, sinuate (as in Hemerobiidae: Figures 42, 51, 61 in [14]); (1) short straight or absent (as in Ascalaphidae: Figures 36, 38 in [20]).

Comments. Berothidae and Mantispidae are polymorphic for this character. The basal r-m brace is long and sinuate in Mesithoninae and Rhachiberothinae among Berothidae, and Symphrasinae among Mantispidae, whereas in other taxa of these families it is straight, crossvein-like. State (0) is used for analysis.

**Character 43: ‘M5’**
(0) long (as in Ascalochrysidae: Figure 3 in [65]); (1) short, crossvein-like (as in Hemerobiidae: Figure 150 in [14]); (2) lost or not discernible from crossveins (as in Parakenseneuridae: Fig. 2C).

Comments. The long ‘M5’ occurring in the families Permithonidae (see Plate 1, Figure 1 in [66]), Nevorthidae (see Plate 8, Figures 1, 2 in [47]) and Ascalaphidae is considered plesiomorphic [65].

**Character 44: CuP**

(0) well developed, complete; (1) strongly reduced (as in Ascalochrysidae; Figure 3 in [65]).

Comments. Mantispidae is polymorphic for this character; the complete CuP is present only in Symphrasinae, and strongly reduced in others. CuP of Berothidae varies in its appearance in different genera from the reduction of its middle part (basal and distal parts are present) to entire loss.

**References to Table S1**

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