The classification and diversity of dragonflies and damselflies (Odonata)*

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Abstract

An updated classification and numbers of described genera and species (until 2010) are provided up to family level. We argue for conserving the family-group names Chlorocyphidae, Euphaeidae and Dicteriadidae, as well as retaining Epiophlebiidae in the suborder Anisozygoptera. Pseudostigmatidae and New World Protoneuridae are sunk in Coenagrionidae and Old World Protoneuridae in Platycnemididae. The families Amphipterygidae and Megapodagrionidae as traditionally recognized are not monophyletic, as may be the superfamily Calopterygoidea. The proposal to separate Chlorogomphidae, Cordulegastridae and Neopetaliidae from Libelluloidea in their own superfamily Cordulegastridea is adopted. Macromiidae, Libellulidae and Synthemistidae and a restricted Corduliidae are accepted as families, but many genera of Libelluloidea are retained as incertae sedis at present. 5952 extant species in 652 genera have been described up to 2010. These are placed here in 30 families; recent proposals to separate additional families from Amphipterygidae and Megapodagrionidae have not yet been incorporated.
Introduction

This publication presents a classification of extant suborders, superfamilies and families of Odonata, based on the principles of taxonomic stability (usage should change as little as possible) and monophyly of extant groups, ordered preferably by placing smaller sister-groups first (see Dijkstra & Kalkman 2012). Family-group names and authorities follow Bechly (1996; 2003), i.e. assuming that Selys’s legions are not available (see Bechly 1999; Trueman 1999). Exceptions are three names that should be assigned to Kennedy (1920), three that are conserved because of prevailing usage, and the preferred spelling Yakobson over Jacobsen. Subfamilies are omitted as these generally are still unresolved. Novel (often rankless) terms like Lestomorpha, Caloptera, Epiprocta, Aeshnomorpha and Cavilabiata are avoided as these, in our opinion, have only a vernacular application.

In the past, wing venation was used as the main guide for classifying Odonata, but as similar characters evolved multiple times, this often does not reliably indicate close relationships (e.g. Carle et al. 2008; Dijkstra & Vick 2006; Fleck et al. 2008a; Pilgrim & von Dohlen 2008; Ware et al. 2007). Moreover, as any potential outgroup of winged insects lacks wings, wing-based phylogenies and classifications (e.g. Bechly 1996; 2003; Trueman 1996) rely on prior assumptions about wing evolution, and must thus be treated with caution (Trueman 2007). Studies incorporating other morphological features, such as those of genitalia and larvae, may help overcome this (e.g. Fleck et al. 2008a; Pessaq 2008; Rehn 2003; von Ellenrieder 2002), as increasingly are genetic studies (e.g. Bybee et al. 2008; Dumont et al. 2010). Recent phylogenetic progress in Anisoptera (Blanke et al. 2013) and Zygoptera (Dijkstra et al. 2013) could not be fully integrated in the present paper. We exclude fossil taxa, since they lack most morphological and all genetic information, and can therefore not be classified with the same criteria as extant taxa. Once the phylogeny of extant Odonata is settled this may provide a framework to classify fossils (Trueman 2007).

Information on the number of genera and species per family is derived from the Global Species Database Odonata prepared for the Catalogue of Life (van Tol 2005), updated by the compiler to 2010. 5952 extant species of Odonata have been described (30 families, 652 genera), of which 2941 belong to the suborder Zygoptera (18 families, 308 genera; but see notes 11 and 20), 3011 to the Anisoptera (11 families, 344 genera), and two in one genus to the Anisozygoptera (but see note 29). It is estimated that between 1000 and 1500 species still await description (Kalkman et al. 2008). If true, the actual number of extant species will lie between 7000 and 7500. Since 1970 nearly 40 species have been described annually and with an undiminished rate of description an estimated 95% of all species will be described by 2030. About 250 species were described between 2006 to 2010, nearly all from tropical regions, with the highest contributions from the Neotropical (43%), Oriental (28%) and Australasian regions (19%, nearly all from New Guinea and Wallacea). Three-fifths belonged to just three families, Coenagrionidae (85 species), Libellulidae (37), and Platystictidae (27). In 2011 and 2012 approximately 90 new species and 10 genera were described and, as a number of species were also synonymized, the total is estimated to be close to 6000 species.

Classification

Order Odonata Fabricius, 1793 (3 suborders, 10 superfamilies, 30 families)¹

Suborder Zygoptera Selys, 1854 (4 superfamilies, 18 families)²

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¹ Modern odonates are considered monophyletic, consisting of three suborders. Zygoptera is placed first because it has about 70 fewer species than its sister-group. Anisoptera plus Anisozygoptera is now larger by a factor of only 1.02 and as the number of undiscovered species may be higher in Zygoptera, the total number may as well. Even if that is the case, we would favour retaining the traditional sequence of the suborders.

² It is generally agreed that Zygoptera is monophyletic (Bechly 1996; 2003; Bybee et al. 2008; Carle et al. 2008; Dumont et al. 2010; Rehn 2003). See superfamilies for the phylogenetic reasoning for their order.
Superfamily **Lestoidea** Calvert, 1901 (4 families)  
Family **Hemiphractidae** Kennedy, 1920 (1 genus, 1 species)  
Family **Perilestidae** Kennedy, 1920 (2 genera, 19 species)  
Family **Systelidae** Tillyard, 1917 (9 genera, 39 species)  
Family **Lestidae** Calvert, 1901 (9 genera, 151 species)  
Superfamily **Platystictoidea** Kennedy, 1920 (1 family)  
Family **Platystictidae** Kennedy, 1920 (6 genera, 224 species)  
Superfamily **Calopterygoidea** Selys, 1850 (10 families)  
Family **Amphipterygidae** Tillyard, 1917 (4 genera, 14 species)  
Family **Calopterygidae** Selys, 1850 (21 genera, 185 species)

3. A monophyletic group that includes Lestidae and three smaller families is the sister-group of all other Zygoptera (Bybee et al. 2008; Carle et al. 2008; Davis et al. 2011; Dumont et al. 2010). This is treated as a superfamily, called either Lestoidea (e.g. Carle et al. 2008) or Lestinoidea (e.g. Bybee et al. 2008; Rehn 2003) to avoid confusion with the unrelated genus Lestoidea Tillyard, 1913. Grammatically the former is correct, while the latter implies there is also a family Lestinidae (etc.); the principle of homonymy does not apply where names belong to different groups (family- and genus- respectively). Moreover, if the principle would be applied, the genus name would be the junior homonym. Thus Lestoidea is used and, while inconvenient, its meaning should be obvious from context. Family order is phylogenetic (Bybee et al. 2008; Dumont et al. 2010).

4. The monotypic Hemiphractidae is the sister-group of all remaining Lestoidea (Davis et al. 2011; Dumont et al. 2010; Rehn 2003).

5. The monophyly of this small and fairly homogeneous family was supported by morphological analyses (Bechly 1996; 2003; Dumont et al. 2010; Rehn 2003), but not by some permutations of molecular analyses (Bybee et al. 2008). The latter excluded the geographically disparate Nubiolestes, for which Bechly (1996) established the subfamily Nubiolestinae. Genetic data and morphology indicate it belongs to Systelidae (Dijkstra et al. 2013; May et al. unpubl.). Bybee et al. (2008) doubted their own recovery of this family as paraphyletic, suggesting data limitations of sequenced genes as one possible explanation.

6. Systelidae may not be monophyletic: the monotypic Chorismagrionidae Tillyard & Fraser, 1938 is probably included (Bybee et al. 2008; Dumont et al. 2010), but the placement of Megalestes (= Megalestidae Tillyard & Fraser, 1938) and other similar genera vary among analyses (Bechly 1996; 2003; Dumont et al. 2010; Rehn 2003). New molecular evidence suggests the family includes Nubiolestes (note 5) and the geographically disparate genus Phylolastes (May et al. unpubl.).

7. The name Chlorolestidae Fraser, 1951 is frequently used (23% preference in Google search), but predated by Systelidae.

8. Lestidae appears to be monophyletic (Bybee et al. 2008; Dumont et al. 2010; Rehn 2003).

9. The family Platystictidae is monophyletic and the sister-group of all Zygoptera excluding Lestoidea (Bybee et al. 2008; Davis et al. 2011; Dumont et al. 2010; van Tol et al. 2009). Thus it falls well outside Coenagrionioidea and requires a superfamly Platystictoidea of its own.

10. The superfamly name Calopterygoidea has been used for a very diverse assemblage of mostly densely-veined damselflies. With the superfamilies Lestoidea, Platystictoidea and Coenagrionioidea reasonably well defined (notes 3, 9, 24), the remaining families are left together without much support for their monophyly, although Bybee et al. (2008) found support for it in some analyses, as did Carle et al. (2008) if Isostictidae is included. Because of the ‘amphipterygid’ and ‘megapodagrionid’ problems (notes 11, 20), relationships between the families are unresolved, and therefore it is most convenient to group all these families together for the time being. Calopterygoidea may prove paraphyletic, requiring the creation of further superfamilies. Families are listed alphabetically.

11. Based on larvae, Novelo-Gutiérrez (1995) restricted Amphipterygidae to the small and geographically disjunct genera *Amphipteryx* and *Devadatta* (together forming subfamily Amphipteryginae), and *Pentaphlebia* and *Rimanella* (forming Rimanellinae Davies & Tobin, 1984 = Pentaphlebiinae Novelo-Gutiérrez, 1995). Rehn’s (2003) morphological phylogenetic reconstruction confirmed this classification, but molecular analysis shows the group is probably polyphyletic (Bybee et al. 2008; Dumont et al. 2010), although the important position of *Amphipteryx* was untested. Recent molecular analysis indicates that each genus is probably best regarded a family of its own (Dijkstra et al. 2013).

12. Calopterygidae appears monophyletic (Bybee et al. 2008; Dumont et al. 2010; Rehn 2003), although Caliphaeidae Fraser, 1929 and especially Hetaerinae Tillyard & Fraser, 1939 are sometimes considered as separate families. The former falls within Calopterygidae, while the latter is the sister-group of all remaining Calopterygidae (Dijkstra et al. 2013; Dumont et al. 2005; 2010). However, with Calopterygidae *sensu lato* monophyletic as a whole, taxonomic stability is served by treating *Hetaerina* and its close relatives as a subfamily.
Family Chlorocyphidae Cowley, 1937 (19 genera, 144 species) 

Family Dicteriadidae Montgomery, 1959 (2 genera, 2 species) 

Family Euphaeidae Yakobson & Bianchi, 1905 (12 genera, 68 species) 

Family Lestoideidae Munz, 1919 (2 genera, 9 species) 

Family Megapodagrionidae Calvert, 1913 (42 genera, 296 species) 

Family Philogangidae Kennedy, 1920 (1 genus, 4 species) 

Family Polythoridae Munz, 1919 (7 genera, 59 species) 

Family Pseudolestidae Fraser, 1957 (1 genus, 1 species) 

Superfamily Coenagrionoidea Kirby, 1890 (3 families) 

Family Isostictidae Fraser, 1955 (12 genera, 46 species) 

13. The distinctive family Chlorocyphidae is clearly monophyletic (Bybee et al. 2008; Dumont et al. 2010; Rehn 2003).

14. Widely known as Chlorocyphidae (almost 99% preference in Google search), although that name is predated by Libellaginidae Yakobson & Bianchi, 1905. An application to the ICZN for the suppression of this name will be prepared by some of the present authors.

15. A tiny but distinctive family, molecular data and larvae indicate Dicteriadidae fall within the calopterygoid complex (Dumont et al. 2010; Fleck et al. 2008b: 2012).

16. Three family-group names are in use and while Heliocharitidae Tillyard & Fraser, 1939 is the oldest (5% preference in Google search), Dicteriadidae (85%) and Dicteriastidae (10%) are preferred. An application to the ICZN for the preservation of Dicteriadae will be prepared by some of the present authors.

17. The distinctive family Euphaeidae appears to be monophyletic (Bybee et al. 2008; Dumont et al. 2010; Rehn 2003).

18. Bechly (1999) argues that the older name Epallagidae Needham, 1903 should be applied, although Euphaeidae dominates in usage by almost 85% (Google search). An application to the ICZN for the suppression of the older name will be prepared by some of the present authors.

19. Novelo-Gutiérrez (1995) recognized the shared characters of the superficially dissimilar genera Diphlebia and Lestoidea, placing them in Diphlebiidae Heymer, 1975, which is predated by Lestoideidae Munz (van Tol 1995). Molecular evidence confirms this placement (Bybee et al. 2008; Carle et al. 2008; Dijkstra et al. 2013). As family-group names are available, each of these rather distinct genera could also be treated as a family. However, genus- and family-group names that refer to the same group of species are redundant, while distinctness is subjective: classifying these lineages under a single name communicates their common ancestry.

20. The heterogeneity of Megapodagrionidae has long been recognized, as is apparent from the many family-group names available (e.g. Philosinidae Kennedy, 1925; Hypolestidae Tillyard & Fraser, 1938; Thaumatoneuridae Tillyard & Fraser, 1938; Argiolestidae Fraser, 1957; Heteragrionidae Rácinis, 1959; Philogeniidae Rácinis, 1959). Molecular and morphological data indicate the group is not monophyletic and contains at least six independent lineages (Bybee et al. 2008; Dumont et al. 2010; Kalkman et al. 2010; Rehn 2003; van Tol et al. 2009). Recent molecular analyses suggest that all aforementioned families should be reinstated and up to eight additional families may require description (Dijkstra et al. 2013; Kalkman & Theischinger 2013).

21. Novelo-Gutiérrez (1995) removed Philoganga from Amphipterygidae, assuming it was close to Diphlebia. That, however, is not supported by the phylogenetic evidence published (Bybee et al. 2008; Dijkstra et al. 2013; Rehn 2003). It is best to place this distinctive genus in its own family Philogangidae.

22. The distinctive family Polythoridae appears to be monophyletic (Bybee et al. 2008; Rehn 2003).

23. The distinct morphology of Pseudolestes mirabilis warrants considering it a monotypic family and not part of the polyphyletic Megapodagrionidae, where it has often been placed, or Amphipterygidae, with which it shares larval features (Yu & Bu 2011). This is confirmed by molecular analysis (Dijkstra et al. 2013).

24. A monophyletic group including Coenagrionidae, Protonuridae, Platycnemididae and Pseudostigmatidae as traditionally known, is well supported (Bybee et al. 2008; Carle et al. 2008; Dijkstra et al. 2013). Isostictidae is either the sister-group of this assemblage (Bybee et al. 2008) or part of the calopterygoid complex (Carle et al. 2008). We believe that until further evidence is available, the best solution is to retain them in Coenagrionoidea, placing them before the remaining families. The family classification and order of those families, however, have been unsettled by the discovery of the polyphyly of Protonuridae Yakobson & Bianchi, 1905 sensu lato, and paraphyly of Platycnemididae and Coenagrionidae sensu stricto (notes 26–27).

25. Molecular evidence suggests Isostictidae is monophyletic (Bybee et al. 2008; Carle et al. 2008; Dijkstra et al. 2013).
Family Platycnemididae Yakobson & Bianchi, 1905 (40 genera, 404 species) 26
Family Coenagrionidae Kirby, 1890 (114 genera, 1267 species) 27
Suborder Anisozygoptera Handlirsch, 1906 (1 superfamily, 1 family) 28
Superfamily Epiophlebioidea Muttkowski, 1910 (1 family)
Family Epiophlebiidae Muttkowski, 1910 (1 genus, 2 species) 29
Suborder Anisoptera Selys, 1854 (5 superfamilies, 11 families) 30
Superfamily Aeshnoidea Leach, 1815 (2 families) 31
Family Austropetalidae Carle & Louton, 1994 (4 genera, 11 species) 32

26. Old World ‘protoneurids’ are not closely related to the true New World Protonuridae (Pessacq 2008), possibly being the sister-group of Platycnemididae (Bybee et al. 2008; Dumont et al. 2010; van Tol et al. 2009), but falling within that family in more extensive analyses (Carle et al. 2008; Dijkstra et al. 2013; Rehn 2003). We prefer to merge these morphologically similar groups, as combined they are monophyletic and separating them establishes a family name that would probably soon disappear again. Molecular evidence for the transfer of a few genera from Coenagrionidae and vice versa is incorporated in the diversity figures (Dijkstra et al. 2013).

27. While earlier subdivisions of Coenagrionidae are not supported by morphology (O’Grady & May 2003), molecular studies indicate that the family consists of two major groups. The first includes large genera like Agriocnemia, Coenagrion and Pseudagrion, and ‘ischnurine’ genera characterized by a vulvar spine, such as Enallagma and Ichnura (see also Hornmøller 2006). The second, of which many genera possess an angulate frons, incorporates Protonuridae sensu stricto, Pseudostigmatidae Kirby, 1890, Teinobasinae Tillyard, 1917 (see De Marmels 2007), and possibly other genera such as Argia (Bybee et al. 2008; Carle et al. 2008; Dijkstra et al. 2013; Dumont et al. 2010). Coryphagrionidae Pinhey, 1962 was recovered with Pseudostigmatidae (Bechly 1996; Clausnitzer & Lindeboom 2002; Groenceveld et al. 2007; Ingle et al. 2012; Rehn 2003). Each of the two groups may contain over 600 species. If they are supported by more extensive investigations, each could be treated as a family. As they are likely to be sister-groups, each could also be considered a subfamily, retaining a massive Coenagrionidae as the order’s largest family, as is done here.

28. Epiophlebia is accepted as the extant sister-group of ‘true’ Anisoptera (Bechly 1996; 2003; Bybee et al. 2008; Davis et al. 2011; Fleck et al. 2008b; Rehn 2003). The genus has traditionally been placed in the suborder Anisozygoptera, although the initial usage of that name was for fossil taxa. Because that assemblage is considered paraphyletic, the suborder is often rejected (e.g. Davis et al. 2011) and all extant non-zygopteran odonates are combined in an alternative suborder Epiprocta Lohmann, 1996 (= Epiproctophora Bechly, 1996). Alternatively, Anisoptera could be expanded to include Epiophlebia (Dumont et al. 2010) or all ‘anisozygopterans’ (Trueman 2007). As higher level names are not governed by the ICZN we prefer a solution that retains Anisoptera and Anisozygoptera as well-understood and widely preferred terms predating Epiprocta by 142 and 90 years. Moreover, we believe that each of the three fundamentally different types of male secondary genitalia found in Odonata deserve separate and equivalent taxonomic status. Therefore we leave Epiophlebia in Anisozygoptera and accept the consequence that, while the suborder is monophyletic so far as extant species are concerned, it may be paraphyletic when fossil taxa are included. Alternatively, Epiophlebiota Bechly, 1996 (introduced as infra-order) can be accepted as a suborder. However, this only replaces a familiar name for the extant species, while leaving fossil Anisozygoptera paraphyletic as before, except that now it is so by the inclusion of Anisoptera as well as Epiophlebiota. If the fossil group is paraphyletic, we anticipate its subdivision with further revision, ultimately restricting Anisozygoptera to the extant species and its nearest fossil relatives.

29. A third and fourth species of Epiophlebia were described recently from China based on limited evidence (Carle 2012; Li et al. 2012), especially in the light of negligible genetic variation found in three of the species (Büsse et al. 2012).

30. There is general agreement that Anisoptera is monophyletic (Bechly 1996; 2003; Bybee et al. 2008; Carle et al. 2008; Davis et al. 2011; Fleck et al. 2008b; Rehn 2003). Although the major groupings are resolved, three well-defined monophyletic groups (Aeshnoidea, Gomphoidea and Petaluroidea, sometimes combined into larger clades) rotate as the sister-group of remaining anisopterans in the various published trees. This makes the order of the first three superfamilies difficult: we follow the most comprehensive analysis of odonate phylogeny (Bybee et al. 2008) in placing Aeshnoidea sister to the remainder of Anisoptera (followed by Petaluroidea, Gomphoidea and the remaining groups), although extensive recent morphological analysis places Gomphoidea there (Blanke et al. 2013).

31. The monophyly of Aeshnoidea, Austropetalidae and their combination in Aeshnoidea is well supported (Bybee et al. 2008; Carle et al. 2008; Davis et al. 2011; Fleck et al. 2008b), with only Fleck et al. (2008b) and Fleck (2011) presenting support for an even larger monophyletic group including Petaluroidea as well. We propose to exclude the latter from the superfamily, as did Fleck (2011).

32. Bechly (1996) separated Archipetalia in Archipetalidae, but while a detailed phylogenetic analysis of Austropetalidae is wanting, the whole appears monophyletic and splitting is thus unwarranted.
Family Aeshnidae Leach, 1815 (51 genera, 456 species)
Superfamily Petaluroidea Needham, 1903 (1 family)
Family Petaluridae Needham, 1903 (5 genera, 10 species)
Superfamily Gomphoidea Rambur, 1842 (1 family)
Family Gomphidae Rambur, 1842 (87 genera, 980 species)
Superfamily Cordulegastroidea Hagen, 1875 (3 families)
Family Chlorogomphidae Needham, 1903 (3 genera, 47 species)
Family Cordulegastridae Hagen, 1875 (3 genera, 46 species)
Family Neopetaliidae Tillyard & Fraser, 1940 (1 genus, 1 species)

33. A morphological analysis of all existing genera found little support for most recognized subfamilies of Aeshnidae (von Ellenrieder 2002). Some of these are occasionally treated as families, for example by Bechly (1996; 2003) and Peters & Theischinger (2007), e.g. Allopetaliidae Cockerell, 1913; Brachytronidae Cockerell, 1913; Gynacanthidae Cockerell, 1913; Telephlebiidae Cockerell, 1913; Gomphaeschnidae Tillyard & Fraser, 1940; Caliaeschnidae Bechly, 1996. No extensive molecular work has been published to date.

34. The well supported monophyletic family Petaluridae (Bybee et al. 2008; Fleck et al. 2008b) is best separated in a superfamily of its own, Petaluroidea (see Fleck 2011; note 30, 31).

35. The monophyly of the family Gomphidae is well supported (Bybee et al. 2008; Dumont et al. 2010; Fleck et al. 2008b; Rehn 2003). The first two authors favoured its recognition at superfamily level, which we follow. Carle (1986) recognised eight subfamilies, of which Lindeniidae Yakobson & Bianchi, 1905 is occasionally treated as a family (e.g. Davis et al. 2011). However, with no extensive molecular phylogenetic reconstruction available, the validity of any classification remains untested. Moreover, for the sake of stability, it seems best to express any supported subdivision at the subfamily level at most.

36. While the monophyly of the ‘higher’ libelluloids (sensu Ware et al. 2007) is strongly supported (note 40) both the inclusion of the three ‘lower’ families in Libelluloidea and their relationships to each other and the ‘higher’ families are poorly resolved (e.g. Blanke et al. 2013; Dumont et al. 2010; Fleck et al. 2008b). Fleck (2011) defined Cordulegastroidea to include Cordulegastridae and Neopetaliidae, but left the position of Chlorogomphidae undecided, although not ruling out the possibility that they may form the sister-group of the former pair. Indeed, some analyses suggest they form a monophyletic group, but sampling has been very limited (Bybee et al. 2008; Carle et al. 2008; Davis et al. 2011). We propose to restrict the superfamily Libelluloidea to Libellulidae and its nearest relatives, and classify Chlorogomphidae in Cordulegastroidea, although there is a chance the latter is paraphyletic. As Chlorogomphidae is morphologically more diverse than the other two families, only an extensive molecular study can settle the matter. The family order is alphabetic.

37. Until recently Chlorogomphidae was included in Cordulegastridae but it is morphologically distinct (Carle 1995; Fleck 2011) and in some analyses comes out closer to Neopetaliidae (e.g. Carle et al. 2008; Fleck et al. 2008b), ‘higher’ libelluloids (e.g. Bechly & Ueda 2002; Blanke et al. 2013; Davis et al. 2011; Ware et al. 2007) or as sister-group to Cordulegastroidea and Libelluloidea combined (e.g. one scenario in Fleck 2011).

38. The homogeneous family Cordulegastridae is very likely monophyletic (Lohmann 1992).

39. Neopetaliidae is monotypic since all genera except Neopetalia were transferred to the distantly related Austropetaliidae (Carle & Louton 1994).
Superfamily **Libelluloidea** Leach, 1815 (4 families)  
Family **Synthemistidae** Tillyard, 1911 (9 genera, 46 species)  
Family **Macromiidae** Needham, 1903 (4 genera, 125 species)  
Family **Corduliidae** Selys, 1850 (20 genera, 154 species)  
Family **Libellulidae** Leach, 1815 (142 genera, 1037 species)  
Genera **incertae sedis** (19 genera, 98 species)

40. The monophyly of Libelluloidea (Libellulidae plus Corduliidae *sensu lato*) is strongly supported (Bybee et al. 2008; Davis et al. 2011; Dumont et al. 2010; Fleck et al. 2008b; Ware et al. 2007). However, the paraphyletic nature of traditional ‘cordulids’ has long been recognized, as is apparent from the many family-group names available. Ware et al. (2007) retrieved four clades, which find support in the other studies listed as well. We recognize three of these as families, although relationships within and among them are largely unresolved, and leave a large number of genera *incertae sedis* (note 45). We follow the supertree of Davis et al. (2011) in placing Synthemistidae as the sister-group of remaining Libelluloidea, and Corduliidae *sensu stricto* as the sister-group of Libellulidae. This also seems most in agreement with morphology (Bechly 1996, 2003).

41. Ware et al. (2007) found similar support for their so-called GSI-clade as for the families Macromiidae, Corduliidae *sensu stricto* and Libellulidae. This is completely incongruent with the morphological analysis of Bechly (1996; 2003), who placed the constituent genera in seven families. Ware et al. (2007) recovered four of these as polyphyletic: Synthemistidae represented by *Choristhemis, Eusynthemis, Synthemisops* and *Synthemis* (*Archaeosynthemis, Austrosynthemis, Palaeosynthemis, Parasyntemis* and *Tonyosynthemis* not sampled); Gomphomacromiidae Tillyard & Fraser, 1940 by *Archaeophya* and *Gomphomacromia*; Austrocorduliidae Bechly, 1996 by *Austrocordulia, Austrophya, Lathrocordulia, Micromidia* and *Syncordulia* (*Apocordulia* and *Lauromacromia* not sampled); Oxygastridae Bechly, 1996 by *Hesperocordulia* and *Oxygastra* (*Neocordulia* not sampled). The genera *Idionyx* and *Macromidia* of *Idionychidae* Tillyard & Fraser, 1940 were sister-groups with low support, while only *Cordulephyia* was sampled of *Cordulephyidae* Tillyard, 1917 (*Neophya* not). Pseudocordulidae Lohmann, 1996 was sampled but is monotypic. The genera *Idomacromia* and *Nesocordulia* of *Idomacromiidae* Tillyard & Fraser, 1940 were not sampled. Bechly’s “eurypalpid” (*Synthemistidae, Gomphomacromiidae* and *Pseudocordulidae*) and “trichopalpid” groups (remaining families) were also not recovered. While this result calls the validity of these families into question, the inconsistence (even for the “eurypalpid” (Synthemistidae, Gomphomacromiidae and Pseudocorduliidae) and “trichopalpid” groups (remaining families) can be added based on morphology (Bybee et al. 1996; 2003). We follow the supertree of Davis et al. (2007) retrieved four clades, which find support in the other studies listed as well. We recognize three of these as families, although relationships within and among them are largely unresolved, and leave a large number of genera *incertae sedis* (note 45). However, Synthemistidae is the oldest available name in the complex and will thus eventually be retained in some form or other. As it is counterproductive to temporarily cancel this name, we apply it here for the traditional combination of genera (Bechly 1996; 2003).

42. May (1997) showed that *Macromia, Phyllocordia, Didymops* and *Epophthalmia* form a monophyletic group based on morphology, which is supported by the molecular analysis of Ware et al. (2007).

43. In its restricted sense, Cordulidae consist of mostly Holarctic genera, a few Neotropical groups and the predominantly Australasian group around *Hemicordulia*, which Bechly (1996) separated as Hemicordulidae. The latter, however, makes the family paraphyletic (Ware et al. 2007). Genera included by Ware et al. (2007) were *Aeschnosoma, Cordulia, Epitheca, Helocordulia, Hemicordulia, Neurocordulia, Pentathemis, Procordulia, Rialla, Somatochloro*, to which *Antipodochlora, Cordulisantosia, Dorocordulia, Guadalca, Heteronaias, Libellulasoma, Metaphya, Navicordulia, Paracordulia* and *Williamsonia* can be added based on morphology (Bechly 1998; 2003; Fleck 2012).

44. The monophyly of Libellulidae is strongly supported (Bybee et al. 2008; Dumont et al. 2010; Fleck et al. 2008b; Ware et al. 2007). Although a few clusters of related genera have been identified, no overall divisions are apparent (Fleck et al. 2008a; Ware et al. 2007; 2008; Pilgrim & von Dohlen 2007). Of many named subfamilies, only *Urotermistidae* Lieftinck, 1954 (= *Macrodiplacidae* Fraser, 1957) is sometimes recognized as a family (e.g. Bechly 1996, 2003). While it may be monophyletic, it does not stand apart from Libellulidae as a whole (Ware et al. 2007; Fleck et al. 2008b; Pilgrim & von Dohlen 2008).

45. The genera *Apocordulia, Archaeophya, Austrocordulia, Austrophya, Cordulephyia, Gomphomacromia, Hesperocordulia, Idionyx, Idonacromia, Lathrocordulia, Lauromacromia, Micromidia, Neocordulia, Neophya, Nesocordulia, Oxygastra, Pseudocordulia* and *Syncordulia* are considered *incertae sedis*. The only alternative would be to treat the main libelluloid clades retrieved by Ware et al. (2007) equally and unite these genera associated with GSI-clade under the oldest available name (*Synthemistidae*), but we are hesitant to apply a name associated with a strictly Papua-Australian group to such a diverse and dispersed assemblage without more evidence (note 41).
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