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Australian Dragonfly (Odonata) Larvae: Descriptive history and identification

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Abstract

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To improve the reliability of identification for Australian larval Odonata, morphological and geographic information is summarised for all species. All known references that contain information on characters useful for identification of larvae are presented in an annotated checklist. For polytypic genera information is provided to clarify whether each species can already, or cannot yet, be distinguished on morphological characters, and whether and under which conditions geographic locality is sufficient to make a diagnosis. For each species the year of original description and of first description of the larva, level of confidence in current identifications, and supportive information, are included in tabular form. Habitus illustrations of generally final instar larvae or exuviae for more than 70% of the Australian dragonfly genera are presented.

Keywords

Odonata, Australia, larvae, descriptive history, identification

Introduction

The size, colour, tremendous flight abilities and unusual reproductive behaviours of dragonflies make them one of the most attractive and conspicuous orders of insects. Larval dragonflies are aquatic and usually associated with clean water making them useful biological indicators of water quality. Thus information on the presence, abundance, diversity and reproductive ability are in high demand for assessments and modelling connected with river health, biodiversity, conservation, climate change and other environmental issues. Although flying adults are generally more likely to be encountered specific habitat data from larvae, which are confined to freshwater environments, provides extremely valuable and inclusive information on the health of aquatic ecosystems. For at least 20 years numerous nation- and state-wide, as well as regional monitoring programs have incorporated dragonfly larvae, amongst other macroinvertebrates, in their aquatic sampling protocols.

Unfortunately, while adult dragonflies can usually be reliably identified from a number of national and regional field guides and keys (e.g. Watson et al. (1993), Theischinger & Hawking (2006), Theischinger & Endersby (2009)), the situation is quite different for larvae. Although a wealth of information useful for identification of Australian odonate larvae is available, it is currently scattered throughout the literature, often in rather obscure journals. The descriptive literature on dragonfly larvae ranges from brief descriptions or line drawings of single structures in single species to comprehensive revisions (including colour photos and keys) of large taxonomic groups. The most comprehensive treatments come from Tillyard (1916a, 1926), Watson (1962), Theischinger (1982, 1998d, 2000b, 2001a, 2002, 2007a), Theischinger & Watson (1984), Hawking (1986, 1993), Hawking & Theischinger (1999) and Theischinger and Endersby (2009). However, morphological characters of larvae are more variable within single species and therefore less diagnostic than those of adults. They can also change significantly with development from early to late instars, and sometimes with habitat conditions. In addition, keys are usually constructed only for final instars and require more or less perfect and complete specimens, and some characters included in descriptions and keys have proved less consistent than originally envisaged. In monitoring programs early instar larvae are much more frequently collected than final instars. As well, the fragile larvae of zygopteran species often lose body parts during the collection process. Reliable specific identifications are rarely possible when diagnostic morphological characters are not available or when sympatric congeneric species have undescribed larvae. And even for parts of a geographic range where a species is supposedly the only member of its genus or species group, there is always a chance that we have underestimated the geographical range of other closely related species.

We have more than forty years of experience with the identification of Australian dragonfly larvae (including checking identifications in many voucher collections) and must emphasize the importance of considering the above variables when making identifications. Therefore we feel it is necessary to complement the basic descriptive information on known Australian dragonfly larvae by providing a realistic view of achieving accurate species identifications. It must be stressed here that it is the final instar (larva or exuvia) that is referred to in the literature, and that distribution-based identifications need to be treated with some caution. However the known geographical ranges of species should not be neglected when making identifications because greater reliability in identification is possible by finding larval exuviae in association with adults and by having the best possible knowledge of the regional fauna where the specimens are found.

Map 1. The regions of Australia referred to in text and table (from Watson *et al*. (1991). SWA = south-western Australia; SES = south-eastern South Australia; VIC = Victoria; TAS = Tasmania; SEN = south-eastern New South Wales; NEN = north-eastern New South Wales; SEQ = south-eastern Queensland; NEQ = north-eastern Queensland; CY = Cape York Peninsula; NNT = top end of Northern Territory; KIM = Kimberley region; NWA = north-western Australia; IN = inland New South Wales; SIQ = southern inland Queensland; NIQ = northern inland Queensland; IA = inland Australia.

Methods

All known species of Australian dragonflies are listed following the family order of the World Systematic Consensus of Dijkstra *et al*. (2013) (with the additions of Kalkman & Theischinger (2013)), and all references that include descriptive details and/or illustrations/photos of larvae are given in chronological order, not in the order of usefulness for identifications. The reliability/difficulty of generic identifications is indicated under the family headings. Following the species of each polytypic genus/subgenus (marked with an asterisk *) a brief summary is presented of the potential for reliable specific identification. Line drawings (Figs 1-81) and colour photographs (Figs 82-94) of at least one species per family are presented followed by a table giving references for descriptive information, the basis for reliable identification of each species, the present state of knowledge and the level of confidence for species identification. We construct and present a graph that shows the chronological growth of specific descriptive information on Australian dragonfly larvae, and a summary of all information included in the paper is given. Maps 1 and 2 are taken from Watson *et al*. (1991) and Watson & Theischinger (1984), and distributional details are based on the dot maps in Theischinger & Endersby (2009) and additional unpublished information.

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Descriptive literature on the larvae of Australian dragonfly species, with remarks on species identification within polytypic genera

Order Odonata

Two suborders, clearly distinguishable on morphology (Theischinger & Hawking 2006; Theischinger & Endersby 2009; Hawking *et al*. 2013).

Suborder **Zygoptera**

Eight families, clearly distinguishable on morphology (Theischinger & Hawking 2006; Theischinger & Endersby 2009; Hawking *et al*. 2013).

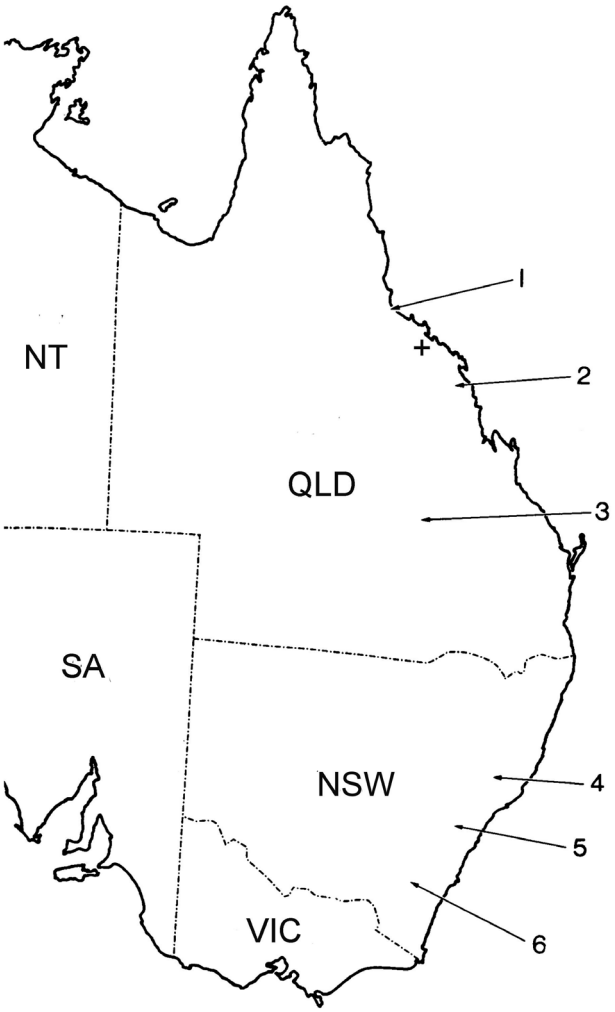
Family **Hemiphlebiidae**

Monotypic family, distinguishable on morphology (Theischinger & Hawking 2006; Theischinger & Endersby 2009; Hawking *et al*. 2013).

Hemiphlebia mirabilis Selys, 1869

Fig. 1

Tillyard (1928); Hawking (1995); Williams (1980); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.



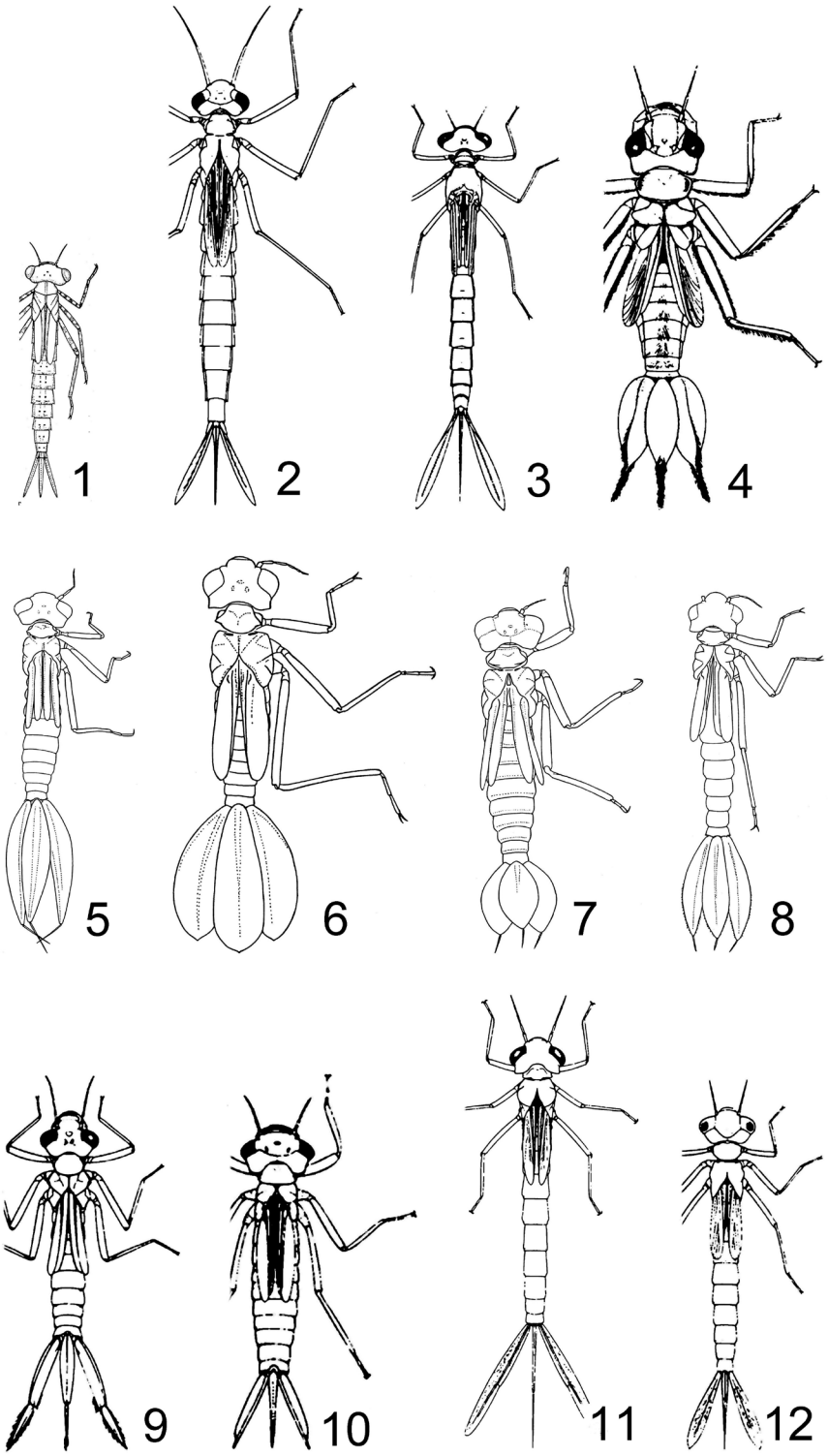
Map 2. Map of eastern Australia showing relevant localities (from Watson & Theischinger (1984). NSW = New South Wales; NT = Northern Territory; QLD = Queensland; SA = South Australia; VIC = Victoria; 1 = Paluma Range; 2 = Eungella; 3 = Carnarvon Gorge; 4 = Barrington Tops; 5 = Blue Mountains; 6 = Canberra. The Paluma-Eungella gap (marked with +, ca. 19°S) spans between 1 and 2.

Family **Synlestidae**

Three genera clearly distinguishable on morphology (Theischinger & Hawking 2006; Theischinger & Endersby 2009; Hawking *et al*. 2013).

Chorismagrion risi Morton, 1914

Fraser (1956); Theischinger *et al*. (1993); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.



Figs 1-12. Final instar larvae of Australian Zygoptera: (1) *Hemiphlebia mirabilis* (Hemiphlebiidae); (2) *Synlestes weyersii* (Synlestidae); (3) *Austrolestes annulosus* (Lestidae); (4) *Diphlebia euphoeoides* (Lestoideidae); (5-8) Argiolestidae: (5) *Archiargiolestes parvulus*; (6) *Austroargiolestes icteromelas*; (7) *Griseargiolestes griseus*; (8) *Miniargiolestes minimus*; (9) *Austrosticta soror* (Isostictidae); (10) *Nososticta pilbara* (Platycnemididae); (11, 12) Coenagrionidae: (11) *Caliagrion billinghursti*; (12) *Ischnura heterosticta*.

Episynlestes albicauda (Tillyard, 1913)

Theischinger *et al*. (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Episynlestes cristatus Watson & Moulds, 1977

Fraser (1956), as *Synlestes tropicus*; Theischinger *et al*. (1993); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Episynlestes intermedius Theischinger & Watson, 1985

Theischinger *et al*. (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Episynlestes*** Kennedy, 1920

Specific identifications based on morphology need confirmation by distributions (Theischinger *et al*. 1993). North of Paluma-Eungella gap: *E.cristatus*; Eungella area: *E. intermedius*; south of Paluma-Eungella gap: *E. albicauda*.

Synlestes selysi Tillyard, 1917

Theischinger *et al*. (1993); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Synlestes tropicus Tillyard, 1917

Theischinger *et al*. (1993); Theischinger & Hawking (2006); Theischinger & Endersby (2009); The description of *S. tropicus* by Fraser (1956) refers to *Episynlestes cristatus*.

Synlestes weyersii Selys, 1869

Figs 2, 82

Tillyard (1914, 1917a, 1917b, 1926); O'Farrell (1970); Williams (1980), as *S. tillyardi*; Nuttall (1982); Hawking (1986, 1995); Watson & O'Farrell (1991); Watson *et al*. (1991); Theischinger *et al*. (1993); Hawking & Theischinger (1999); Gooderham & Tsyrlin (2002); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Synlestes*** Selys, 1869

At present **s**pecific identifications based on morphology need confirmation by distributions (Theischinger *et al*. 1993). North of Paluma-Eungella gap: *S. tropicus*; from Eungella area south to approximately 36ºS: *S. selysi/weyersii*; south of approximately 36ºS: *Synlestes weyersii*.

Family **Lestidae**

Three genera clearly distinguishable on morphology (Theischinger & Hawking 2006; Theischinger & Endersby 2009; Hawking *et al*. 2013).

Austrolestes aleison Watson & Moulds, 1979

Watson (1962), as *A. psyche*; Watson *et al*. (1991); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austrolestes analis (Rambur, 1842)

Tillyard (1906, 1917b, 1932); Ris (1910), as larva B; Lieftinck (1960); Watson (1962); O'Farrell (1970); Allbrook (1979); Williams (1980); Nuttall (1982); Hawking (1986); Watson & O'Farrell (1991); Hawking & Theischinger (1999); Gooderham & Tsyrlin (2002); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Austrolestes annulosus (Selys, 1862)

Fig. 3

Ris (1910), as larva A; Lieftinck (1960); Watson (1962); O'Farrell (1970); Allbrook (1979); Nuttall (1982); Hawking (1986); Watson & O'Farrell (1991, 1994); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Austrolestes aridus (Tillyard, 1908)

Lieftinck (1960); Watson (1962); Nuttall (1982); Hawking (1986); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Austrolestes cingulatus (Burmeister, 1839)

Tillyard (1906, 1914, 1917a, 1917b, 1926); Allbrook (1979); Nuttall (1982); Hawking (1986, 1995); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Austrolestes insularis Tillyard, 1913

Larva not yet recognized.

Austrolestes io (Selys, 1862)

Lieftinck (1960); Watson (1962); Allbrook (1979); Nuttall (1982); Hawking (1986); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Austrolestes leda (Selys, 1862)

Tillyard (1906, 1917a); Watson (1962); Allbrook (1979); Hawking (1986, 1995); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Austrolestes minjerriba Watson, 1979

Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austrolestes psyche (Hagen, 1862)

Tillyard (1917a, 1717b); Lieftinck (1960); Allbrook (1979); Nuttall (1982); Hawking (1986, 1995); Hawking & Theischinger (1999); Gooderham & Tsyrlin (2002); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009). Watson (1962) has to be referred to *Austrolestes aleison*.

*Genus ***Austrolestes*** Tillyard, 1913

Morphology based identifications need geographical confirmation for two species: South-western Australia: *A. aleison*; south-eastern Australia: *A. psyche*. *A. insularis* (larva still undescribed) should be the only species across most of northern Australia (Theischinger & Endersby 2009).

Indolestes alleni (Tillyard, 1913)

Larva not yet recognized.

Indolestes obiri Watson, 1979

Larva not yet recognized.

Indolestes tenuissimus (Tillyard, 1906)

Lieftinck (1960); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Indolestes*** Fraser, 1922

Morphology based identifications of *Indolestes* from north-eastern Queensland may include both *I. tenuissimus* and *I. alleni*, those from the north of Northern Territory *I. alleni* and *I. obiri* (Theischinger & Endersby 2009).

Lestes concinnus Hagen, 1862

Lieftinck (1960); Hawking (1993); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al.* (2013), as *Lestes*. Sole species of the genus in Australia.

Family **Lestoideidae**

Two genera clearly distinguishable on morphology and size (Theischinger & Hawking 2006, Theischinger & Endersby 2009, both under Diphlebiidae and Lestoideidae; Hawking *et al*. 2013).

Lestoidea barbarae Watson, 1967

Larva probably not available

Lestoidea brevicauda Theischinger, 1996

Larva not identifiable at the present.

Lestoidea conjuncta Tillyard, 1913

Fraser (1956); Hawking (1995); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al.* (2013). Larva not identifiable at present.

Lestoidea lewisiana Theischinger, 1996

Larva not yet recognized.

*Genus ***Lestoidea*** Tillyard, 1913

The available descriptions by Fraser (1956); Theischinger & Hawking (2006) and Theischinger & Endersby (2009) enable firm identification of *Lestoidea* sp. only. *L. lewisiana* may be endemic to, and the only *Lestoidea* species in, the Mt Lewis area.

Diphlebia coerulescens Tillyard, 1913

Stewart (1980); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Diphlebia euphoeoides Tillyard, 1907

Fig. 4

Stewart (1980); Watson & O'Farrell (1991); Watson *et al*. (1991); Hawking (1995); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Diphlebia hybridoides Tillyard, 1912

Stewart (1980); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Diphlebia lestoides (Selys, 1853)

Tillyard (1909b, 1912, 1915a, 1917b, 1926); Stewart (1980); Williams (1980); Hawking (1986); Hawking & Smith (1997); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Diphlebia nymphoides Tillyard, 1912

Tillyard (1912); Stewart (1980); Hawking (1986); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Diphlebia*** Selys, 1869

On the basis of the available information on morphology (Stewart 1980) confident identifications were hitherto found impossible. *D. euphoeoides* and *D. hybridoides* are known only from north of the Paluma-Eungella gap; *D. coerulescens* from the Eungella area south to approximately 30ºS, whereas both *D. lestoides* and *D. nymphoides* seem to inhabit only eastern Australia south of 24ºS, but with only *D. nymphoides* inhabiting Carnarvon N.P. (Theischinger & Endersby 2009).

Family **Argiolestidae**

Five genera clearly distinguishable on morphology (Theischinger & Hawking 2006, Theischinger & Endersby 2009, both under Megapodagrionidae; Hawking *et al*. 2013).

Archiargiolestes parvulus (Watson, 1977)

Fig. 5

Theischinger (1998b). Hawking *et al.* (2013), as *Archiargiolestes*.
Larva not identifiable at present.

Archiargiolestes pusillissimus Kennedy, 1925

Theischinger (1998b).
Larva not identifiable at present.

Archiargiolestes pusillus (Tillyard, 1908)

Watson (1962). Theischinger (1998b).
Larva not identifiable at present.

*Genus ***Archiargiolestes*** Kennedy, 1925

Even though larval details of all three species are available specific identifications are not possible at the present (Theischinger & Endersby 2009).

Austroargiolestes alpinus (Tillyard, 1913)

Larva not yet recognized.

Austroargiolestes amabilis (Förster, 1899)

Larva not yet recognized.

Austroargiolestes aureus (Tillyard, 1906)

Larva not identifiable at present.

Austroargiolestes brookhousei Theischinger & O'Farrell, 1986

Larva not yet recognized.

Austroargiolestes calcaris (Fraser, 1958)

Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Larva not identifiable at present.

Austroargiolestes christine Theischinger & O'Farrell, 1986

Larva not yet recognized.

Austroargiolestes chrysoides (Tillyard, 1913)

Larva not identifiable at present.

Austroargiolestes elke Theischinger & O'Farrell, 1986

Larva not yet recognized.

Austroargiolestes icteromelas (Selys, 1862)

Fig. 6

Tillyard (1917a, 1917b, 1926, 1932); O'Farrell (1970), all as *Argiolestes icterom*elas; Lieftinck (1976), Nuttall (1982), as *Austroargiolestes* sp. 1; Hawking (1986, 1995); Watson & O'Farrell (1991, 1994); Watson *et al*. (1991); Hawking & Smith (1997); Theischinger (1998b); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).
Larva not identifiable at present.

Austroargiolestes isabellae Theischinger & O'Farrell, 1986

Murray (1995); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).
Larva not identifiable at present.

*Genus ***Austroargiolestes*** Kennedy, 1925

With *A. icteromelas* potentially coexisting with any other of its extremely similar congeners, generally the only confident identification appears to be *Austroargiolestes* sp. (Theischinger & Endersby 2009) even though most of the usually collected larvae belong to *A. icteromelas*.

Griseargiolestes albescens (Tillyard, 1913)

Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Griseargiolestes bucki Theischinger, 1998

Theischinger (1998c); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Griseargiolestes eboracus (Tillyard, 1913)

Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Griseargiolestes fontanus (Tillyard, 1913)

Larva not yet recognized.

Griseargiolestes griseus (Hagen, 1862)

Fig. 7

Tillyard (1914, 1917a), Hawking (1986), both as *Argiolestes griseus*; (Theischinger 1998b); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Griseargiolestes intermedius (Tillyard, 1913)

Fig. 83

Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Griseargiolestes metallicus (Sjöstedt, 1917)

Larva not yet recognized.

*Genus ***Griseargiolestes*** Theischinger, 1998

It should be easy to identify the larva of *G. metallicus* once it is found as it is the only *Griseargiolestes* species known from north of the Paluma-Eungella gap. The larva of *G. fontanus* is expected to be found most likely near springs of subtropical rainforest streams. Distributions may be needed to establish/confirm the identification of *G. griseus* and *G. intermedius* with only *G. intermedius* present in the alpine region and *G. griseus* mostly north and east of it (Theischinger & Endersby 2009).

Miniargiolestes minimus (Tillyard, 1908)

Fig. 8

Watson (1962), Hawking (1995), both as *Argiolestes minimus*; Theischinger (1998b); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al.* (2013). Genus monotypic.

Podopteryx selysi (Förster, 1899)

Watson & Dyce (1978); Hawking (1995); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al.* (2013). Sole species of the genus in Australia.

Family **Isostictidae**

Eight genera clearly distinguishable on morphology (Theischinger & Hawking 2006; Theischinger & Endersby 2009; Hawking *et al.* 2013).

Austrosticta fieldi Tillyard, 1908

Hawking (1993); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austrosticta frater Theischinger, 1997

Larva not yet recognized.

Austrosticta soror Sjöstedt, 1917

Fig. 9

Watson & O'Farrell (1991); Watson *et al.* (1991).

*Genus ***Austrosticta*** Tillyard, 1908

Because of the possible sympatric existence of the three species, larvae of this genus without associated imago can only be identified as *Austrosticta* sp. (Theischinger & Endersby 2009).

Eurysticta coolawanyah Watson, 1969

Watson (1969); Watson *et al.* (1991); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Eurysticta coomalie Watson, 1991

Hawking (1993); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Eurysticta kununurra Watson, 1991

Hawking (1993, 1995); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Eurysticta reevesi Theischinger, 2001

Larva not yet recognized.

*Genus ***Eurysticta*** Watson, 1969

It appears that the known larvae of this genus can be identified to species in spite of the possible sympatric existence of *E. coomalie* and *E. kununurra* (Theischinger & Endersby 2009).

Labidiosticta vallisi (Fraser, 1955)

Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al.* (2013). Genus monotypic.

Lithosticta macra Watson, 1991

Hawking (1993, 1995); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al.* (2013). Genus monotypic.

Neosticta canescens Tillyard, 1913

Tillyard (1914, 1917a, 1917b); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al.* (2013).

Neosticta fraseri Watson, 1991

Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Neosticta silvarum (Sjöstedt, 1917)

Larva not yet recognized.

*Genus ***Neosticta*** Tillyard, 1913

Based on distributions, larvae from south-eastern Australia can be identified as *N. canescens*, whereas *Neosticta* larvae from north of the Paluma-Eungella gap may be the common *N. fraseri* or the more local and uncommon *N. silvarum* (Theischinger & Endersby (2009).

Oristicta filicicola Tillyard, 1913

Fraser (1956); Williams (1980); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al.* (2013). Genus monotypic.

Rhadinosticta banksi (Tillyard, 1913)

Hawking (1993), as *Rhadinosticta handschini*; Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Rhadinosticta simplex (Martin, 1901)

Tillyard (1914, 1917a, 1917b, 1926); Hawking (1986), all as *Isosticta simplex*; Hawking (1995); Hawking & Smith (1997); Hawking & Theischinger (1999); Gooderham & Tsyrlin (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Rhadinosticta*** Watson, 1991

A good generic character is the presence of 6 dark spots on the otherwise pale labium. The two species are identifiable based on morphology. Larvae from south-eastern Australia can be confirmed by distribution as *R. simplex* (Theischinger & Endersby (2009).

Selysioneura sp.

Theischinger (2009). Sole species of the genus in Australia. It appears that only one and as yet undescribed *Selysioneura* species exists in tropical Queensland.

Family **Platycnemididae**

A single genus clearly distinguishable on morphology (Theischinger & Hawking 2006, under Protoneuridae; Theischinger & Endersby 2009; Hawking *et al*. 2013).

Nososticta baroalba Watson & Theischinger, 1984

Larva not yet recognized.

Nososticta coelestina (Tillyard, 1906)

Larva not yet recognized.

Nososticta fraterna (Lieftinck, 1933)

Hawking (1993); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Nososticta kalumburu Watson & Theischinger, 1984

Larva not yet recognized.

Nososticta koolpinyah Watson & Theischinger, 1984

Larva not yet recognized.

Nososticta koongarra Watson & Theischinger, 1984

Hawking (1993); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Nososticta liveringa Watson & Theischinger, 1984

Larva not yet recognized.

Nososticta mouldsi Theischinger, 2000

Larva not yet recognized.

Nososticta pilbara Watson, 1969

Fig. 10

Watson (1969), as *Nososticta solida pilbara*; Watson & O'Farrell (1991); Watson *et al*. (1991); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Nososticta solida (Hagen, 1860)

Nuttall (1982), as Protoneuridae sp.; Hawking (1986, 1995); Hawking & Theischinger (1999); Gooderham & Tsyrlin (2002); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Nososticta solitaria (Tillyard, 1906)

Larva not yet recognized.

Nososticta taracumbi Watson & Theischinger, 1984

Larva not yet recognized.

*Genus ***Nososticta*** Hagen in Selys, 1860

Because of the sympatric existence of two or more species across much of northern Australia and rather weak characters, *Nososticta* larvae cannot be identified to the species at present except for larvae from New South Wales and Victoria that can be referred to *N. solida*, the sole *Nososticta* species occurring there (Theischinger & Endersby (2009).

Family **Coenagrionidae**

13 genera distinguishable on morphology, two of them, *Austroagrion* and *Xanthagrion*, difficult (see there), larva of *Archibasis* unknown (Theischinger & Hawking 2006; Theischinger & Endersby 2009; Hawking *et al*. 2013).

Aciagrion fragile (Tillyard, 1906)

Hawking (1993); Theischinger (2000a); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of the genus in Australia.

Agriocnemis argentea Tillyard, 1906

Larva not yet recognized.

Agriocnemis dobsoni Fraser, 1954

Larva not yet recognized.

Agriocnemis femina (Brauer, 1868)

Lieftinck (1962).

Agriocnemis kunjina Watson, 1969

Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Agriocnemis pygmaea (Rambur, 1842)

Allbroook (1979); Nuttall (1982); Hawking (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Agriocnemis rubricauda Tillyard, 1913

Larva not yet recognized.

*Genus ***Agriocnemis*** Selys, 1877

With the larvae of most species still undescribed, and the available larvae having few diagnostic characters, the only reliable specific identifications possible at present are *A. femina* with its range in Australia restricted to Cape York and *A. pygmaea* if collected in New South Wales (Theischinger & Endersby 2009).

Archibasis mimetes (Tillyard, 1913)

Larva not yet recognized. Sole species of the genus in Australia.

Argiocnemis rubescens Selys, 1877

Tillyard (1917a, 1917b), Hawking (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of the genus in Australia.

Austroagrion cyane (Selys, 1876)

Watson (1962), as *Austroagrion coeruleum*; Hawking (1986). The reference to *A. cyane* by Allbrook (1979) refers to *A. watsoni*.

Austroagrion exclamationis Campion, 1915

Hawking (1993); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austroagrion pindrina Watson, 1969

Larva not yet recognized.

Austroagrion watsoni Lieftinck, 1982

Tillyard (1917a), Allbrook (1979), Nuttall (1982), all as *Austroagrion cyane*; Hawking (1986, 1993); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Austroagrion*** Tillyard, 1913

The larva of *A. exclamationis* can confidently be identified. Based on morphology larvae from south-western Australia and South Australia can confidently be referred to *A. cyane*, larvae from south-eastern Australia to *A. watsoni*, and larvae from the Pilbara area in north-western Australia to *A. pindrina* (Theischinger & Endersby 2009). However, there is an overlap of *A. cyane* and *A. watsoni* in the extreme west of Victoria (Richter 2014). The diagnostic characters of *Austroagrion* (from *Xanthagrion erythroneurum*) of the median caudal gill seem to work only for final instar larvae. More distinctly ringed antennae and a narrower labium usually distinguish younger *Austroagrion* larvae from *Xanthagrion*.

Austrocnemis maccullochi (Tillyard, 1926)

Hawking (1993); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austrocnemis obscura Theischinger & Watson, 1991

Larva not yet recognized.

Austrocnemis splendida (Martin, 1901)

Tillyard (1917a); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Austrocnemis*** Tillyard, 1913

The larvae of *A. maccullochi* can confidently be identified based on morphology, of the remaining larvae those from eastern Australia can confidently be referred to *A. splendida*, those from the Kimberley to *A. obscura* (Theischinger & Endersby 2009).

Austrocoenagrion lyelli (Tillyard, 1913)

Allbrook (1979), where it appears that the caudal gill is described upside down; Nuttall (1982); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013); all under *Coenagrion lyelli*. Genus monotypic.

Caliagrion billinghursti (Martin, 1901)

Fig. 11

Tillyard (1914, 1917a, 1917b, 1926); O'Farrell (1970); Williams (1980); Nuttall (1982), Hawking (1986, 1995); Watson & O'Farrell (1991); Watson *et al*. (1991); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009). Genus monotypic.

Ceriagrion aeruginosum (Brauer, 1869)

Lieftinck (1936); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of the genus in Australia.

Ischnura aurora (Brauer, 1865)

Tillyard (1917b); Lieftinck (1962); Watson (1962); Allbrook (1979); Nuttall (1982); Hawking (1986, 1993, 1995); Hawking & Smith (1997); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Ischnura heterosticta (Burmeister, 1839) (Fig. 12)

Tillyard (1917a, 1917b), Watson (1962); O'Farrell (1970); Allbrook (1979); Nuttall (1982); Hawking (1986, 1993, 1995); Watson & O'Farrell (1991), Ingram *et al*. (1997); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Ischnura pruinescens (Tillyard, 1906)

Hawking (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Ischnura*** Charpentier, 1840

Distributions do not confirm any identification based on morphology of the often sympatric species but size and morphology of final instars should be sufficient for reasonably confident identifications (Theischinger & Endersby 2009).

Pseudagrion aureofrons Tillyard, 1906

Hawking (1986, 1993, 1995); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Pseudagrion cingillum (Brauer, 1869)

Larva not yet recognized.

Pseudagrion ignifer Tillyard, 1906

Theischinger (2000a); Theischinger & Hawking (2006); Theischinger & Endersby (2009). Reference to this species by Hawking & Theischinger (1999) probably refers to *P. microcephalum*.

Pseudagrion jedda Watson & Theischinger, 1991

Larva not yet recognized.

Pseudagrion lucifer Theischinger, 1997

Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Pseudagrion microcephalum (Rambur, 1842)

Lieftinck (1962); Watson *et al*. (1991); Hawking (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Pseudagrion*** Selys, 1876:

The known larvae of the Australian *Pseudagrion* species can be confidently distinguished from each other by the combination of morphological characters and distributions. However, only *P. aureofrons*, *P. microcephalum* and *P. ignifer* from eastern Australia south of about latitude Rockhampton can be confidently identified because *P. cingillum* and *P. jedda* coexist in the same areas as *P. aureofrons*, *P. ignifer*, *P. microcephalum* and *P. lucifer* in northern Australia (Theischinger & Endersby 2009) and their as yet undescribed larvae may be indistinguishable from one or two of them.

Teinobasis rufithorax (Selys, 1877)

Larva not yet recognized. Sole species of the genus in Australia.

Xanthagrion erythroneurum (Selys, 1876)

Fig. 84

Watson (1962); Allbrook (1979); Nuttall (1982); Hawking (1986,1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of the genus in Australia. The diagnostic characters (from *Austroagrion*) of the median caudal gill seem to work only for final instar larvae. Less distinctly ringed antennae and a wider labium usually distinguish younger *X. erythroneurum* larvae from *Austroagrion*.

Suborder **Anisoptera**

Eight families + one group of genera incertae sedis, clearly distinguishable on morphology (Theischinger & Hawking 2006, under Epiproctophora; Theischinger & Endersby 2009, under Epiprocta; Hawking *et al*. 2013).

Family **Austropetaliidae**

Two genera clearly distinguishable on morphology (Theischinger & Hawking 2006, under Archipetaliidae and Austropetaliidae; Theischinger & Endersby 2009; Hawking *et al*. 2013).

Archipetalia auriculata Tillyard, 1917

Fig. 13

Albrook (1979); Gooderham & Tsyrlin (2002); Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.

Austropetalia annaliese Theischinger, 2013

Larva not yet recognized.

Austropetalia patricia (Tillyard, 1910)

Fig. 14

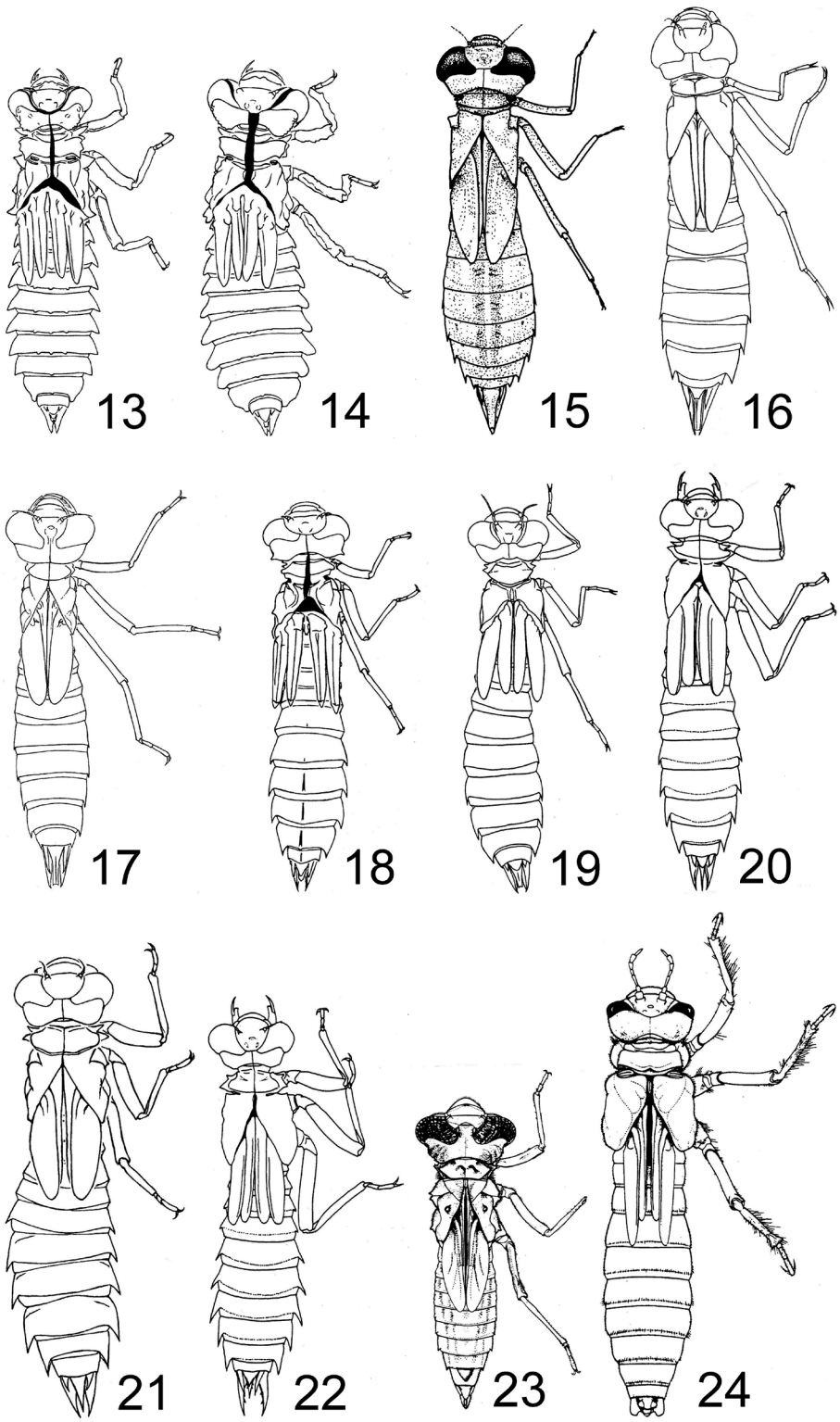
Tillyard (1910a, 1916a,1917b, 1926); Hawking (1986, 1995), has to be referred to *A. tonyana*; Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Theischinger & Tang (2012).

Austropetalia tonyana Theischinger, 1995

Hawking (1986, 1995), as *A. patricia;* Hawking & Smith (1997); Hawking & Theischinger (1999); Theischinger (2002); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Theischinger & Tang (2012); Hawking *et al*. (2013).

*Genus ***Austropetalia*** Tillyard, 1916

The easiest specific identification for *Austropetalia* larvae is by the probably exclusive distributions. North of the Hunter River: *A. annaliese* (larva as yet not available); south of the Hunter River to approximately 35ºS: *A. patricia*; south of approximately 35ºS: *A. tonyana* (Theischinger 2002; Theischinger & Endersby 2009; Theischinger & Tang 2013).



Figs 13-24. Final instar larvae/exuviae of Australian Anisoptera: (13, 14) Austropetaliidae: (13) *Archipetalia auriculata*; (14) *Austropetalia patricia*; (15-23) Aeshnidae: (15) *Adversaeschna brevistyla*; (16) *Anax gibbosulus*; (17) *Austrogynacantha heterogena*; (18) *Dendroaeschna conspersa*; (19) *Acanthaeschna victoria*; (20) *Austroaeschna (Pulchaeschna) muelleri*; (21) *Austrophlebia costalis*; (22) *Spinaeschna tripunctata*; (23) *Telephlebia brevicauda*; 24) *Petalura hesperia* (Petaluridae).

Family **Aeshnidae**

13 genera and several subgenera clearly distinguishable on morphology (Theischinger & Hawking 2006, under Aeshnidae and Telephlebiidae; Theischinger & Endersby 2009, under Aeshnidae, Brachytronidae and Telephlebiidae; Theischinger 2012).

Adversaeschna brevistyla (Rambur, 1842)

Fig. 15

Ris (1910), as larva D, Tillyard (1910a, 1914, 1916a, 1916b, 1917b, 1926), Watson (1962), O'Farrell (1970), Allbrook (1979), Williams (1980), Hawking (1986), Watson & O'Farrell (1991, 1994), Hawking & Theischinger (1999), Theischinger & Hawking (2003), all as *Aeshna brevistyla*; Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of the genus in Australia.

Agyrtacantha dirupta (Karsch, 1889)

Larva not yet recognized. Sole species of the genus in Australia.

Anaciaeschna jaspidea (Burmeister, 1839)

Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of the genus in Australia.

Anax georgius Selys, 1872

Watson & Theischinger (1987); Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Anax gibbosulus Rambur, 1842

Fig. 16

Watson & Theischinger (1987); Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Anax guttatus (Burmeister, 1839)

Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Anax papuensis (Burmeister, 1839)

Fig. 85

Tillyard (1916a, 1916b, 1917b, 1932); Calvert (1934); Watson (1962, 1968); Allbrook (1979); Hawking (1986, 1993, 1995), Hawking & Smith (1997); Ingram *et al*. (1997); Hawking & Theischinger (1999); Gooderham & Tsyrlin (2002), as *Aeshna brevistyla*; Theischinger (2002); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Up to 2006 most generally referred to as *Hemianax papuensis*.

Genus ***Anax*** Leach, 1815

Morphological characters are insufficient to distinguish among species. Identifications of larvae from southern, inland and central Australia can be confirmed by distribution as *A. papuensis*. In northern Australia the other three species may coexist with each other (*A. georgius* most restricted and morphologically distinct) and *A. papuensis* (Theischinger 2002; Theischinger & Endersby 2009).

Austrogynacantha heterogena Tillyard, 1908

Fig. 17

Hawking (1993); Hawking & Theischinger (1999); Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.

Gynacantha dobsoni Fraser, 1951

Tillyard (1916a, 1917b), as *G. rosenbergi*; Hawking (1993); Theischinger (2007b); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Gynacantha kirbyi Krüger, 1898

Larva not yet recognized.

Gynacantha mocsaryi Förster, 1898

Fraser (1963), somewhat incorrect; Theischinger (2001c, 2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Gynacantha nourlangie Theischinger & Watson, 1991

Hawking (1993); Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Gynacantha rosenbergi Kaup, 1867

Theischinger (2007b); Theischinger & Endersby (2009). Tillyard (1916a), as *G. rosenbergi* described the larva of *G. dobsoni*.

*Genus ***Gynacantha*** Rambur, 1842

Distributions cannot be used to confirm identifications based on morphology. *G. kirbyi* and *G. mocsaryi* appear to be restricted to north-eastern Queensland, but the other more widely distributed species occur there as well (Theischinger & Endersby 2009).

Dendroaeschna conspersa (Tillyard, 1907)

Fig. 18

Tillyard (1914, 1916a, 1916b, 1917b); Hawking (1991); Hawking & Theischinger (1999); Theischinger (2002); Theischinger & Hawking (2006); Peters & Theischinger (2007); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.

Acanthaeschna victoria Martin, 1901

Fig. 19

Theischinger (2000a, 2000c, 2002, 2008a); Theischinger & Hawking (2006); Peters & Theischinger (2007); Theischinger & Endersby (2009); Theischinger & Jacobs (2012); Hawking *et al*. (2013). Genus monotypic.

Antipodophlebia asthenes (Tillyard, 1916)

Watson & Theischinger (1980); Hawking & Theischinger (1999); Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.

Austroaeschna (Austroaeschna) christine Theischinger, 1993

Theischinger (1993, 2002); Theischinger & Hawking (2006); Peters & Theischinger (2007); Theischinger & Endersby (2009).

Austroaeschna (Austroaeschna) ingrid Theischinger, 2008

Theischinger (2008b); Theischinger & Endersby (2009).

Austroaeschna (Austroaeschna) multipunctata (Martin, 1901)

Theischinger (1982, 2002), Hawking (1986), Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Peters & Theischinger (2007); Theischinger & Endersby (2009). The description of *A. multipunctata* by Tillyard (1916a) refers to *A. obscura*.

Austroaeschna (Austroaeschna) obscura Theischinger, 1982

Tillyard (1916a, 1916b, 1917b), as *A. multipunctata*; Hawking & Theischinger (1999); Theischinger (1982, 2002, 2012); Theischinger & Hawking (2006); Peters & Theischinger (2007); Theischinger & Endersby (2009).

Austroaeschna (Austroaeschna) parvistigma (Selys, 1883)

Tillyard (1916a), from notes only; Allbrook (1979); Theischinger (1993, 2002); Hawking (1986); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Peters & Theischinger (2007); Theischinger & Endersby (2009).

Austroaeschna (Austroaeschna) sigma Theischinger, 1982

Theischinger (1982, 1993, 2002); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Austroaeschna***, Subgenus ***Austroaeschna*** Selys, 1883

Only *A. obscura* can be distinguished from congeners on the basis of morphology. Four more species can confidently be identified by their distributions. Eungella area: *A. christine*; south-eastern Queensland and New South Wales N of latitude Sydney: *A. sigma*; south-eastern New South Wales south of approximately 35º30'S and Victoria except for the Grampians: *A. multipunctata*; Grampians: *A. ingrid*. *A. parvistigma* is the only species in Tasmania. On the mainland it may, however, coexist in places with with *A. sigma*, *A. multipunctata* and *A. ingrid*. But, whereas the larvae of these three species inhabit running water often with rocky substrate, the larva of *A. parvistigma* is usually found only in swampy and boggy situations (Theischinger 2002, 2012; Theischinger & Endersby 2009).

Austroaeschna (Glaciaeschna) flavomaculata Tillyard, 1916

Theischinger (1982, 2002, 2012); Hawking (1986); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009). Subgenus monotypic.

Austroaeschna (Montiaeschna) atrata Martin, 1901

Theischinger (1982, 2002, 2012); Hawking (1986, 1995); Hawking & Watson (1990); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Peters & Theischinger (2007); Theischinger & Endersby (2009); Hawking *et al*. (2013). The description of *A. atrata* by Tillyard (1916a) refers to the larva of *A. subapicalis*.

Austroaeschna (Montiaeschna) hardyi Tillyard, 1917

Allbrook (1979); Theischinger (1982, 2002); Theischinger & Hawking (2006); Peters & Theischinger (2007); Theischinger & Endersby (2009).

Austroaeschna (Montiaeschna) subapicalis Theischinger, 1982

Tillyard (1916a), as *A. atrata*; Theischinger (1982, 2002, 2012); Theischinger & Hawking (2003, 2006); Peters & Theischinger (2007); Theischinger & Endersby (2009).

Austroaeschna (Montiaeschna) tasmanica Tillyard, 1916

Allbrook (1979); Theischinger (1982, 2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Austroaeschna***, Subgenus ***Montiaeschna*** Theischinger, 2012

Of the two very similar mainland species, *A. atrata* seems to be restricted to the alpine region, whereas *A. subapicalis* may reach north into Queensland and in the south certainly reaches west to the Grampians. The two Tasmanian species can be identified based on morphology only (Theischinger 2002, 2012).

Austroaeschna (Occidaeschna) anacantha Tillyard, 1908

Ris (1910), as larva C; Tillyard (1916a), as *Acanthaeschna anacantha*; Watson (1962); Theischinger (1982, 2002, 2012); Watson *et al*. (1991); Theischinger & Hawking (2006); Theischinger & Endersby (2009). Subgenus monotypic. Morphology based identification can be confirmed by distribution: only south-western Australia.

Austroaeschna (Petersaeschna) cooloola Theischinger, 1991

Hawking & Theischinger (1999), as *A. unicornis cooloola*; Theischinger (2002, 2012); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austroaeschna (Petersaeschna) inermis Martin, 1901

Theischinger (1975, 1982, 2002, 2012); Hawking (1986); Hawking & Smith (1997); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Austroaeschna (Petersaeschna) pinheyi Theischinger, 2001

Theischinger (1982), Hawking & Theischinger (1999), both partly as *A. unicornis speciosa*; Theischinger (2001b, 2002), Theischinger & Hawking (2006), all as *Austroaeschna unicornis pinheyi*; Peters & Theischinger (2007); Theischinger & Endersby (2009).

Austroaeschna (Petersaeschna) speciosa Sjöstedt, 1917

Theischinger (1982, 2002); Theischinger & Hawking (2006); Peters & Theischinger (2007); Theischinger & Endersby (2009). Hawking & Theischinger (1999), as *A. unicornis speciosa* should be referred to *A. pinheyi* and *A. unicornis*.

Austroaeschna (Petersaeschna) unicornis (Martin, 1901)

Tillyard (1916a), Albrook (1979), both as *A. longissima*; Theischinger (1982, 2002, 2012); Hawking (1986); Hawking & Theischinger (1999); Gooderham & Tsyrlin (2002); Theischinger & Hawking (2003, 2006); Peters & Theischinger (2007); Theischinger & Endersby (2009).

*Genus ***Austroaeschna***, Subgenus ***Petersaeschna*** Theischinger, 2012

Distributions can at least in part support identification of four of the five species. Tropical Queensland north of Paluma-Eungella gap: *A. speciosa*; inland Queensland: *A. pinheyi*; Cooloola region, Stradbroke Island and Fraser Island: *A. cooloola;* most of eastern Queensland south of Paluma-Eungella gap, eastern New South Wales, Victoria, Tasmania, South Australia: *A. unicornis*. There is no need for confirming identification of *A. inermis* on geography (Theischinger 2002, 2012).

Austroaeschna (Pulchaeschna) eungella Theischinger, 1993

Theischinger (1993, 2002); Theischinger & Hawking (2006); Peters & Theischinger (2007); Theischinger & Endersby (2009).

Austroaeschna (Pulchaeschna) muelleri Theischinger, 1982

Fig. 20

Theischinger (1982, 1993, 2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austroaeschna (Pulchaeschna) pulchra Tillyard, 1909

Tillyard (1916a) as *A. unicornis*; Fraser (1959) as *A. unicornis pulchra*; Theischinger (1982, 1993, 2002, 2012); Hawking (1986); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

*Genus ***Austroaeschna***, Subgenus ***Pulchaeschna*** Peters & Theischinger, 2007

Identification of all species can be confirmed by distributions. Eungella region and Clarke Range: *A. eungella*; Carnarvon Range in southern inland Queensland: *A. muelleri*; most of eastern Australia south of Eungella area: *A. pulchra* (Theischinger 2002, 2012).

*Genus ***Austroaeschna*** Selys, 1883

The five subgenera *Austroaeschna*, *Glaciaeschna*, *Montiaeschna*, *Occidaeschna*, *Petersaeschna* and *Pulchaeschna* are clearly separable on morphological differences (Theischinger 2012).

Austrophlebia costalis (Tillyard, 1907)

Fig. 21

Tillyard (1916a); Theischinger (1982, 1996, 2002, 2012); Hawking & Theischinger 1999); Theischinger & Hawking (2006); Peters & Theischinger (2007); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Austrophlebia subcostalis Theischinger, 1996

Theischinger (1996, 2002); Theischinger & Hawking (2006); Peters & Theischinger (2007); Theischinger & Endersby (2009).

*Genus ***Austrophlebia*** Tillyard, 1916

Identification can be confirmed by specific distributions. North of Eungella-Paluma gap: *A. subcostalis*; south of Eungella-Paluma gap: *A. costalis* (Theischinger 2002). However, the adults of both these species fly very well, and overlap in distribution of the two species cannot completely be excluded.

Dromaeschna forcipata (Tillyard, 1907)

Theischinger (1982, 2002), Theischinger & Hawking (2006), all as *Austroaeschna forcipata*; Theischinger & Endersby (2009); Theischinger (2012).

Dromaeschna weiskei (Förster, 1908)

Theischinger (1982, 2002); Theischinger & Hawking (2006), all as *Austroaeschna weiskei*; Theischinger & Endersby (2009); Theischinger (2012).

*Genus ***Dromaeschna*** Förster, 1908

Reliable identification of the two often coexisting species can be achieved based on morphology (Theischinger 1982; Theischinger & Endersby 2009).

Notoaeschna geminata Theischinger, 1982

Tillyard (1916a), as *N. sagittata*; Theischinger (1982, 2002); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Notoaeschna sagittata (Martin, 1901)

Fig. 86

O'Farrell (1970); Theischinger (1982, 2002); Hawking (1986); Watson & O'Farrell (1991); Watson *et al*. (1991); Hawking & Smith (1997); Hawking & Theischinger (1999); Gooderham & Tsyrlin (2002); Theischinger & Hawking (2003, 2006); Peters & Theischinger (2007); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Notoaeschna*** Tillyard, 1916

At present confident identification of the two species is possible only by their specific distributions. North of the Hunter River: *N. geminata*; south of the Hunter River: *N. sagittata* (Theischinger 2002).

Spinaeschna tripunctata (Martin, 1901)

Fig. 22

Theischinger (1975, 1982, 2002); Hawking (1986, 1995); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Peters & Theischinger (2007); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Spinaeschna watsoni Theischinger, 1982

Theischinger (1982, 2002); Theischinger & Hawking (2006); Peters & Theischinger (2007); Theischinger & Endersby (2009).

*Genus ***Spinaeschna*** Theischinger, 1982

Identification can be confirmed by **s**pecific distributions. North of Eungella-Paluma gap: *S. watsoni*; New South Wales and Victoria: *S. tripunctata* (Theischinger 2002).

Telephlebia brevicauda Tillyard, 1916

Fig. 23

O'Farrell (1970); Watson & O'Farrell (1991); Hawking (1986); Hawking & Theischinger (1999); Theischinger (2002); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Telephlebia cyclops Tillyard, 1916

Hawking & Theischinger (1999); Theischinger (2002); Theischinger & Hawking (2003, 2006); Peters & Theischinger (2007); Theischinger & Endersby (2009).

Telephlebia godeffroyi Selys, 1883

Tillyard (1916a); Watson & Theischinger (1980); Hawking & Theischinger (1999); Theischinger (2002); Theischinger & Hawking (2003, 2006); Peters & Theischinger (2007); Theischinger & Endersby (2009).

Telephlebia tillyardi Campion, 1916

Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Telephlebia tryoni Tillyard, 1917

Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Telephlebia undia Theischinger, 1985

Larva not yet recognized.

*Genus ***Telephlebia*** Selys, 1883

Two 'species groups' can be distinguished based on the shape of the paraprocts of male final instar larvae. Geography helps specific identification (Theischinger 2002). Group A: North of Paluma-Eungella gap: *A. tillyardi*; Carnarvon N. P.: *T. undia* (but larva still undescribed); coastal south-eastern Queensland: *T. tryoni*. Group B: Coastal south-eastern Queensland: *T. cyclops*; south-eastern NSW south to approximately 35ºS: *T. godeffroyi*; NSW south of 35ºS and Victoria: *T. brevicauda*. *Telephlebia* larvae from north-eastern New South Wales may belong to either *T. cyclops* or T. *godeffroyi*.

Family **Petaluridae**

A single genus clearly distinguishable on morphology (Theischinger & Hawking 2006; Theischinger & Endersby 2009; Hawking *et al*. 2013).

Petalura gigantea Leach, 1815

Tillyard (1909a, 1910a, 1911a, 1917b, 1926), Schmidt (1941); Watson (1958), incorrect; Williams (1980); Hawking & Theischinger (1999); Gooderham & Tsyrlin (2002); Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Petalura hesperia Watson, 1958

Fig. 24

Watson (1958, 1962); Williams (1980); Watson & O'Farrell (1991); Watson *et al*. (1991); Theischinger (2002); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Petalura ingentissima Tillyard, 1908

Andress (1998); Theischinger (2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Petalura litorea Theischinger, 1999

Theischinger (2000a, 2002); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Petalura pulcherrima Tillyard, 1913

Status doubtful (Ware *et al*. 2014).

*Genus ***Petalura*** Leach, 1815

Distributions support identifications based on morphology (Theischinger 2002). Cape York and north-eastern Queensland north of Paluma- Eungella gap: *P. ingentissima*/*?pulcherrima*; coastal south-eastern Queensland and coastal north-eastern New South Wales: *P. litorea*; montane south-eastern Queensland and most of eastern New South Wales: *P. gigantea*; south-western Australia: *P. hesperia*.

Family Gomphidae

Two subfamilies, seven genera and several subgenera clearly distinguishable on morphology (Theischinger & Hawking 2006, Theischinger & Endersby 2009, both under Gomphidae and Lindeniidae; Hawking *et al*. 2013).

Ictinogomphus australis (Selys, 1873)

Figs 25, 87

Tillyard (1917b); Hawking (1993); Hawking & Smith (1997); Theischinger (1998d, 2000b); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Ictinogomphus dobsoni (Watson, 1969)

Theischinger (1998d, 2000b); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Ictinogomphus paulini Watson, 1991

Larva not yet recognized.

*Genus ***Ictinogomphus*** Cowley, 1934

Distributions largely support identifications based on morphology (Theischinger 2000b; Theischinger & Endersby (2009). Most of eastern and northern Australia: *I. australis*; Pilbara area and further west in Western Australia: *I. dobsoni*. *Ictinogomphus* larvae from the tip of Cape York may belong to either *I. australis* or *I. paulini*.

Antipodogomphus acolythus (Martin, 1901)

Figs 26, 88

Tillyard (1917b), as *Austrogomphus manifestus*; Fraser (1959), most probably as *A. proselythus*; Theischinger (1998d, 2000b); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Antipodogomphus dentosus Watson, 1991

Hawking (1993); Theischinger (1998d, 2000b); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Antipodogomphus edentulus Watson, 1991

Larva not yet recognized.

Antipodogomphus hodgkini Watson, 1969

Theischinger (1998d, 2000b); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Antipodogomphus neophytus Fraser, 1958

Hawking (1993); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Antipodogomphus proselythus (Martin, 1901)

Theischinger (2007a); Theischinger & Endersby (2009). Fraser (1959) most probably has to be referred to *A. acolythus*.

*Genus ***Antipodogomphus*** Fraser, 1951

Confident identifications based on morphology are not possible at present. Only *A. hodgkini* has an exclusive range (Western Australia: Pilbara area), and *A. acolythus* seems to be the only species of the genus in New South Wales and Victoria (Theischinger 2000b; Theischinger & Endersby 2009).

Armagomphus armiger (Tillyard, 1913)

Fig. 27

Watson (1962, 1991), as *Hemigomphus armiger*; Theischinger (1998d, 2000b); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.

Austroepigomphus* (*Austroepigomphus*) *praeruptus (Selys, 1857)

Fig. 28

Theischinger (1998d, 2000b), Hawking & Theischinger (1999), Theischinger (2004), all as *Austrogomphus melaleucae*; Theischinger & Hawking (2006); Theischinger & Endersby (2009). Subgenus monotypic.

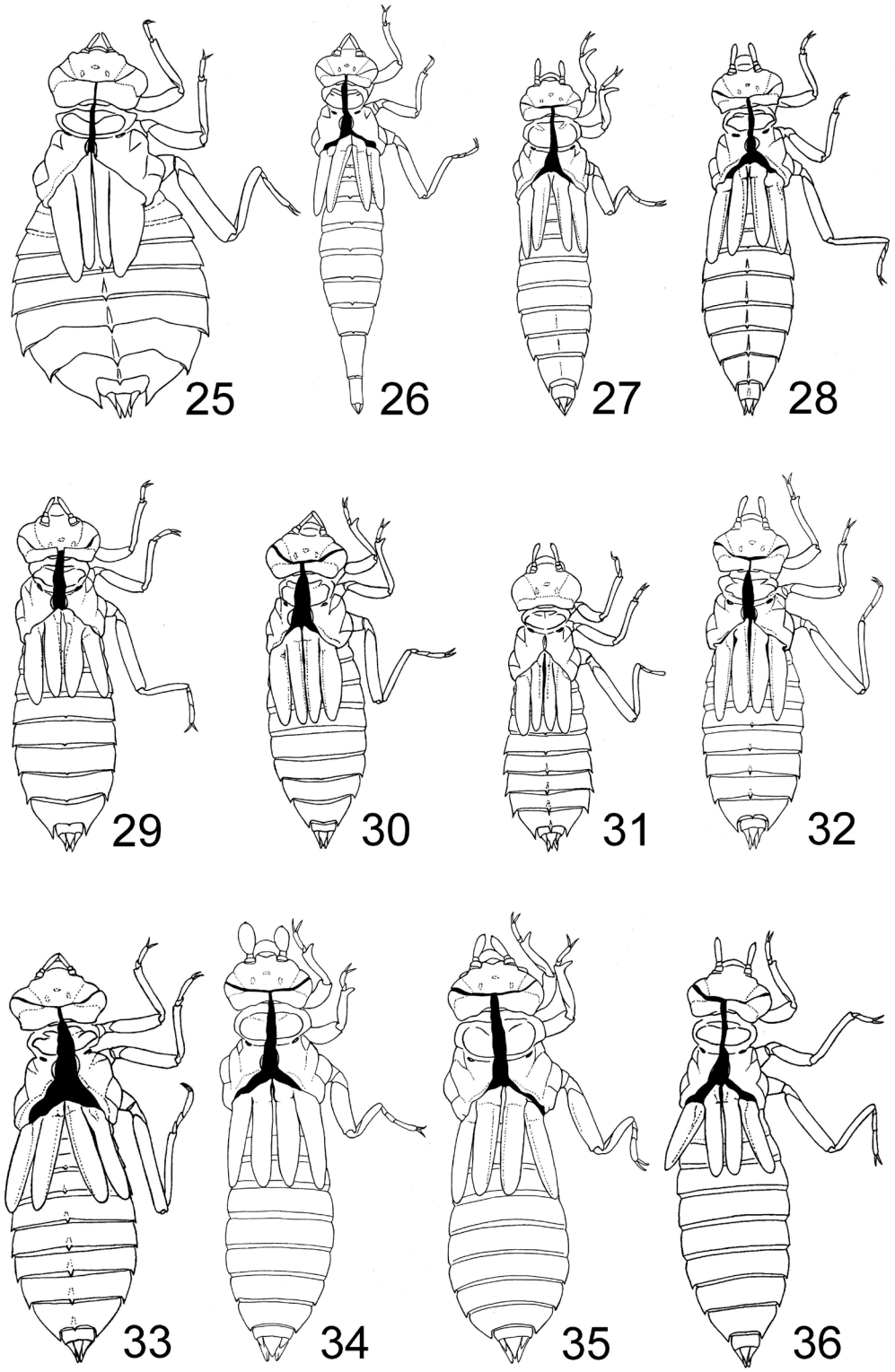
Austroepigomphus* (*Xerogomphus*) *gordoni (Watson, 1962)

Watson (1962), as *Austrogomphus gordoni*; Theischinger (1998d, 2000b);Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austroepigomphus* (*Xerogomphus*) *turneri (Martin, 1901)

Fig. 89

Hawking (1993); Theischinger (1998d, 2000b; 2004); Theischinger & Hawking (2006); Theischinger & Endersby (2009).



Figs 25-36. Final instar larvae of Australian Gomphidae: (25) *Ictinogomphus australis*; (26) *Antipodogomphus acolythus*; (27) *Armagomphus armiger*; (28) *Austroepigomphus paeruptus*; (29) *Austrogomphus (A.) australis*; (30) *A. (A.) cornutus*; (31) *A. (A.) mjobergi*; (32) *A. (A.) ochraceus*; (33) *Austrogomphus (Pleiogomphus) amphiclitus*; (34) *Hemigomphus heteroclytus*; (35) *Odontogomphus donnellyi*; (36) *Zephyrogomphus lateralis*.

*Genus ***Austroepigomphus***, Subgenus ***Xerogomphus*** Watson, 1991

Distributions confirm identifications (on the basis of morphology) of the two species (Theischinger 2000b, 2004). Central and Western Australia: *A. gordoni*; north-eastern and northern Australia: *A. turneri*.

*Genus ***Austroepigomphus*** Fraser, 1951

South-eastern, rarely north-eastern, Australia: subgenus *Austroepigomphus*; north-eastern, central and western Australia: subgenus *Xerogomphus* (Theischinger 2000b, 2004).

Austrogomphus* (*Austrogomphus*) *angelorum Tillyard, 1913

Larva not yet recognized.

Austrogomphus* (*Austrogomphus*) *arbustorum Tillyard, 1906

Theischinger (1998d, 2000b); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austrogomphus* (*Austrogomphus*) *australis Dale, 1854

Fig. 29

Hawking (1986, 1995); Theischinger (1998d, 2000b); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austrogomphus* (*Austrogomphus*) *collaris Hagen, 1854

Watson (1962); Watson *et al*. (1991); Theischinger (1998d, 2000b); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austrogomphus* (*Austrogomphus*) *cornutus Watson, 1991

Fig. 30

Hawking (1986), as *Austrogomphus* sp. "c"; Hawking & New (1996); Theischinger (1998d, 2000b); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Austrogomphus* (*Austrogomphus*) *doddi Tillyard, 1909

Larva not yet recognized.

Austrogomphus* (*Austrogomphus*) *guerini (Rambur, 1842)

O'Farrell (1970); Allbrook (1970); Hawking (1986); Watson & O'Farrell (1991); Watson et al. (1991), Hawking & Smith (1997), as *A. ochraceus*; Theischinger (1998d, 2000b); Hawking & Theischinger (1999); Gooderham & Tsyrlin (2002); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Austrogomphus* (*Austrogomphus*) *mjobergi Sjöstedt, 1917

Fig. 31

Hawking (1993); Theischinger (1998d, 2000b); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austrogomphus* (*Austrogomphus*) *mouldsorum Theischinger, 1999

Larva not yet recognized.

Austrogomphus* (*Austrogomphus*) *ochraceus (Selys, 1869)

Fig. 32

Tillyard (1916b, 1917b, 1926); Hawking (1986); Hawking & New (1996); Theischinger (1998d, 2000b, 2004); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Austrogomphus* (*Austrogomphus*) *pusillus Sjöstedt, 1917

Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Austrogomphus***, Subgenus ***Austrogomphus*** Selys, 1854

The larvae of two species, *A. angelorum*, probably restricted, if still surviving, to the mature Murray River, and *A. mouldsorum*, a large species possibly endemic to the Kimberley, are still undescribed and assumed to be recognisable when found. Other than that a single species and four twin groups can confidently be separated based on morphology. Three of the twin groups are identifiable to the species by allopatry. Only *A. guerini* and *A. ochraceus* cannot be distinguished at present. Of these two only *A. guerini* is found in South Australia and Tasmania (Theischinger 2000b; Theischinger & Endersby 2009).

Austrogomphus* (*Pleiogomphus*) *amphiclitus (Selys, 1873)

Fig. 33

Theischinger (1998d, 2000b, 2004); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austrogomphus* (*Pleiogomphus*) *bifurcatus Tillyard, 1909

Theischinger (1998d, 2000b); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Austrogomphus* (*Pleiogomphus*) *divaricatus Watson, 1991

Larva not available or inseparable from *A. bifurcatus*.

Austrogomphus* (*Pleiogomphus*) *prasinus Tillyard, 1906

Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Austrogomphus***, Subgenus ***Pleiogomphus*** Watson, 1991

Of the four species only *A. amphiclitus* can confidently be identied on morphology, and it is also the only species found over much of eastern and inland Queensland and New South Wales, whereas the other three species are apparently restricted to north-eastern Queensland (Theischinger 2000b; Theischinger & Endersby 2009).

*Genus ***Austrogomphus*** Selys, 1854

The larvae of the two subgenera *Austrogomphus* and *Pleiogomphus* are clearly separable on morphological differences (Theischinger 2000b; Theischinger & Endersby 2009).

Hemigomphus atratus Watson, 1991

Larva not yet recognized.

Hemigomphus comitatus (Tillyard, 1909)

Theischinger (1998d, 2000b); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Hemigomphus cooloola Watson, 1991

Theischinger (1998d, 2000b); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Hemigomphus gouldii (Selys, 1854)

Williams (1980); Hawking (1986); Hawking & New (1996); Hawking & Smith (1997); Theischinger (1998d, 2000b); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Hemigomphus heteroclytus Selys, 1854

Figs 34, 90

Tillyard (1910a, 1914, 1916b, 1917b); Hawking (1986); Theischinger (1998d, 2000b); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Hemigomphus magela Watson, 1991

Hawking (1993); Theischinger (1998d, 2000b); Theischinger & Hawking (2006); Peters & Theischinger (2007); Theischinger & Endersby (2009).

Hemigomphus theischingeri Watson, 1991

Theischinger (1998d, 2000b); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

*Genus ***Hemigomphus*** Selys 1854

H. cooloola and *H. magela* have characters different from the morphologically rather uniform remaining species. In addition *H. magela* has a restricted geographical range within the Northern Territory, whereas *H. atratus* (larva still unknown), *H. comitatus* and *H. theischingeri* are restricted to north-eastern Queensland and *H. gouldii* and *H. heteroclytus* are more or less confined to south-eastern Australia. Only *H. heteroclytus*, the only *Hemigomphus* occurring in southern inland Queensland, slightly overlaps the range of the three north-eastern species (Theischinger 2000b; Theischinger & Endersby 2009).

Odontogomphus donnellyi Watson, 1991

Fig. 35

Watson (1991), under Genus *Odontogomphus*; Theischinger (1998d, 2000b); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.

Zephyrogomphus lateralis (Selys, 1873)

Fig. 36

Watson (1962), as *Austrogomphus lateralis*; Theischinger (1998d, 2000b); as *Austrogomphus (Zephyrogomphus) lateralis*; Theischinger (2004); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Zephyrogomphus longipositor (Watson, 1991)

Theischinger (1998d, 2000b), as *?Austrogomphus (?Zephyrogomphus) longipositor*; Theischinger (2004); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Zephyrogomphus*** Watson, 1991

Widely disjunct distributions confirm identification based on morphology of the two species (Theischinger 2000b; Theischinger & Endersby 2009).

Family **Synthemistidae**

Eight genera distinguishable on morphology, two of them, *Choristhemis* and *Eusynthemis* difficult **(**Theischinger & Hawking 2006; Theischinger & Endersby 2009; Hawking *et al*. 2013).

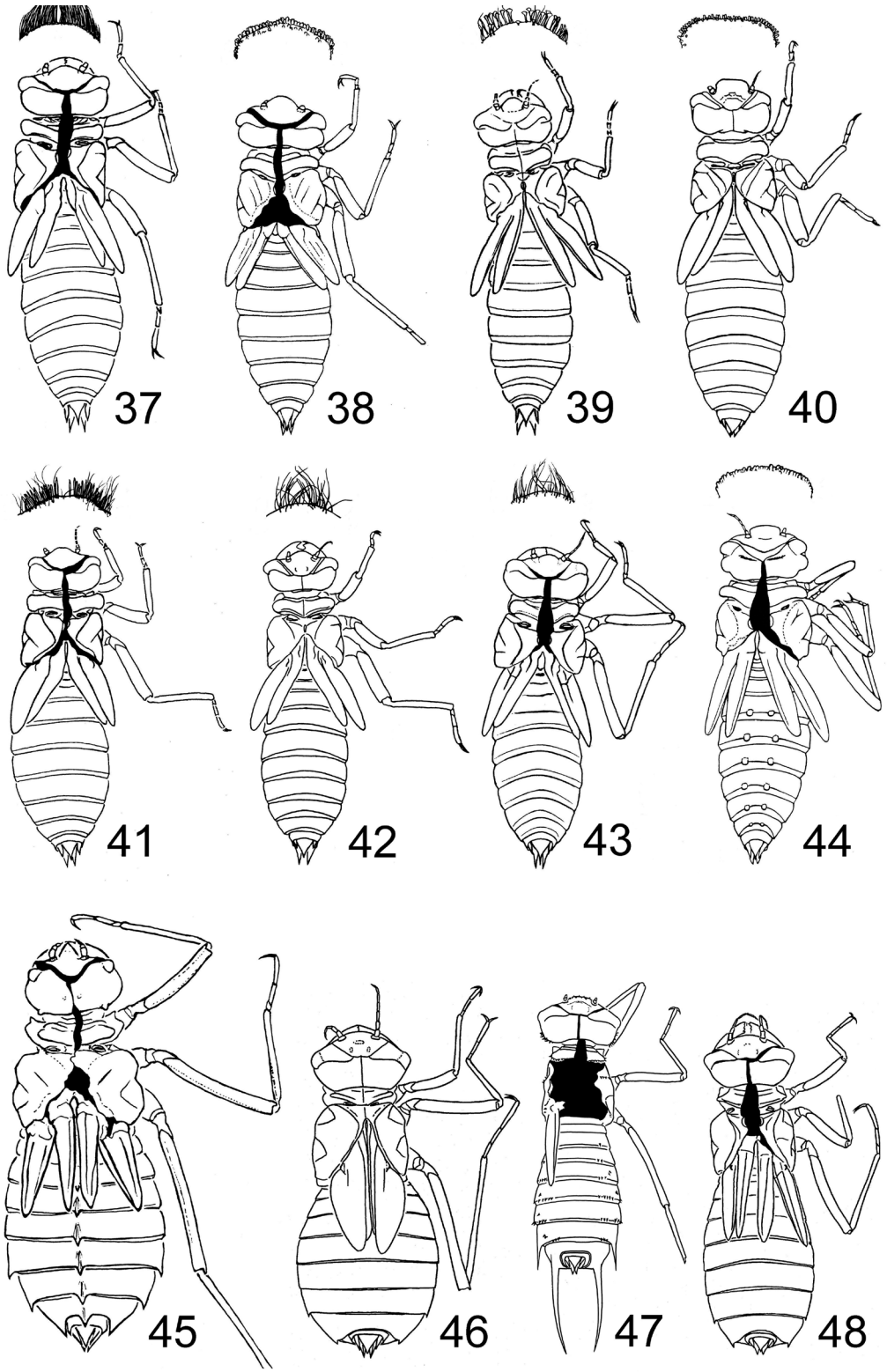
Archaeosynthemis leachii (Selys, 1871)

Fig. 37

Watson (1967); Watson *et al*. (1991); Theischinger (2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Archaeosynthemis occidentalis (Tillyard, 1910)

Watson (1962, 1967), Watson & O'Farrell (1991, 1994), all as *Synthemis macrostigma*; Watson *et al*. (1991), as *Synthemis macrostigma occidentalis*; Theischinger (2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009).



Figs 37-48. Final instar larvae of Australian Anisoptera: (37-44) Synthemistidae (with insert of frontal plate): (37) *Archaeosynthemis leachii*; (38) *Austrosynthemis cyanitincta*; (39) *Choristhemis flavoterminata*; (40) *Eusynthemis ursula*; (41) *Parasynthemis regina*; (42) *Synthemiopsis gomphomacromioides*; (43) *Synthemis eustalacta*; (44) *Tonyosynthemis claviculata*; (45) *Macromia tillyardi* (Macromiidae); (46-48) Corduliidae: (46) *Hemicordulia tau*; (47) *Pentathemis mebranulata*; (48) *Procordulia jacksoniensis.*

Archaeosynthemis orientalis (Tillyard, 1910)

Tillyard (1910b, 1914, 1916b, 1917b), O'Farrell (1970), Allbrook (1979), Hawking (1986), Watson & O'Farrell (1991), Watson *et al*. (1991), all as *Synthemis macrostigma*; Hawking & Theischinger (1999), as *Archaeosynthemis macrostigma*; Theischinger (2001a); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Archaeosynthemis spiniger (Tillyard, 1913)

Watson (1962, 1967), as *Synthemis spiniger*; Theischinger (2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Archaeosynthemis*** Carle, 1995

Confident identifications based on morphology can be achieved for the three south-western Australian species *S. leachii*, *S. occidentalis* and *S. spiniger*; *S. orientalis* is the only species from south-eastern Australia (Theischinger 2001a; Theischinger & Endersby 2009).

Austrosynthemis cyanitincta (Tillyard, 1908)

Fig. 38

Watson (1962, 1967), as *Synthemis cyanitincta*; Watson *et al*. (1991); Theischinger (1998a, 2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.

Choristhemis flavoterminata (Martin, 1901)

Fig. 39

Tillyard (1910b); Hawking & Theischinger (1999); Theischinger (2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Choristhemis olivei (Tillyard, 1909)

Theischinger (2003); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Choristhemis*** Tillyard, 1910

Confident morphology based identifications should be possible (Theischinger 2001a, 2003), but all larvae from south of the Daintree River, certainly from south of the Paluma-Eungella gap, can be confirmed as *C. flavoterminata*.

Eusynthemis aurolineata (Tillyard, 1913)

Theischinger (1998e); Hawking & Theischinger (1999); Theischinger (2001); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Eusynthemis barbarae (Moulds, 1985)

Theischinger (2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Eusynthemis brevistyla (Selys, 1871)

Hawking (1986, 1995); Hawking & Theischinger (1999); Theischinger (2001a); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Eusynthemis deniseae Theischinger, 1977

Theischinger (1977, 2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Eusynthemis guttata (Selys, 1871)

Theischinger (1995, 1998e, 2001a); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009). Tillyard (1910b) and Hawking (1986) have to be referred to *E. tillyardi*.

Eusynthemis netta Theischinger, 1999

Larva not yet recognized.

Eusynthemis nigra (Tillyard, 1906)

Hawking & Theischinger (1999); Theischinger (2001a); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Eusynthemis rentziana Theischinger, 1998

Theischinger (1998e; 2001a); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

Eusynthemis tenera Theischinger, 1995

Larva not yet recognized.

Eusynthemis tillyardi Theischinger, 1995

Tillyard (1910b, 1916b), Hawking (1986), all as *E. guttata*; Theischinger (1995, 1998e); Hawking & Theischinger (1999); Theischinger (2001a); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Eusynthemis ursa Theischinger, 1999

Larva not yet recognized.

Eusynthemis ursula Theischinger, 1998

Fig. 40

Theischinger (2000a, 2001a); Theischinger & Hawking (2000, 2006); Theischinger & Endersby (2009).

Eusynthemis virgula (Selys, 1874)

Fig. 91

Hawking (1986); Hawking & Theischinger (1999); Theischinger (2001a); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009).

*Genus ***Eusynthemis*** Förster, 1903

Based on the morphology of the described larvae three groups can be distinguished: *E. ursula*; *E. brevistyla* and *E. virgula*; the remaining species (Theischinger 2001a; Theischinger & Endersby 2009). It is supposed that *E. ursa* (larva still undescribed) will closely resemble *E. ursula* and that *E. netta,* the adults of which are quite distinct, will be recognisable when found. Firm geographical support for specific identification is not available but the specific ranges (Theischinger 2001a; Theischinger & Endersby 2009) should be looked at when morphology based results appear doubtful.

Parasynthemis regina (Selys, 1874)

Fig. 41

Tillyard (1910b), Hawking (1986), both as *Synthemis regina*; Hawking & Theischinger (1999); Theischinger (2001a); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.

Synthemiopsis gomphomacromioides Tillyard, 1917

Fig. 42

Theischinger (2000d, 2001a); Gooderham & Tsyrlin (2002), as *Synthemiopsis*; Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Tillyard (1917b), Allbrook (1979), both to be referred to a different synthemistid species. Genus monotypic.

Synthemis eustalacta (Burmeister, 1839)

Fig. 43

Tillyard (1910b, 1917b, 1926); O'Farrell (1970); Williams (1980); Hawking (1986); Watson & O'Farrell (1991, 1994); Hawking & Smith (1997); Hawking & Theischinger (1999); Theischinger (2001a, 2010); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Synthemis tasmanica Tillyard, 1910

Allbrook (1979); Theischinger (2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Synthemis*** Selys, 1870

Confirmation of morphology based specific identification by available distributions (Theischinger 2001a; Theischinger & Endersby 2009)). Mainland Australia: *S. eustalacta*; Tasmania: *S. tasmanica*. However, *Synthemis* larvae from the west of Victoria and eastern South Australia agree with *S. tasmanica* and may well be this species.

Tonyosynthemis claviculata (Tillyard, 1909)

Fig. 44

Theischinger 1998a, 2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Tonyosynthemis ofarrelli (Theischinger & Watson, 1986)

Theischinger (1998a, 2001a, 2010); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Tonyosynthemis*** Theischinger, 1998

Confident specific identification possible only by considering distributions (Theischinger 1998a, 2001a). North of Paluma-Eungella gap: *T. claviculata*; south-eastern Queensland and north-eastern New South Wales: *T. ofarrelli*.

Family **Macromiidae**

Only a single genus clearly distinguishable on morphology (Theischinger & Hawking 2006; Theischinger & Endersby 2009; Hawking *et al*. 2013).

Macromia tillyardi Martin, 1906

Fig. 45

Hawking (1993); Theischinger (2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Macromia viridescens Tillyard, 1911

Theischinger (2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Macromia*** Rambur, 1842

Identifications are reliable based on morphology (Theischinger 2001). It seems clear that *M. viridescens* is restricted to Cape York peninsula but existence there of *M. tillyardi* cannot be excluded.

Family **Corduliidae**

Four genera clearly distinguishable on morphology (Theischinger & Hawking 2006, under Corduliidae and Hemicorduliidae; Theischinger & Endersby 2009; Hawking *et al*. 2013).

Hemicordulia australiae (Rambur, 1842)

Watson (1962), O'Farrell (1970); Allbrook (1979); Williams (1980), Hawking (1986); Watson & O'Farrell (1991); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009).

Hemicordulia continentalis Martin, 1907

Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009).

Hemicordulia flava Theischinger & Watson, 1991

Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Hemicordulia intermedia (Selys, 1871)

Hawking (1993); Hawking & Theischinger (1999); Theischinger & Fleck (2003); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009).

Hemicordulia kalliste Theischinger & Watson, 1991

Larva not yet recognized.

Hemicordulia koomina Watson, 1969

Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Hemicordulia superba Tillyard, 1911

Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Hemicordulia tau (Selys, 1871)

Fig. 46

Tillyard (1914, 1915b, 1916b, 1917b, 1926, 1932); Watson (1962, 1968); O'Farrell (1970); Allbrook (1979); Williams (1980); Hawking (1986, 1993, 1995); Watson & O'Farrell (1991); Watson *et al*. (1991); Hawking & Smith (1997); Ingram *et al*. (1997); Hawking & Theischinger (1999); Gooderham & Tsyrlin (2002); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Hemicordulia*** Selys, 1870

The larvae of each of *H. australiae*, *H. flava* and *H. superba* can be identified based on morphology (Theischinger 2007a). Of the morpho-group *H. intermedia* and *H. koomina* only *H. intermedia* has a wide geographical range including northern, central and much of eastern Australia so that only identifications from the Pilbara area are doubtful. Of the morpho-group *H. tau*, *H. continentalis* and *H. kalliste* it appears that *H. kalliste* is the only species at, and restricted to, the extreme north of Australia, whereas *H. tau* is the only one occurring in Western Australia, central and most of southern Australia.

Metaphya tillyardi Ris, 1913

Larva not yet recognized. Sole species of the genus in Australia. Some information on the larva of *M. elongata* Campion, 1921, made available by Fleck (2007) is produced by Theischinger & Endersby (2009) in order to give an idea of what the still undescribed larva of *M. tillyardi* may look like.

Pentathemis membranulata Karsch, 1890

Fig. 47

Hawking (1993); Young (2001); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.

Procordulia affinis (Selys, 1871)

Watson (1962); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Procordulia jacksoniensis (Rambur, 1842)

Fig. 48

O'Farrell (1970); Allbrook (1979); Hawking (1986); Watson & O'Farrell (1991); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Procordulia*** Martin, 1907

Identifications of the two species based on morphology are confirmed beyond any doubt by their widely disjunct distributions (Theischinger 2007a). Southwestern Australia: *P. affinis*; eastern Australia and South Australia: *P. jacksoniensis*.

Family **Libellulidae**

Of 27 genera four, *Crocothemis*, *Diplacodes*, *Nannodiplax* and *Neurothemis,* are difficult to distinguish from each other, and of two, *Notolibellula* and *Raphismia*, the larvae are still undescribed (Theischinger & Hawking 2006, under Urothemistidae and Libellulidae; Theischinger & Endersby 2009; Hawking *et al*. 2013).

Aethriamanta circumsignata Selys, 1897

Hawking (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013), as *Aethriamanta*.

Aethriamanta nymphaeae Lieftinck, 1949

Fig. 49

Hawking (1993); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

*Genus ***Aethriamanta*** Kirby, 1889

The known morphological characters (Hawking 1993) appear insufficient to distinguish the two species. Only *A. circumsignata* has hitherto been found to occur in New South Wales (Theischinger 2007a; Theischinger & Endersby 2009).

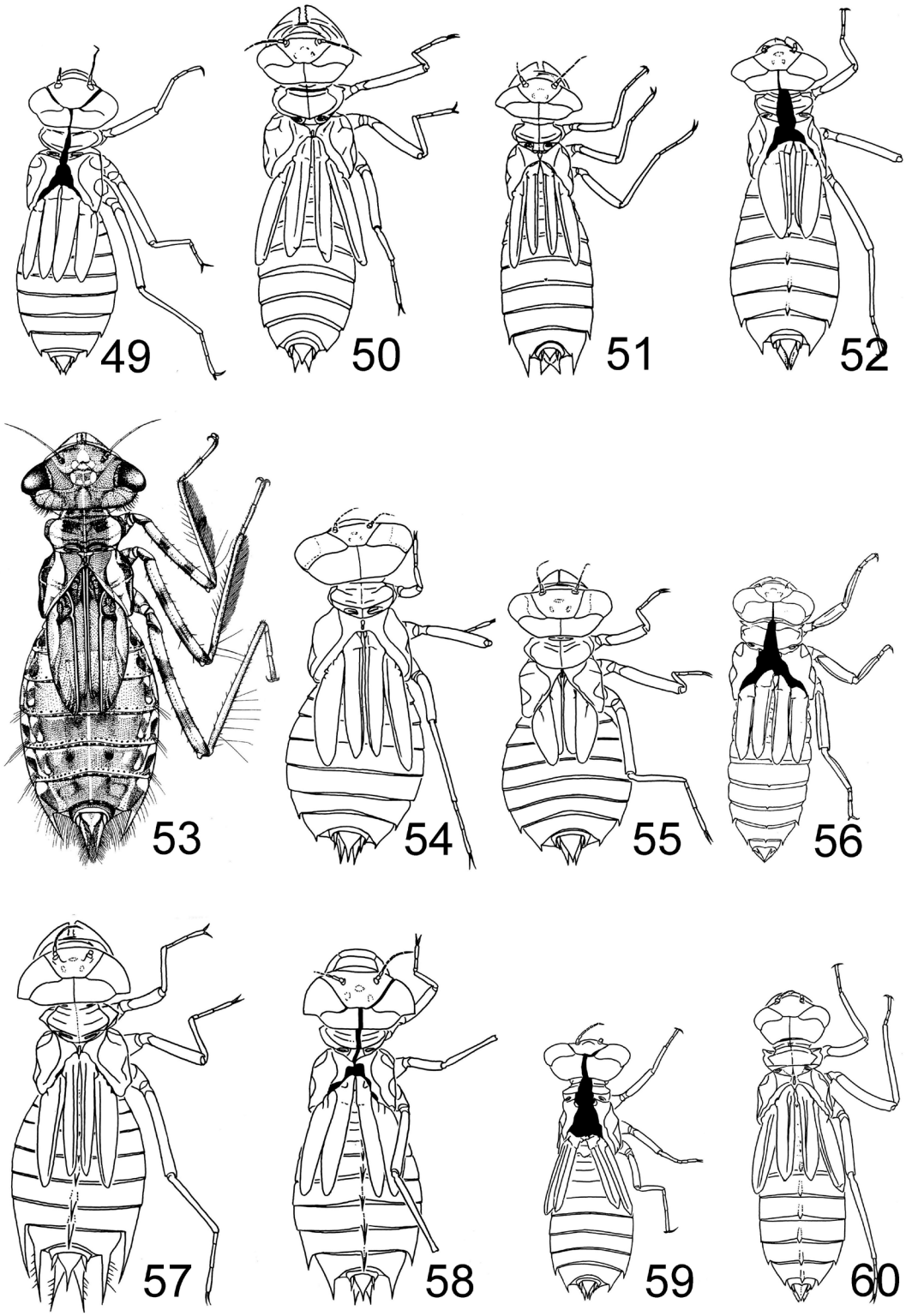
Agrionoptera insignis allogenes Tillyard, 1908

Hawking (1993); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Agrionoptera longitudinalis biserialis Selys, 1879

Fig. 50

Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).



Figs 49-60. Final instar larvae of Australian Libellulidae: (49) *Aethriamanta nymphaeae*; (50) *Agrionoptera longitudinalis*; (51) *Austrothemis nigrescens*; (52) *Brachydiplax denticauda*; (53) *Camacinia gigantea*; (54) *Crocothemis nigrifrons*; (55) *Diplacodes haematodes*; (56) *Huonia melvillensis*; (57) *Hydrobasisleus brevistylus*; (58) *Macrodiplax cora*; (59) *Nannodiplax rubra*; (60) *Nannophlebia risi*.

*Genus ***Agrionoptera*** Brauer, 1854

The two species can confidently be identified based only on morphology. Only A. *insignis* ranges south and west beyond tropical Queensland (Theischinger 2007a; Theischinger & Endersby 2009).

Austrothemis nigrescens (Martin, 1901)

Fig. 51

Watson (1962); Allbrook (1979); Hawking (1986); Hawking & Smith (1997); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.

Brachydiplax denticauda (Brauer, 1867)

Fig. 52

Hawking (1993); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Brachydiplax duivenbodei (Brauer, 1866)

Larva not yet recognized.

*Genus ***Brachydiplax*** Brauer, 1868

Only *Brachydiplax* larvae from south of the Paluma-Eungella gap can with high probability be confirmed as *B*. *denticauda* (Theischinger 2007a).

Camacinia othello Tillyard, 1908

(Fig. 53, *C*. *gigantea*)

Larva not yet recognized. Sole species of *Camacinia* in Australia. It is assumed that the larva of *C*. *othello* will be found to be very similar to its closely related congener *C*. *gigantea* which should be used as a substitute to allow identification of *C*. *othello* in future (Theischinger & Hawking 2006; Theischinger & Endersby 2009; Hawking *et al*. 2013).

Crocothemis nigrifrons (Kirby, 1894)

Fig. 54

Watson (1962); Hawking (1986, 1993); Hawking & Smith (1997); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of *Crocothemis* in Australia. Difficult to distinguish from *Diplacodes*, *Nannodiplax* and *Neurothemis*.

Diplacodes bipunctata (Brauer, 1865)

Tillyard (1917b, 1926); Lieftinck (1962); Watson (1962); O'Farrell (1970); Hawking (1986, 1993); Watson & O'Farrell (1991); Watson *et al*. (1991); Rowe (1992); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009).

Diplacodes haematodes (Burmeister, 1839)

Fig. 55

Tillyard (1914, 1916b, 1917b); Watson (1962); Williams (1980); Hawking (1986, 1993); Hawking & New (1996); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009).

Diplacodes melanopsis (Martin, 1901)

Hawking (1986); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Diplacodes nebulosa (Fabricius, 1793)

Hawking (1993); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Diplacodes trivialis (Rambur, 1842)

Lieftinck (1962); Kumar (1977); Hawking (1993); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

*Genus ***Diplacodes*** Kirby, 1889

Morphological differences separate either of *D*. *haematodes* and *D*. *melanopsis* from the remainder of this genus and from *Nannodiplax rubra*, whereas *D*. *bipunctata* morphologically pairs up with *D*. *trivialis* and *D*. *nebulosa* pairs up with *N*. *rubra*. Confident identifications can be achieved for only *D*. *bipunctata* from Western Australia, central and southern Australia and *N*. *rubra* from the Kimberley (Theischinger 2007a; Theischinger & Endersby 2009).

Huonia melvillensis Brown & Theischinger, 1998

Fig. 56

Theischinger & Brown (2002); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of *Huonia* in Australia.

Hydrobasileus brevistylus (Brauer, 1865)

Fig. 57

Fraser (1963); Hawking (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of *Hydrobasileus* in Australia.

Lathrecista asiatica festa (Selys, 1879)

Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009). The larva referred to in these three papers was identified by supposition only. Sole species of *Lathrecista* in Australia.

Macrodiplax cora (Kaup, 1867)

Fig. 58

Lieftinck (1962); Watson (1962); Hawking (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of *Macrodiplax* in Australia.

Nannodiplax rubra Brauer, 1868

Fig. 59

Hawking (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009). Genus monotypic. Larva at present indistinguishable from *Diplacodes nebulosa,* but can be identified if found in the Kimberley (see under Genus *Diplacodes*).

Nannophlebia eludens Tillyard, 1908

Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Nannophlebia injibandi Watson, 1969

Hawking (1993); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Nannophlebia mudginberri Watson & Theischinger, 1991

Hawking (1993); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Nannophlebia risi Tillyard, 1913

Fig. 60

Tillyard (1913); Hawking (1986, 1995); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Nannophlebia*** Selys, 1878

Distributions confirm *Nannophlebia* larvae from New South Wales and Victoria as *N. risi*. Larvae from north-eastern Australia may be either *N. risi* or *N. eludens*, whereas larvae from northern and Western Australia may be either *N. eludens*, *N. injibandi* or *N. mudginberri* (Theischinger 2007a; Theischinger & Endersby 2009).

Nannophya australis Brauer, 1865

Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007); Theischinger & Endersby (2009).

Nannophya dalei (Tillyard, 1908)

Fig. 92

Allbrook (1979); Hawking (1986); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Nannophya occidentalis (Tillyard, 1908)

Watson (1962); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009).

Nannophya paulsoni Theischinger, 2003

Larva not yet recognized.

Nannophya sp.

Fig. 61

Status uncertain; known only from larvae from near Barcaldine, Queensland.

*Genus ***Nannophya*** Rambur, 1842

Distributions confirm most of the identifications based on morphology (Theischinger 2007a). Larvae from the very north of Australia may belong to either *N. australis* or *N. paulsoni* (larva still undescribed).

Neurothemis oligoneura Brauer, 1867

Larva not yet recognized.

Neurothemis stigmatizans (Fabricius, 1775)

Fig. 62

Lieftinck (1962); Hawking (1993); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013). Difficult to distinguish from *Crocothemis*, *Diplacodes* and *Nannodiplax*.

*Genus ***Neurothemis*** Brauer, 1867

Neurothemis larvae from the very north of Australia may belong to either *N. stigmatizans* or to *N. oligoneura*, but only *N. stigmatizans* occurs in the Kimberley and in south-eastern Queensland and north-eastern New South Wales (Theischinger 2007a).

Notolibellula bicolor Theischinger & Watson, 1977

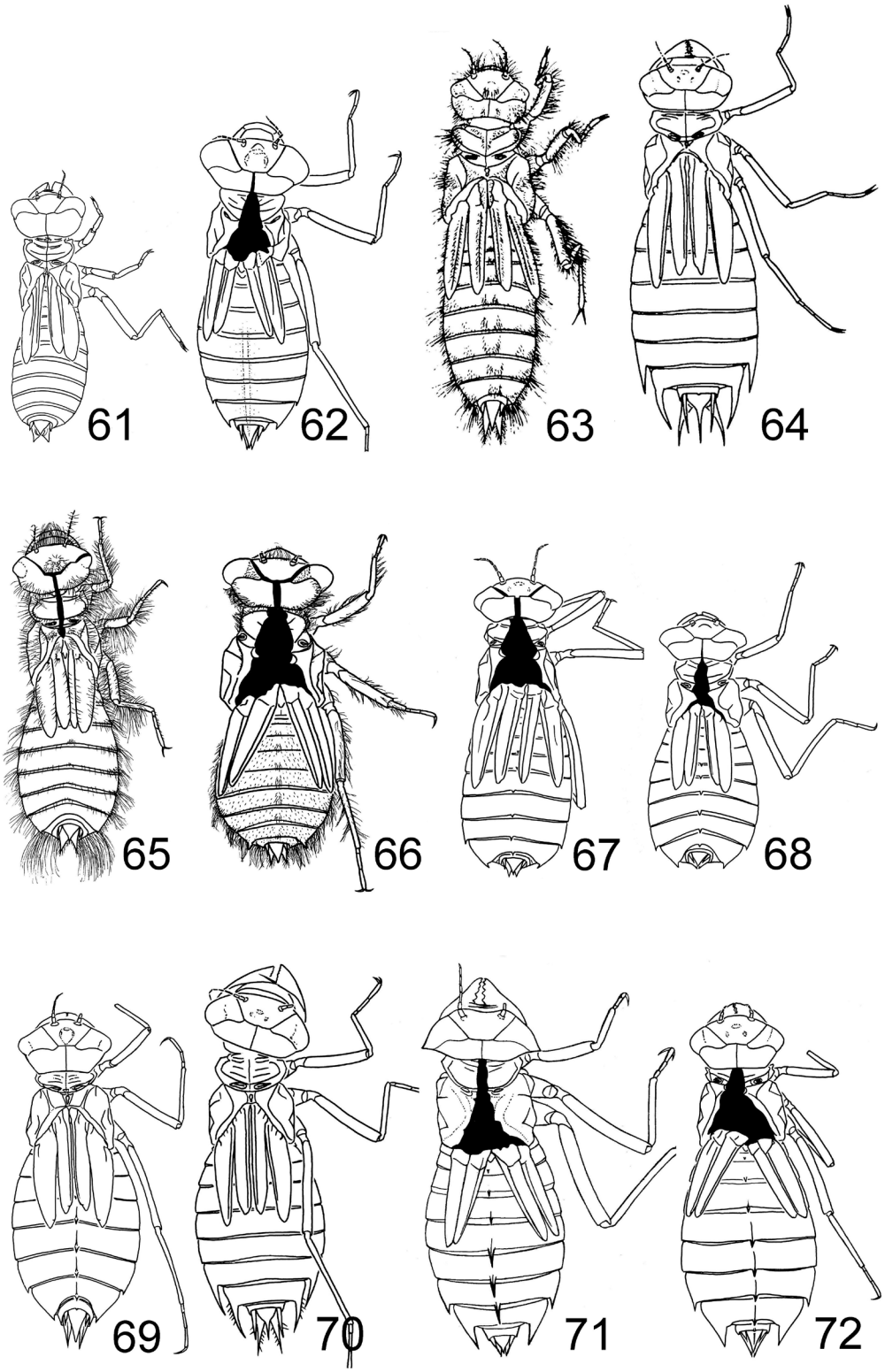
Larva not yet recognized. Genus monotypic.

Orthetrum balteatum Lieftinck, 1933

Hawking & Theischinger (2002); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009). The larva was identified by supposition only.

Orthetrum boumiera Watson & Arthington, 1978

Watson & Arthington (1978), with error as pointed out in Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009).



Figs 61-72. Final instar larvae of Australian Libellulidae: (61) *Nannophya* sp. (from Barcaldine); (62) *Neurothemis stigmatizans*; (63) *Orthetrum caledonicum*; (64) *Pantala flavescens*; (65) *Potamarcha congener*; (66) *Rhodothemis lieftincki*; (67) *Rhyothemis princeps*; (68) *Tetrathemis irregularis*; (69) *Tholymis tillarga*; (70) *Tramea stenoloba*; (71) *Urothemis aliena*; (72) *Zyxomma elgneri*.

Orthetrum caledonicum (Brauer, 1865)

Figs 63, 93

Tillyard (1916b, 1917b); Watson (1962); O'Farrell (1970); Watson & Arthington (1978); Hawking (1986, 1993, 1995); Watson & O'Farrell (1991), Hawking & New (1996); Hawking & Smith (1997); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Orthetrum migratum Lieftinck, 1951

Watson & Arthington (1978); Hawking (1993); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Larva not identifiable at present.

Orthetrum sabina (Drury, 1770)

Needham (1904); Watson & Arthington (1978); Hawking (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Orthetrum serapia Watson, 1984

Larva not yet recognized.

Orthetrum villosovittatum (Brauer, 1868)

Watson & Arthington (1978); Hawking (1986, 1993); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009).

*Genus ***Orthetrum*** Newman, 1833

Distributions confirm identifications on morphological basis from New South Wales and Victoria as *O. sabina* and *O. villosovittatum* and from north-western Australia as *O. migratum*. Larvae from northern Australia identified based on morphology as *O. sabina* may belong to either *O. sabina* or *O. serapia*. *O. caledonicum* can also be confidently identified if the larvae do not come from coastal south-eastern Queensland and coastal north-eastern New South Wales where *O. boumiera* occurs in dune situations (Theischinger 2007a).

Pantala flavescens (Fabricius, 1798)

Fig. 64

Cabot (1890), Lieftinck (1962); Watson (1962); Hawking (1993); Hawking & Ingram (1994); Hawking & Smith (1997); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of *Pantala* in Australia.

Potamarcha congener (Rambur, 1842)

Fig. 65

Kumar (1977); Van Tol (1992); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of *Potamarcha* in Australia.

Raphismia bispina (Hagen, 1867)

Larva not yet recognized. Sole species of *Raphismia* in Australia.

Rhodothemis lieftincki Fraser, 1954

Fig. 66

Hawking (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of *Rhodothemis* in Australia.

Rhyothemis braganza Karsch, 1890

Hawking (1993); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Rhyothemis graphiptera (Rambur, 1842)

Hawking (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Rhyothemis phyllis (Sulzer, 1776)

Lieftinck (1962); Hawking & Theischinger (1999); Theischinger (2000a, 2007a); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Rhyothemis princeps Kirby, 1894

Fig. 67

Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Rhyothemis resplendens Selys, 1878

Larva not yet recognized.

*Genus ***Rhyothemis*** Hagen, 1867

Larvae from tropical Queensland identified as either *R. braganza, R. graphiptera, R. phyllis* or *R. princeps* may belong to *R. resplendens* the larva of which is still undescribed, whereas *Rhyothemis* larvae collected outside of tropical Queensland can confidently be identified on morphology (Theischinger 2007a).

Tetrathemis irregularis cladophila Tillyard, 1908

Fig. 68

Theischinger & Fleck (2003); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of *Tetrathemis* in Australia.

Tholymis tillarga (Fabricius, 1798)

Fig. 69

Lieftinck (1962); Hawking (1993); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of *Tholymis* in Australia

Tramea eurybia Selys, 1878

Larva not yet recognized.

Tramea loewii Kaup, 1866

Tillyard (1917b, 1926); Hawking (1986, 1993), all as *Trapezostigma loewii*; Theischinger & Hawking (2003, 2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Tramea propinqua Lieftinck, 1942

Lieftinck (1962); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Tramea stenoloba (Watson, 1962)

Fig. 70

Watson (1962), Hawking (1993), both as *Trapezostigma stenoloba*; Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Larva not identifiable at present.

*Genus ***Tramea*** Hagen, 1861

Distributions confirm only identification of *Tramea* larvae from southern New South Wales and Victoria as *T. loewii*. *Tramea* larvae from north-eastern New South Wales may belong to either *T. loewii* or *T. eurybia*, from inland (including northern) and Western Australia either to *T. loewii* or *T. stenoloba*, whereas all four *Tramea* species may have to be considered in north-eastern Australia (Theischinger 2007a).

Urothemis aliena Selys, 1878

Fig. 71

Hawking (1993); Burwell & Theischinger (2003); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Sole species of the genus in Australia.

Zyxomma elgneri Ris, 1913

Fig. 72

Hawking (1993); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Zyxomma multinervorum Carpenter, 1897

Larva not yet recognized.

Zyxomma petiolatum Rambur, 1842

Lieftinck (1962); Hamada & Inoue (1985), not conforming to Lieftinck (1962); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

*Genus ***Zyxomma*** Rambur, 1842

The larva of *Z. multinervorum* is still unknown and non-conforming descriptive information is available for *Z. petiolatum*. All three species inhabit northern Queeensland and Northern Territory, but only *Zyxomma elgneri* occurs in southern Queensland, New South Wales and north-western Australia (Theischinger 2007a).

Genera Incertae Sedis

Nine genera clearly distinguishable on morphology; several very distinct units distinguishable but without general taxonomic recognition (Theischinger & Hawking 2006, under Gomphomacromiidae, Pseudocorduliidae, Austrocorduliidae, Cordulephyidae and Oxygastridae; Theischinger & Endersby 2009, under Gomphomacromiidae, Pseudocorduliidae, Austrocorduliidae and Cordulephyidae; Hawking *et al*. 2013).

Archaeophya adamsi Fraser, 1959

Fig. 73

Theischinger & Watson (1984); Hawking & Theischinger (1999); Theischinger (2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Archaeophya magnifica Theischinger & Watson, 1978

Theischinger (1978), as Gomphomacromiinae sp.; Williams (1980), as *Archaeophya*; Theischinger & Watson (1984); Hawking (1995); Theischinger (2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

*Genus ***Archaeophya*** Fraser, 1959

Identifications based on morphology can be confirmed by the widely disjunct distributions (Theischinger 2001a) . Tropical Queensland: *A. magnifica*; greater Sydney area: *A. adamsi*. (Theischinger et al. 2011)

Pseudocordulia circularis Tillyard, 1909

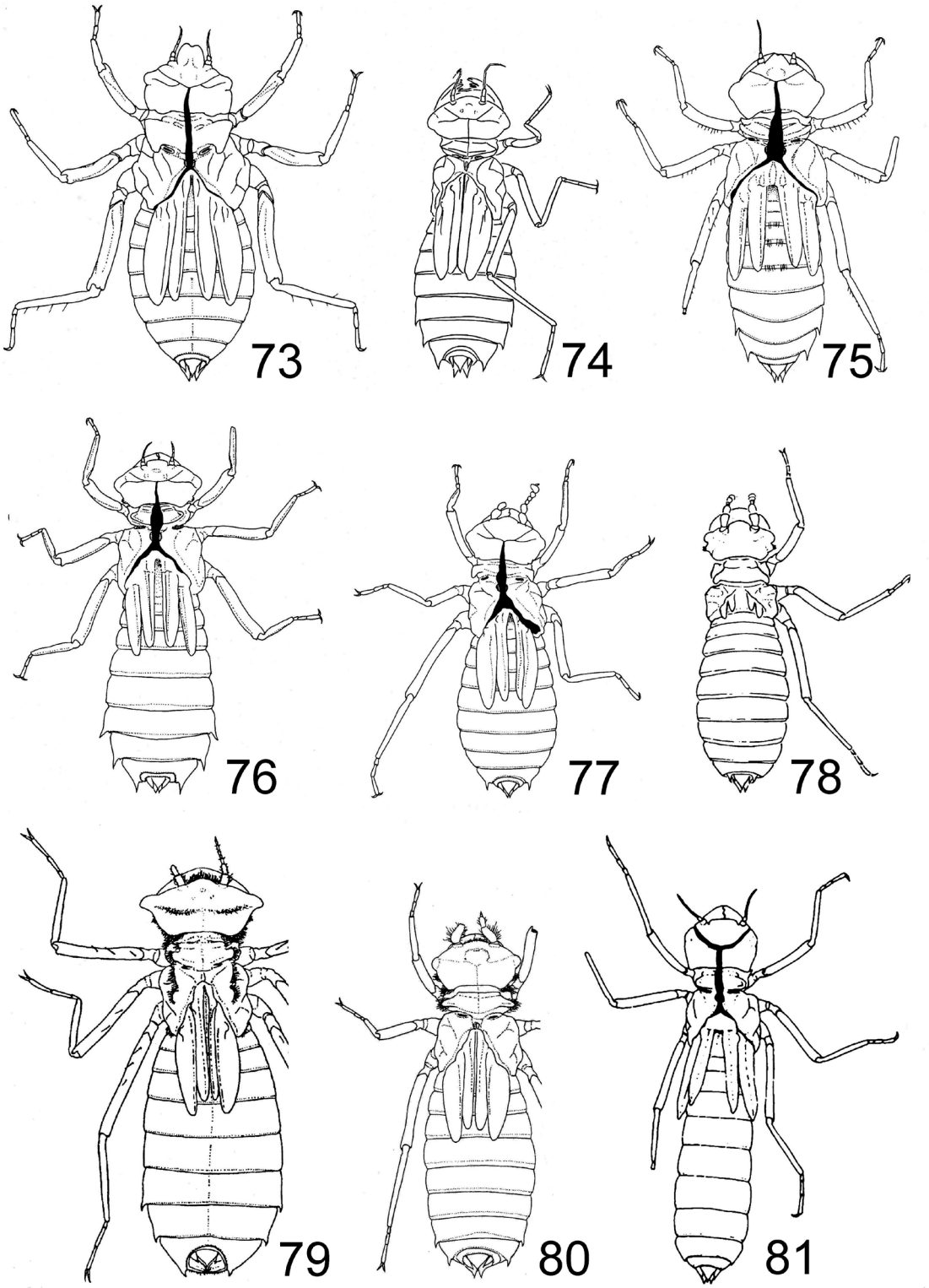
Fig. 94

Larva not identifiable/?available.

Pseudocordulia elliptica Tillyard, 1913

Fig. 94

Larva not identifiable/?available.



Figs 73-81. Final instar larvae of Australian Libelluloidea of genera *incertae sedis*: (73) *Archaeophya adamsi*; (74) *Cordulephya pygmaea*; (75) *Apocordulia macrops*; (76) *Austrocordulia leonardi*; (77) *Austrophya mystica*; (78) *?Austrophya* sp.; (79) *Hesperocordulia berthoudi*; (80) *Lathrocordulia metallica*; (81) *Micromidia convergens*.

*Genus ***Pseudocordulia*** Tillyard, 1909

Watson (1982), Theischinger & Watson (1984), Theischinger (2001a, 2010), Theischinger & Hawking (2006), Theischinger & Endersby (2009), Hawking *et al*. (2013), all as *Pseudocordulia* sp. The adults of the two *Pseudocordulia* species are extremely similar, and apparently the two species usually coexist (Theischinger & Watson 1978). Specific identification will probably be difficult even when larvae associated with adults of both species become available.

Cordulephya bidens Sjöstedt, 1917

Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Cordulephya divergens Tillyard, 1917

Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Cordulephya montana Tillyard, 1911

Tillyard (1911b, 1917b); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger (2007a); Theischinger & Endersby (2009).

Cordulephya pygmaea Selys, 1870

Fig. 74

Tillyard (1911b, 1914, 1916b, 1917b); Williams (1980), Hawking (1986); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger (2007a, 2010); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Cordulephya*** Selys, 1870

Cordulephya larvae identified from north of the Paluma-Eungella gap can be confirmed by distribution as *C. bidens*. *C. pygmaea* is probably the only species in Queensland south of the Paluma-Eungella gap (Theischinger 2007a). *C. pygmaea*, *C. divergens* and *C. montana* may coexist in south-eastern Australia and distinguishing *C. pygmaea* from *C. divergens*/*montana* from there is difficult and often doubtful. Separating larvae of *C. divergens* and *C. montana* is not possible at present.

Apocordulia macrops Watson, 1980

Fig. 75

Theischinger & Watson (1984); Hawking (1986); Hawking & Theischinger (1999); Theischinger (2001a, 2009, 2010); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Theischinger *et al*. (2012, 2013); Hawking *et al*. (2013).

Genus monotypic.

Austrocordulia leonardi Theischinger, 1973

Fig. 76

Theischinger (1973, 2001a, 2010); Theischinger & Watson (1984); Hawking & Theischinger (1999); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Theischinger *et al*. (2009, 2013).

Austrocordulia refracta Tillyard, 1909

Tillyard (1910c, 1914, 1916b 1917b); Theischinger (1973, 1999, 2001a, 2010); Theischinger & Watson (1984); Hawking (1986); Hawking & Theischinger (1999); Theischinger & Hawking (2003, 2006); Theischinger & Endersby (2009); Theischinger *et al*. (2009).

Austrocordulia territoria Theischinger & Watson, 1978

Theischinger & Watson (1984); Hawking (1993); Theischinger (2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Austrocordulia*** Tillyard, 1909

A significant disjunction exists between the ranges of *A. territoria* (north of Northern Territory) and *A. leonardi* (eastern New South Wales). A disjunction also exists between the ranges of *A. territoria* and *A. refracta* (eastern Australia) which in eastern New South Wales coexists in places with *A. leonardi*. However, exclusive geographical ranges are not necessary for confident identifications of the three species (Theischinger 2001a).

Austrophya mystica Tillyard, 1909

Fig. 77

Theischinger & Watson (1984); Theischinger (2001a, 2010); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus possibly monotypic.

?Austrophya sp.

Fig. 78

Theischinger (2001a), as Genus "L", species"m".

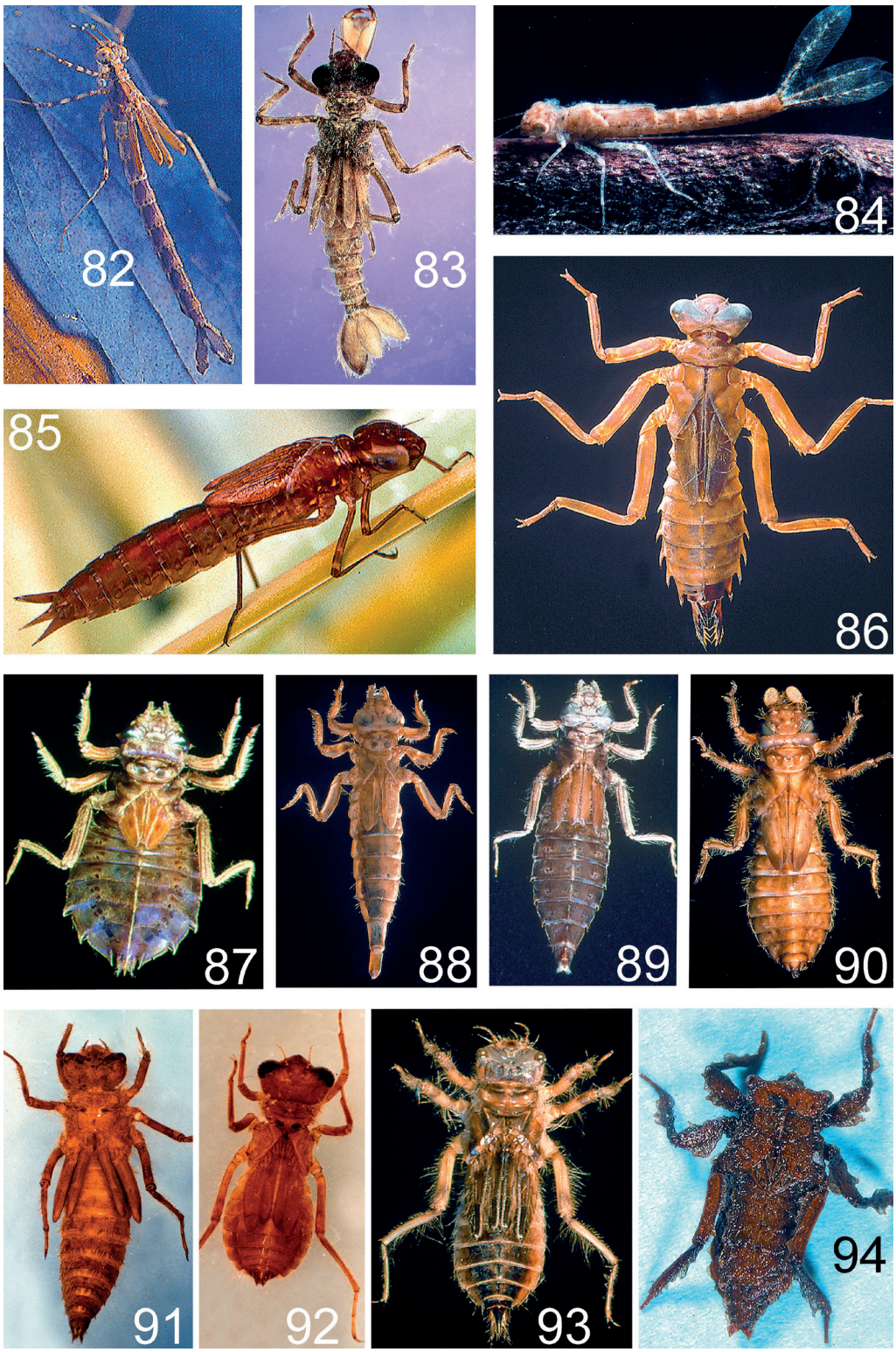
*Genus ***Austrophya*** Tllyard, 1909

There are marked morphological and size differences between *A. mystica* and *A.* sp. It is not considered certain that *A.* sp. is congeneric with *A. mystica*.

Hesperocordulia berthoudi Tillyard, 1911

Fig. 79

Ris (1910), as larva E; Watson (1962); Theischinger & Watson (1984); Theischinger (2001a, 2010); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013). Genus monotypic.



Figs 82-94. Larvae of Australian Odonata: (82) *Synlestes weyersii* (Synlestidae); (83) *Griseargiolestes intermedius* (Argiolestidae); (84) *Xanthagrion erythroneur*um (Coenagrionidae); (85, 86) Aeshnidae: (85) *Anax papuensis*; (86*) Notoaeschna sagittata*; (87- 90) Gomphidae: (87) *Ictinogiomphus australis*; (88) *Antipodogomphus acolythus*; (89) *Austroepigomphus (Xerogomphus) turneri*; (90*) Hemigomphus heteroclytus*; (91) *Eusynthemis virgula* (Synthemistidae); (92, 93) Libellulidae: (92) *Nannophya dalei*; (93) *Orthetrum caledonicum*; (94) *Pseudocordulia* sp. (Libelluloidea genera *incertae sedis*).

Lathrocordulia garrisoni Theischinger & Watson, 1991

Larva not available.

Lathrocordulia metallica Tillyard, 1911

Fig. 80

Watson (1962); Theischinger & Watson (1984); Theischinger (2001a, 2010); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

*Genus ***Lathrocordulia*** Tillyard, 1911

The significant disjunction between the ranges of *L. metallica* (south-western Australia) and *A. garrisoni* (tropical Queensland) should be sufficient to establish or support confident identification of the two species once the larva of *L. garrisoni* is discovered (Theischinger 2001a; Theischinger & Endersby 2009).

Micromidia atrifrons (McLachlan, 1883)

Theischinger (1978), as Gomphomacromiinae sp.; Theischinger & Watson (1984); Hawking & Theischinger (1999); Theischinger (2001a); Theischinger & Hawking (2006); Theischinger & Endersby (2009); Hawking *et al*. (2013).

Micromidia convergens Theischinger & Watson, 1978

Fig. 81

Theischinger & Watson (1984), as *Micromidia* "l"; Hawking & Theischinger (1999); Theischinger (2001a, 2010); Theischinger & Hawking (2006); Theischinger & Endersby (2009).

Micromidia rodericki Fraser, 1959

Larva not available.

*Genus ***Micromidia*** Fraser 1959

The island distribution (Thursday Island, Torres Strait) will most probably confirm the identification of the larva of *M. rodericki* once it is available (Theischinger 2001a). Distributional support is not needed to distinguish the larvae of the other two species. It appears that *M. atrifrons* is not present in southern inland Queensland, whereas there are no records of *M. convergens* from north-eastern Queensland (Theischinger & Endersby 2009).

Table 1. Australian odonate species and their larvae: original description, first descriptions of larva, confidence in identifications, supportive information

Taxon	OD	Ld	Au	IDR (*=for species, + =for group of species) based on				n	IDR	Total geographical range or, indicated by P, part of it where I based on M is reliable or supported
				M	G	g	e			
ORDER ODONATA	2 suborders clearly distinguishable on morphology									
SUBORDER ZYGOPTERA	8 families clearly distinguishable on morphology									
Family Hemiphlebiidae	**monotypic**									
Hemiphlebia mirabilis	1869	1928	Ti	*					*	
Family Synlestidae	**3 genera clearly distinguishable on morphology**									
Chorismagrion risi	1914	1956	Fr	*					*	
Episynlestes albicauda	1913	1993	Thea	+	*				*	**s and i Qld, ne NSW**
Episynlestes cristatus	1977	1956	Fr		*				*	**Qld N of P-E gap**
Episynlestes intermedius	1985	1993	Thea		*				*	**Qld: Eungella area**
Synlestes selysi	1917	1993	Thea	+	+	*			*	**P:** Qld: Eungella area
Synlestes weyersii	1869	1914	Ti			*			*	**P:** Qld: Carnarvon N.P., Victoria
Synlestes tropicus	1917	1993	Thea		*				*	**Qld: N of P-E gap**
Family Lestidae	**3 genera clearly distinguishable on morphology**									
Austrolestes aleison	1979	1962	Wa	+	*				*	**s WA**
Austrolestes psyche	1862	1917	Ti		*				*	**se A, SA**

Taxon	OD	Ld	Au	IDR (*=for species, + =for group of species) based on				n	IDR	Total geographical range or, indicated by P, part of it where I based on M is reliable or supported
				M	G	g	e			
Austrolestes minjerriba	1979	1999	HaTh	*					*	
Austrolestes annulosus	1862	1910	Ri	*					*	
Auslrolestes analis	1842	1906	Ti	*					*	
Austrolestes aridus	1908	1960	Li	*	+				*	
Austrolestes cingulatus	1839	1906	Ti	*					*	
Austrolestes io	1862	1960	Li	*					*	
Austrolestes leda	1862	1906	Ti	*					*	
Austrolestes insularis	1913				*			0	/	**most of n A**
Indolestes alleni	1913							0		
Indolestes obiri	1979			?+	+			0		
Indolestes tenuissimus	1906	1960	Li							
Lestes concinnus	1862	1960	Li	*					*	
Family Lestoideidae	**2 genera clearly distinguishable on morphology and size**									
Lestoidea barbarae	1967							0		
Lestoidea brevicauda	1996			?				0		
Lestoidea conjuncta	1913	1956	Fr	+	+					
Lestoidea lewisiana	1996					*		0	/	**P:** Qld: Mt Lewis area
Diphlebia coerulescens	1913	1980	St			*			*	**P:** Qld: Eungella area
Diphlehia euphoeoides	1907	1980	St	?	+					
Diphlebia hybridoides	1912	1980	St							
Diphlebia lestoides	1853	1909	Ti	+						
Diphlebia nymphoides	1912	1912	Ti		+	*			*	**P:** Qld: Carnarvon N.P.
Family Argiolestidae	**5 genera clearly distinguishable on morphology**									
Archiargiolestes parvulus	1977	1998	Th							
Archiargiol. pusillissimus	1925	1998	Th	+	+					
Archiargiolestes pusillus	1908	1962	Wa							
Austroargiolestes alpinus	1913							0		
Austroargiol. brookhousei	1986							0		
Austroargiolestes amabilis	1899							0		
Austroargiolestes aureus	1906	2006	ThHa							
Austroargiolestes calcaris	1958	1999	HaTh							
Austroargiolestes christine	1986			+	+			0		
Austroargiolestes chrysoides	1913	2006	ThHa							
Austroargiolestes elke	1986							0		
Austroargiolestes isabellae	1986	1995	Mu							
Austroargiolestes icteromelas	1862	1917	Ti							

Taxon	OD	Ld	Au	IDR (*=for species, + =for group of species) based on				n	IDR	Total geographical range or, indicated by P, part of it where I based on M is reliable or supported
				M	G	g	e			
Griseargiolestes albescens	1913	1999	HaTh	*	+				*	
Griseargiolestes bucki	1998	1998	Th	*					*	
Griseargiolestes eboracus	1913	1999	HaTh	*					*	
Griseargiolestes griseus	1862	1914	Ti	+		*			*	**P:** N and E from alpine region
Griseargiolestes intermedius	1913	1999	HaTh			*			*	**P:** alpine region
Griseargiolestes fontanus	1913						*	0		**E:** rain forest
Griseargiolestes metallicus	1917				*			0	/	**Qld N of P-E gap**
Miniargiolestes minimus	1908	1962	Wa	*					*	
Podopteryx selysi	1899	1978	WaDy	*			*		*	**E:** treeholes
Family Isostictidae	**8 genera clearly distinguishable on morphology**									
Austrosticta fieldi	1908	1993	Ha	+	+	*			*	**P:** NT
Austrosticta soror	1917	1991	WaOF	?						
Austrosticta frater	1997					*		0	/	**P:** most of n Qld
Eurysticta coolawanyah	1969	1969	Wa	+	*				*	**n WA: Pilbara area**
Eurysticta coomalie	1991	1993	Ha	?	+					
Eurysticta kununurra	1991	1993	Ha							
Eurysticta reevesi	2001				*			0	/	**n Qld**
Labidiosticta vallisi	1955	1999	HaTh	*					*	
Lithosticta macra	1991	1993	Ha	*					*	
Neosticta canescens	1913	1914	Ti		*				*	**se Qld, e NSW**
Neosticta fraseri	1991	2006	ThHa		+					
Neosticta silvarum	1917							0		
Oristicta filicicola	1913	1956	Fr	*					*	
Rhadinosticta banksi	1913	1993	Ha	*	+				*	
Rhadinosticta simplex	1901	1914	Ti	*		*			*	**P:** s Q, NSW, Vic
Selysioneura sp.		2009	Th	*					*	**Qld N of P-E gap;** Adults unknown
Family Platycnemididae	**1 genus distinguishable on morphology**									
Nososticta baroalba	1984			?+	+			0		
Nososticta coelestina	1906							0		
Nososticta fraterna	1933	1993	Ha							
Nososticta kalumburu	1984							0		
Nososticta koolpinyah	1984							0		
Nososticta koongarra	1984	1993	Ha							
Nososticta liveringa	1984							0		
Nososticta mouldsi	2000							0		
Nososticta pilbara	1969	1969	Wa							
Nososticta solitaria	1906							0		
Nososticta taracumbi	1984							0		
Nososticta solida	1860	1982	Nu			*			*	**P:** NSW, Vic

Taxon	OD	Ld	Au	IDR (*=for species, + =for group of species) based on				n	IDR	Total geographical range or, indicated by P, part of it where I based on M is reliable or supported
				M	G	g	e			
Family Coenagrionidae	**13 genera distinguishable on morphology, two of them difficult, larvae of one unknown**									
Aciagrion fragile	1906	1993	Ha	*					*	
Agriocnemis argentea	1906			?+	+			0		
Agriocnemis dobsoni	1954							0		
Agriocnemis kunjina	1969	2006	ThHa							
Agriocnemis rubricauda	1913							0		
Agriocnemis pygmaea	1842	1979	Al			*			*	**P:** NSW
Agriocnemis femina	1868	1962	Li		*				*	**n CY**
Archibasis mimetes	1913							0		no substitute species
Argiocnemis rubescens	1877	1917	Ti	*					*	
Austroagrion cyane	1876	1962	Wa	+	*				*	**s WA, SA**
Austroagrion watsoni	1982	1917	Ti		*				*	**se A** (excl. western Victoria)
Austroagrion pindrina	1969				*			0	/	**n WA: Pilbara area**
Austroagrion exclamationis	1915	1993	Ha	*					*	**ne and n A except Pilbara area**
Austrocnemis maccullochi	1926	1993	Ha	*					*	
Austrocnemis obscura	1991			?	*			0	/	**WA: Kimberley**
Austrocnemis splendida	1901	1917	Ti	+	*				*	**e A**
Austrocoenagrion lyelli	1913	1979	Al	*					*	
Caliagrion billinghursti	1901	1914	Ti	*					*	
Ceriagrion aeruginosum	1869	1936	Li	*					*	
Ischnura aurora	1865	1917	Ti	*					*	
Ischnura heterosticta	1839	1917	Ti	*	+				*	
Ischnura pruinescens	1906	1993	Ha	*					*	
Pseudagrion aureofrons	1906	1986	Ha	*					*	
Pseudagrion microcephalum	1842	1962	Li	*					*	
Pseudagrion ignifer	1906	2000	Th	*					*	
Pseudagrion lucifer	1997	2006	ThHa	*	+				*	
Pseudagrion cingillum	1869							0		
Pseudagrion jedda	1991							0		
Teinobasis rufithorax	1877			+				0	/	**ne Qld, CY;** id by substitution (*T. ariel*)
Xanthagrion erythroneurum	1876	1962	Wa	*					*	
SUBORDER ANISOPTERA	8 families + 1 group of genera incertae sedis clearly distinguishable on morphology									
Family Austropetaliidae	**2 genera clearly distinguishable on morphology**									
Archipetalia auriculata	1917	1979	Al	*					*	
Austropetalia annaliese	2013				*			0	/	**NSW N of Hunter River**
Austropetalia patricia	1910	1910	Ti	*	*				*	**NSW N of latitude ca 35º and S of Hunter River**
Austropetalia tonyana	1995	1986	Ha	*	*				*	**NSW S of latitude ca 35º, Vic**
Family Aeshnidae	**15 genera: 14 distinguishable on morphology and size, larvae of one undescribed;** several very distinct units distinguishable but without general taxonomic recognition									
Adversaeschna brevistyla	1842	1910	Ri	*					*	
Agyrtacantha dirupta	1889			+				0	/	**CY**

Taxon	OD	Ld	Au	IDR (*=for species, + =for group of species) based on				n	IDR	Total geographical range or, indicated by P, part of it where I based on M is reliable or supported
				M	G	g	e			
Anaciaeschna jaspidea	1839	2002	Th	*					*	
Anax georgius	1872	1987	WaTh	*					*	
Anax gibbosulus	1842	1987	WaTh	*					*	
Anax guttatus	1839	2002	Th	*					*	
Anax papuensis	1839	1916	Ti	*		*			*	**P:** WA W of Kimberley, c & s A
Austrogynac. heterogena	1908	1993	Ha	*					*	
Gynacantha dobsoni	1951	1916	Ti							
Gynacantha rosenbergi	1867	2007	Th	+						
Gynacantha kirbyi	1898			?	+			0		
Gynacantha mocsaryi	1898	1963	Fr	+						
Gynacantha nourlangie	1991	1993	Ha	*					*	
Dendroaeschna conspersa	1907	1914	Ti	*					*	
Acanthaeschna victoria	1901	2000	Th	*					*	
Antipodophlebia asthenes	1916	1980	WaTh	*					*	
Austroaeschna christine	1993	1993	Th		*				*	**Qld: Eungella area**
Austroaeschna ingrid	2008	2008	Th		*				*	**Vic: Grampians**
Austroaeschna multipunctata	1901	1982	Th	+	*				*	**NSW S of lat. ca 35ºS, most of Vic**
Austroaeschna sigma	1982	1982	Th		*				*	**se Qld; NSW N of lat. ca 34ºS**
Austroaeschna parvistigma	1883	1916	Ti				*		*	**E:** boggy and swampy habitats
Austroaeschna obscura	1982	1916	Ti	*					*	
Austroaesch. flavomaculata	1916	1982	Th	*					*	
Austroaeschna atrata	1901	1982	Th	*		*			*	**NSW and Vic: alpine region**
Austroaeschna subapicalis	1982	1916	Ti	*	+	*			*	**se Qld; NSW and Vic: N, S, E and W of alpine region**
Austroaeschna hardyi	1917	1979	Al	*	+				*	
Austroaeschna tasmanica	1916	1979	Al	*					*	
Austroaeschna anacantha	1908	1910	Ri	*	*				*	**s WA**
Austroaeschna cooloola	1991	1999	HaTh		*				*	**Qld: Cooloola area**
Austroaeschna pinheyi	2001	1982	Th		*				*	**si Qld**
Austroaeschna speciosa	1917	1982	Th	+	*				*	**Qld N of P-E gap**
Austroaeschna unicornis	1901	1916	Ti		*				*	**e A S of P-E gap & except Cooloola region**
Austroaeschna inermis	1901	1975	Th	*					*	
Austroaeschna eungella	1993	1993	Th	*	*				*	**Qld: Eungella a. & Clarke Ra.**
Austroaeschna muelleri	1982	1982	Th	*	*				*	**Qld: Carnarvon N.P.**
Austroaeschna pulchra	1909	1916	Ti	*	*				*	**much of e A**
Austrophlebia costalis	1907	1916	Ti	*	*				*	**e A: S of P-E gap**
Austrophlebia subcostalis	1996	1996	Th	*	*				*	**Qld: N of P-E gap**
Dromaeschna forcipata	1907	1982	Th	*	+				*	
Dromaeschna weiskei	1908	1982	Th	*					*	
Notoaeschna geminata	1982	1916	Ti	+	*				*	**se Qld, NSW N of Hunter River**
Notoaeschna sagittata	1901	1970	OF		*				*	**NSW S of Hunter River, Vic**

Taxon	OD	Ld	Au	IDR (*=for species, + =for group of species) based on				n	IDR	Total geographical range or, indicated by P, part of it where I based on M is reliable or supported
				M	G	g	e			
Spinaeschna tripunctata	1901	1975	Th	*	*				*	**NSW, Vic**
Spinaeschna watsoni	1982	1982	Th	*	*				*	**Qld: N of P-E gap**
Telephlebia brevicauda	1916	1970	OF	+	*				*	**NSW S of lat. ca 35º30'S, Vic**
Telephlebia cyclops	1916	1999	HaTh		*				*	**Qld S of P-E gap, ne NSW**
Telephlebia godeffroyi	1883	1916	Ti		*				*	**NSW N of lat. ca 35º30'S**
Telephlebia tillyardi	1916	2002	Th	+	*				*	**Qld: N of P-E gap**
Telephlebia tryoni	1917	2002	Th		*				*	**coastal se Qld and ne NSW**
Telephlebia undia	1985				*			0	/	**Qld: Carnarvon N. P.**
Family Petaluridae	**1 genus distinguishable on morphology**									
Petalura gigantea	1815	1909	Ti	+	*				*	**non-coastal se Qld, most of NSW**
Petalura litorea	1999	2000	Th		*				*	**coastal se Qld and ne NSW**
Petalura hesperia	1958	1958	Wa	*	*				*	**s WA**
Petalura ingentissima	1908	1998	An	*	+				*	**Qld: N of P-E gap**
Petalura pulcherrima	1913			*				0	/	specific status of *P. pulcherrima* still uncertain
Family Gomphidae	**7 genera clearly distinguishable on morphology; 2 subfamilies**									
Ictinogomphus australis	1873	1917	Ti	+	+	*			*	**P:** much of n and e A
Ictinogomphus paulini	1991							0		
Ictinogomphus dobsoni	1969	1998	Th		*				*	**WA: Pilbara area**
Antipodogomphus acolythus	1901	1917	Ti	+	+	*			*	**P:** NSW, Vic
Antipodogomphus dentosus	1991	1993	Ha							
Antipodogomphus edentulus	1991							0		
Antipodogomphus neophytus	1958	1993	Ha							
Antipodogomph. proselythus	1901	2007	Th							
Antipodogomphus hodgkini	1969	1998	Th		*				*	**WA: Pilbara area**
Armagomphus armiger	1913	1962	Wa	*					*	
Austroepigomph. praeruptus	1857	1998	Th	*		*			*	**P:** much of s Qld, NSW, Vic
Austroepigomphus gordoni	1962	1962	Wa	*	*				*	**WA, c A**
Austroepigomphus turneri	1901	1993	Ha	*	*				*	**n A**
Austrogomphus angelorum	1913						*	0		**E:** mature Murray River
Austrogomphus arbustorum	1906	1998	Th	+	*				*	**e Qld**
Austrogomphus pusillus	1917	2006	ThHa		*				*	**WA: Kimberley**
Austrogomphus mjobergi	1917	1993	Ha	*	*				*	**n Au**
Austrogomphus australis	1854	1986	Ha	+	*				*	**e A, SA**
Austrogomphus collaris	1854	1962	Wa		*				*	**s WA**
Austrogomphus cornutus	1991	1986	Ha	+	*				*	**i & se Qld, NSW, Vic, SA**
Austrogomphus doddi	1909				*			0	/	**ne Qld**
Austrogomphus guerini	1842	1970	OF	+	+	*			*	**P:** SA, Tas
Austrogomphus ochraceus	1869	1916	Ti							
Austrogomphus mouldsorum	1999				*			0		WA: Kimberley

Taxon	OD	Ld	Au	IDR (*=for species, + =for group of species) based on				n	IDR	Total geographical range or, indicated by P, part of it where I based on M is reliable or supported
				M	G	g	e			
Austrogomphus amphiclitus	1873	1998	Th	*		*			*	**P:** much of e and i Qld, NSW
Austrogomphus bifurcatus	1909	1998	Th	?	+					
Austrogomphus divaricatus	1991			+				0		
Austrogomphus prasinus	1906	2006	ThHa							
Hemigomphus atratus	1991							0		
Hemigomphus comitatus	1909	1998	Th							
Hemigomphus theischingeri	1991	1998	Th	+						
Hemigomphus heteroclytus	1854	1910	Ti		+	*			*	**P:** si Qld
Hemigomphus gouldii	1854	1980	Wi							
Hemigomphus cooloola	1991	1998	Th	*			*		*	**Qld: Coolola area;** **E:** dune situations
Hemigomphus magela	1991	1993	Ha	*	*				*	**n NT**
Odontogomphus donnellyi	1991	1991	Wa	*					*	
Zephyromphus lateralis	1873	1962	Wa	*	*				*	**s WA**
Zephyrogomph. longipositor	1991	1998	Th	*	*				*	**Qld N of P-E gap**
Family Synthemistidae	**8 genera distinguishable on morphology, two of them difficult**									
Archaeosynthemis leachii	1871	1967	Wa	*					*	
Archaeosynth. occidentalis	1910	1962	Wa	*	+				*	
Archaeosynthemis spiniger	1913	1962	Wa	*					*	
Archaeosynthemis orientalis	1910	1910	Ti		*				*	**se A**
Austrosynthemis cyanitincta	1908	1962	Wa	*					*	
Choristhemis flavoterminata	1901	1910	Ti	*		*			*	**P:** e Au S of Daintree River
Choristhemis olivei	1909	2003	Th	*	+				*	
Eusynthemis barbarae	1985	2001	Th	+	*				*	**Qld: Mt Lewis**
Eusynthemis tenera	1995			?				0		
Eusynthemis aurolineata	1913	1998	Th	*					*	
Eusynthemis rentziana	1998	1998	Th	*					*	
Eusynthemis tillyardi	1995	1910	Ti	*					*	
Eusynthemis guttata	1871	1995	Th	*	+				*	
Eusynthemis nigra	1906	1999	HaTh	*					*	
Eusynthemis deniseae	1977	1977	Th	*					*	
Eusynthemis brevistyla	1871	1986	Ha	*					*	
Eusynthemis virgula	1874	1986	Ha	*	+				*	
Eusynthemis netta	1999							0		**Qld: Mt Lewis area**
Eusynthemis ursa	1999			?	*			0	/	**NSW: Barrington Tops**
Eusynthemis ursula	1998	2000	Th	+	*				*	**NSW: Chichester S.F.**
Parasynthemis regina	1874	1910	Ti	*			*		*	**E:** streams that dry to pools
Synthemiopsis gomphomacromioides	1917	2000	Th	*					*	
Synthemis eustalacta	1839	1910	Ti	*	*				*	**se A exc. Grampians, Tas and e SA**
Synthemis tasmanica	1910	1979	Al	*	*				*	**Vic: Grampians, SA, Tas**

Taxon	OD	Ld	Au	IDR (*=for species, + =for group of species) based on					IDR	Total geographical range or, indicated by P, part of it where I based on M is reliable or supported
				M	G	g	e	n		
Tonyosynthemis claviculata	1909	1998	Th	+	*				*	**Qld N of P-E gap**
Tonyosynthemis ofarrelli	1986	1998	Th		*				*	**se Qld, ne NSW**
Family Macromiidae	**1 genus distinguishable on morphology**									
Macromia tillyardi	1906	1993	Ha	*		*			*	**P:** e Qld ?except CY, ne NSW
Macromia viridescens	1911	2001	Th	*					*	
Family Corduliidae	**4 genera clearly distinguishable on morphology**									
Hemicordulia australiae	1842	1962	Wa	*					*	
Hemicordulia continentalis	1907	1999	HaTh	+	+					
Hemicordulia tau	1871	1914	Ti			*			*	**P:** WA, s & c A
Hemicordulia kalliste	1991				*			0	/	**extreme N of Au**
Hemicordulia flava	1991	2006	ThHa	*					*	**c A**
Hemicordulia intermedia	1871	1993	Ha	+	+	*			*	**P:** n, c and much of e A; WA except Pilbara area
Hemicordulia koomina	1969	2006	ThHa							
Hemicordulia superba	1911	1999	HaTh	*					*	
Metaphya tillyardi	1913			+				0	/	ident. by subst. (*M. elongata*)
Pentathemis membranulata	1890	1993	Ha	*					*	
Procordulia affinis	1871	1962	Wa	*	*				*	**s WA**
Procordulia jacksoniensis	1842	1970	OF	*	*				*	**e Au**
Family Libellulidae	**27 genera: 21 clearly distinguishable on morphology, larvae of 2 genera unknown**									
Aethriamanta circumsignata	1897	1993	Ha	+	+	*			*	**P:** NSW
Aethriamanta nymphaeae	1949	1993	Ha							
Agrionopt. insignis allogenes	1908	1993	Ha	*	+	*			*	**P:** NT, Qld S of P-E gap, NSW
Agr. longitudinalis biserialis	1879	2006	ThHa	*					*	
Austrothemis nigrescens	1901	1962	Wa	*					*	
Brachydiplax denticauda	1867	1993	Ha	+	+	*			*	**P:** Kimberley, NT, Qld S of P-E gap
Brachydiplax duivenbodei	1866							0	/	
Camacinia othello	1908			+				0	/	id by substitution (*C. gigantea*)
Crocothemis nigrifrons	1894	1962	Wa	*					*	
Diplacodes haematodes	1839	1914	Ti	*	+				*	
Diplacodes bipunctata	1865	1917	Ti	+		*			*	**P:** WA, c and s A
Diplacodes trivialis	1842	1962	Li							
Diplacodes melanopsis	1901	1986	Ha	*					*	
Diplacodes nebulosa	1793	1993	Ha	+						
Nannodiplax rubra	1868	1993	Ha			*			*	**P:** Kimberley
Huonia melvillensis	1998	2002	ThBr	*					*	
Hydrobasileus brevistylus	1865	1963	Fr	*					*	
Lathrecista asiatica festa	1879	2006	ThHa	*					*	identified by supposition
Macrodiplax cora	1867	1962	Li	*					*	

Taxon	OD	Ld	Au	IDR (*=for species, + =for group of species) based on				n	IDR	Total geographical range or, indicated by P, part of it where I based on M is reliable or supported
				M	G	g	e			
Nannophlebia eludens	1908	2006	ThHa	+	+					
Nannophlebia injibandi	1969	1993	Ha			*			*	**P:** Pilbara area
Nannophlebia mudginberri	1991	1993	Ha							
Nannophlebia risi	1913	1913	Ti			*			*	**P:** NSW, Vic
Nannophya australis	1865	1999	HaTh	*		*			*	**P:** most of ne A
Nannophya paulsoni	2003					*		0		
Nannophya sp.		2007	Th	*					*	**Qld: nr Barcaldine;** adults unknown
Nannophya dalei	1908	1979	Al	+	*				*	**se A**
Nannophya occidentalis	1908	1962	Wa		*				*	**s WA**
Neurothemis oligoneura	1867			?	+			0		
Neurothemis stigmatizans	1775	1962	Li	+		*			*	**P:** S of extreme n NT and CY
Notolibella bicolor	1977							0		
Orthetrum balteatum	1933	2002	HaTh	*					*	identified by supposition
Orthetrum boumiera	1978	1978	WaAr	+	+		*			**E:** dune situations
Orthetrum caledonicum	1865	1916	Ti			*			*	**P:** A except coastal se Qld and ne NSW
Orthetrum migratum	1951	1978	WaAr	+	+	*			*	**P:** Kimberley, Pilbara area
Orthetrum villosovittatum	1868	1978	WaAr			*			*	**P:** NSW, Vic
Orthetrum sabina	1770	1904	Ne	?	+	*			*	**P:** n WA and se A, i Qld
Orthetrum serapia	1984			+				0		
Pantala flavescens	1798	1890	Ca	*					*	
Potamarcha congener	1842	1977	Ku	*					*	
Raphismia bispina	1867							0		
Rhodothemis lieftincki	1954	1993	Ha	*					*	
Rhyothemis braganza	1890	1993	Ha	+	+	*			*	**P:** WA: Kimberley, n NT, se Qld
Rhyothemis resplendens	1878			?				0		
Rhyothemis graphiptera	1842	1993	Ha	*	+	*			*	**P:** Pilbara, c-Au
Rhyothemis phyllis	1776	1962	Li	*					*	
Rhyothemis princeps	1894	2006	ThHa	*					*	
Tetra. irregularis cladophila	1908	2003	ThFl	*					*	
Tholymis tillarga	1798	1962	Li	*					*	
Tramea eurybia	1878			+	+			0		
Tramea loewii	1866	1917	Ti			*			*	**P:** se NSW, Vic
Tramea propinqua	1942	1962	Li							
Tramea stenoloba	1962	1962	Wa							
Urothemis aliena	1878	1993	Ha	*					*	
Zyxomma elgneri	1913	1993	Ha	+	+	*			*	**P:** s Qld, NSW. n-w Australia
Zyxomma multinervorum	1897			?				0		
Zyxomma petiolatum	1842	1962	Li							

Taxon	OD	Ld	Au	IDR (*=for species, + =for group of species) based on				n	IDR	Total geographical range or, indicated by P, part of it where I based on M is reliable or supported
				M	G	g	e			
Genera incertae sedis	**9 genera clearly distinguishable on morphology;** several very distinct units distinguishable but without general taxonomic recognition									
Archaeophya adamsi	1959	1984	ThWa	+	*				*	**se NSW**
Archaeophya magnifica	1978	1978	Th		*				*	**Qld N of P-E gap**
Pseudocordulia circularis	1909	1982	Wa	?+	+		*	?		**P:** terrestrial in rain forest leaf litter
Pseudocordulia elliptica	1913						*	?		
Cordulephya bidens	1917	2006	ThHa	+	*				*	**Qld N of P-E gap**
Cordulephya pygmaea	1870	1911	Ti		*				*	**mainland e A S of P-E gap**
Cordulephya divergens	1917	2006	ThHa	+	+					
Cordulephya montana	1911	1911	Ti							
Apocordulia macrops	1980	1984	ThWa	*					*	
Austrocordulia refracta	1909	1910	Ti	*		*			*	**P:** Qld, ne NSW, Vic
Austrocordulia leonardi	1973	1973	Th	*					*	
Austrocordulia territoria	1978	1984	ThWa	*	*				*	**n NT**
Austrophya mystica	1909	1984	ThWa	*	+				*	
***?Austrophya* sp.**		2001	Th	*					*	**Qld: Thornton Peak;** adults unknown
Hesperocordulia berthoudi	1911	1910	Ri	*					*	
Lathrocordulia garrisoni	1991			?	*			0	/	**Qld N of P-E gap**
Lathrocordulia metallica	1911	1962	Wa	+	*				*	**s WA**
Micromidia atrifrons	1883	1978	Th	*	+	*			*	**P:** ne Qld, CY
Micromidia convergens	1978	1984	ThWa	*					*	
Micromidia rodericki	1959				*			0	/	**Thursday Island**

Abbreviations used in the table. General terms: OD=year of original description of adult; Ld=first description/descriptive detail of larva; Au=author/s of Ld; M=morphological disparity; G=distributional disparity; g=partial distributional disparity; e=ecological particular; n=larva not available (given by 0); IDR=reliable Identification possible. Geographical terms: A=Australia; CY=Cape York Peninsula; e=eastern; i=inland; n (in table head)= no descriptive information available at the present time (indicated by 0); n (in distribution column) northern; N=north; ne=north-eastern; P-E gap=Paluma-Eungella gap; s=southern; S=south; se=south-eastern; NG=New Guinea; NSW=New South Wales; NT=Northern Territory; Qld=Queensland; SA=South Australia; si=southern inland;WA=Western Australia; Vic=Victoria. Distributional data are included only with species for which these details markedly improve the reliability of identification. Authors: Al=Allbrook; An=Andress; Ca=Cabot; Fr=Fraser; Ha=Hawking; HaTh=Hawking & Theischinger; Ku=Kumar; Li=Lieftinck; Mu=Murray; Ne=Needham; Nu=Nuttall; OF=O'Farrell; St=Stewart; Th=Theischinger; Thea=Theischinger *et al.;* ThBr=Theischinger & Brown; ThFl=Theischinger & Fleck; ThHa=Theischinger & Hawking; Ti=Tillyard; Wa=Watson; WaAr=Watson & Arthington; WaDy=Watson & Dyce; WaOF= Watson & O'Farrell; WaTh=Watson & Theischinger; Wi=Williams.

Geographical range or part of is only given if it markedly effects the reliability of identification. Full geographical ranges are written in **bold**; part of the range for which reliable identification is written in normal subsequent to **P:**.

Some species are, within their genus, not listed in alphabetical order to better show morphological or geographical mutualities by the symbol + in cells 'merged' down the subcolumns M and G of column IDR.

Reasonably reliable identifications can be achieved at least for part of their ranges for 235 of the 325 species if the individuals to be identified are in good shape and close to final instar, and if their origin is known. Of these 215 are marked in column IDR by the symbol *, the remaining 20 by the symbol /. Identifications for 90 of the 325 species are at present hardly possible and therefore not marked with any symbol in the column IDR. Should larvae be identified as belonging to a species without an icon in the column IDR, it is strongly recommended that the details be thoroughly checked by repeating the identification procedure.

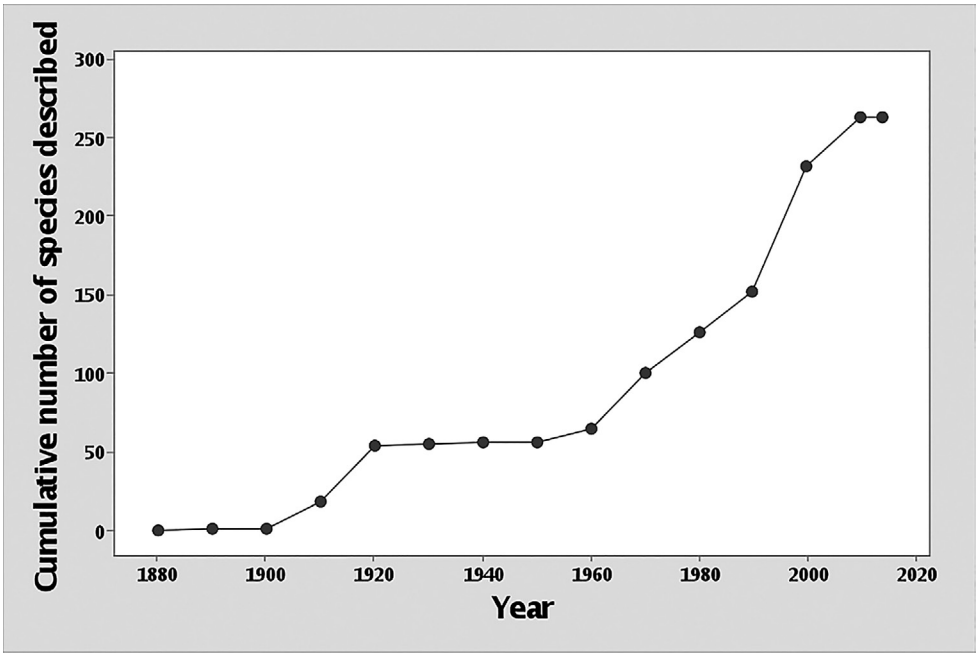


Figure 95. Accumulation curve illustrating the increase in descriptive information for Australian odonate larvae between 1880 and 2014.

Conclusions and outlook

This compilation of the information regarding Australian dragonfly larvae and the possibility for accurate identification provides some interesting results. Of 325 Australian Odonata species, larvae are known for 263 species, or about 80% of the total fauna. No descriptive information is available for the larvae of 62 species (marked with the symbol 0 in column n of Table 1).

Reliable identifications, based on morphology alone are possible for 136 species, an additional 47 species can be identified reliably using a combination of morphological and distributional data. On top of that identifications of 30 more species are reliable within particular parts of their ranges, and one more can be identified based on its ecology. Considering these factors, it should also be possible to reliably identify another 20 species once their larvae are available.

The larvae of four Australian dragonfly genera, *Archibasis*, *Camacinia*, *Notolibellula* and *Raphismia* are unknown or undescribed.

These numbers show that the ratio 'Number of identifiable species/Total number of species' is markedly higher for Anisoptera (170/214) than for Zygoptera (64/111) and makes the Platycnemididae, Lestoideidae and Argiolestidae (in that order) the families for which progress in larval taxonomy is most urgently needed. This is of course also a reflection of the larval taxonomic difficulties of these groups. To improve the situation remains a big challenge for identification certifiers and taxonomists and would also make, perhaps in connection with more applied and timely issues, great topics for regional or Australia-wide PhD studies. Also DNA-matching of adults and larvae/exuviae will be a powerful method of confirming identifications in future.

Table 2. Distribution of knowledge sufficient for specific identifications across families

Family	Species identifiable	Total species	Ratio
Platycnemididae	1	12	0.08
Lestoideidae	3	9	0.33
Argiolestidae	8	22	0.36
Gomphidae	23	38	0.61
Isostictidae	11	16	0.69
Libellulidae	40	57	0.70
Coenagrionidae	23	30	0.77
Lestidae	11	14	0.79
Lib. incertae sedis	16	20	0.80
Corduliidae	10	12	0.83
Aeshnidae	46	50	0.92
Synthemistidae	24	26	0.92
Hemiphlebiidae	1	1	1.00
Synlestidae	7	7	1.00
Austropetaliidae	4	4	1.00
Petaluridae	5	5	1.00
Macromiidae	2	2	1.00
Total	**235**	**325**	**0.72**

Summary

This paper summarises the morphological and geographic information for the larvae of all species of Australian dragonflies. We present an annotated checklist giving all known references which provide information on the identification characters of each species. For each genus that includes more than one species there is a paragraph which discusses if species can already, or cannot yet, be distinguished on morphological characters. We also include information on whether, and under which conditions, geographic locality helps or is enough to make a diagnosis. A table provides the year of original description and of first description of the larva of each species. It also indicates the level of confidence of identifications from available keys and other supportive information. The paper is fully referenced and includes, for more than 70% of the Australian dragonfly genera, illustrations of final stage larvae or exuviae ("shells").

We wrote this paper to improve the reliability of identification of the larvae of Australian species of dragonflies. It brings together references to all available information on the identification of larvae of any Australian dragonfly species. This encourages access to original sources and to confirm results of identifications by using several ways of diagnosing when in doubt. In particular it emphasizes the geographical aspect of making identifications. Geographical information can improve confidence of inconclusive morphological identifications of larvae by reducing the number of possible options and improves the chances for reliable identification of even relatively early larval stages. Identifications are only valuable if they are accurate and reliable, so the paper will be helpful in many current issues including biodiversity, conservation, river health, climate change and others.

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