Critical species of Odonata in Australia

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Abstract

The Australian Odonata fauna is reviewed. The state of the current taxonomy and ecology, studies on biodiversity, studies on larvae and the all identification keys are reported. The conservation status of the Australian odonates is evaluated and the endangered species identified. In addition the endemic species, species with unusual biology and species, not threatened yet, but maybe becoming critical in the future are discussed and listed.

Introduction

Australia has a diverse odonate fauna with many relict (most endemic) and most of the modern families (Watson et al. 1991). The Australian fauna is now largely described, but the lack of organised surveys resulted in limited distributional and ecological information. The conservation of Australian Odonata also received scant attention, except for Watson et al. (1991) promoting the awareness of Australia's large endemic fauna, the listing of four species as endangered (Moore 1997; IUCN 2003) and the suggesting of categories for all Australian species (Hawking 1999). This conservation report summarizes the odonate studies/ literature for species found in Continental Australia (including nearby smaller and larger islands) plus Lord Howe Island and Norfolk Island. Australia encompasses tropical, temperate, arid, alpine and off shore island climatic regions, with the land mass situated between latitudes 11-44°S and 113-154°E, and flanked on the west by the Indian Ocean and on the east by the Pacific Ocean.

Table 1. Australian odonate species with unusual biology.

Family/species	Biology
Lestidae	
Austrolestes minjerriba Watson, 1979	Largely confined to brown acid coastal lakes
Indolestes obiri Watson, 1979	Breeds in rock pools in caves
Lithosticta macra Watson, 1991	Breeds in temporary streams draining rocky out crops
Megapodagrionidae	
Podopteryx selysi (Förster, 1899)	Larva lives in water-filled tree holes
Petaluridae	
Petalura gigantea Leach, 1815	Larva lives in water-filled tunnels, near water
hesperia Watson, 1958	Larva lives in water-filled tunnels, near water
ingentissima Tillyard, 1908	Larva lives in water-filled tunnels, near water
pulcherrima Tillyard, 1913	Larva lives in water-filled tunnels, near water
litorea Theischinger, 1999	Larva lives in water-filled tunnels, near water
Austropetaliidae	
Austropetalia patricia (Tillyard, 1910)	Larva lives on logs and moss or between rocks on the edges of waterfalls
Austropetalia tonyana Theischinger, 1995	Larva lives on logs and moss on the edges of waterfalls
Aeshnidae s.l.	
Acanthaeschna victoria Martin, 1901	Larva possibly inhabits coastal *Melaleuca* swamps
Antipodophlebia asthenes (Tillyard, 1916)	Last larval stage terrestrial
Gynacantha nourlangie Theischinger & Watson, 1991	Possibly breeds in rock pools in caves
Telephlebia brevicauda Tillyard, 1916	Larva semi-aquatic
cyclops Tillyard, 1916	Larva semi-aquatic
godeffroyi Selys, 1883	Larva semi-aquatic
tillyardi Campion, 1916	Larva semi-aquatic
tryoni Tillyard, 1917	Larva semi-aquatic
undia Theischinger, 1985	Larva semi-aquatic
Corduliidae s.l.	
Pseudocordulia circularis Tillyard, 1909	Larva lives in moist leaf litter
elliptica Tillyard, 1913	Larva lives in moist leaf litter
Libellulidae	
Orthetrum boumiera Watson & Arthington, 1978	Confined to brown acid coastal lakes

State of the art

Studies on taxonomy and ecology

Starting with Fabricius (1775), many workers, most notably H. Burmeister, J.P. Rambur, F. Brauer, W.F. Kirby, E. de Selys Longchamps, Y. Sjöstedt, R.J. Tillyard, R. Martin, M.A. Lieftinck, F.C. Fraser, J.A.L. Watson, A.F. O'Farrell and G. Theischinger, accumulated taxonomic and some biological information on Australian Odonata, from which Houston & Watson (1988) compiled it in the Odonata section of the Zoological catalogue of Australia. Watson et al. (1991) included all the 301 known species in an illustrated book enabling the identification of the

adults and listed the major taxonomic revisions and studies on regional faunas, ecology and biodiversity of Australian Odonata. Watson & Houston (1994) published a checklist including the species and genera of Australian odonates and the relevant primary taxonomic literature.

Between 1991 and 2001, Carle (1995) and Theischinger (1998a, 1998b) established six genera, and Theischinger (1993, 1995a, 1995b, 1996a, 1996b, 1997a, 1997b, 1998b, 1998c, 1998d, 1998f, 1999a, 1999b, 1999c, 1999d, 2000c, 2001b, 2001c, 2003), Carle (1995) and Brown & Theischinger (1998) described 25 Australian species and subspecies. All these and other new taxonomic information were incorporated into a list of common (and scientific) names for all Australian odonate species (Hawking & Theischinger 2002) before the established records of *Nannophya pygmaea* Rambur, 1842 from Australia were referred to the newly established *N. paulsoni* (Theischinger 2003). Even more recently Theischinger (2004) attributed full generic status to two subgenera of *Austrogomphus* and, facing the uncertainty about *Austrogomphus praeruptus* and *A. melaleucae* Tillyard, 1909 being one or two species, stressed the existing urgency to get material of this complex/species from the far south of its distribution. Fresh larval evidence indicates the presence in Australia of *Selysioneura*, of an undescribed new species or genus close to *Austrophya mystica* and of a possibly undescribed species of *Nannophya* (GT unpubl.).

Detailed studies on the ecology of Odonata are scarce and the available information is generally natural history notes. Many of the early papers of R.J. Tillyard contained ecological information on the adults, larvae or both (Tillyard 1909a, 1909b, 1910a, 1910b, 1910c, 1911a, 1911b, 1912, 1913, 1916, 1928). Watson (1958, 1962, 1963, 1967, 1969) and Hodgkin & Watson (1958) presented ecology of Odonata from Western Australia, whereas Hawking (1986), Sant & New (1988), Hawking & Ingram (1994) and Hawking & New (1995a, 1995b, 1996, 1999, 2003) presented ecology of species from Victoria. Watson (1981) presented an overview of the ecology and biogeography of Australian Odonata, while Watson & Theischinger (1984) and Theischinger (2001, 2002) proposed and elaborated on, regions of taxonomic disjunctions.

Studies on biodiversity

Biodiversity studies of Australian Odonata are limited to particular areas or regions (Watson & Abbey 1980; Thompson 1989, 1991; Reeves & Woodall 1991; Wells & Cartwright 1992; Woodall 1992, 1993; Reeves 1993, 1995, 1998, 2003; Buck 1997, 1998; Davis 1997; Hawking 1998; Endersby 2000), islands (Reeves 1988a, 1988b, 1990; Endersby 2002), streams (Watson et al. 1978; Arthington & Watson 1982; Reeves 1987; O'Connor 1993; Hawking & New 1999, 2003) and unique habitats (Horwitz 1997). However, valuable information is available in the many major environmental surveys of invertebrates: Victoria (Smith et al. 1978; Malipatil & Blyth 1982; Marchant et al. 1984a, 1984b; Metzeling et al. 1984; Boulton & Lake 1992); New South Wales (Chessman & Williams 1999); Northern Territory (Marchant 1982; Davis 1997); Western Australia (Davis & Christidis 1997).

Identification guides

The Australian Odonata can be identified by Watson et al. (1991), however, this book does not include the 24 new taxa described since 1991 or specific information on the larvae. To address this we are currently preparing a new guide for the identification of adults and larvae of the Australian Odonata. Theischinger & Hawking (2003) produced an illustrated handbook for the identification of adults and larvae of Victoria and GT is also preparing an updated version of 'Tasmanian Odonata' (cf. Allbrook 1979).

Studies on larvae

In the past the poor state of larval taxonomy has been a major impediment to aquatic surveys, however, recent publications have started addressing this deficiency. Hawking (1993) complemented the biodiversity study of Northern Territory Odonata by Watson & Abbey (1980) based on adults only. Theischinger et al. (1993) studied the larvae of the Australian Synlestidae, Hawking & Theischinger (1999) of the entire order Odonata from New South Wales, and Theischinger (1998, 2000, 2001, 2002) of the Australian Gomphidae, Synthemistidae, Petaluridae, Archipetaliidae, Austropetaliidae, Aeshnidae s.l. and some Corduliidae s.l. For some of the more modern Corduliidae s.l. and the Libellulidae s.l. a larval identification and ecology guide is also being prepared by GT.

Critical taxa and conservation concerns

Notes on the species previously listed by IUCN

For Australia four species have been listed in the IUCN Red List of threatened species (IUCN 2003):
as critically endangered [CR]:
Austrocordulia leonardi
as endangered [EN]:
Petalura pulcherrima
as vulnerable [VU]:
Acanthaeshna victoria, *Hemiphlebia mirabilis*

Additionally, the following species were listed as "priority species" for Australia by Moore (1997):
as monotypic genera confined to one country only:
Chorismagrion risi, *Hemiphlebia mirabilis*, *Caliagrion billinghursti*, *Archipetalia auriculata*, *Austropetalia patricia*, *Acanthaeschna victoria*, *Antipodophlebia asthenes*, *Austrogynacantha heterogena*, *Austrophlebia costalis*, *Dendroaeschna conspersa*, *Armagomphus armiger*, '*Austroepigomphus*' *praeruptus*, *Apocordulia macrops*, *Austrophya mystica*, *Hesperocordulia berthoudi*, *Pentathemis membranulata*, *Synthemiopsis gomphomacromioides*, *Austrothemis nigrescens*, *Notolibellula bicolor*.

Table 2. Odonate species, not threatened yet, but might become critical in the future, mainly taxonomically isolated species and monotypic genera endemic to Australia. TT: taxonomically isolated; ME: only species of monotypic, endemic genus.

Family/species	TT	ME	Threats and notes
Chorismagrionidae			
Chorismagrion risi Morton, 1914	○	●	Restricted range
Megapodagrionidae			
Archiargiolestes parvulus (Watson, 1977)	○	○	Restricted range
pusillissimus Kennedy, 1925	○	○	Restricted range
pusillus (Tillyard, 1908)	○	○	Restricted range
Miniargiolestes minimus (Tillyard, 1908)	○	●	Restricted range
Isostictidae			
Labidiosticta vallisi (Fraser, 1955)	○	●	Scattered distribution; habitat destruction
Oristicta filicicola Tillyard , 1913	○	●	
Coenagrionidae			
Caliagrion billinghursti (Martin, 1901)	○	●	Scattered distribution; habitat destruction
Coenagrion lyelli (Tillyard, 1913)	●	○	
Diphlebiidae			
Diphlebia coerulescens Tillyard, 1913	○	○	Habitat destruction in south of range
hybridoides Tillyard, 1912	●	○	Restricted range
Lestodeidae			
Lestoidea barbarae Watson, 1967	●	○	Restricted range
lewisiana Theischinger, 1996	○	○	Restricted range
Archipetaliidae			
Archipetalia auriculata Tillyard, 1917	○	●	Habitat destruction outside national parks
Austropetaliidae			
Austropetalia patricia (Tillyard, 1910)	○	○	Habitat destruction outside national parks
Aeshnidae s.l.			
Antipodophlebia asthenes (Tillyard, 1916)	○	●	Larva semi-terrestrial
Austrogynacantha heterogena Tillyard, 1908	○	●	
Dendroaeschna conspersa (Tillyard, 1907)	○	●	
Gomphidae			
Austrogomphus lateralis (Selys, 1873)	●	○	
Synthemistidae			
Austrosynthemis cyanitincta (Tillyard, 1908)	○	●	
Parasynthemis regina (Selys, 1874)	○	●	
Synthemiopsis gomphomacromioides Tillyard, 1917	○	●	
Corduliidae s.l.			
Apocordulia macrops Watson, 1980	○	●	Habitat destruction
Cordulephya montana Tillyard, 1911	●	○	Distribution scattered
Pentathemis membranulata Karsch, 1890	○	●	Scattered distribution
Libellulidae			
Austrothemis nigrescens (Martin, 1901)	○	●	Habitat destruction
Notolibelulla bicolor Theischinger & Watson, 1977	○	●	Scattered distribution

as taxonomically isolated species:

Diphlebia coerulescens, *D. euphoeoides* Tillyard, 1907, *D. hybridoides*, *D. lestoides* (Sely, 1853), *D. nymphoides* Tillyard, 1912, *Chorismagrion risi*, *Lestoidea barbarae* Watson, 1967, *L. conjuncta* Tillyard 1913, *Hemiphlebia mirabilis*, *Petalura gigantea*, *P. hesperia*, *P. ingentissima*, *P. pulcherrima*, *Archipetalia auriculata*, *Austropetalia patricia*, *Cordulephya bidens* Sjöstedt, 1917, *C. divergens*, *C. montana*, *C. pygmaea*.

The species listed by the IUCN (2003) are commented on in the next chapter. Concerning the species listed by Moore (1997) it has to be noted that the genus *Austroepigomphus* is synonym to *Austrogomphus*.

Table 3. Suggested Red List categories (SRL) for critical species. CR: critically endangered; EN: endangered; VU: vulnerable; NT: near threatened.

Family/species	SRL	Threats and notes
Megapodagrionidae		
Griseargiolestes bucki Theischinger, 1998	VU	Restricted range
Hemiphlebidae		
Hemiphlebia mirabilis Selys, 1869	VU	Habitat destruction
Isostictidae		
Lithosticta macra Watson, 1991	VU	Restricted range
Petaluridae		
Petalura gigantea Leach, 1815	VU	Habitat destruction
hesperia Watson, 1958	VU	Habitat destruction
ingentissima Tillyard, 1908	VU	Habitat destruction
litorea Theischinger, 1999	VU	Habitat destruction
pulcherrima Tillyard, 1913	EN	Status uncertain
Aeshnidae		
Acanthaeschna victoria Martin, 1901	EN	Habitat destruction
Gomphidae		
Antipodogomphus dentosus Watson, 1991	EN	Restricted range
hodgkini Watson, 1969	EN	Restricted range
Armagomphus armiger (Tillyard, 1913)	VU	
Austrogomphus gordoni Watson, 1962	VU	Restricted range
longipositor (Watson, 1991)	VU	Scattered distribution
praeruptus (Selys, 1857)	EN	Known only from holotype
Hemigomphus atratus Watson, 1991	VU	Known only from holotype
magela Watson, 1991	VU	Restricted Range
Odontogomphus donnellyi Watson, 1991	VU	Restricted range
Synthemistidae		
Archaeosynthemis spiniger (Tillyard, 1913)	VU	Very few specimens known

Family/species	SRL	Threats and notes
Corduliidae s.l.		
Archaeophya adamsi Fraser, 1959	CR	Habitat destruction
Austrocordulia leonardi Theischinger, 1973	CR	Habitat destruction, disappeared from several localities
Cordulephya divergens Tillyard, 1917	VU	Known only from the Sydney area
Hesperocordulia berthoudi Tillyard, 1911	VU	
Lathrocordulia garrisoni Theischinger & Watson, 1991	VU	Known only from holotype
Libellulidae		
Huonia melvillensis Brown & Theischinger, 1998	VU	Known only from a single locality

Species to be considered

Hemiphlebia mirabilis

It is probably the world's most primitive odonate, retaining venation characteristic of the Permian Period. *H. mirabilis* was thought to be extinct until rediscovered by Davies (1985) at Wilsons Promontory, Victoria. Later it was re-discovered at its original location at Alexandra, Victoria and it is now known from six small, scattered populations ranging from central eastern Victoria to Northern Tasmania (Trueman et al. 1992; Endersby 1993a, 1993b). Its biology and conservation were studied by Sant & New (1988) and by New (1993), its habitat is threatened by grazing and burning (Watson 1995). This species is still listed as 'endangered' and is protected under the Victorian Government Flora and Fauna Guarantee Act 1988 (Birkin & Quin 1993).

Genus *Petalura*

Members of the ancient family Petaluridae were abundant in the Jurassic, 190 million years ago (Carpenter 1992) and possibly five of the 11 extant species occur in Australia. They all belong in the endemic genus *Petalura* and include some of the largest and most spectacular odonates of the world. They are of conservation concern due to the unique life-style of the larvae, being semi-aquatic, having a long life-cycle and inhabiting permanent burrows excavated in swampy ground. Presently five species are known, *P. hesperia* from south-western Australia, *P. gigantea* from New South Wales, *P. litorea* from south-eastern Queensland and north-eastern New South Wales, and *P. ingentissima* and *P. pulcherrima* from north-eastern Queensland. The IUCN (2003) red-listed *P. pulcherrima* as 'endangered', however, its status is uncertain, and Davies (1998) suggested it was "awaiting rediscovery and confirmation of specific status".

In 2000-2001 National Parks & Wildlife Service funded searches for *P. gigantea* in eastern New South Wales, and these confirmed the distribution of *P. gigantea* over a large geographical range, but in a small number of sites and usually in small populations (J. Trueman pers. comm.; GT unpubl.). Subsequently, *P. gigantea* was finally listed as an 'endangered' species under Schedule 1, Part 1, of the 'Threatened Species Conservation Act' in New South Wales; <http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Giant+dragonfly+-+endangered+species+listing>.

P. gigantea is reasonably secure occurring in areas now protected as national parks and reserves. *P. ingentissima* is wide-spread, occurring in the Wet Tropics World Heritage zone of northern Queensland and is protected in the Heritage area. However, *P. litorea* is known from a small number of sites in southern Queensland and from only two in New South Wales. The aquifer under Stradbroke Island where the largest and best-known population still exists is being "pumped" to provide water for Brisbane. *P. hesperia* was known from nine populations, but is currently recorded from only six populations in south-western Australia (Barrett 1996). The species' patchy distribution subjects it to threats from land clearing for agriculture and bauxite mining.

Acanthaeschna victoria

Until fairly recently *A. victoria* was not collected or seen alive by collectors of odonates, and only a few specimens were collected, these by non-specialists, over more than 100 years. In 1999, however, several individuals were collected/observed in coastal swampland near Broadwater in north-eastern New South Wales. Several weeks later this habitat was found completely destroyed by bulldozers (Theischinger 2000b). However, since then single individuals have been observed in three more coastal swamps, situated at some distance from each other, in north-eastern New South Wales. Draining of the coastal fringe for housing, agriculture and entertainment still remain the biggest threat to *A. victoria*, especially as its behaviour and ecology are still unknown. Habitat reduction and fragmentation have probably threatened this species since its original discovery in the 19th century.

Archaeophya adamsi

Only the type locality in south-eastern Queensland and very few localities, all within 100 km of Sydney, were previously known for *A. adamsi* (Theischinger & Watson 1977, 1982; Hawking & Theischinger 1999). It was gazetted on 12 November 1999 as a vulnerable species in New South Wales and now legally protected (NSW Fisheries 2002) (http://www.fisheries.nsw.gov.au/thr/species/fn-adams-emerald-dragonfly.htm). However, in 2002 two adults were collected in the foothills of the Blue Mountains (GT unpubl.) and recently larvae were found in a few creeks near Jamison, New South Wales. Larvae were also collected in 2000 in Tunks Creek near Galston Gorge where the species was collected in 1969 and was supposed to have disappeared since. Fewer than ten adults and only a few larvae have ever been collected, even with extensive searches. This inability to find specimens, the occurrence of only six localised populations and major threats from rapid housing development from the expansion of Sydney have resulted in action to protect *A. adamsi*. It is now listed as a 'vulnerable' species in New South Wales and legally protected.

Austrocordulia leonardi

It was discovered in 1968 from Woronora River and Kangaroo Creek, south of Sydney (Theischinger 1973) and later recorded from the Nepean River, Maldon

Bridge near Wilton (Theischinger 1997c; Hawking & Theischinger 1999). This species has always been rare (only 11 adult specimens are known) and its occurrence is generally only recorded from the presence of exuviae. However, intensive surveys by GT over the last two years have failed to detect the presence of any of the life stages along Woronora River and Kangaroo Creek. *A. leonardi* was red-listed by Moore (1997) as 'critically endangered' due to its rareness and restricted nature. This listing is extremely relevant with the disappearance of the species from the type locality, along the Woronora River, after the removal of the weir at Heathcote. All specimens ever collected come from deep and shady man-made riverine pools with cooler water (along Woronora River, Kangaroo Ck and Nepean River). Natural deep pools probably disappeared some time ago with the creation of large dams.

Endemism

Compared to its size, Australia's odonate fauna has a very high share of endemism at familial, generic and specific level. According to Watson et al. (1991) almost 50% of the species appear to be Gondwanic in origin and of the 325 now recognised species of Australian Odonata, some 245 or 75% are endemic, and most of these are distributed over relatively small areas, or even site restricted.

Table 4. Critical Odonata found in the Australian region, also data deficient species, which might have to be deleted from the list. DD: data deficient; RR: range restricted; IC: identity of species needs clarification; A: action recommended.

Family/species	DD	RR	IC	A	Distribution and notes
Calopterygidae					
Neurobasis australis Selys, 1897	●	?	○	○	Status of (single) record uncertain
Chlorocyphidae					
Rhinocypha tincta semitincta Selys, 1869	●	?	○	○	Only records from 19th century
Synlestidae					
Episynlestes intermedius Theischinger & Watson, 1985	●	●	○	○	Possibly confined to Eungella area, Qld
Lestidae					
Austrolestes aleison Watson & Moulds, 1979+	●	○	○	○	
Indolestes alleni (Tillyard, 1913)	●	○	○	○	
Lestoideidae					
Lestoidea barbarae Watson, 1967	●	●	○	○	Known from a few specimens
lewisiana Theischinger, 1996	●	●	○	○	Possibly restricted to Mt Lewis, Qld
Megapodagrionidae					
Griseargiolestes bucki Theischinger, 1998	●	○	○	○	Scattered distribution in ne NSW
fontanus (Tillyard, 1913)	●	○	○	○	Scattered distribution. Known from only a few localities
metallicus (Sjöstedt, 1917)	●	○	○	○	Confined to tropical rainforests in Qld
Austroargiolestes alpinus (Tillyard, 1913)	●	○	○	○	Scattered distribution
brookhousei Theischinger & O'Farrell, 1986	●	○	○	○	Scattered distribution
christine Theischinger & O'Farrell, 1986	●	○	○	○	Scattered distribution
chrysoides (Tillyard, 1913)	●	○	○	○	
elke Theischinger & O'Farrell, 1986	●	●	○	○	Possibly confined to Eungella area, Qld

Family/species	DD	RR	IC	A	Distribution and notes
Hemiphlebidae					
Hemiphlebia mirabilis Selys, 1869	○	●	○	●	Listed as "endangered" in Victoria; IUCN Red List (VU)
Coenagrionidae					
Agriocnemis dobsoni Fraser, 1954	●	○	○	○	
rubricauda Tillyard, 1913	●	○	○	○	
thoracalis Sjöstedt, 1917	●	○	●	○	Single male known
Austrocnemis obscura Theischinger & Watson, 1901	●	●	○	○	
Isostictidae					
Austrosticta fieldi Tillyard, 1908	●	○	○	○	
frater Theischinger, 1997	●	●	○	○	Known only from two specimens
soror Sjöstedt, 1917	●	○	○	○	
Eurysticta kununurra Watson, 1991	●	○	○	○	Known from only a few localities
Lithosticta macra Watson, 1991	○	●	○	●	Noted as critical in environmental reports of ERISS [1]
Neosticta silvarum (Sjöstedt, 1917)	●	○	○	○	Scattered distribution
Protoneuridae					
Nososticta kalumburu Watson & Theischinger, 1984	○	●	○	○	Confined to the Kimberley, W.A.
koolpinyah Watson & Theischinger, 1984	?	?	○	○	Known from only a few localities
Petaluridae					
Petalura gigantea Leach, 1815	●	○	○	●	Listed as "endangered" in NSW
hesperia Watson, 1958	○	●	○	●	Surveys have been undertaken
ingentissima Tillyard, 1908	●	○	○	○	Identification of some material doubt ful because of status problem in *P. pulcherrima*
litorea Theischinger, 1999	●	○	○	○	Widely scattered distribution
pulcherrima Tillyard, 1913	●	?	●	●	Status uncertain; IUCN Red List (EN)
Austropetaliidae					
Austropetalia tonyana Theischinger, 1995	●	○	○	○	Restricted distribution
Aeshnidae s.l.					
Acanthaeschna victoria Martin, 1901	●	○	○	●	Apparently scattered distribution due to habitat destruction; IUCN Red List (VU)
Austroaeschna christine Theischinger, 1993	●	●	○	○	Possibly confined to Eungella area, Qld; threatened by dairy farming
eungella Theischinger, 1993	●	●	○	○	Possibly confined to wider Eungella area, Qld; threatened by dairy farming
flavomaculata Tillyard, 1916	○	●	○	○	Restricted to the snow areas of southern alps
muelleri Theischinger, 1982	●	●	○	○	Possibly restricted to Carnarvon Gorge, Qld
Austrophlebia subcostalis Theischinger, 1996	●	○	○	○	Scattered distribution in tropical Qld
Anax georgius Selys, 1872	●	●	○	○	Possibly restricted to the Kimberley
Spinaeschna watsoni Theischinger, 1982	●	○	○	○	Only two adults available
Telephlebia cyclops Tillyard, 1916	●	○	○	○	Confined to rainforest in NSW and Qld
tillyardi Campion, 1916	●	○	○	○	Confined to rainforests in tropical Qld
tryoni Tillyard, 1917	●	○	○	○	Possibly confined to coastal situations in NSW and southern Qld
undia Theischinger, 1985	●	●	○	○	Possibly restricted to Carnarvon Gorge, Qld

Family/species	DD	RR	IC	A	Distribution and notes
Gomphidae s.l.					
Antipodogomphus dentosus Watson, 1991	○	●	○	○	Possibly restricted to South Alligator and Katherine Rivers
edentulus Watson, 1991	●	●	○	○	Only a few females known
hodgkini Watson, 1969	●	●	○	○	Restricted to nw Australia
Armagomphus armiger (Tillyard, 1913)	○	●	○	○	Restricted distribution in sw Australia
Austrogomphus angelorum Tillyard, 1913	●	○	○	○	Known from fewer than 10 specimens; only found along the Murray River, larva unknown
bifurcatus Tillyard, 1909	●	●	○	○	
divaricatus Watson, 1991	●	●	○	○	
doddi Tillyard, 1909	●	○	○	○	
gordoni Watson, 1962	○	●	○	○	Restricted distribution
longipositor (Watson, 1991)	●	○	○	○	Known from a few females
mouldsorum Theischinger, 1999	●	●	○	○	Probably confined to the Kimberley; Known only from a single female
praeruptus (Selys, 1857)	●	●	●	○	Known from the holotype. Possibly the same species as *A. melaleuca* Tillyard, 1909
pusillus Sjöstedt, 1917	●	○	○	○	Single male known
Hemigomphus atratus Watson, 1991	●	○	○	○	Known only from the holotype
cooloola Watson, 1991	●	●	○	○	Apparently confined to Cooloola area and Fraser and Stradbroke Islands
magela Watson, 1991	●	●	○	○	Restricted distribution
theischingeri Watson, 1991	●	●	○	○	Confined to rainforests in tropical Qld
Ictinogomphus paulini Watson, 1991	●	●	○	○	Only a few males are known
Odontogomphus donnellyi Watson, 1991	●	●	○	○	Apparently confined to a small area in tropical Qld
Synthemistidae					
Archaeosynthemis spiniger (Tillyard, 1913)	●	●	○	○	Very few specimens known
Choristhemis olivei (Tillyard, 1909)	●	●	○	○	Very few specimens known
Eusynthemis barbarae (Moulds, 1985)	●	●	○	○	Apparently confined to Mt Lewis area, Qld; very few specimens known
deniseae Theischinger, 1977	●	●	○	○	Apparently confined to the Carnarvon Range, Qld
netta Theischinger, 1999	●	●	○	○	Apparently confined to Mt Lewis area, Qld; only three specimens known
rentziana Theischinger, 1998	●	○	○	○	?Scattered distribution
tenera Theischinger, 1995	●	●	○	○	Very few specimens known
ursa Theischinger, 1999	●	●	○	○	Possibly confined to high altitude on Barington Tops, NSW
ursula Theischinger, 1998	●	●	○	○	Possibly confined to Nothofagus forest in Chichester State Forest, NSW
Tonyosynthemis claviculata (Tillyard, 1909)	●	○	○	○	
ofarrelli (Theischinger & Watson, 1986)	●	○	○	○	Known only from a few specimens
Corduliidae s.l.					
Archaeophya adamsi Fraser, 1959	●	●	○	●	Listed as "vulnerable" in NSW
magnifica Theischinger & Watson, 1978	●	○	○	○	Systematically significant species,
Austrocordulia leonardi Theischinger, 1973	○	●	○	○	IUCN Red List (CE)

Family/species	DD	RR	IC	A	Distribution and notes
Corduliidae s.l. (continued)					
Austrophya mystica Tillyard, 1909	●	○	○	○	Confined to tropical rainforests in Qld
Cordulephya divergens Tillyard, 1917	○	●	○	○	Known only from the Sydney area
Hemicordulia kalliste Theischinger & Watson, 1991	●	●	○	○	
novahollandiae (Selys, 1871)	●	?	●	○	Taxonomic interpretation not possible at the present
Hesperocordulia berthoudi Tillyard, 1911	●	○	○	○	
Lathrocordulia garrisoni Theischinger & Watson, 1991	●	●	○	○	Known only from the holotype
metallica Tillyard, 1911	●	○	○	○	
Macromia viridescens Tillyard, 1911	●	●	○	○	Confined to Iron Range
Metaphya tillyardi Ris, 1913	●	●	○	○	Only a single specimen from an Australian island off the Papuan coast
Micromidia rodericki Fraser, 1959	●	●	○	○	Possibly extinct (habitat destruction)
Libellulidae					
Austrothemis nigrescens (Martin, 1901)	○	●	○	○	Monotypic genus; ?confined to coastal acid lakes;
Camacinia othello Tillyard, 1908	●	●	○	○	
Huonia melvillensis Brown & Theischinger, 1998	●	●	○	○	Known only from type locality on Melville Is.
Nannophlebia mudginberri Watson & Theischinger, 1991	○	●	○	○	Confined to Kakadu National Park
Orthetrum boumiera Watson & Arthington, 1978	○	●	○	○	Confined to brown acid coastal lakes; Threat from housing development
serapia Watson, 1984	●	○	○	○	
Tetrathemis irregularis cladophila Tillyard, 1908	●	●	○	○	Confined to tropical rainforests in Qld
Trapezostigma[2] *propinqua* (Lieftinck, 1942)	●	○	○	○	Habitats unknown

[1] Environmental Research Institute of Supervising Scientist, NT [2] Syn. *Tramea*

Seven taxa treated variously as families or subfamilies in recent systematic papers (Watson et al. 1991; Carle 1995; Bechly 1996; Lohmann 1996) are endemic for Australia: Chorismagrionidae, Lestoideidae, Hemiphlebiidae, Archipetaliidae, Austropetaliidae, Pseudocorduliidae, Cordulephyinae. All are also monotypic at the generic level, and three of them even at the specific level. Independent of their current or future recognition at this or any other taxonomic level, these groups are significant for the understanding of evolution and relationships within the Odonata. In the currently recognised 110 genera of Australian Odonata, 49 are endemic, 22 of which are also monotypic. Monotypic endemic Australian genera comprise: *Miniargiolestes*, *Chorismagrion*, *Hemiphlebia*, *Labidiosticta*, *Lithosticta*, *Oristicta*, *Acanthaeschna*, *Antipodophlebia*, *Archipetalia*, *Dendroaeschna*, *Armagomphus*, *Odontogomphus*, *Apocordulia*, *Austrophya*, *Austrosynthemis*, *Hesperocordulia*, *Parasynthemis*, *Pentathemis*, *Synthemiopsis*, *Austrothemis*, and *Notolibellula*. Genera are increasingly recognised as the most useful supra-specific taxon on which to base phylogenetic studies and these endemic and monotypic taxa have high predictive value for environmental assessment studies.

Species with unusual biology

Australia has a wide range of aquatic and semi-aquatic habitats; therefore it is not surprising that 23 species are different to most Odonata because of their unusual biology and unique habitats (Table 1). They range from species like *Antipodophlebia asthenes* whose final larval stage lives in rainforest leaf-litter (Watson & Theischinger 1980), to species of *Telephlebia* which have semi-aquatic larvae and *Indolestes obiri* which lives in pools in caves (Watson et al. 1991).

Species, not threatened yet, but might become critical in the future

Twenty-seven species qualify for near threatened (Table 2), as they could become critical if endangered in the future due to environmental degradation. Sixteen species are monotypic, endemic genera. Five species are taxonomically isolated. Most species have restricted ranges or scattered distributions and are confined to streams or bogs.

Suggested Red List category

Twenty-five species are deemed critical (Table 3). Two species should be listed as critically endangered, five as endangered and 18 as vulnerable.

General on conservation

Most of the knowledge about distributions and habitats of Australian Odonata has been gathered by naturalists, in their own time, and is largely anecdotal, but has provided the basis of most of Australia's Odonata knowledge. The lack of properly designed, commissioned surveys by professional researchers has resulted in the high proportion of 'data deficient' species, approximately 30% (Table 4), and is possibly the major concern facing the Australian Odonata conservation. Another concern is the export of the rare, unprotected fauna. According to D.A.L. Davies (in litt.), there is considerably more material of tropical *Petalura* in overseas collections than in Australian collections. It appears that the export control for *Petalura* was and is not effective and should be stepped up, because recently the purchase price of *P. ingentissima* on the "Japanese market" dropped manyfold (H. Karube pers. comm.).

Hawking (1999) presented a comprehensive paper on conservation issues for Australian Odonata and evaluated the conservation status for all known species and suggested IUCN categories for these species. Since then, two species, *Archaeophya adamsi*, and *P. gigantea* have been listed as vulnerable/endangered in New South Wales, and *Hemphlebia mirabilis* has been listed as endangered in Victoria. In 2000-2001 National Parks & Wildlife Service funded searches for *P. gigantea* in eastern New South Wales, and a colour brochure on the "Giant dragonfly" was handed out to the public.

Current activities

Between 1994 and 2000 a nationwide program MRHI (Monitoring River Health Initiative) was conducted Australia-wide. During this study which amassed a large quantity of macroinvertebrate material from several thousand sites, many odonate larvae were collected, preserved and identified to familial level. There is now a funded project to identify at least some of them to species and to establish ecological species profiles. Similar studies conducted by the EPA (Environment Protection Authority) New South Wales on the Sydney Catchment, by the EPA Victoria on Victorian streams and by the Australian Water Quality Centre on South Australian streams have identified the odonate larvae to specific level.

The data basing of adult Odonata in the Australian National Insect Collection - Australia's largest Odonata collection - is currently processing the final group, the libellulids. This data base will be a valuable resource to odontologists, however, presently there are no plans to data base the odonates in the collections of other museums.

Colour photographs and conservation information on *Petalura gigantea*, *Apocordulia macrops* and *Archaeophya adamsi* have been published in newspaper articles and brochures handed out to the public on water quality and conservation issues. The New South Wales government is trying to raise public awareness of the conservation of odonates and promote them as indicators of a healthy environment.

The Australian Dragonfly Society was formed in February 2000 in order to disseminate information on Odonata of Australia and south-west Pacific. The society produces a newsletter 'Austrolestes' several times a year and it is an important organ to disseminate technical information, raise conservation concerns and provide naturalist notes on distribution. The Worldwide Dragonfly Association "Symposium of Odonatology" was held at Beechworth, Victoria (January 2003) and the post-symposium collecting trip supplied a good species list of several areas in Victoria and provided valuable information regarding the conservation status of *Telephlebia brevicauda*.

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