

## Critical species of Odonata in Malaysia, Indonesia, Singapore and Brunei

Albert G. Orr

CRC-TREM, AES, ENS, Griffith University, Nathan, Q4111, Australia.

<agorr@universal.net.au>

Key words: Odonata, dragonfly, IUCN, critical species, conservation, Malaysia, Indonesia, Singapore, Brunei.

### ABSTRACT

Malaysia, Brunei and the Indonesian archipelago comprise a total land area of ca 1.84 million km<sup>2</sup> including ca 13,000 islands, lying entirely within the tropics. The region is bisected by Wallace's line and supports a rich Oriental fauna to the west (Sundaland) and mainly Australian elements to the east. Taxonomic studies throughout the region were greatly advanced in the first part of the last century by M.A. Lieftinck especially, but many areas remain totally unexplored. Present knowledge suggests ca 700 species occur in the region of which ca 500 are endemic. Many species are known from limited material, often a single specimen or a type series from a poorly defined locality. It is certain that many are highly stenotopic and sometimes occur naturally at low abundance. The most critical habitats are mixed-dipterocarp terra firma forests and fresh-water swamp forests, both of which exhibit high  $\alpha$  and  $\beta$  diversity and harbour a majority of stenotopic species. However all potentially critical species must presently be classified as data deficient. On present knowledge it is not possible to recommend specific action against any species or habitat. No red listings are appropriate. There is an acute need for baseline data, especially from Central Borneo. Wholesale, unregulated habitat destruction for short-term profit poses the gravest threat to the region. Formerly well-studied areas such as Java are in urgent need of reassessment.

### REGIONAL DEFINITION

Indonesia, Malaysia, Singapore and Brunei collectively occupy a vast area straddling the equator and ranging from the Sunda plate to West Papua. Indonesia thus extends over significant subregions of two faunal realms, the Oriental and Australian, and includes the zoogeographically important transition zone termed Wallacea (Knight & Holloway 1990). For the purposes of this report West Papua, which politically remains part of Indonesia, is excluded as it is best dealt with in context with Papua New Guinea. The total land area included in the remainder is ca 1.84 million km<sup>2</sup>, with 7% represented by peninsular Malaysia, and a further 89% by the large islands of Borneo (0.76 million km<sup>2</sup>), Sumatra (0.52 million km<sup>2</sup>), Sulawesi (0.19 million km<sup>2</sup>), Java (0.13 million km<sup>2</sup>) and Timor (0.03 million km<sup>2</sup>). The remaining

4% of land area is made up by about 13,000 small islands, the most important groups being the lesser Sundas (Lombok, Sumbawa, Flores, Sumba Alor and Wetar) and the Moluccas (Halmahera, Ceram, Buru, Bachan, Obi, Ambon). Most of the area is subject to high rainfall and is vegetated by closed canopy forest. In low-lying areas, especially in Borneo, this often takes the form of swamp forest, especially peat-swamp forest, of which there are many formations. Drier conditions prevail in the lesser Sundas and parts of Java and southern Sulawesi where the natural vegetation is mostly open canopy monsoon forest. Significant montane habitats are present on all large islands. Well illustrated popular accounts of the geography, flora and fauna of the region are provided by Cubitt & Payne (1990), Cubitt et al. (1992) and Cranbrook & Edwards (1994). The books of the ecology of Indonesia series (Whitten et al. 1987, 1996, 1997; MacKinnon et al. 1996; Monk et al. 1997) provide a wealth of general information on the ecology of all major islands. An accurate account of the condition of forests in the area was provided by Collins et al. (1991). However a good deal of environmental degradation which is not well documented has occurred since, especially following catastrophic fires associated with the el niño event in 1997.

For biogeographic and historical reasons it is convenient to consider the Western Archipelago (Borneo, Sumatra, Java) and Malay Peninsula, i.e. Sundaland, and the Eastern Archipelago (Sulawesi, Moluccas and lesser Sundas) as well defined subregions which may be discussed separately.

## STUDIES ON BIODIVERSITY AND TAXONOMY

### Sundaland

In the first half of the 20th century the Indonesian part of the area was explored by M.A. Lieftinck (and associates), who was for 25 years stationed at the Museum Zoologicum Bogoriense in Buitenzorg (now Bogor) Java. The faunae of Sarawak, Sabah and peninsular Malaysia were studied by several workers, most notably F.F. Laidlaw. Several publications provide faunal lists for particular localities such as Laidlaw (1934) on Mt Kinabalu, or sub-regions, such as Lieftinck (1934) for Java, Lieftinck (1936, 1953) for the lesser Sunda Islands and Laidlaw (1931a, 1931b) for the Malay Peninsula and Borneo respectively. Between them Lieftinck and Laidlaw described over 250 species from the region. Lieftinck (1954) published a so called 'Handlist of Malaysian Odonata', an area he defined as the elements of the Sunda Plate, Peninsular Malaysia, Sumatra, Borneo and Java; this was before the creation of the political unit of 'Malaysia', hence the broad zoogeographical use of this term. This study lists a total of 472 species, together with their distributions, habitat preferences and bibliographic history.

Subsequent work by Lieftinck (1964a, 1964b, 1965a, 1965b, 1968, 1971, 1977, 1984) added several species, especially in the genera *Vestalis* (Calopterygidae), *Drepanosticta* (Platystictidae) and *Oligoaeschna* (Aeshnidae) and a steady trickle of new species described by van Tol, Orr, Kemp, Karube and others has brought the total number of known species from Sundaland to about 500 (see Kemp 1989,

1994; van Tol 1990; van Tol & Norma Rashid 1995; Karube 1990, 1994, 1997; Lempert 1999; Orr 1999, 2002; Orr & van Tol 2001; Sasamoto 2001). Moreover recent surveys by Norma Rashid, Hämäläinen, Yong and other workers have greatly increased our knowledge of the distribution of species within Sundaland (Asahina 1966; Tsuda & Kitagawa 1987, 1988, 1989; Huisman & van Tol 1989; Kemp & Kemp 1989; Hämäläinen 1994, 2000; Yong & Hämäläinen 1994; Norma Rashid 1995; Norma Rashid & van Tol 1995; Hämäläinen et al. 1996; Norma Rashid et al. 1996; Kitagawa 1997a, 1997b, 1999; Murphy 1997; Kitagawa et al. 1999; Yong et al. 2000; Hisamatsu & Sasamoto 2003). These relatively recent discoveries of new species have almost all originated from Borneo and Peninsular Malaysia and the fauna of the Peninsula at least has become quite well surveyed in the last two decades. The recent publication of a popular colour guide to the dragonflies of Borneo (Orr 2003) and the soon to be published family keys to adults and larvae of Malaysia (East and West) (Orr et al. 2004) will enhance general understanding and interest in the faunae of those areas.

For Java the total listed by Lieftinck (1954) of 156 species and subspecies, 26 endemic, has scarcely changed and is almost certainly close to the total fauna. Lieftinck's (1934) annotated checklist of the Javanese Odonata remains a valuable reference. Collecting effort in recent years in Sumatra has been low and publications few but the fauna was previously better known than for either Borneo or the Malay Peninsula. Nevertheless significant new discoveries are to be expected from that island.

The approximate total numbers of known species in the main subregions of Sundaland are shown in Table 1. Borneo stands out as having the largest fauna in absolute terms and also the highest rate of endemism – 42% overall, Zygoptera 64%, Anisoptera 20% (Orr 2003).

Apart from taxonomic studies and unannotated species lists for particular areas a significant number of ecological and ethological studies have been made on odonate communities in Peninsular Malaysia and North Borneo. Studies such as Furtado (1969), Thompson & van Tol (1993) and Orr (1994, 2001) in particular attempt to relate community structure to particular habitat types and generalised environmental factors, knowledge which will certainly provide a better understanding of what habitat management protocols are needed to maximise odonate conservation. Studies of general biology and behaviour, mainly sexual behaviour (e.g. Furtado 1970, 1972, 1974, 1975; Norma Rashid 1993, 1999; Orr 1996, 1997;

Table 1. Species richness in major subregions of Sundaland.

Subregion	Zygoptera	Anisoptera	Total
Malay Peninsula	89	143	232
Borneo	138	137	275
Sumatra	95	139	234
Java	57	99	156

Orr & Cranston 1997; Thompson 1998, 2000), are generally of less direct benefit in conservation planning but undoubtedly enhance the perceived conservation value of the group.

### The eastern archipelago – Sulawesi, Moluccas and lesser Sundas

Although Lieftinck worked on material from Sulawesi the first significant enumeration of the fauna was provided by van Tol (1987a); see also Askew et al. (1989). Since 1987 Jan van Tol has focussed considerable attention on Sulawesi, describing several new species and even a new genus of Chlorocyphidae (van Tol 1987b, 1998a, 1998b, 2000), and is presently revising other groups in the Chlorocyphidae and Platystictidae. The total now known exceeds 155 species with about 70% endemic.

Apart from private working lists there is no recent or summary faunal list for the Moluccas but Lieftinck (1949) mentions 45 species from eight islands in the Moluccas and a survey of later New Guinean literature by Lieftinck adds about a further 20 species making 65 in total. Lieftinck in particular investigated the Moluccas rather thoroughly in his later years in Bogor resulting in large holdings from this area in the museums of both Bogor (now Cibinong) and Leiden. The fauna shows a distinct influence from the nearby, very rich Papuan fauna.

The lesser Sundas were surveyed in detail by Lieftinck (1936, 1953) and although this list is rather old, it is probably still fairly accurate. The islands making up this group are for the most part small and fairly open hence more easily collected than larger forested areas. Lieftinck (1953) records 86 species and subspecies from these islands (including Timor), with 26 of these endemic. The total number of species known from the eastern archipelago is therefore probably in excess of 250. Many of these are endemic or at least not found in Sundaland hence the total number of species for the entire area considered must be at least 700. At least 500 of these, or 10% of the world fauna, are found nowhere else.

Table 2. Table of critical Odonata found in the 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.

Family/species	DD	RR	IC	Distribution and notes
Chlorocyphidae				
<i>Heliocypha nubecula</i> Lieftinck, 1948	●	●	○	North Sumatra
<i>Melanocypha snellemani javana</i> Laidlaw, 1950	●	●	○	West Java
<i>Pachycypha aurea</i> Lieftinck, 1950	●	●	○	Southeast Borneo; known only from type series; habitat believed destroyed
<i>Rhinocypha pallidifrons</i> Ris, 1927	●	●	●	Gn. Kerinci, Sumatra; male unknown
<i>Rhinoneura caerulea</i> Kimmins, 1936	●	●	○	Gn. Dulit, Sarawak; known only from type series; status of habitat doubtful
<i>Watuwila vervoorti</i> van Tol, 1998	●	●	○	Central Sulawesi; known only from type series

Family/species	DD	RR	IC	Distribution and notes
<b>Lestidae</b>				
<i>Indolestes dajakanus</i> Lieftinck, 1948	●	●	○	Kuching, Sarawak; known from single specimen, habitat believed destroyed
<b>Megapodagrionidae</b>				
<i>Bornargiolestes niger</i> Kimmins, 1936	●	●	●	North-west Borneo; Two specimens known, doubtfully conspecific
<i>Podolestes coomansi</i> Lieftinck, 1940	●	●	○	East Sumatra; known only from area of high habitat disturbance
<b>Coenagrionidae</b>				
<i>Amphicnemis</i> spp.	●	●	●	Genus extensively radiated in Borneo; most species known from small series from type locality
<i>Mortonagrion arthuri</i> Fraser, 1942	●	●	○	Malay Peninsula; known only from type locality; no recent records
<i>Pseudagrion nigrofasciatum</i> Lieftinck, 1934	●	●	○	Central and East Java; stenotopic; extensive habitat destruction
<i>Teinobasis suavis</i> Lieftinck, 1953	●	●	○	South-east Borneo; habitat threatened
<b>Platystictidae</b>				
<i>Drepanosticta</i> spp.	●	●	●	Many highly restricted stenotopic species throughout the region including new taxa. Genera <i>Drepanosticta</i> and <i>Protosticta</i> poorly delineated
<i>Protosticta</i> spp.	●	●	●	See <i>Drepanosticta</i>
<b>Protoneuridae</b>				
<i>Elatoneura erythromma</i> Lieftinck, 1953	●	●	○	South Borneo; known only from type locality
<b>Aeshnidae</b>				
<i>Linaeschna polli</i> Martin, 1909	●	●	○	North-west Borneo; known from two specimens collected 90 years apart
<b>Gomphidae</b>				
<i>Gompidea caesarea</i>	●	●	○	West Borneo; known only from type locality
<i>Leptogomphus</i> spp.	●	●	○	Sundaland; several species known from very restricted areas
<i>Megalogomphus junghuhni</i> Lieftinck, 1934	●	●	●	Java; known from a single female
<i>Onychogomphus aemulus</i> Lieftinck, 1937	●	●	○	South Sumatra; habitat threatened
<i>banteng</i> Lieftinck, 1929	●	●	○	West Java, Gn. Selak; one specimen only known; habitat disturbed
<i>nigrescens</i> Laidlaw, 1902	●	●	●	Malay Peninsula; known from a single female
<i>rappardi</i> Lieftinck, 1937	●	○	○	Sumatra; very few specimens known from threatend forest habitats
<b>Corduliidae</b>				
<i>Macromia celebensis</i> van Tol, 1998	●	●	○	Sulawesi
<i>polyhymnia</i> Lieftinck, 1929	●	●	○	Central-west Sumatra
<i>Macromidia atrovirens</i> Lieftinck, 1935	●	●	○	Sumatra; known only from type locality
<b>Libellulidae</b>				
<i>Orthetrum borneense</i> Kimmins, 1936	●	●	○	Gn. Dulit, Sarawak; known only from type series; status of habitat doubtful

## CRITICAL SPECIES

A significant number of species are known from only one specimen or a small type series from a single locality. We may be fairly certain that most of these are highly stenotopic and also rare. Some may be genuinely vulnerable or endangered; others may be simply under-collected. However species and subspecies belonging to this category include: *Heliocypha nubecula*, *Melanocypha snellemani javana*, *Rhinocypha pallidifrons* (perhaps very local but not rare on Mt Kerinci), *Rhinoneura caerulea*, *Pachycypha aurea*, *Watuwila vervoorti* (Chlorocyphidae); *Indolestes dajakanus* (Lestidae); *Bornargiolestes nigra*, *Podolestes coomansi* (Megapodagrionidae); *Pseudagrion nigrofasciatum*, several *Amphicnemis* spp. (especially in Borneo), *Teinobasis suavis*, *Mortonagrion arthuri*, (Coenagrionidae); many species of *Drepanosticta* and *Protosticta* (Platystictidae) which show 100% endemism within each major island; *Elatoneura erythromma* (Protoneuridae); *Linaeschna polli* (Aeshnidae); *Gompidea caesarea*, *Leptogomphus* sp., (especially in Borneo) *Onychogomphus banteng* (extinct or endangered in Java?), *O. aemulus*, *O. nigrescens*, *O. rappardi*, *Megalogomphus junguhni* (extinct or endangered in Java?), (Gomphidae); *Macromia polyhymnia*, *M. celebensis*, *Macromidia atrovirens*, (Corduliidae), *Orthetrum borneense* (Libellulidae).

The above list is necessarily somewhat subjective, intended to point towards possible concerns rather than to specify definite conservation threats. It is by no means a comprehensive list of species that might be under threat. However this approach is the best which is possible at present and to select species by strict criteria would only produce a spurious accuracy, misleading to the reader.

Otherwise it is only possible to assess possible threats in terms of known or reputed habitat loss, and in this case risks apply to entire communities rather than to single species. As noted above, in Borneo and Sumatra especially many endemic species are known just from their type series or even from a single specimen. Although it may be inferred that most of these species are either localized or rare and mostly stenotopic it is simply not possible to assess their present conservation status. For example *Drepanosticta barbatula* Lieftinck, 1940 was known only from the holotype from Kutai in East Borneo, an area which has been subject to much degradation, but last year a probable photographic record was made by Rory Dow at Kubah, near Kuching, on the other side of the island. Confounding records such as this occur on a regular basis.

The best known large fauna is that of Java, with ca 156 species, 26 of which are endemic. Almost no primary forest now exists outside reserves which are few in number, compromised and probably unrepresentative of the original vegetation (Collins et al. 1991). However no recent collecting has been carried out with sufficient thoroughness or regard to historical records to properly assess the state of the fauna. Certainly many species reported by Lieftinck in various localities can no longer be found in those same places and the number of species occurring in the highly disturbed botanical gardens in Bogor has almost halved since 1930 when Lieftinck compiled a list for the same locality (P. Aswari and A.G. Orr unpubl.). In this case it is believed that the building of concrete embankments along the stream which bisects the gardens has destroyed rheophytic vegetation, and thus the larval

microhabitats, of many species. Domestic water pollution may also have contributed to the decline. Small collections of both adults and larvae are made on a semi-regular basis, at locations such as Gunung Halimun, by the staff of the Museum Zoologicum Bogoriense. I have had the opportunity to inspect these collections and can report that they show a disconcerting lack of rare or uncommon species, but this may result from the lack of experience on the part of the collectors, none of whom has a good knowledge of the fauna nor had hands-on training in field techniques. However it is certain that there is a general scarcity of what were once moderately common species in many localities, which, from the perspective of trying to preserve maximal diversity, is perhaps as worrying as the endangerment of very rare species.

Species listed in the IUCN Red List and in the 1997 action plan

There are no species from the region, which have been listed on the global Red List up to now (IUCN 2003).

The 1997 action plan (Moore 1997) lists only a few species from Indonesia and Malaysia. Some are known to be not threatened. In the category of taxonomically isolated species only four species of *Onychothemis*, (Libellulidae) and two species of *Devadatta* (Amphipterigidae) are listed. Three species of *Onychothemis* – *coccinea* Lieftinck, 1953, *culminicola* Foerster, 1904 and *testacea* Laidlaw, 1902 – are certainly not threatened and may even be common in some localities. *O. abnormis* Brauer, 1868 is considered secure at least in the Philippines (M. Hämäläinen in litt). *Devadatta argyroides* (Selys, 1859) and *D. podolestoides* Laidlaw, 1934 are widespread and common in Peninsular Malaysia and Borneo respectively. Unusual variation in *D. podolestoides* seems to be confined to the protected habitats at high altitudes in Sabah.

The following 10 species were listed as monotypic genera confined to one country:

Indonesia: *Disparocypha biedermanni* Ris, 1916, *Melanocypha snellemani* (Selys, 1879), *Pachycypha aurea*, *Sclerocypha bisignata* (McLachlan, 1870), *Celebargiolestes cinctus* (Selys, 1886), *Austroallagma sagittiferum* (Lieftinck, 1949), *Celebophlebia dactylogastra* Lieftinck, 1936, *Celebothemis delecollei* (Ris, 1909);  
 Malaysia: *Bornargiolestes niger*, *Linaeschna polli*.

To this list may now be added *Watuwila vervoorti* (Chlorocyphidae), known only from three males from Central Sulawesi. *Celebophlebia dactylogastra* should be removed from the list as it is not monotypic (see *C. carolinae* van Tol, 1987). Otherwise the list may remain as it stands. A second *Bornargiolestes* has now been taken in Brunei (Orr 2001) and the Javanese and Sumatran races of *Melanocypha snellemani* may soon be regarded as separate species. The taxonomic status of the new *Bornargiolestes* specimen remains uncertain and it is questionable if its occurrence in a state as small as Brunei (5,765 km<sup>2</sup>) should count as occurring in another country, except that Brunei's conservation practices are undoubtedly the best in the region.

There are no species of special biology or red-listed species from the region in the 1997 report.

## CRITICAL SITES, CONSERVATION PRIORITIES AND RECOMMENDATIONS

Small (Thompson & van Tol 1995) and medium scale (Orr 2001) studies of diversity and habitat associations in Borneo indicate close associations between stenotopic forest species and forest type – the greatest number of species is found in streams in lowland terra firma forest, a complex habitat with many subsets, all of which are highly threatened outside of national parks. This relationship is likely to hold throughout Sundaland and in much of Sulawesi and the Moluccas. It is thought (Orr 2003) that the system of national parks in Borneo and elsewhere throughout much of Malaysia and Indonesia should be adequate to preserve much original species richness. However disturbance of protected forest areas by fire and illegal logging are compromising the effectiveness of many reserves throughout the region. In mountainous tropical rainforest even limited logging activity affects the turbidity of streams compromising many species.

In Indonesia park protection has been particularly difficult to implement since the introduction of decentralized government in 1998. Officials at LIPI (Lembaga Ilmu Pengetahuan Indonesia) in Bogor are well aware of the necessity of preserving national parks, as well as the difficulties faced. Several non-confrontational schemes involving local communities in park management have been proposed. It is too early yet to judge if these are effective.

North Borneo in particular has been identified as a biodiversity hotspot. In so far as present knowledge allows us to judge, it appears this trend is also present in Odonata. In particular a centre of endemism has been identified in the area around Mt Kinabalu and several species are known from nowhere else. None of these is at present considered vulnerable.

Sulawesi, where virtually every forest-stream species is endemic (van Tol 1987a), must also be considered a hotspot for Odonata. Approximately 17% of the land area has protected status, representing most critical habitats. Similarly in the Moluccas, critical island faunas are apparently well protected by a well planned system of reserves. However as in other parts of Indonesia, protected areas and national parks are generally less secure than in other countries in the region.

## RESEARCH PRIORITIES

The critical need in the region is for baseline data. There is not a single rare species which can be categorized other than DD (data deficient), with respect to its conservation status, although many other species are known to be ubiquitous and common.

Basic survey work is needed throughout the entire region. Even areas thought to be well known – Kinabalu National Park, Sabah, Danum Valley Research Centre, Sabah and Kuala Belalong, Brunei – regularly yield surprises. And in areas where the fauna is well known this applies only to the adults. Larvae and larval ecology remain very poorly understood. Ideally surveys of all life stages should attempt to relate distribution to habitat and behaviour. Where possible the relationships of

various species to special features of the habitat – such as sediment type, rheophytes or fallen timber – should be recorded.

The centre of Kalimantan remains terra incognita. It is significant that a recent Cambridge University undergraduate expedition to the Ulu Barito produced a spectacular new species of *Rhinocypha*, present in sufficient numbers to support a detailed behavioural study. Similarly parts of Sumatra and Sulawesi remain very poorly investigated.

Survey work should ideally be concentrated on protected reserves but legislation often makes this difficult. In Sarawak it is illegal to collect or remove from the country any specimen regardless of its provenance. A complex permit system is in place to allow collecting permits but a condition of this is that all material should be returned to the collections of the Sarawak Biodiversity Council<sup>1</sup>. In Sabah, West Malaysia and Brunei collecting permits for legitimate scientific projects are normally fairly easily obtained. In Indonesia the situation is fluid, but remains over-beaurocratized. Moreover travel in many parts of Indonesia is becoming unsafe.

It is certain that many new species await discovery and a substantial number are already in collections awaiting description. Revisionary taxonomic work on certain groups such as the Platystictidae is needed.

There has been little recent collecting in Java, for which fairly good records exist from 50 years ago. Intensive fieldwork on that island would clarify the conservation status of many of its rare and endemic species. Unfortunately there is little attraction for the visiting odonatologist to engage in this type of study when the riches of Sumatra, Kalimantan and Sulawesi beckon and there are no entomologists living on Java with an interest in Odonata at a professional level.

## CURRENT ACTIVITIES

Several workers focus their research on the region and others are undertaking taxonomic revisions of regional groups.

Norma Rashid of the University of Malaya is undertaking behavioural studies and making general faunistic surveys of areas in Peninsular Malaysia. Bert Orr is preparing of complete guide to the odonates of Borneo with illustrated keys. At present the text for the Zygoptera is virtually complete and that for the Anisoptera is advanced. As support for this work he is also undertaking several taxonomic investigations on an ad hoc basis. Bert Orr, Steve Butler, Matti Hämäläinen and Bob Kemp have produced a well illustrated chapter on Odonata (Orr et al. 2004) for a book on Malaysian freshwater invertebrates edited by Cathy Yule and Yong Hoi Sen (Yule & Yong 2004). The chapter introduces biology and regional biogeography and has keys to families of adults and larvae. Matti Hämäläinen is conducting a long term survey (beginning 1995) of the odonate fauna of Krau Wildlife Reserve in Pahang. Publication is intended ultimately. At present over 100 species have been recorded but significant areas of the park remain to be investigated.

<sup>1</sup> At the time of proof reading (03 vi 2004) the SBC has transferred responsibility for administration of collecting permits to the Sarawak Forestry Department. However, as the Forestry Department has not yet been granted ministerial authority to issue permits, no legal collecting is currently possible.

Matti Hämäläinen and Bert Orr are preparing a book covering all aspects of the biology of the genus *Neurobasis* including an identification guide in full colour. André Günther, of TU Bergakademie Freiberg, has conducted a detailed study of reproductive behaviour of *Neurobasis kaupii* (Brauer, 1867) in Sulawesi (Günther 2002). He has also made many behavioural notes on various Chlorocyphidae, especially species of the *Rhinocypha monochroa* Selys, 1873 group, reported at the Beechworth Symposium of the WDA (Günther 2003). Rodzay Wahab of the Universiti Brunei Darussalam is investigating the larval fauna of the streams around Kuala Belalong, Brunei, as part of a MSc degree being supervised by Jan van Tol and Vincent Kalkman, from Leiden. This project already has discovered larval forms of species not recorded by Orr (2001) and eventually aims to associate adults and larvae by DNA analysis. Jan van Tol has almost completed a revision of the Sulawesi *Libellago rufescens* (Selys, 1873) group (Chlorocyphidae) and also is revising *Drepanosticta* of Sulawesi and other areas. Klaas-Douwe B. Dijkstra has produced a revision of Bornean and Peninsular *Coelicia*. This manuscript, which also covers Palawan and Philippines, may not be published for some time but is still the best source of information on this difficult group. Pudji Aswari of the Museum Zoologicum Bogoriense, Cibinong, is leading local expeditions to Gunong Halimun and other areas in Java and Sulawesi. Jongkar Grinang of the Sarawak Biodiversity Council has made a study of the odonate fauna of the Bau Limestone formation near Kuching.

There is a growing popular interest in Malaysia which will hopefully be encouraged by the publication of 'Dragonflies of Borneo' (Orr 2003), the first popular book on the odonate fauna of any part of the area and the most comprehensively illustrated of any large tropical fauna. Unfortunately at \$US 70, it is priced beyond most people in Indonesia, where it would also be very useful. Plans for more affordable productions are in place. The value of well produced colour guides in generating both local and international interest in the fauna cannot be overemphasised. Prospective authors should not be discouraged by the fact that there are taxonomic impediments to producing complete or definitive guides. Even partial guides illustrating as little as 60% of the species are invaluable provided species figured are chosen with care.

## REFERENCES

- Asahina, S., 1966. Malayan dragonflies taken by Mr. E. Kawase in 1960/1962. *Kontyû* 34: 18-21.
- Askew, R.R., G.G. Cleland, D.A.L. Davies & T.W. Harman, 1989. A report on a collection of Odonata from North Sulawesi, Indonesia. *Tijdschrift voor Entomologie* 132: 115-121.
- Butler, S.G., 2002. The larva of *Macromia euterpe* Laidlaw, 1915 (Anisoptera: Macromiidae). *Odonatologica* 31: 383-388.
- Collins, N.M., J.A. Sayer, & T.C. Whitmore (eds), 1991. The conservation atlas of tropical forests Asia and the Pacific. Macmillan, London & Basingstoke.
- Cranbrook, Lord & D.S. Edwards, 1994. Belalong: a tropical rainforest. Suntree Press, Singapore.
- Cubitt, G. & J. Payne, 1990. Wild Malaysia – the wildlife and scenery of Peninsular Malaysia, Sarawak and Sabah. New Holland Publishers, London.

- Cubitt, G., A. Whitten & J. Whitten, 1992. Wild Indonesia – the wildlife and scenery of the Indonesian archipelago. New Holland Publishers, London.
- Furtado, J.I., 1969. Ecology of Malaysian odonates: biotopes and association of species. *Verhandlungen der Internationalen Vereinigung für Theoretische und Angewandte Limnologie* 17: 868-887.
- Furtado, J.I., 1970. The territorial behaviour of *Devadatta a. argyroides* (Selys) (Odonata, Amphipterygidae). *Tombo* 13: 12-16.
- Furtado, J.I., 1972. The reproductive behaviour of *Ischnura senegalensis* (Rambur), *Pseudagrion microcephalum* (Rambur) and *P. perfuscatum* Lieftinck (Odonata, Coenagrionidae). *Malaysian Journal of Science* 1 (A): 57-69.
- Furtado, J.I., 1974. The reproductive behaviour of *Copera marginipes* (Rambur) and *C. vittata acutumargo* (Kruger) (Zygoptera: Platycnemididae). *Odonatologica* 3: 167-177.
- Furtado, J.I., 1975. The reproductive behaviour of *Prodasineura collaris* (Selys) and *P. verticalis* (Selys) (Odonata, Protoneuridae). *Malaysian Journal of Science* 3 (A): 61-67.
- Günther, A., 2002. Reproduktionsverhalten von *Neurobasis kaupi* Brauer, 1867. Programm und Abstracts der 21. Jahrestagung der Gesellschaft Deutschsprachiger Odonatologen in Worms, 2 pp.
- Günther, A., 2003. Threatening flights of *Rhinocypha* species from Sulawesi – an exceptional function for population coherence? Symposium Abstracts of the 3rd Symposium of the Worldwide Dragonfly Association, Beechworth, Australia, 7-13 January 2003, p. 13.
- Hämäläinen, M., 1994. Dragonflies of Mount Kinabalu (the highest mountain in Borneo). *Malangpo* 11: 77-81.
- Hämäläinen, M., 2000. Ten species added to the list of Peninsular Malaysian Odonata. *Notulae Odonatologicae* 5: 53-55.
- Hämäläinen, M., Y. Norma-Rashid & M. Zakaria-Ismail, 1996. Notes on Odonata collected in Kelantan (Peninsular Malaysia) in April 1995. *Opuscula Zoologica Fluminensia* 146: 1-11.
- Hisamatsu, S. & A. Sasamoto, 2003. A record of Odonata collected in Sarawak, Borneo (Kalimantan) Island [sic], Malaysia. *Aohada* 2: 22-26.
- Huisman, J. & J. van Tol, 1989. Dragonflies and caddisflies (Odonata and Trichoptera) from waters around the Danum Valley Field Centre. *Sabah Society Journal* 9: 90-109.
- IUCN, 2003. 2003 IUCN Red List of threatened species. <[www.redlist.org/](http://www.redlist.org/)>.
- Karube, H., 1990. Description of a new subspecies of *Asiagomphus xanthenatus* (Williamson) from West Malaysia. *Tombo* 33: 21-24.
- Karube, H., 1994. A new species and a newly recorded species of the genus *Chlorogomphus* (Odonata, Cordulegastridae) from West Malaysia. *Bulletin of Kanagawa Prefectural Museum (Natural Science)* 23: 7-12.
- Karube, H., 1997. A new species of the genus *Oligoaeschna* (Odonata, Aeshnidae) from Sumatra. *Bulletin of Kanagawa Prefectural Museum (Natural Science)* 26: 47-49.
- Kemp, R.G., 1989. *Archibasis rebecca* spec. nov. from West Malaysia (Zygoptera: Coenagrionidae). *Odonatologica* 18: 385-389.
- Kemp, R.G., 1994. *Drepanosticta berinchangensis* spec. nov. from West Malaysia (Zygoptera: Platystictidae). *Odonatologica* 23: 69-72.
- Kemp, R.G. & G.S. Kemp, 1989. Some dragonfly records from the states of Pahang and Perak, West Malaysia. *Notulae Odonatologicae* 3: 37-40.
- Kitagawa, K., 1997a. Records of the Odonata from Penang Island, Malaysia. *Aeschna* 32: 11-18.

- Kitagawa, K., 1997b. Records of the Odonata from Sarawak, Malaysia. *Aeschna* 34: 5-10.
- Kitagawa, K., 1999. Rediscovery of *Linaeschna polli* from Borneo. *Aeschna* 35: 41-42.
- Kitagawa, K., T. Yagi, A. Nakanishi, N. Wahid & M. Mohamed, 1999. Dragonflies of Tabin wildlife reserve. In: "Tabin Scientific Expedition", Universiti Malaysia Sabah, Kota Kinabalu, pp. 79-85.
- Knight, W.J. & J.D. Holloway (eds), 1990. Insects and the rain forests of South East Asia (Wallacea). The Royal Entomological Society of London, London.
- Laidlaw, F.F., 1931a. A list of the dragonflies (Odonata) of the Malay Peninsula with descriptions of new species. *Journal of the Federated Malay States Museum* 16: 175-233.
- Laidlaw, F.F., 1931b. Revised list of the dragonflies (Odonata) of Borneo. *Journal of the Federated Malay States Museum* 16: 234-250.
- Laidlaw, F.F., 1934. A note on the dragonfly fauna (Odonata) of Mt Kinabalu and of some other mountain areas of Malaysia. *Journal of the Federated Malay States Museum* 17: 549-561.
- Lempert, J., 1999. *Gynacantha corbeti* spec. nov., a new dragonfly from West Malaysia (Anisoptera: Aeschnidae). *International Journal of Odonatology* 2: 17-21.
- Lieftinck, M.A., 1934. An annotated list of the Odonata of Java, with notes on their distribution, habits and life-history. *Treubia* 14: 377-462.
- Lieftinck, M.A., 1936. Die Odonaten der kleinen Sunda-Inseln. *Revue Suisse de Zoologie* 43: 99-160.
- Lieftinck, M.A., 1949. The dragonflies (Odonata) of New Guinea and neighbouring islands. Part VII. Results of the Third Archbold expedition 1938-1939 and of the Le Roux Expedition 1939 to Netherlands New Guinea (II. Zygoptera). *Nova Guinea (N.S.)* 5: 1-271.
- Lieftinck, M.A., 1953. The Odonata of the island Sumba with a survey of the dragonfly fauna of the lesser Sunda Islands. *Verhandlungen der Naturforschenden Gesellschaft Basel* 64: 118-228.
- Lieftinck, M.A., 1954. Handlist of Malaysian Odonata. A catalogue of the dragonflies of the Malay Peninsula, Sumatra, Java and Borneo, including the adjacent small islands. *Treubia* 22 (Suppl.): i-xiii, 1-202.
- Lieftinck, M.A., 1964a. Synonymic notes on east Asiatic Gomphidae with descriptions of two new species (Odonata). *Zoologische Mededelingen* 39: 89-110.
- Lieftinck, M.A., 1964b. Some Gomphidae and their larvae, chiefly from the Malay Peninsula (Odonata). *Zoologische Verhandlungen* 69: 1-38.
- Lieftinck, M.A., 1965a. Some Odonata of the genus *Drepanosticta* Laidlaw, chiefly from the Malay Peninsula (Platystictidae). *Zoologische Mededelingen* 40: 171-186.
- Lieftinck, M.A., 1965b. The species-group of *Vestalis amoena* Selys, 1853, in Sundaland (Odonata, Calopterygidae). *Tijdschrift voor Entomologie* 108 : 325-364.
- Lieftinck M.A., 1968. A review of the genus *Oligoaeschna* Selys in Southeast Asia. *Tijdschrift voor Entomologie* 111: 137-186.
- Lieftinck, M.A., 1971. Studies in Oriental Corduliidae (Odonata) I. *Tijdschrift voor Entomologie* 114: 1-63.
- Lieftinck, M.A., 1977. New and little known Corduliidae (Odonata: Anisoptera) from the Indo-Pacific region. *Oriental Insects* 11: 157-179.
- Lieftinck, M.A., 1984. Further notes on the specific characters of *Calicnemia* Strand, with a key to the males and remarks on some larval forms (Zygoptera: Platycnemididae). *Odonatologica* 13: 351-375.
- MacKinnon, K., G. Hatta, M. Malim & A. Mangalik, 1996. The ecology of Kalimantan. Periplus Editions (HK) Ltd., Singapore.

- Monk, K.A., Y. de Fretes & G. Reksodiharjo-Lilley, 1997. The ecology of Nusa Tenggara and Maluku. The ecology of Indonesia Series. Vol. V. Periplus Editions, Singapore.
- Moore, N.W., 1997. Dragonflies – status survey and conservation action plan. IUCN/SSC Odonata Specialist Group. IUCN, Gland & Cambridge.
- Murphy, D.H., 1997. Odonata biodiversity in the nature reserves of Singapore. Garden's Bulletin, Singapore 49: 333-352.
- Norma-Rashid, Y., 1993. Dramatic behaviour of Odonata. Nature Malaysiana 18: 21-23.
- Norma-Rashid, Y., 1999. Behavioural ecology of *Tyriobapta torrida* Kirby at the breeding and resting sites (Anisoptera: Libellulidae). Odonatologica 28: 139-150.
- Norma-Rashid, Y. & J. van Tol, 1995. New records of Odonata for West Malaysia. Notulae Odonatologicae 4: 101-103.
- Norma-Rashid, Y., M. Zakaria-Ismail & M. Hämäläinen, 1996. Odonate fauna from Kelantan, Pahang and Muar drainages, Malaysia. In: Zainal Abidin, A.N. & A. Zubaid (eds) "Conservation and faunal diversity in Malaysia", Penerbit Universiti Kebangsaan Malaysia Bangi, Kuala Lumpur, pp. 129-139.
- Orr, A.G., 1994. Life histories and ecology of Odonata breeding in phytotelmata in Bornean rain forest. Odonatologica 23: 365-377.
- Orr, A.G., 1996. Territorial and courtship displays in Bornean Odonata. Odonatologica 25: 119-141.
- Orr, A.G., 1997. Odonate predation in Bornean treehole communities: some observations on predator density and prey diversity. In: Ulrich, H. (ed.) "Tropical biodiversity and systematics", Proceedings of the International Symposium on Biodiversity and Systematics in Tropical Ecosystems, Bonn, 2-7 May 1994. Zoologisches Forschungsinstitut und Museum A. Koenig, Bonn, pp. 223-228.
- Orr, A.G., 1999. *Sundacypha striata* spec. nov., a new damselfly from Borneo (Zygoptera: Chlorocyphidae). Odonatologica 28: 181-185.
- Orr, A.G., 2001. An annotated checklist of the Odonata of Brunei with ecological notes and descriptions of hitherto unknown males and larvae. International Journal of Odonatology 4: 151-196.
- Orr, A.G., 2002. Notes on the *Rhinocypha cucullata* Selys group from Borneo with a description of *R. viola* spec. nov. (Zygoptera: Chlorocyphidae). Odonatologica 31: 287-295.
- Orr, A.G., 2003. Dragonflies of Borneo. Natural History Publications, Kota Kinabalu.
- Orr, A.G. & P.S. Cranston, 1997. Hitchhiker or parasite? A ceratopogonid midge and its odonate host. Journal of Natural History 31: 1849-1858.
- Orr, A.G. & J. van Tol, 2001. *Pseudagrion lakense* spec. nov. from Borneo with notes on its ecology (Odonata: Coenagrionidae). International Journal of Odonatology 4: 51-56.
- Orr, A.G., S.G. Butler, M. Hämäläinen & R.G. Kemp, 2004. Insecta: Odonata. In: "Freshwater invertebrates of the Malaysian region", National Academy of Sciences Malaysia, Kuala Lumpur, pp. 405-438.
- Sasamoto, A., 2001. Description of a new subspecies of *Stylogomphus lawrenceae* Yang et Davies, 1996 from the Malay Peninsula (Anisoptera: Gomphidae). Tombo 43: 14-18.
- Thompson, D.J., 1998. On the biology of the damselfly *Euphaea ameeke* van Tol & Norma-Rashid in Borneo (Zygoptera: Euphaeidae). Odonatologica 27: 259-265.
- Thompson, D.J., 2000. On the biology of the damselfly *Vestalis amabilis* Lieftinck (Odonata: Calopterygidae) in Borneo. International Journal of Odonatology 3: 179-190.
- Thompson, D.J. & J. van Tol, 1993. Damselflies and dragonflies from four forest types in Brunei. Brunei Museum Journal 8: 57-72.
- Tsuda, S. & K. Kitagawa, 1987. Odonata of southeast Asia collected by the late Mr. M. Iwasaki. Part 1. Odonata of Malay peninsula (West Malaysia) and Singapore. Gracile 38: 1-7.

- Tsuda, S. & K. Kitagawa, 1988. Odonata of southeast Asia collected by the late Mr. M. Iwasaki. Part 2. Odonata of North Sumatra, Indonesia. *Gracile* 39: 1-5.
- Tsuda, S. & K. Kitagawa, 1989. Odonata of Southeast Asia collected by the late Mr. M. Iwasaki. Part 3. Odonata of North Borneo (Sabah) Malaysia. *Gracile* 40: 37-39.
- van Tol, J., 1987a. The Odonata of Sulawesi (Celebes), Indonesia: an introduction. *Advances in Odonatology* 3: 147-155
- van Tol, J., 1987b. The Odonata of Sulawesi and adjacent islands. Part 1. A new species of *Celebophlebia* Lieftinck from Sangihe Islands, with some notes on the taxonomic status of the genus. Part 2. The genus *Diplacina* Brauer on Sulawesi. *Zoölogische Mededelingen* 61: 155-176.
- van Tol, J., 1990. Key to the Malesian species of *Leptogomphus* Selys, with the description of a new species from Sabah (Odonata, Gomphidae). *Tijdschrift voor Entomologie* 133: 97-105.
- van Tol, J., 1992. An annotated index to names of Odonata used in publications by M.A. Lieftinck. *Zoologische Verhandelingen* 279: 1-263.
- van Tol, J., 1998a. The Odonata of Sulawesi and adjacent islands. Part 3. The genus *Macromia* Rambur (Corduliidae). *Tijdschrift voor Entomologie* 137: 87-94.
- van Tol, J., 1998b. The Odonata of Sulawesi and adjacent islands. Part 4. A new genus and species of Chlorocyphidae from South-East Sulawesi. *Zoologische Verhandelingen* 323: 441-448.
- van Tol, J., 2000. The Odonata of Sulawesi and adjacent islands. Part 5. The genus *Protosticta* Selys (Platystictidae). *Tijdschrift voor Entomologie* 143: 221-266.
- van Tol, J. & Y. Norma Rashid, 1995. The genus *Euphaea* Rambur in Borneo (Odonata: Euphaeidae). *Tijdschrift voor Entomologie* 138: 131-142.
- Whitten, A.J., M. Mustafa & G.S. Henderson, 1987. The ecology of Sulawesi. Gadjah Mada University Press, Yogyakarta.
- Whitten, T., R.E. Soeriaatmadja & S.A. Afiff, 1996. The ecology of Java and Bali. The ecology of Indonesia Series. Vol. II. Periplus Editions, Singapore.
- Whitten, T., S.J. Damanik, J. Anwar & N. Hisyam, 1997. The ecology of Sumatra. The ecology of Indonesia Series. Vol. I. Reprinted 2000. Periplus Editions, Singapore.
- Yule, C.M. & H.S. Yong (eds), 2004. Freshwater invertebrates of the Malaysian region. National Academy of Sciences Malaysia, Kuala Lumpur: in press.