AGRION

NEWSLETTER OF THE WORLDWIDE DRAGONFLY ASSOCIATION

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AGRION is Worldwide Dragonfly Association's (WDA's) newsletter, published twice a year, in January and July. The WDA aims to advance public education and awareness by the promotion of the study and conservation of dragonflies (Odonata) and their natural habitats in all parts of the world. *AGRION* covers all aspects of WDA's activities; it communicates facts and knowledge related to the study and conservation of dragonflies and is a forum for news and information exchange for members. *AGRION* is available for downloading from the WDA website at http://ecoevo.uvigo.es/WDA/dragonfly.htm. WDA is a Registered Charity (Not-for-Profit Organization), Charity No. 1066039/0.

Editorial

Keith Wilson [kdpwilson@gmail.com]

During December 2008 the WDA Board of Trustees decided to remove the password restriction for access to download *AGRION* from the WDA website. As a result of this decision this current edition of *AGRION* and all past issues are now freely available for downloading to members and non-members. The Odonatological Abstracts will continue to require password authorisation. Passwords for the latter are renewed annually and issued to all paid-up members.

This January 2009 edition of *AGRION* contains a series of articles providing details of various initiatives to create comprehensive odonate databases for regions and countries. The databases cover Africa (including Madagascar and Indian Ocean Islands), Australia, Europe, Malesia (including Malaysia, Singapore, Brunei, Indonesia, Papua New Guinea and the Solomon Islands), New Zealand, North America and Suriname. In addition there are articles from the Middle East, Australia and Singapore. I have also penned a short factual account providing information on dragonfly giants which I was able to write following valuable information generously provided by Dennis Paulson and KD Dijkstra. Also included is the sixth edition of *ECHO* collated by Vincent Kalkman. *ECHO* publishes news, small notes and articles on dragonflies of tropical Asia. It is available here as part of *AGRION* and will also be made available at the Asia Dragonfly web pages [http://www.asia-dragonfly.net/Articles/ECHO_PHAON_Intro.php].

For the next issue of *AGRION,* to be published at the beginning of July 2009, please send me or Graham Reels [gtreels@cyberdude.com] your contributions. All articles, information and news items related to dragonflies or of interest to WDA members are most welcome and will be considered for publication. Please send a Word file by email (preferably) or on disk by post. Please do not forward any original artwork but send a soft copy, ideally in a compressed format e.g. 'jpeg' or 'gif', or as a file on disk if sent by post.

In keeping with the practice adopted for WDA's official organ, the International Journal of Odonatology a dragonfly photo now appears on the front cover of each issue of *AGRION.* If you have a photo illustrating any rarely observed aspect of dragonfly biology, or an unusual species, or simply a stunning dragonfly shot, please submit it for consideration for publication *in AGRION*.

Cover photo: Female *Tetracanthagyna plagiata* 13 May 2005, Endau Rompin, P. Malaysia. Photo credit: Keith Wilson. The female *Tetracanthagyna plagiata* is significantly larger than the male and is regarded as the largest Anisopteran dragonfly with a wingspan up to 163 mm. See article on 'Dragonfly Giants' pages 29-31.

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President's Message

Gordon Pritchard [gpritcha@ucalgary.ca]

As this will be my last President's Message in *AGRION*, I am delighted to report some really good news. Our journal, the *IJO*, has received the blessing of the ISI Web of Knowledge and will be listed on their web site as well as in Current Contents, Biological Abstracts, Zoological Record etc. We owe Reinhard a huge vote of thanks for his passion and perseverance in getting the *IJO* this truly deserved recognition. And I hope that this will lead to more manuscripts being submitted to *IJO*. As you know, many of us were excited about a merger of *IJO* and *ODONATOLOGICA* because, although it would have meant a lot of work for some of us, we felt that the odonatological community would be better served by a single journal. However, although I have not been informed personally by *FSIO*, I understand from our Japanese friends that *FSIO* has decided to continue to produce *ODONATOLOGICA*, although they will not organize any more biennial Symposia. They will encourage their subscribers to attend our Symposium in Mexico in June and possibly cooperate in organizing our 2011 Symposium. So, my feeling is that this has worked out rather well. We will have a single gathering of the world's odonatologists every two years and we will be served by two recognized journals.

Also in this issue of *AGRION* you will find two forms – an election form for Trustee-at-Large and a 2009 Membership Application form. Please support your Association by returning both of these forms.

Season's Greetings and I look forward to seeing you in Mexico in June.

Gordon

A further step in the differentiation between *Sympetrum arenicolor* and *S. sinaiticum* – photo documentation in the field

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Several Palaearctic *Sympetrum* taxa from regions with an arid climate share very similar field characters: they are 'decolorate', which means a paucity in black thoracic markings and a pale brownish body coloration. All males have a salmon-red abdomen. Typical representatives of this 'decolorate' group are *S. arenicolor*, *S. haritonovi*, *S. meridionale*, *S. sinaiticum*, *S. striolatum pallidum*, *S. vulgatum decoloratum*, and *S. v. ibericum*.

Two of them, *S. arenicolor* and *S. sinaiticum*, are extremely alike. Neither the structure of the secondary genitalia of the males, nor the length of the inferior appendage, nor the projection of the vulvar scale are reliable characters to separate both taxa. Fortunately, their ranges do not overlap, so a well-defined origin considerably alleviates the identification. *S. arenicolor* is a Central Asiatic species, which has been collected in NE Syria, E Turkey, Iraq, Iran, Turkmenistan, Uzbekistan, Kyrgyzstan, Tajikistan, and Pakistan (Jödicke et al., 2000). The range of *S. sinaiticum* covers the whole of North Africa and extends from Saudi Arabia and Jordan in the east to Spain in the west (Jödicke et al., 2000). Notably, Laurent Juillerat and Keith DP Wilson (pers. comm.) separately recorded the species in Morocco for the first time in 2007. Only a handful of odonatologists have ever met *S. arenicolor* in the field. Correspondingly, its biology is hardly known. On the other hand, *S. sinaiticum* has been in the focus of odonatologists since the discovery of a European population in Spain. We now know that it is univoltine and has an exceptionally postponed sexual maturation (Jödicke, 2003). In the Tunisian oases at the northern fringe of the Sahara we (RJ, BK) observed emergence in May and June but oviposition did not start before October and lasted at least until March. We assume that the long pre-reproductive period is caused by an obligate diapause. During this stage individuals are widely dispersed in the desert and semi-desert, far away from wet habitats. The last record of an old female was in early June, indicating a potential adult life-span of one year and a clear overlap of the generations.

The long way to a correct taxonomic classification

The correct taxonomic definition of *S. arenicolor* and *S. sinaiticum* needed a long time to determine; no wonder given their overall structural similarity. The history of our knowledge of both species started with the description of *S. vulgatum decoloratum* from NE Turkey (Selys, 1884). Later Selys received a male of another species (the true *S. arenicolor*) from Malatya, E Turkey, which he erroneously intermingled with the pale subspecies of *S. vulgatum* (Selys 1987). This error became even more evident, when Ris (1911) in his monograph of Libellulinae depicted this male from Malatya and a true female of *S. v. decoloratum* under the name *S. decoloratum*. He also included a series of a similar *Sympetrum* [the true *S. sinaiticum*] from Libya under *S. decoloratum*. Bartenev (1915, 1919) recognised the heterospecific sexes figured in Ris' chapter on *S. decoloratum* but incorrectly fixed the name *decoloratum* to the taxon represented by the Malatya male (Bartenev, 1919), and introduced a new name to denote the taxon represented by the female, *S. v. flavum* (Bartenev, 1915). From this time on the name *flavum* was used for the pale Asian subspecies of *S. vulgatum*. On the other hand, the name *decoloratum* was established for the pale *Sympetrum* populations from Asia and North Africa that shared the structure of the secondary genitalia with the Malatya male. Consequently, when Dumont (1977) separated populations from the Sinai and North Africa as a distinct (darker) subspecies from the nominotypical subspecies, he introduced the name *S. decoloratum sinaiticum*.

A comparison of a Spanish series of *S.* '*decoloratum*' with the original *decoloratum* series in the Selys collection revealed the true identity of *S. v. decoloratum* and the synonymy of *S. v. flavum* (Jödicke et al., 1994). As *sinaiticum* was the only available name in the former '*decoloratum*' complex, all populations were unified under the species name *S. sinaiticum*. In a first approach, the species was interpreted as being polytypic, with the nominotypical ssp. in North Africa, ssp. *tarraconense* in Spain, ssp. *deserti* in Asia Minor, and ssp. *arenicolor* in Central Asia (Jödicke et al., 1994). However, this solution was unsatisfactory due to new findings. The first important realisation was the nonconformity of the larval descriptions: larvae from Tajikistan show considerable dorsal spines on the abdomen and long lateral spines on S9 (Haritonov & Borisov, 1991), while larvae from Spain lack dorsal spines and have short lateral spines on S9 (Jödicke, 1995). The second important discovery was structural differences in the genital ligula of males from Spain and Tajikistan: either with two long cornua on the tip of the first segment, or with two short filaments, respectively (Seidenbusch, 1997). A new study, including a long adult series of adults and of all subspecies, and a larva from Tunisia, was initiated. Focusing on the morphology of the ligula, of which the tip is visible without preparation in most dry specimens, two clear groups were discernible: all *deserti* and *arenicolor* males matched in having two short filaments on the tip of the ligula, and all *sinaiticum* and *tarraconense*

males exhibited the same long cornua. Correspondingly, the exuviae of *sinaiticum* and *tarraconense* were identical. As a result of these clear findings the concept of a polytypical species *S. sinaiticum* was given up in favour of two distinct species, *S. sinaiticum* and *S. arenicolor*; the names *tarraconense* and *deserti* vanished into synonymy (Jödicke et al., 2000). This new taxonomic arrangement has proved to be most satisfactory in recent years.

Live photos reveal a good field character

During a trip to the Shirvan National Park in Azerbaijan, one of us (AW) took photographs (Figs 1, 2) of a *Sympetrum*, which was identified as *S. arenicolor* without any doubt. Hence, this is, to our knowledge, the first record of this species in Azerbaijan and also a rare photographic documentation. All photos originate from the brackish, man-made 'Flamingo Lake' in the semi-desert of the National Park. Both sexes of *S. arenicolor* actively foraged for small insects at the outer, dry edge of the huge reed belt. Obviously all these individuals were sexually mature, because their eyes were partly bluish. Earlier in the season, in August 2005, AW took photos of still immature individuals of this species in Kazakhstan with completely brownish eyes (photo in Kalkman & van Pelt, 2006: 149).

For comparison with *S. sinaiticum* we offer photographs (Figs 3, 4) taken by BK in the oasis of Tozeur, Tunisia, at an irrigation ditch along a swamp in the transition zone between palm-trees and the salty steppe. The photos show fully mature individuals in early November; at this time of year copulations and oviposition took place.

At first view both species in mature condition are easy to differentiate by their eye colouration: *S. arenicolor* with a light bluish underside, and *S. sinaiticum* with only traces of blue in the predominantly brownish underside of the eye. This is a surprising result for us having previously studied only dry specimens of *S. arenicolor*. The eye coloration feature provides us with a good discriminating field character, negating the need for a thorough analysis of the genital ligula under microscope.

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Figure 1: Male *Sympetrum arenicolor* in the Shirvan National Park, Azerbaijan, 3 September 2008. Photo credit: A. Wijker.

Figure 2: Female *Sympetrum arenicolor* in the Shirvan National Park, Azerbaijan, 9 September 2008. Photo credit: A. Wijker.

Figure 3: Male *Sympetrum sinaiticum* in the Tozeur oasis, Tunisia, 5 November 2000. Photo credit: B. Kunz.

Figure 4: Female *Sympetrum sinaiticum* in the Tozeur oasis, Tunisia, 5 November 2000. Photo credit: B. Kunz.

New Records for Singapore Dragonflies

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Introduction

Singapore is a small tropical island with a land area of about 700 km2 and situated at the southern tip of Peninsular Malaysia. Being a highly urbanised city-state, Singapore has lost an estimated 95 percent (578 km2) of its original forest cover to urban development. Today, only about 28.6 km2 of forests remains (Tan et al., 2007) with a majority of it being secondary forest with pockets of primary and freshwater swamp forests in designated Nature Reserves. The extensive loss of rainforest has resulted in the extinction of several odonate species. For example, the siltation of the stream in the Nature Reserves area caused by the construction and subsequent widening of an automobile expressway has caused the apparent extinction of *Neurobasis chinensis* (Murphy, 1997). This species has not been seen since 1970. Despite the drastic loss of forest habitats, Singapore still harbours an amazing diversity of odonates.

Prior to the new records reported here, a total of 106 odonate species from 14 families has been recorded from Singapore (Cheong, unpub., 2008) of which eight species are probably locally extinct. This is the result of outstanding work done by odonatologists and naturalists who had contributed to the current knowledge of Singapore odonates since the 19th Century (Isawaki, 1981; Kiauta & Kiauta, 1982; Laidlaw, 1931; Lieftinck, 1954; Murphy, 1997; Orr, 2005; Paulson, unpub.; Wallace, 1855; Yokoi, 1996). In the past four to five years, a dedicated group of dragonfly enthusiasts in Singapore, many of them armed with digital photographic equipment, has discovered 11 new records since the last major dragonfly work by Murphy (1997). Thus this brings the total odonate species ever recorded from Singapore to 117 species (Norma-Rashid et al., 2008).

The following text describes the 11 new records with accompanying pictures and notes on their discovery and habitats.

Gynacantha dohrni, male. Photo credit: Tang Hung Bun

Gynacantha dohrni, female. Photo credit: Tang Hung Bun

ANIPSOPTERA
Aeshnidae
***Gynacantha dohrni* Krüger, 1899**

This species has been sighted a few times since 2005, but has been mistaken for the similar looking *Gynacantha basiguttata*. It was not until May 2008 when close-up photos of both male and female individuals were taken that its identity could be confirmed. *G. dohrni* male's inferior anal appendage is pale in colour and is less than one third of the length of the superiors, while that of *G. basiguttata* is darker and is between one third and half the length of the superiors (Orr, 2003). According to Tsuda (2000), *G. dohrni* occurs in Indonesia, East Malaysia and the Philippines. This new record confirmed its presence in Singapore and it is highly probable that it also occurs in Peninsular Malaysia.

Heliaeschna uninervulata female. Photo credit: Tang Hung Bun

***Heliaeschna uninervulata* Martin, 1909**

On 12th April 2007, an unidentified female aeshnid was observed landing on a broken twig about 1m above the surface of a small stagnant pond outside the boundaries of the Central Catchment Nature Reserve. It was later confirmed that the dragonfly

was *Heliaeschna uninervulata* by looking at the following features:
(1) The median space (r + m) is crossed by one vein in all wings
(2) Leaf-like cerci are broad and long
(3) The anal loop of the hindwing has nine cells

Merogomphus femoralis ? male. Photo credit: Tang Hung Bun

While *Heliaeschna uninervulata* has not previously been recorded in Peninsular Malaysia or Singapore, it has been recorded in Sumatra, Java, Borneo (type locality), South Myanmar, Cambodia, Thailand and the Philippines (Lieftinck, 1954; Tsuda, 2000). With this recent discovery in Singapore, it is highly probable that the species also occurs in Peninsular Malaysia. This would mean that the range of the species extends from Thailand in the north, to Java in the south.

Gomphidae
***Merogomphus femoralis* Laidlaw, 1931 ?**
It was first sighted in September 2007 and again in July 2008, at the same site, which is a forest swamp inside the Central Catchment Nature Reserve. During one of the sightings, a female was seen with a male. Photographs of the dragonflies were taken but no specimens were collected. Based on the photos, it is likely to be *Merogomphus femoralis* (A. Orr, pers. comm.). Regular visits to the site in order to secure a specimen are necessary to confirm the identity. *M. femoralis* is known from just a single male specimen captured about 80 years ago in Kuala Lumpur, Malaysia (Orr, 2005).

Merogomphus femoralis ? female. Photo credit: Tang Hung Bun

Leptogomphus risi. Photo credit: Cheong Loong Fah

***Leptogomphus risi* Laidlaw, 1933**
This species was spotted on 7th March 2004 at the fringe of Rifle Range forest near Murnane Service Reservoir within Singapore's Nature Reserves. It was found perching quite low on some scrub, apparently sunning itself in the open at an early hour (9:50am). This species is reported as rare and local in Peninsular Malaysia and Thailand (Orr, 2005).

Libellulidae
***Cratilla lineata* Brauer, 1878**
The first unconfirmed sighting of *Cratilla lineata* was at the Singapore Night Safari Park. Subsequently on 6th October 2006, the species

Cratilla lineata. Photo credit: Robert Teo

seen there. This species was subsequently also spotted at various locations such as the ponds in the Sungei Buloh Wetland Reserve and various other public parks.

***Onychothemis testacea testacea* Laidlaw, 1902**
This subspecies is widespread in tropical Asia, occurring in Laos, Myanmar, Thailand and Peninsular

Onychothemis testacea testacea. Photo credit: Richard Ong

Orchithemis pulcherrima, the species might have been overlooked in the past. *O. pruinans* (hw 26mm) is slightly larger than *O. pulcherrima* (hw 22mm). The abdomen of *O. pruinans* is longer and thinner than that of *O. pulcherrima*. White markings cover the second, third and half of the fourth abdominal segments, while in *pulcherrima*, white markings cover only the second and third abdominal segments. With this new record, the known distribution of this species is Indonesia, East Malaysia, Peninsular Malaysia and Singapore.

was clearly identified from a sighting in Pulau Ubin, a northern offshore island that still retains the rustic charm of village life. It was observed resting over a puddle along an earth track in a secondary forest. Currently *C. lineata* is known to exist in two other locations in Singapore.

***Aethriamanta brevipennis* Rambur, 1842**
This species is indeed quite widely distributed but seems to be uncommon. It was first spotted at a pond in Singapore Botanic Garden on 8th December 2004 but since then, it has not been

Aethriamanta brevipennis. Photo credit: Robin Ngiam

Malaysia. Its first record in Singapore was made on 8th January 2008 along a nature trail by the side of MacRitchie Reservoir in the Nature Reserve. With this new record, the most southern range of this subspecies reaches Singapore. It is also rare in Peninsular Malaysia.

***Orchithemis pruinans* Selys, 1878**
This species was first recorded on 9th August 2007 in a forest swamp within Central Catchment Nature Reserve. As it looks very similar to the dark form of

Orchithemis pruinans. Photo credit: Tang Hung Bun

Ceriagrion chaoi ? Photo credit: Tang Hung Bun

Zygoptera
Coenagrionidae
***Ceriagrion chaoi* ? Schmidt, 1964**

This species was first discovered on 7th June 2005 at a stream in the Upper MacRitchie Basin area in the Nature Reserves. The stream has a lot of submerged vegetation. A male and female were found in tandem, with the male clasping the female while the latter was ovipositing on the underwater vegetation with only her abdomen submerged. This species was subsequently also spotted at a pond in a public park near the Central Catchment Nature Reserve. Based on its colouration, this damselfly was initially identified as *Ceriagrion auranticum*. However recent examination of the anal appendages reveals it is most probably *C. chaoi* (M. Hämäläinen, pers. comm.). More specimens need to be collected to confirm the identification. Whether it is *C. auranticum* or *C. chaoi,* the damselfly would still be a new record for Singapore.

Platycnemididae
***Copera vittata* Selys, 1863**

From 2006 to 2007, the National Parks Board of Singapore conducted an island wide biodiversity survey. One significant result from the work is a new record of the damselfly *Copera vittata*. It was sighted on 23rd August 2006 along a secondary forest stream in western Singapore in an area that is being used intensively for military training. Further surveys revealed another healthy population at a remnant swamp in another part of western Singapore. To date, these are the only two known locations for *C. vittata* in Singapore. Thus its status remains rare and highly endangered although it is somewhat protected due to the military training area being highly restricted from public access and urban development.

Copera vittata. Photo credit: Yeo Suay Hwee

Prodasineura humeralis. Photo credit: Tang Hung Bun

Protoneuridae
***Prodasineura humeralis* Selys, 1860**

This species, which is common in Peninsular Malaysia, was discovered at the Chestnut Forest in the nature reserve, along a stream flowing out from Chestnut Reservoir on 21st Oct 2006. There were five to six males, hovering and fighting over the stream for territory, as is typical of this species. One week later, near the edge of the Chestnut Reservoir itself, another five females were discovered. Subsequently, the various streams in

the Mandai area were also found to be a stronghold for this species. It is strange that this locally rather abundant species was not discovered during the last Central Catchment Nature Reserves survey carried out by Murphy (1997) during 1994 to 1997, especially as some of the areas mentioned above were indeed covered in that survey.

Conclusions

The 11 new records added in just three to four years indicate there may still be species that have been overlooked in the past. This is particularly so for crepuscular aeshnids and fast flying gomphids. Besides the new records, other species such as *Brachygonia oculata* and *Paragomphus capricornis* were recently recorded after many years without sightings. Although Singapore is small in size and highly urbanised, the 117 species and perhaps many yet to be recorded attest to Singapore's location within the odonate rich Sundaland. Continued efforts will be made to study the odonata diversity of Singapore to aid conservation efforts especially in vulnerable habitats such as freshwater swamp forests.

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Egg-laying observations in the Pilbara region of NW Australia

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The Gorges in Karijini National Park and the pools in Millstream-Chichester National Park are ideal locations for observing dragonflies. There is a rich variety and they include many endemic species. I was interested to see many laying eggs. The Scarlet Percher, *Diplacodes haematodes* is one of the most abundant and widespread species and I saw many of them laying eggs. Usually the female flew in tandem with the male and she repeatedly dipped her abdomen in the water to wash the eggs off as they were laid. In Knox Gorge I saw pairs of Narrow-lobed Gliders *Tramea stenoloba* laying eggs too. These are much larger, more handsome red dragonflies. Their technique was quite different. They would fly around looking for a suitable spot over clear water, then hover for a moment before the female is released to duck down to the surface and dip the tip of the abdomen in. She then flies up to be immediately caught by the male again and they repeat this sequence several times. I was lucky enough to catch an image of this.

Cinderwariner Pool

At Millstream I saw other species where the females chose to lay their eggs on their own. A Western Red Hunter, *Austrogomphus gordoni*, was flying quickly just above a waterfall splashing her abdomen in the water, as was a Pilbara Archtail, *Nannophlebia injibandi,* a tiny endemic species. The latter chose a spot under some overhanging reeds.

It is interesting that some of these species are very elusive – I do not know where they go when not laying eggs. The late Tony Watson, who did all the original work on Millstream dragonflies, said he only once saw a Pilbara Dragon, *Antipodogomphus hodgkini* in flight – and that was laying eggs. He had to rear larvae to get adults. (He named the species after his supervisor at UWA, Ernest Hodgkin). The only Pimple-headed Hunter, *Austrogomphus mjobergi*, I have seen was one which had only just emerged – even though the cast off skins show that they are abundant there. The males of other species are constantly in view, such as the endemic Pilbara Tiger, *Ictinogomphus dobsoni*, which take up positions on tall reeds to view their territories.

The final observation was on the Pilbara Pin, *Eurysticta coolawanyah*, an endemic damselfly. Madeleine found

a group on a branch of a small cadjeput tree overhanging a waterfall. It was made up of two pairs in tandem, with the females busy inserting eggs into the bark. It is interesting that they were doing this about two metres above the water level. I wondered if the larvae dropped into the water after hatching? The branch was heavily scarred from many other eggs having been laid there, and it seemed to have been an important meeting place, because I later saw four males waiting there. This was the only place where I saw these damselflies.

Above: *Ictinogomphus dobsoni;* left & bottom left: *Eurysticta coolawanyah* ovipositing; bottom right: *Eurysticta coolawanyah* oviposition site.

Databasing the World

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During the meeting of the IUCN Odonata Specialist Group in 2007 an afternoon was spent discussing the Global Dragonfly Assessment (GDA). This project is supported by IUCN and Conservation International (CI). The latter two are mainly interested in getting all dragonfly species red listed (= assessed) but the aim of the Specialist Group is more ambitious: to build distributional databases of all dragonflies in the world. We are not aiming for a central database but rather for regional databases with a similar structure but without geographic overlap: allowing for the data to 'communicate' easily. The databases built thus far result from different initiatives. Africa was partly made possible by the IUCN but most others are being developed by other organizations (e.g. North-Africa, Europe) or private initiatives (e.g. Australia, Suriname). In 2008 CI hired Ian Harrison to fund raise for the Global Freshwater Assessment, which includes fish, mollusks and dragonflies. His work resulted in grants for assessments in mainland tropical Asia, which ultimately will result in databases for these areas (more on this in the next Agrion). Financial support from CI and the National Museum of Natural History in Leiden made it possible for KDBD to support fundraising and databasing initiatives.

The articles in this issue of *AGRION* give an overview of many of the currently existing databases. One thing to be learned from this overview is that we, the dragonfly community, can be proud of ourselves. On many continents good co-operation of (mainly) volunteers has resulted in strong databases. There is still much to do, but within ten years time Odonata might be the first insect order for which database-generated distribution maps of all species are available.

The presented overview does not include all available databases and in the next *AGRION* we hope to present additions. Especially our knowledge of databases for Central and South America is poor and we ask anyone with information on this region to contact us.

The Australian Odonata Database

Ian Endersby [endersby@mira.net]

The Australian Odonata database contains the label data from over 25,000 specimens. It was compiled from those Museum collections which had been electronically registered. This included the museums in Canberra, Melbourne, Hobart, Launceston, Adelaide, Perth and Darwin, plus the collection of Dennis Paulson which he had made during his own visits to Australia or obtained from other visiting collectors. Some of the recent data from the Australian Museum in Sydney was available but the bulk of its collection awaits databasing. This will contain important historical records, as will the Macleay Museum at the University of Sydney. The Queensland Museum needs volunteers to register its collection so that is not yet available either.

The project started with my curiosity about the distribution of the Odonata in my own State, Victoria, and thus

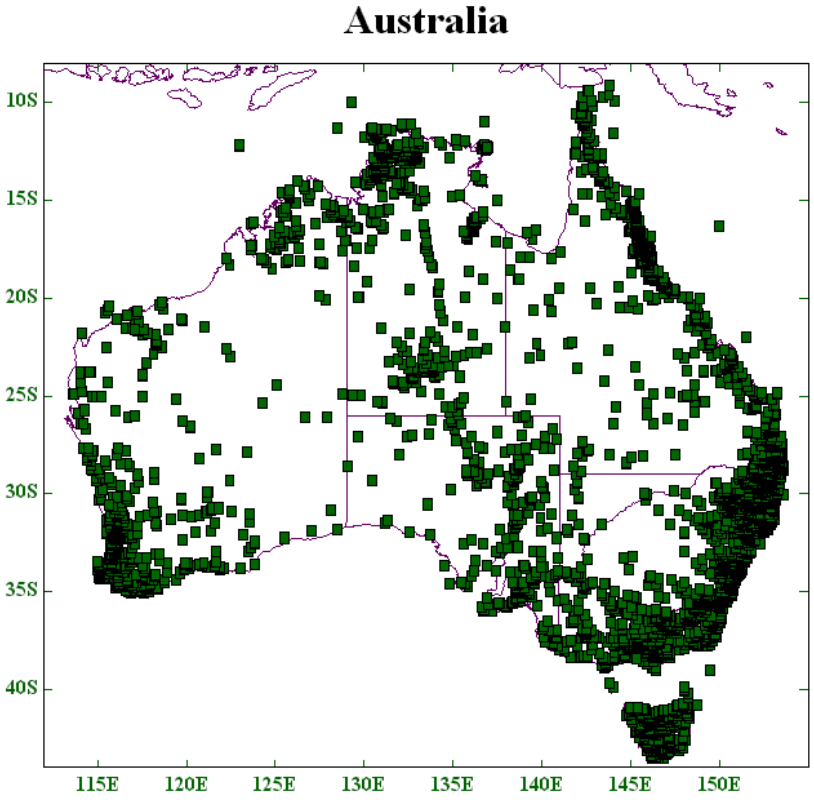

Figure 1. Distribution of dragonfly records across Australia.

an offer to extract the label data from the Melbourne Museum's collection. The irony is that the long-term curator of that collection used to take his annual holidays in the northern parts of Australia and so the collection contains a high proportion of interstate specimens. During this time the Australian National Insect Collection (ANIC), housed in Canberra and by far the largest collection in the country, put part of its records on the web, fortunately including the Odonata. I knew that the South Australian collection was also available digitally because I had obtained a copy when helping an author with a range extension paper, and I had sought and obtained the Victorian records from the Western Australian Museum.

During the WDA Symposium held in Swakopmund a call was made for point data to support the IUCN sponsored Global Biodiversity Assessment of the Odonata. Feeling sure that probably 80% of the Australian information was electronically available I offered to collate what could be obtained. That was done and some maps have already been submitted for the Red List study.

For identification of adult Odonata, Australia relies on the major work by Watson, Theischinger & Abbey, from 1991, and the much more recent field guide by Theischinger & Hawking. For larvae there is a set of laboratory manuals covering the bulk of the taxa, that have been presented at annual aquatic invertebrate taxonomy workshops, predominantly prepared by Gunther Theischinger. The field guide contains keys to family and genus for both adults and larvae. With primarily selfish motives I suggested to Gunther that the adult keys could be expanded to species level using information from the 1991 volume if he could assist with details for those species described since that time. I would be delighted to carry out the clerical work under his technical guidance. Gunther embraced the project wholeheartedly and added the larvae as a necessary component.

A number of Australian larvae, even in the final instar, do not yet have recognisable characters to distinguish them from congeners. In many cases they occupy a restricted geographic range and distribution maps of adult occurrence are the primary way to identify the larvae. So, the Australian database has been used to prepare a set of maps to be included in the new identification guide. From those maps incongruous outliers have been removed and any gaps, where no museum specimens have been located, have been filled from literature citations. Every species known from Australia now has a distribution map, albeit rather depauperate for some.

Expressions of interest have been made about using the data for analysis of the conservation implications of the Australian Odonata distribution history but they are awaiting the obtaining of university research funding. Some of the data was released purely for the Global Diversity project and, subsequently, for the identification guide, so uses outside the scope of these will require further permissions, unlikely to be withheld unless they have a commercial gain for the user.

There are specimens from Australia in overseas museums. If they are electronically databased and georeferenced with species, collecting date and collector, I have just the home for them. If there are volunteers out there, the lifeblood of modern museums, who could extract label data or photocopy card indexes, the country Downunder would welcome your assistance. And your reward? - a mud map of how to find *Hemiphlebia mirabilis* if our drought ever breaks.

Odonata Database of New Zealand and South Pacific islands

Milen Marinov [mg_marinov@yahoo.com]

Introduction

Studies on New Zealand Odonata began with the first collection of dragonflies that took place in 1841. The specimens caught by Dr Andrew Sinclair during his botanical expedition led to discovery of three new species for science (Rowe, 1987). Many authors have contributed to the knowledge of the local fauna since. Much of the data available comes from investigations completed more than 30 years ago. The data was compiled by Ken Deacon in 1977 under a research programme financed and organised by Prof. Philip Corbet. Rowe (1987) used it later to underline his results and produce the species distribution pattern for the country. In Richard Rowe's 1987 publication, '*The Dragonflies of New Zealand*', all available information on distribution, habitat and behaviour on all seventeen species known to occur on the islands belonging to New Zealand (Kermadec Islands, Chatham Island, Steward Island, and the sub-Antarctic islands south of them) were summarised. There is a paucity of publications since. Ten of the 17 species occurring in New Zealand are endemic including four species of *Xanthocnemis,* two species of *Uropetala* and one species of *Antipodochlora* (Moore, 1989). The same author points to the necessity for protection of local fauna and encouraging local investigations.

The database

Until recently no database with records of the dragonflies of New Zealand was available. This year I have started to build such a database as part of a postgraduate dissertation project at Lincoln University, Christchurch. At the moment the database contains 2954 entries. Besides records from 66 publications it also contains records from collections at Lincoln University (260 specimens), Canterbury Museum (408 specimens), Auckland Museum

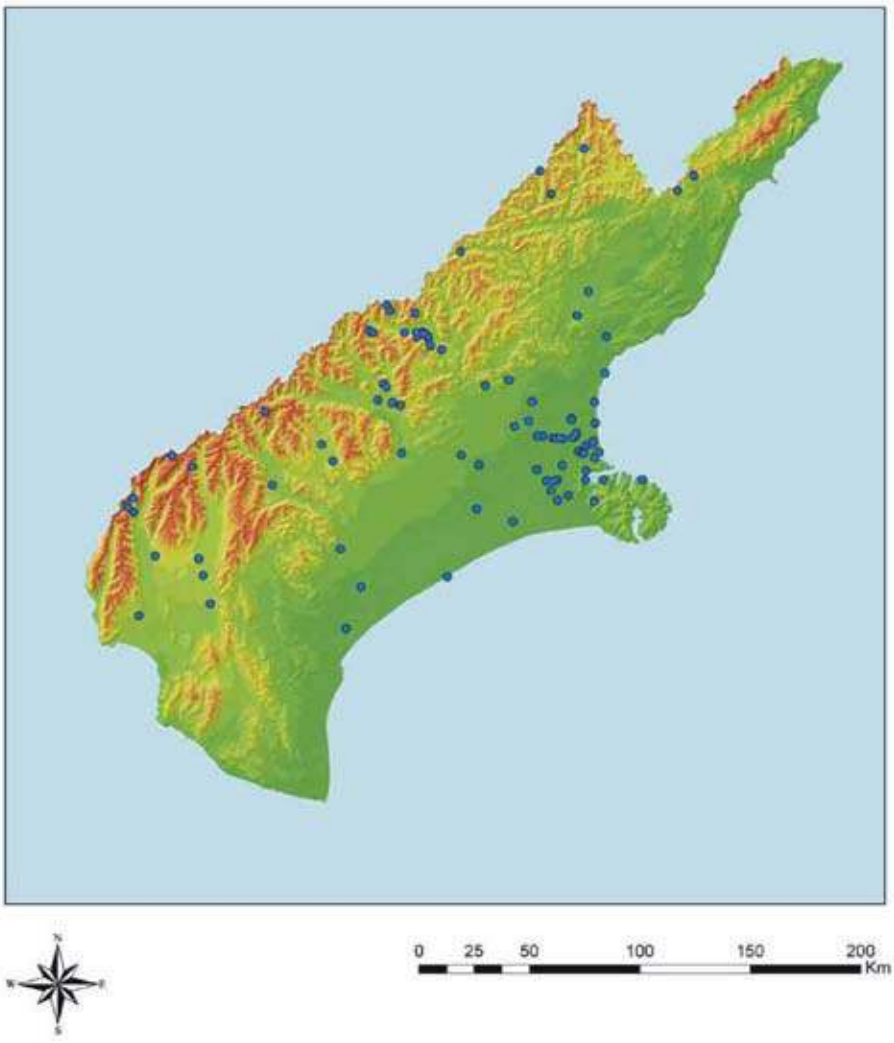

Figure 1. Localities in the Canterbury region where dragonflies have been collected.

(239 specimens), Department of Scientific and Industrial research (DSIR) Auckland (1080 specimens) and the National Museum Wellington (108 specimens) as well as some unpublished data. Thus far the database has focused on New Zealand's main islands, but in 2009 it will be expanded to the adjacent islands in the South Pacific including New Caledonia, Vanuatu, Fiji, Tonga and Samoa. Brief spatial analysis is performed to visualise the degree of knowledge of the Canterbury region on the South Island. Figure 1 represents total sampling location for this area. They come from 322 records included in the database.

Future

The database for New Zealand will be completed by the end of 2008. After its completion it will be used for creating a digitised model to predict the Odonata distributional pattern within New Zealand. Current knowledge of the distribution of species will be compared with the prediction by the model showing, for example, areas of future interest for exploration and Important Dragonfly Areas. Although most information from collection is incorporated in the database it is still necessary to visit some of the collections in order to verify some of the identifications. The next phase in database preparation would be to collect more unpublished records from Universities and some governmental organisations. Contacts with them are important as they might be a valuable source of more recent records.

People who want to use the information on New Zealand or in the future the information on South Pacific Islands can contact me. I would be very happy to receive unpublished records from New Zealand or the South Pacific Islands.

Europe: a jigsaw puzzle of databases

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Towards a European atlas

The study of dragonflies is relatively popular in Europe resulting in a large number of databases build for different countries or regions. Some of these databases have been built by governmental organizations but many have been created by non-governmental organizations or even by single enthusiastic odonatologists. All these databases mean that for Europe more records are available than for any other region in the world. Of course there is also a downside as many of the databases have a different layout and use different systems for the coordinates. In the last

few years a network has been built which aims to make a European atlas by 2010. The first result of this network is an atlas for the Mediterranean and North Africa to be published in the start of 2009 as a supplement to *Libellula*. This atlas will combine the records of 35 countries (15 European) and will show the distribution of 179 species occurring in this region (Fig. 1). For the European part of the maps about 20 national and regional databases were combined. This project shows that with good co-operation it is possible to make atlases based on widely different types of databases. The atlas will also contain a list of persons and organizations maintaining national or regional databases. From 2009 onwards a start will be made to bring together all European databases in order to produce maps for the approximately 140 species occurring in Europe.

European Red List

The initiative for a Mediterranean and North African atlas was taken during a meeting in Portugal of seven odonatologists involved in the Mediterranean and North African Red List. This project was organized by the IUCN Mediterranean team and is largely coordinated by Annabelle Cuttelod. An official publication on these Red Lists will probably appear in 2009. A European Red List is scheduled to appear in the end of 2009. This red list will be written by Jean-Pierre Boudot and Vincent Kalkman and the assessments will be refereed by ten odonatologist from different parts of Europe. The project is funded by the European Union and is organised by the IUCN.

Future of European databases

The database constructed for the European atlas will be used only for the atlas and will not be maintained afterwards. However the amount of contact between people working on dragonflies is showing a steady increase making future exchange of information and records easier. In the last couple of years collecting records by volunteers through the use of the internet is growing swiftly. There are several good working examples of these kinds of sites (see for instance www.hatikka.fi from Finland or www.fugleognatur.dk from Denmark). A Dutch organisation which built such an internet site with great success (collecting 125,000 records of odonates in five years time) has now started to 'export' their site to other countries. In Belgium (www.waarnemingen.be) this has already been a success with 10,000 records in one year and in 2009 a spin off will start in Italy. The Dutch example can be seen on http://waarneming.nl.

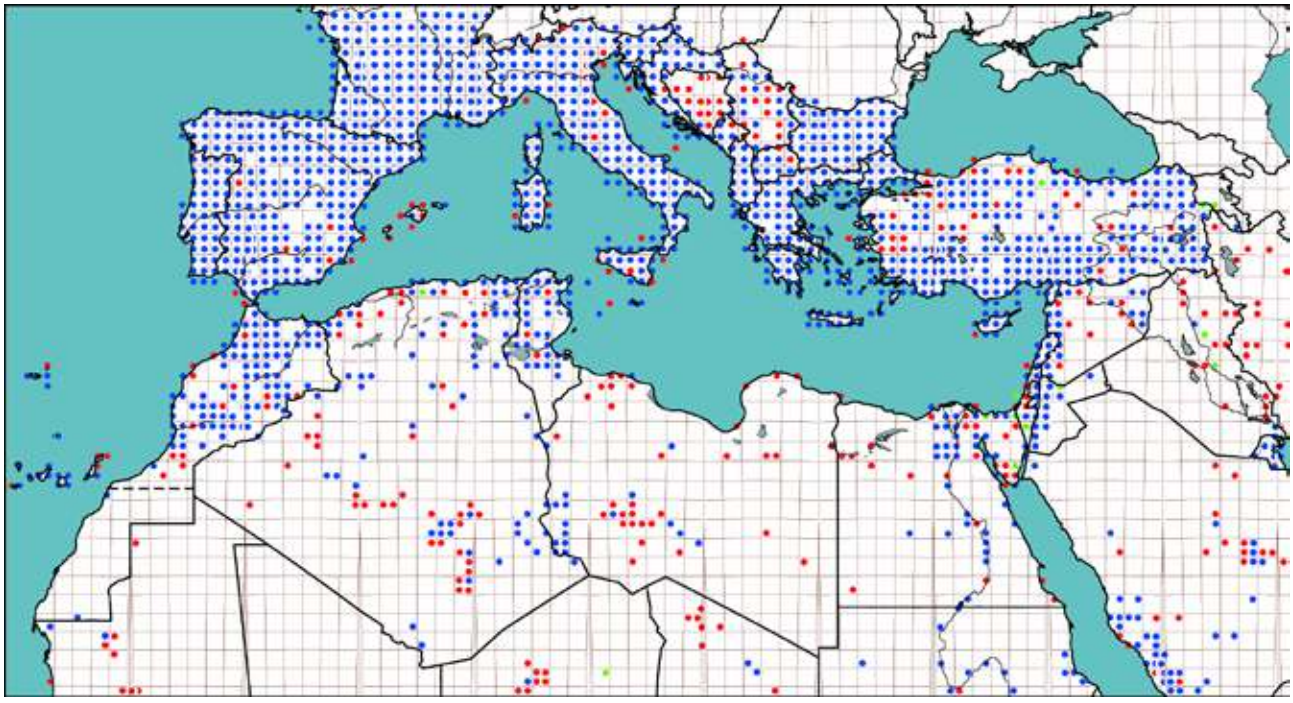

Figure 1. Distribution of records of dragonflies in North Africa and the Mediterranean. Red dots: only record prior to 1980 available; blue dots: records from 1980 onwards available; green dots: only records without date available.

Odonata Database of Africa (ODA)

Jens Kipping[1], Klaas-Douwe B. Dijkstra[2], Viola Clausnitzer[3], Frank Suhling[4] & Kai Schütte[5]

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Thanks to the IUCN Freshwater Biodiversity Assessment, as well as prior or parallel databasing initiatives by Jean-Pierre Boudot, Jens Kipping, Kai Schütte, Mike Samways and Frank Suhling, the collation of point-locality data in Africa is ahead of other parts of the tropics. This has been facilitated by the modest size of the fauna and the reasonable state of its taxonomy relative to tropical America and Australasia. Currently, data of the African Odonata are maintained in four central databases, whose compatibility is ensured by frequent exchanges of relevant data:

(1) North – The nations that border the Mediterranean Sea and/or that have their larger part in the Sahara (Algeria, Canary Islands, Chad, Egypt, Libya, Mali, Mauritania, Morocco, Niger, Sudan, Tunisia and Western Sahara) are maintained by Jean-Pierre Boudot in his database of North Africa and the Middle East. The fauna is largely Palaearctic and/or strongly impoverished, only the extreme south of especially Chad, Mali and Sudan have reasonably rich Afrotropical faunas.

(2) South – South Africa has a distinctive fauna: of about 160 species almost one-third is endemic and over two-fifths are just present in the nation's tropical periphery. Mike Samways and his group at Stellenbosch University manage most of this relatively large (almost 10,000 records) and detailed dataset.

(3) Islands – Madagascar and the Indian Ocean islands of the Comoros, Mauritius, La Réunion, Rodrigues and the Seychelles share less than a quarter of their over 200 species with the mainland. The data are being collated by Kai Schütte as part of his PhD research. Currently the Madagascar database contains about 3,000 records. One third of these were assembled during recent fieldwork by Kai Schütte, mainly from southeastern Madagascar around Tolagnaro, the high plateau near Tolongoina and the Perinet area. The remainder are literature and museum records mainly from Paris (MNHN) and Antananarivo (PBZT). The main literature is entered and only some articles with few or single records have to be added. Some records from recent collecting by the California Academy of Science (CAS) were provided by Mike May and Jessica Ware. Further CAS material should be available, and the collections from Nick Donnelly and Mike Parr contain valuable additional records. With these additional sources the number of records should increase to around 4,000. Extensive further fieldwork is necessary to cover white spots, especially forests and to clarify the status of 'single-spot species' that are only known from their type localities and might already have vanished. Of over 175 species known from Madagascar, more than three-quarters occur nowhere else and almost two-thirds (over 100 species) are possibly threatened and require immediate assessment. However, possibly half of the latter have not been recorded since their discovery. Most endemics are restricted to rainforest, which decreased by 40% in the second half of the 20th century, while the study of dragonflies stood still. Consequently, nowhere in the world is the discrepancy between data deficiency and potential degree of threat as great as in Madagascar. A comprehensive survey of these lost species is therefore required imminently.

(4) Main – With over 700 species, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Congo-Brazzaville, Congo-Kinshasa, Côte d'Ivoire, Djibouti, The Gambia, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Ghana, Guinea-Bissau, Guinea-Conakry, Kenya, Liberia, Malawi, Mozambique, Namibia, Nigeria, Rwanda, Sao Tomé & Príncipe, Senegal, Sierra Leone, Somalia, parts of South Africa, Tanzania, Togo, Uganda, Zambia and Zimbabwe harbour the bulk of African dragonfly diversity. The database is managed by Jens Kipping, with the support of Viola Clausnitzer, KD Dijkstra and Frank Suhling. The overview below focuses on this last subset.

History

The basis was formed by the records from Botswana and Namibia assembled mainly from the field and literature by Jens Kipping and Frank Suhling, augmented by the personal record databases of Viola Clausnitzer (eastern Africa) and KD Dijkstra (throughout Afrotropics). The IUCN Freshwater Biodiversity Assessment gave a major (financial) boost to the databasing process. Jens and Frank expanded the database for southern Africa, especially with the papers of Elliot Pinhey and personal datasets (e.g. Warwick Tarboton), while KD added the main regional literature for western Africa incorporating personal datasets from Tammo Lieckweg (Benin, Togo), Sylvester Ogbogu (Nigeria), Hans Olsvik (Ghana) and Sévérin Tchibozo (Benin). The next and most challenging region to tackle was central Africa, the richest but least known part of the continent. Jens lead the entry of published data, but to combat the huge geographic gaps three additional sources were used: (1) Graham Vick's records from a small but hyper-diverse part of Cameroon; (2) records in the Paris museum, especially from Gabonese material treated by Jean Legrand, extracted by Kai Schütte; (3) records from Congo-Kinshasa in the Africa Museum (see box), by KD. A smaller contribution came from the Equatorial Guinea collections in Madrid, examined by KD.

The last step is to database the eastern African literature (Viola) and the remaining regional and taxonomic papers (Jens, KD and Viola). Although only 130 of over 500 selected titles (25%) have now been entered, this accounts for about 4000 published pages (35% of selected pages). What remains are mainly the

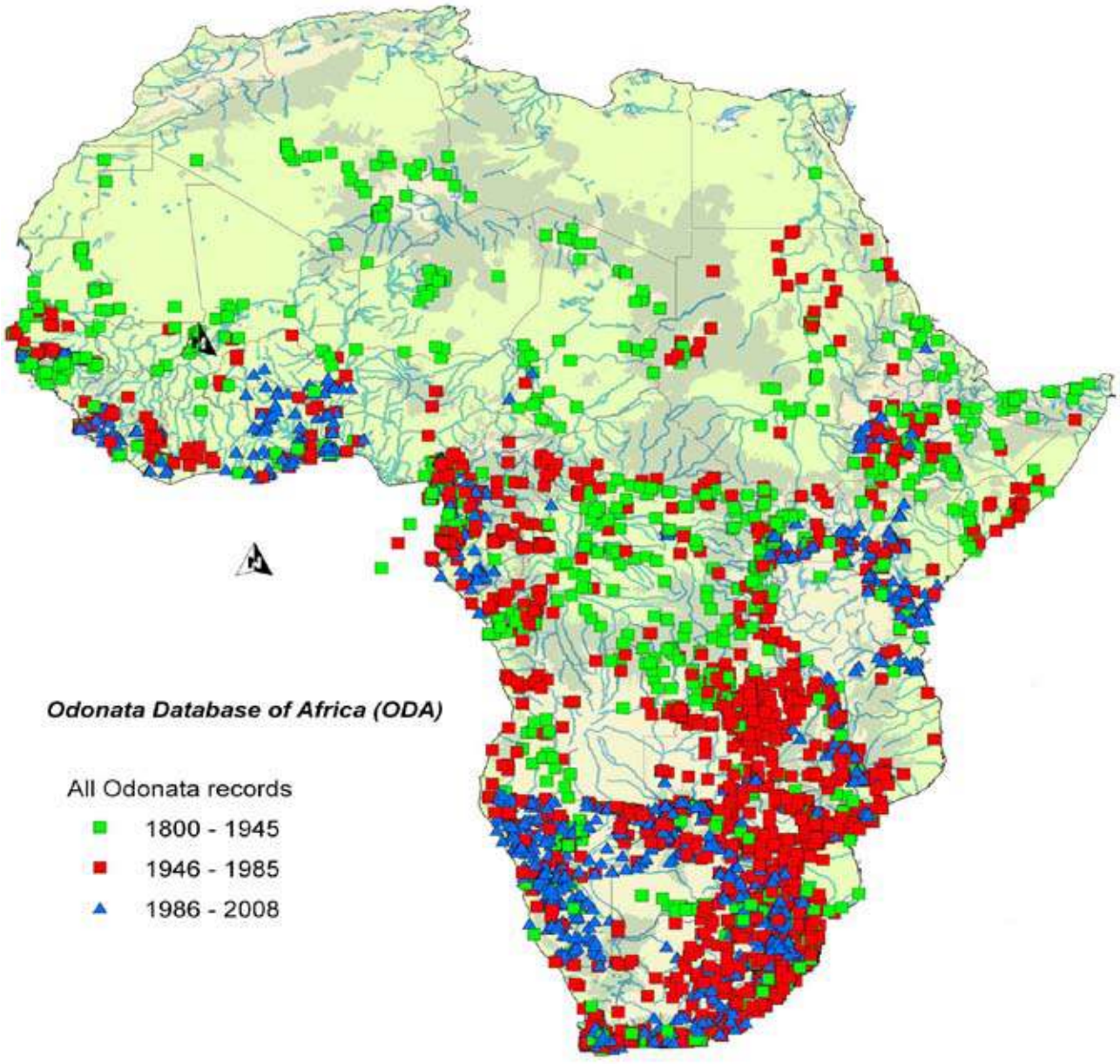

Figure 1. All records currently entered in the database

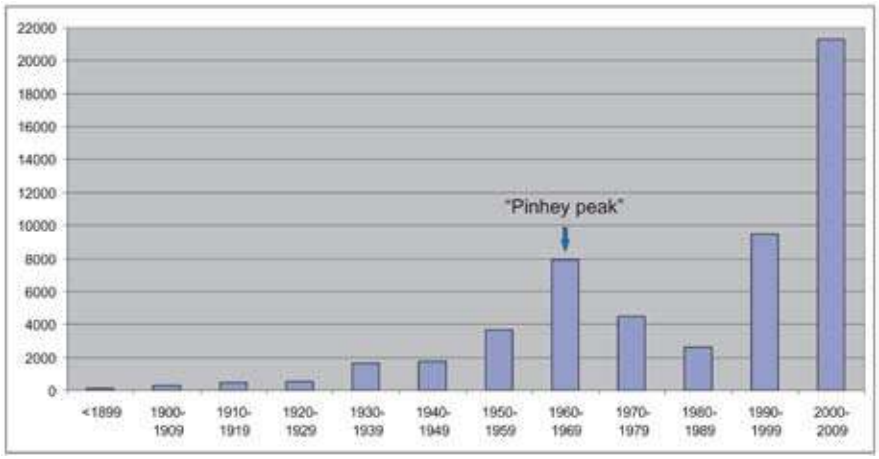

Figure 2. The surge of records in the 1950s and its decline in the 1970s demonstrates the huge contribution of Elliot Pinhey to African odonatology.

smaller and older sources, such as species descriptions. Collections with priority to be entered include those of Robert Gambles (Nigeria), Alain Gauthier (Côte d'Ivoire, Togo), Wolfgang Schneider (Côte d'Ivoire) and Charlie Williams (Uganda). Museums such as in Bulawayo and Nairobi also contain many records, but were reasonably disclosed in Pinhey's publications. Roger Lindley and his collection, with important material from Côte d'Ivoire and Central African Republic, has not yet been traced, despite attempts.

Present status

Currently the database contains over 58,000 records of 738 species (subspecies not considered), which should increase in the near future to 100,000. Fig. 1 shows all the records currently entered, classified roughly in "pre-Pinheyian" (early colonial), "Pinheyian" (late colonial) and "post-Pinheyian" (independence) periods. Parts of southern Africa were studied relatively constantly through time, whereas research in countries like Angola, Congo-Kinshasa, Mozambique and Somalia was impeded by political unrest. The surge of records (see Fig. 2) in the 1950s and its decline in the 1970s demonstrates the huge contribution of Elliot Pinhey to African odonatology.

As expected, Libellulidae provide the bulk of records with 51%, Coenagrionidae follow with 23%. The ten most-recorded species are: *Crocothemis erythraea* (1508), *Trithemis arteriosa* (1497), *Pantala flavescens* (1322), *Ischnura senegalensis* (1206), *Ceriagrion glabrum* (1139), *Orthetrum julia* (1113), *Orthetrum chrysostigma* (1080), *Brachythemis leucosticta* (1038), *Diplacodes lefebvrii* (1011) and *Trithemis kirbyi* (970). However, *B. leucosticta* was recently found to consist of two species. Fig. 3 shows the density of records in a 100x100km grid. Probably the best-studied grid square on the African continent is the southern Okavango Delta with Maun (2696 records), with records collected by Pinhey in the early 1960s to some just a few weeks old. This square is followed by Durban, South Africa (1376); Mt. Kupe, Cameroon (1296); Victoria Falls, Zambia/Zimbabwe (1277); Popa Falls, Namibia (1269); Upper Zambezi, Zambia (628); Makokou, Gabon (576) and Capetown/Stellenbosch, South Africa (570). These rather coarse statistics will change with new research and the ongoing digitalisation of literature and collection data.

Future

A reasonably complete African database is expected by the spring of 2009. This will be the first continent-wide, high-resolution, taxonomically-verified database of a group of tropical freshwater insects. It thus provides the first demonstration at the scale of an entire (tropical!) continent of what the Global Dragonfly Assessment can be worldwide: a tool to determine freshwater biodiversity hot-spots and knowledge gaps, threats and responses to change, and so forth. Thus spatial analysis of the data will be the first priority. The data and analyses should also be presented in a distributional checklist or atlas, facilitating further taxonomic and biogeographic advances in African odonatology.

Another priority now is fieldwork, which is still required in most areas despite a recent surge in records (Figs 2-3). Areas with almost no records but also very few expected species have the lowest priority, e.g. E Kenya and SW Botswana. The highest priority lies in the lowland rainforests, the continent's richest odonate habitat: an almost uninterrupted swathe from S Nigeria, through E Cameroon, E Congo-Brazzaville and C Congo-Kinshasa to N Angola. Of intermediate priority are unsampled regions with medium-rich faunas and open habitats or fragmented (highland) forests: especially (1) Guinea-Conakry, S Mali and N Côte d'Ivoire; (2) N Nigeria, through N Cameroon, S Chad and the Central African Republic to S Sudan; (3) N and W Tanzania; (4) S Tanzania and N Mozambique; (5) S Mozambique; and (6) E Angola and W Zambia.

Problems – the Tervuren example

A dot on a map is not placed easily. The problems are especially taxonomic and toponymic. Aside from straightforward taxonomic changes (mainly synonymies) many misidentifications come to light when records are checked in collections: publications on Afrotropical Odonata may contain 10-15% of such errors on average.

The level of misidentification in the Africa Museum in Tervuren approaches 20% and is even higher in important genera like *Trithemis* (25% of 385 examined males), *Gynacantha* (27% of 130 specimens) and *Orthetrum* (44% of 553 males).

Putting the right coordinates to a record is complicated by the brevity of label data and the complexity of colonial history. Of over 26,000 site names in Congo-Kinshasa, 57% start with either B, K or M, and 21% with either Ka or Ki: obviously many toponyms are homonyms. Moreover, in the past century the borders and names of provinces and districts changed about every ten years: a record date is thus essential to know for which decade to consult a map. European interpretations of African names cause further confusion: English and French ones are relatively phonetic and straightforward, Italian (Ethiopia, Somalia) and Portuguese (especially Angola) sometimes near-indecipherable.

Three examples of the puzzle from label to map:

(1) J. Vrijdagh collected at 'Wamba' in Uele-Itimbiri in October 1932. There are ten places by that name in Congo-Kinshasa, but other labels place the collector in Dingila in that period. No Wamba is nearby, but Mbwa lies only 20 km away: consonants are often reshuffled.

(2) Reconstructing H.J. Brédo's itinerary in early 1932 from numerous labels, an illogical sequence of dates indicate that (not surprisingly) he mixed up material from Binga, Businga and Busira.

(3) The 'Sisters of Tshibala' caught an undated dragonfly in 'Kasai: Tshibala'. Three Tshibalas, 300-400 km apart, were at some time administratively in Kasai. Only one was always in 'Kasai' and was, moreover, a mission station: the likeliest locality for net-toting nuns.

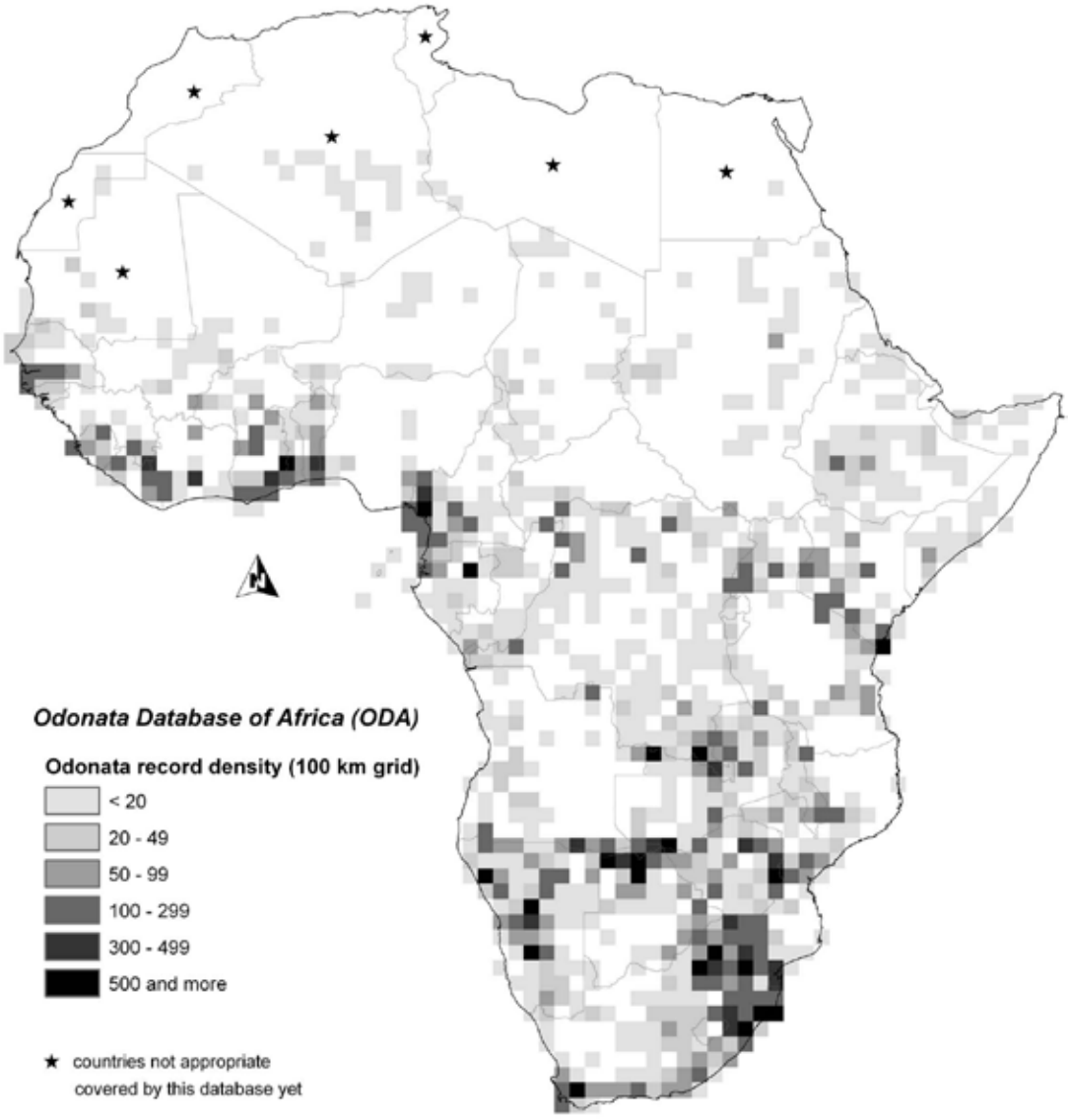

Figure 3. Density of records in a 100x100km grid.

The Lieftinck database, mapping the odonates of Malesia

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Vincent Kalkman [kalkman@naturalis.nl]

In the period 1919 to 1987 Maurits Anne Lieftinck published over 300 papers many of which deal with the dragonfly fauna of the Malesian region. His work still forms a solid base for work on Malesian dragonflies; for this reason his name has been used as a nickname for the distribution database of the region. The area we focus on is the Malesian area, which includes the territory of Malaysia, Singapore, Brunei, Indonesia, Papua New Guinea and the Solomon Islands. The region is one of the richest in the world and has well over 1000 species.

Literature

We identified just over 400 articles containing distribution data from the region. The records from about 350 of these are currently part of the database, probably amounting to over 90% of the published records. This contains all papers by Lieftinck including those outside the Malesian region with the exception of Africa. Where papers contain a mixture of records from the Malesian region and other parts of Asia or Australia, we have included these extra-limital records. In the next months we aim to have the remaining papers done. The database contains at the moment 16,000 records (a species on a day from a location) and over 19,000 entries. Table 1 gives an impression of the number of records from each country. We aim to geo-reference the database in the next half year. Based on this, maps of all species will be made; these will be helpful with tracking down identification mistakes in the literature. We expect that for the whole region about 20,000 records have been published. This may sound like a reasonable amount, but it means that on average for each species less than twenty records are available. This lack of data is especially strong in regions like Kalimantan, Sulawesi and the Moluccas where on average only about 5 to 6 records per species are available. Another problem with the records from the literature is that they are mostly old (see Fig. 1).

Table 1. Number of records in the Lieftinck database per country or region.

COUNTRY	Records
Indonesia	7647
Irian Jaya	1632
Sumatra	1575
Java	1340
Lesser Sunda islands	922
Other/unidentified	784
Sulawesi	510
Kalimantan	508
Moluccas	376
Malaysia	3586
Brunei	841
Papua New Guinea	768
Philippines	245
Singapore	200
Solomon Islands	179

Unpublished records

Large numbers of dragonfly records from the Malesian area have never been published and are stored in collections or in private notebooks. The most important collection in this respect is that of the Nationaal Natuurhistorisch Museum Naturalis, Leiden (RMNH). This collection not only houses material collected by and for Lieftinck, but also has extensive collections from expeditions made in the last three decades. This collection is however so extensive that there is no easy and quick way to digitize it without funding. In recent years several odonatologists have made trips to parts of the region. Most of the results of these trips have not as yet been published. Convincing all odonatologists interested in the region to make their unpublished records available for the database will be one of the initiatives to be undertaken in the next year.

What to do with the Lieftinck database?

The database has already proved to be a very valuable tool in getting a quick overview on what has been published

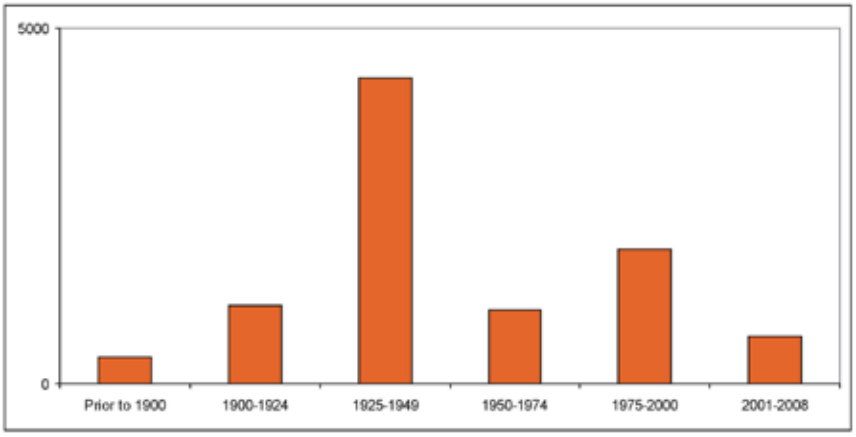

Figure 1. Number of published records from the territories of Malaysia, Singapore, Brunei, Indonesia, Papua New Guinea and the Solomon Islands per period.

on a certain species or a region. In the next half-year we hope to finish the work on the literature. Based on this a publication will be made on the distribution of records across the Malesian region. This will be used to identify areas where no fieldwork has ever been done and areas were no recent fieldwork has been undertaken. This database might also be good enough to make preliminary maps of the diversity of dragonflies across the Malesian area. The effort to include unpublished records will probably be concentrated on Borneo and New Guinea and for these areas maps might be made available of all species in the next few years.

OdonataCentral: The North American Odonata Database

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November 2004 saw the quiet launch of OdonataCentral (http://www.odonatacentral.org), a web site sponsored by the Texas Natural Science Center at the University of Texas at Austin that relied on the novel incorporation of existing World Wide Web, database, and geographic information system (GIS) technologies to produce a truly dynamic, set of distribution maps, interactive field guide and web site for the dragonflies and damselflies of North America (Abbott & Broglie 2005).

At the heart of OdonataCentral lies the North American Dot Map Project. Started in 1994, the project involved the efforts of more than 100 contributors from the Odonata community to accurately document and amalgamate the distributions of all North American odonate species through 2004. A three volume hard copy set of the data was published (Donnelly 2004a,b,c) that included over 124,000 county-level records for the United States and Canada. As odonatologists started digesting the maps and data, we realized the value of such a massive wealth of vetted digital data. The original OdonataCentral, a field guide to the odonates of the south-central United States, was integrated with the Dot Map Project data and re-launched.

History of the site

In 2004, OdonataCentral utilized Active Server Pages (ASP), JavaScript, Microsoft Access databases, and Environmental Systems Research Institute's (ESRI's) mapping software to produce web content. The site quickly ran into a number of limitations due to the amount of data and with a $20,000 grant from the Texas Natural Science Center, in 2006, OdonataCentral once again went through an update. The entire site was re-authored now using PHP, SQL, HTML and JavaScript powered by an Oracle database. Records are stored, retrieved, and displayed from a relational database that houses all data tables. The use of a relational data structure devoted to species, observations, seasonality, photographs, and other fields means that any additions, deletions, or other modifications need only to be updated within the database once. Database modifications are immediately reflected when a user visits the site or refreshes a page. These updates remove the hassle of many individual page edits.

The next logical step is to supplement "generic" county-level distributional data with specific data from individuals and collections. The Dot Map Project included county-level records derived from the literature and all major private and public collections. Currently, the only major collection with specific localities at a specimen-level in the database however, is the one housed at the Texas Natural Science Center at the University of Texas at Austin and includes nearly 12,000 records predominately from North America. Most of the collections in North America are at the early stages of databasing, but as they are databased I would like to develop an interface that will not only allow curators to update their holdings on OdonataCentral but allow users to query the various collections of major museums independently or as one set, much like the successful HerpNet and FishNet programs sponsored by the National Science Foundation.

In the mean time, OdonataCentral allows and solicits community involvement. Anyone can submit

species locality records to the site. Digital photos can be uploaded to the site as vouchers and linked to the user's record entry. However, if unavailable, voucher specimens are given an OdonataCentral reference number upon submission and can be mailed for identification to the University of Texas or other suitable depositories. New records are vetted by regional experts and incorporated into the site based on the expert's determination. The originator of the record is then recognized in perpetuity for the information. This turns out to be a driving force for many contributors. The ability to add to the odonate knowledge base is appealing to many as is the ability to view their contributions. Since 2004, the site has nearly 1,000 registered users who have submitted just under 6,000 records and 6,800 photographs. The total number of records in the database is just under 142,000 (fig. 1). Though the driving force has been with North American species, the site and database is setup to handle species on a world-wide scale and does contain incidental records for a number of countries outside of North America.

The Odonata distribution viewer

The Odonata Distribution Viewer comprises another major facet of OdonataCentral. Users can not only query records, but utilizing Google Maps, the distribution viewer serves as a powerful tool to visualize the geographic distribution of dragonflies and damselflies across North America. Users can zoom, pan, and query the distribution of any North American odonate species to geographically view species limits, find gaps in county records for selected species, or generate accurate county checklists. Queries produce tables that link back to the main OdonataCentral field guide, providing seamless interoperability between checklists, field guides, and distribution maps. Records with specific latitudes and longitudes are plotted right on the map and Dot Map Data is plotted in the center of each county in the United States. Canada and Mexico are divided into 30–minute grids that serve the same purpose as United States county divisions. Records are color coded to indicate whether they represent the Dot Map Project, user submitted records, or the University of Texas collection. These records can also be filtered to only show one or a combination of sources. To complete the viewer, political boundaries such as state and county borders are included and easily combined with the standard map or satellite views provided by Google. Additionally, a KLM file of the data can be downloaded and viewed using Google Earth.

The future

OdonataCentral is evolving quickly. Software and hardware upgrades are on the horizon, allowing for quicker database queries and map production. In addition to integrating museum data, a bibliographic search, the ability to download PDF publications, and an expanded photo gallery are currently in progress.

I believe the uniqueness of OdonataCentral stems not only from its use of technology but also from its promotion of community involvement; something often termed "Citizen Science." The site provides customized user profiles allowing individuals to logon to OdonataCentral and track records they have submitted.

Dragonflies and damselflies are experiencing a tremendous surge in interest in North America. This is evident by the recent creation of festivals in their honor and the increasing number of field guides that are being published. As these field guides become available for nearly every part of the country, our knowledge of distributions, behavior, and ecology is rapidly increasing. What is unusual about odonates as compared to many other insect groups is that much of this knowledge is coming from informed citizens rather than professional scientists. OdonataCentral aims to embrace these intrepid natural historians and collect, vet, and publish this information.

OdonataCentral has been designed to serve as the distribution hub for all information relating to North American Odonata. Ultimately, OdonataCentral's growth lies in the hands of the community it serves. The reciprocity of users submitting and OdonataCentral serving allows for a true sense of group interaction that comes from the knowledge that users are being listened to and their contributions are serving a greater cause. I hope that OdonataCentral may serve as a model for tracking and distributing information at a time when our knowledge is growing at a geometric rate. Distributional data contained within the site is already being used by researchers to discover trends and patterns that may relate to climate change and I believe this is only the beginning of how this data will be utilized.

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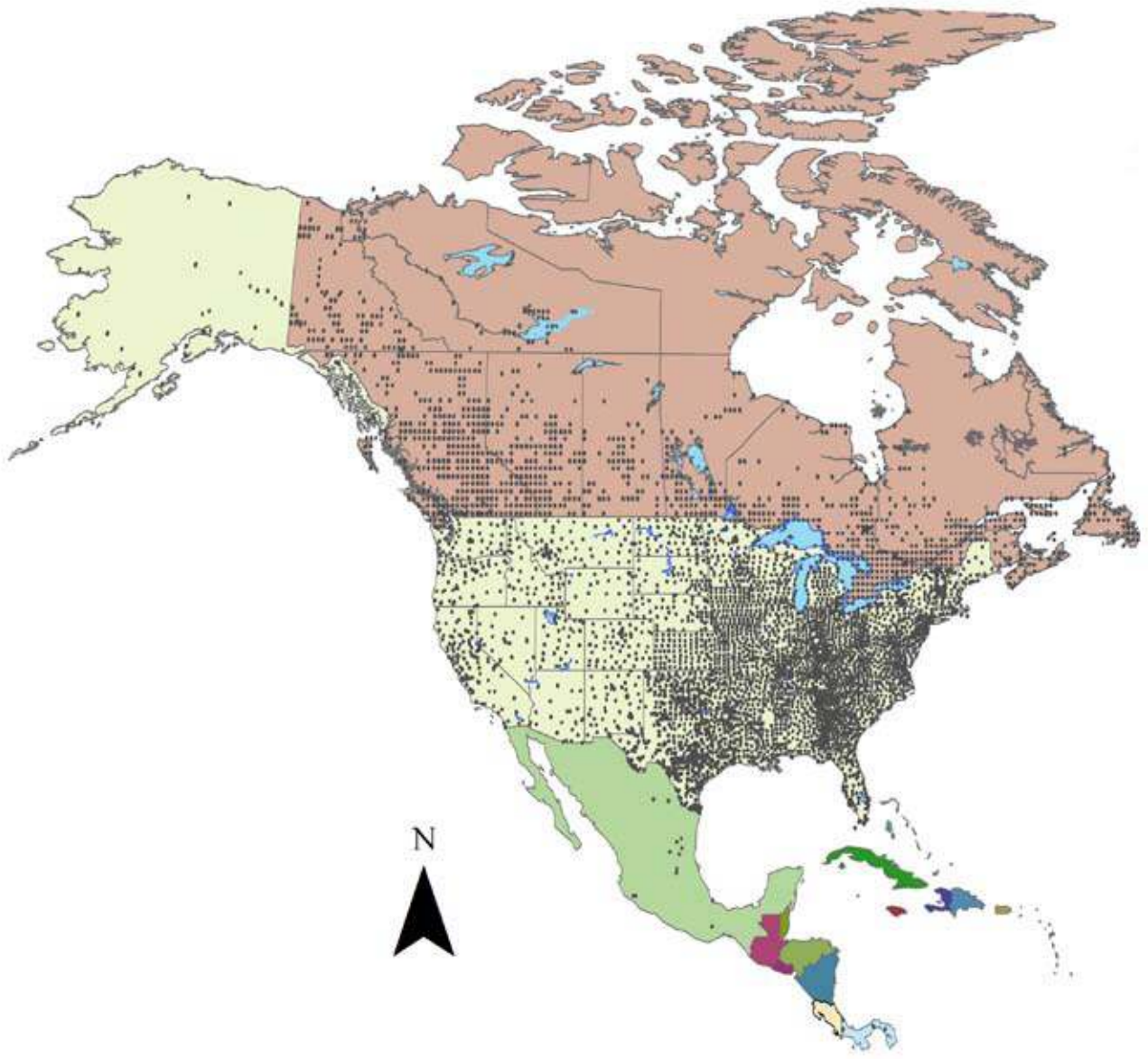

Figure 1. Map showing the distribution of 459 species across North America and Central America based on data contained in OdonataCentral.

Database of Suriname dragonflies

Marcel Wasscher [marcel.hilair@12move.nl] &
Johan van 't Bosch [johanvantbosch@yahoo.co.uk]

The Natural History Museum Naturalis (RMNH) in Leiden, The Netherlands has the largest collection of Suriname Odonata in the world. Most of them have been collected by Dirk Geijskes and Jean Belle, between 1938 and 1975, but tens of others have contributed to the collection. The collection has been well kept and the time has come to put the collection to other uses. Geijskes estimated the collection to contain 20,000 specimens in 1970; only hundreds of specimens have been added since.

Suriname is a relatively small country in the large Neotropics; its fauna is a part of the Guyana region: the region north of the Amazon and east of the Orinoco river. The first species known to occur in Suriname was *Erythrodiplax umbrata* as published by DeGeer in 1773. Around 1930, before Dirk Geijskes started to study its dragonflies, the number of species known from the country was 60; in 1970 it numbered 260 and the checklist of Jean Belle (2002) lists 280 species. The last species added to the list is *Chalcopteryx seabrai*, found at the Brownsberg in 2006.

Goals

- Making the data from the collection available and accessible.
- Getting a better understanding of which species occur in Suriname, their distribution and habitats where they occur.

Methods

- Entering all data of the collection into a database. We have started with the Aeshnidae, a relatively well-known family with not too many species.
- Making distribution maps and flight diagrams based on the collection data. Most location names can be traced, while helpful lists are made available by Piet van Doesburg and the National Zoological Collection of Suriname (NZCS) in Paramaribo.
- Checking identifications and comparing specimens with descriptions and literature. The larger part of the collection was identified by Dirk Geijskes and Jean Belle. Recent publications and opinions were not included and there are still boxes of unnamed specimens and probably even some unnamed species.
- Developing keys for the identification of Odonata in Suriname. Next to specialist keys, identification keys for the commoner species in the area around Paramaribo are possible, useful for non-specialists. This might also been used for creating environmental awareness (among children).
- Expand a website on the Suriname dragonflies, as has been developed some years ago (www.libellen.org/suriname). At the moment most parts of the website are in Dutch with some parts (e.g. the checklist) in English.

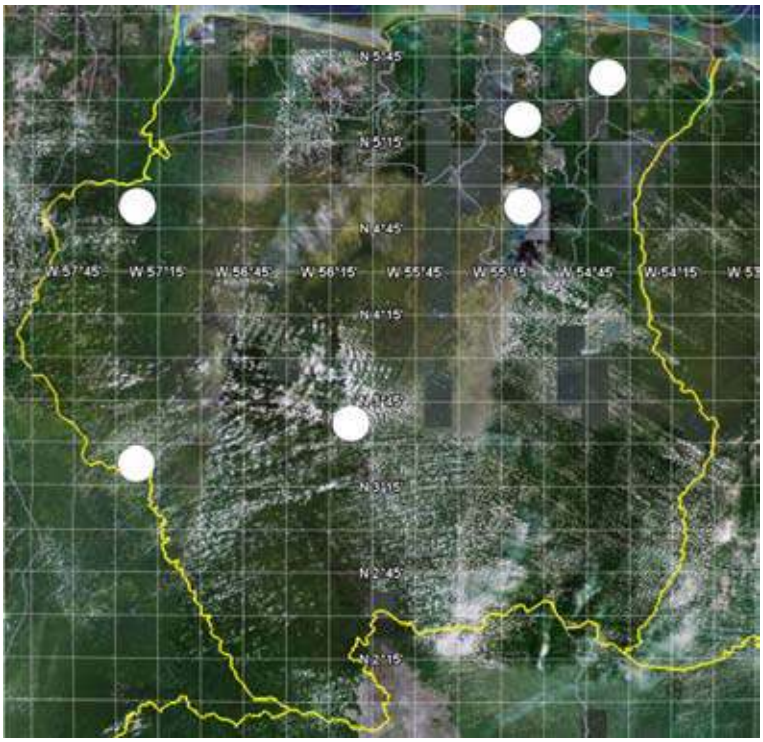

Figure 1. Distribution of *Gynacantha francesca* in Suriname

The first results of our project are presented on the website under 'artikelen' (articles). The database now holds about 1400 records of all Suriname specimens of the Aeshnidae, from both the pinned and the papered collection. Examples of distribution maps for *Gynacantha francesca* and *G. membranalis* are given in Figs 1 & 2.

Dennis Paulson and Rosser Garrisson have given their support while cooperation has been set up with Jean Francois de La Salle (France) and with Jürg DeMarmels (Venezuela) on Odonata of French Guyana and Venezuela respectively. We are still in need of a contact in northern Brazil. Some financial support has been given to the senior author by the Uyttenboogaart-Eliasen Foundation for collecting trips in 1989 and 2006 and travel grants to work on collections.

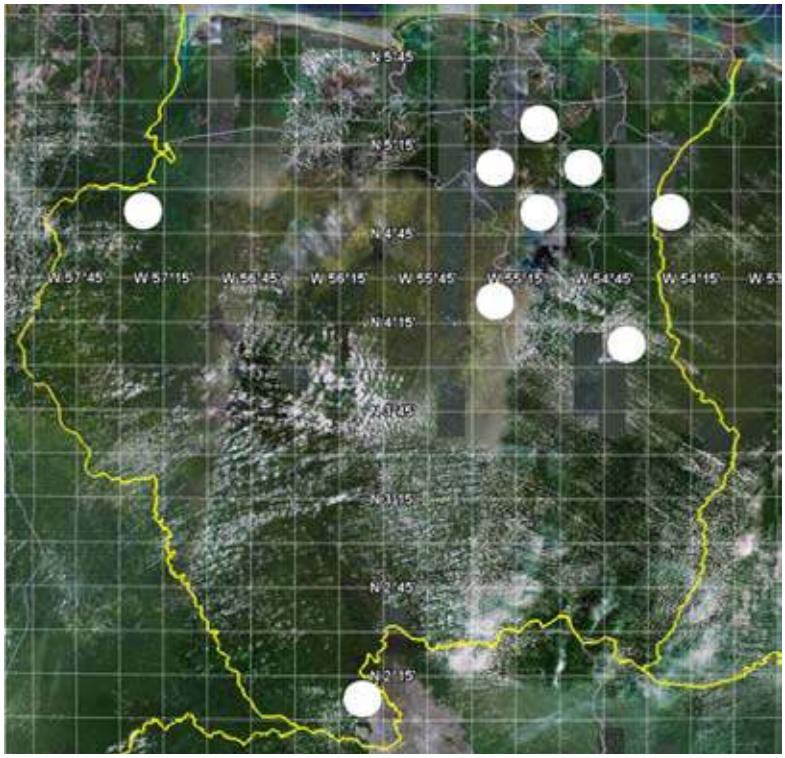

Figure 2. Distribution of *Gynacantha membranalis* in Suriname

Dragonfly Giants

Keith Wilson [kdpwilson@gmail.com]

The Protodonata are well known 'giant dragonflies' preserved as fossils in rocks over 250 million years old. The largest known fossil Protodonata, from Permian deposits, *Meganeuropsis permiana*, has an estimated wingspan of up to 710 mm. *Meganeuropsis americanum* is considered a junior synonym. Almost as large is another giant, the famous *Meganeura monyi* from Upper Carboniferous deposits in Commentry, France, which has a wingspan estimated at about 685 mm. According to Grimaldi & Engel (2005) the Protodonata, which are more properly know as Griffenflies, should not be regarded as true dragonflies. Grimaldi & Engel consider the Protodonata belong to a Palaeozoic ancestral stem group only distantly related to the true Odonata.

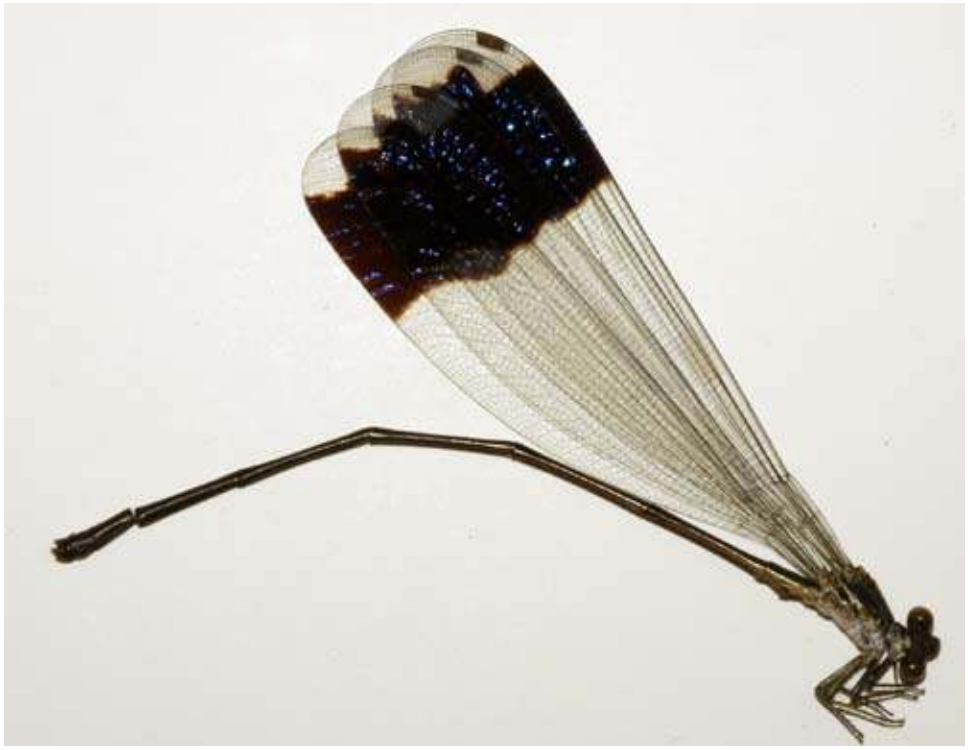

Figure 1. *Megaloprepus caerulatus* from South America. Photo credit: Keith Wilson.

World's largest living dragonflies?

A commonly asked question is: 'Which is the world's largest dragonfly living today?' There is a lot of confusing and somewhat conflicting information available in the published literature and on the internet. Two most commonly used methods of measuring odonate overall size are (i) total wingspan and (ii) total body length. If total wingspan is used then the

Figure 2. Female *Tetracanthagyna plagiata* from P. Malaysia and Borneo, photographed at Endau-Rompin, P. Malaysia. Photo credit: Keith Wilson. See also cover photo.

largest odonate is the zygopteran pseudostigmatid *Megaloprepus caerulatus,* known from South America (see Fig. 1). This huge but dainty insect has been credited with a wingspan of up to 191 mm and a body length of 120 mm. However, Dennis Paulson (2006) reported, in the Odonata-l discussion forum: "My largest specimen of *Megaloprepus caerulatus*, just by eyeballing them (I have 53 specimens), has a total length of 115 mm and a hindwing length of 84 mm. If you double that and add 5 mm for thoracic width, you get a wingspan of 173 mm. If any are larger than that, I can't prove it, but I think there is little doubt that *Megaloprepus* has the longest wings of any odonate." Whether the total wingspan is 191 mm or closer to 173 mm it is clear there are no other extant odonates with wingspans approaching these dimensions.

Figure 4. *Mecistogaster lucretia,* Uitkijk, Suriname, 10 March 2007. Photo credit: KD Dijkstra. KD collected two males that day; one 146 mm and the second 149 mm. Jill Silsby (2001) reports 150 mm total length for this species, which is the longest length of any extant odonate.

Figure 3. *Petalura ingentissima* (male) from the wet tropics, north Queensland, Australia, photographed near Daintree at 13:15 hrs, 23 January 2005. It has the third largest wingspan and the longest anisopteran body length. Photo credit: Keith Wilson.

There are accounts in the literature and on the world-wide web (notably Wikipedia) indicating *Anax strenuus,* endemic to Hawaii, is one of the World's largest dragonflies with a maximum wingspan reported of up to 190 mm! If this dragonfly truly reached such proportions then it would indeed be amongst the largest living dragonflies. But, specimens, for which I have authentic information, measure less than 150 mm wingspan and as such it is extremely unlikely that even an exceptionally-sized *strenuus* specimen would attain anywhere near 190 mm. Dennis Paulson (2006) reports a total wingspan of ca 144 mm for a single female *Anax strenuus* in his collection.

Using wingspan as the means of comparison, the second largest odonate appears to be the gigantic Anisopteran *Tetracanthagyna plagiata* female known from Peninsula Malaysia and Borneo (see Fig. 2). This insect has a wingspan measuring up to 163 mm and 100 mm in total body length. The third largest odonate in terms of wingspan belongs to the female Anisopteran *Petalura ingentissima*, which is known from the wet tropics in northern Queensland, Australia (see Fig. 3). This ancient odonate is incredibly bulky with a wingspan of up to 162

mm (although most specimens measured are significantly smaller) and a massive total body length, measuring up to 125 mm.

If total body length is used as the means of comparison then the largest odonates belong to the South American pseudostigmatid genera *Mecistogaster* and *Pseudostigma*. Dennis Paulson (2006) reports: "… *Mecistogaster linearis* … is considerably longer [than *Megaloprepus caerulatus*]. My longest, again picking it out as the one that looks longest rather than taking measurements on all 59 specimens, is 135 mm. This species is surely the longest damselfly and the longest odonate. I don't think any recent anisopteran reaches that length." But, Hedström & Sahlén (2001) provide dimensions for *Pseudostigma aberrans* ranging from 114-130 mm for male abdominal length; 85-110 mm for females. An abdominal length of 130 mm, for a male *Pseudostigma aberrans*, is indicative of a total body length ca 144 mm. Hedström & Sahlén (2001) also provide a maximim abdominal length for *Pseudostigma accedens* of 130 mm which indicates a total body length of ca 135 mm. Jill Silsby (2001) provides total body length measurements for *Mecistogaster lucretia* of 150 mm and wingspan of 125 mm. Clearly the longest specimens all belong to South American Pseudostigmatidae and given the wide variability in length an exceptionally long indvidual could arise in any of several species. Jill Silsby's report of 150 mm total length for *Mecistogaster lucretia* is the longest I could find in the published literature but no specimen details were provided. However, KD Dijkstra has recently confirmed the great length of this species, by collecting two males, total length 146 & 149 mm in Suriname (see Fig. 4). *Mecistogaster lucretia* appears to be the longest extant species.

The longest body length reported for an Anisopteran dragonfly is just 125 mm for female *Petalura ingentissima*. In January 2005 I measured the largest of approximately 100 specimens collected in Queensland by a local Australian entomologist and the maximum total length found was a female measuring 116 mm (wingspan 155 mm). Given that there were relatively few females in the collection I guess it is quite likely that 120 mm or more is possible.

Another way to compare odonates is to measure overall wing area or maximum breadth. The odonate with the broadest wings is the female Anisopteran, *Chlorogomphus papilio* (see Fig. 5). It is an extremely robust dragonfly, known from South China, which has maximum wing breadth of up to 34 mm. The overall length is relatively short at 101 mm and wingspan is ca 130 mm.

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Figure 5. Female *Chlorogomphus papilio* SW and S China, photographed in north Guangdong. This dragonfly has the broadest wings, which are up to 34 mm in breadth. Photo credit: Keith Wilson.

Worldwide Dragonfly Association
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Please note Canadian members should add US$5 to subscription amount to cover the collection fees incurred by WDA when the check is deposited in the US account

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Application to be sent to:
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角谷 拓 宛 (Mr. Taku Kadoya, Department of Ecosystem Studies, Institute of Agriculture and Life Science, The University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo 113--8657, Japan.) E-mail: kado_taku@yahoo.co.jp

iv) **UK members & all others** – by sterling cheque or GB £ bank notes, or by international money order, postal order or transfer to UK account at Lloyds TSB plc, 942 Brighton Road, Purley, Surrey CR8 2XD. Quoting BIC: LOYDGB21151; IBAN: GB07LOYD30917201048068. Application form to be sent to Linda Averill, 49 James Road, Kidderminster, Worcs, UK DY10 2TR

Election to the Board of Trustees

As a result of the call for nominations sent out in *AGRION* 12(2) one further nomination, properly proposed and seconded, has been received for Trustee-at-Large. Accordingly you are invited to vote for one of the candidates:

I, ……, (Write your name here and give your WDA Membership Number if known) vote for:

Mamoru Watanabe ☐

Natalia von Ellenrieder ☐

Please return to the WDA Secretary, Linda Averill, 49 James Rd, Kidderminster, DY10 2TR, UK or e-mail your vote to Gordon Pritchard <gpritcha@ucalgary.ca>. Please ensure your vote is submitted to arrive by 31 March 2009, after which no votes can be registered.

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Communicating about Odonata of Tropical Asia

No. 6 - January 2009
(published in *AGRION* vol. 13, number 1)

ECHO publishes small notes and articles on dragonflies of tropical Asia. The newsletter is meant to keep other workers updated on work in progress and gives the opportunity to publish short papers. All those interested and active in this region are invited to contribute. This issue of Echo contains two articles on chlorocyphids and several small notes on odonatological activities going on in tropical Asia.

Vincent Kalkman [Kalkman@naturalis.nl]

Damselfly Project on Cebu Island in the Philippines

Franz Seidenschwarz [fseiden(at)yahoo.com]

The Chicago Zoological Society approved a project proposal to support conservation work for the rare and endangered damselflies on Cebu island in the Philippines. The one-year project has several components: taxonomy of the species, ecology of the habitats, as well as education of the public and awareness building. The project is focused on four damselfly species of which one is listed as Critically Endangered and is likely to go extinct within years without conservation measurements taken. The other three have not been assessed to date but would probably fall in the categories Endangered or Critically Endangered.

The project is named “Rescuing Cebu’s Damsels”. The Principal Researcher is Dr. Franz Seidenschwarz and the Co-Researcher is Mr. Reagan Villanueva. The project was endorsed by the IUCN Odonata specialist group and World Dragonfly Organisation (WDA).

Figure 1. *Drepanosticta* sp. – a yet undescribed damselfly from the Kawasan valley on Cebu island (F. Seidenschwarz).

Work on Sarawak odonates continued

Rory Dow [rory.dow230@yahoo.co.uk]

Over the last year I have made two long fieldwork trips to Malaysia, spending most of my time in Sarawak, but also with a very interesting 10 days in the Cameron Highlands of peninsular Malaysia with my colleagues Drs Choong Chee Yen and Yong Foo Ng. As usual Graham Reels joined me in Sarawak for part of the time I was there. We visited far too many places in Sarawak to list them all here, but the highlight was probably a mini-expedition to Mt. Dulit, funded by the IDF, and probably the physically toughest thing I have ever done. It is also worth mentioning here that after two more periods of fieldwork the number of species recorded from Gunung Mulu National Park now stands at around 140, compared with the 106 that Graham and I listed in a previous issue of Echo. At the time of writing I am on a visit to Naturalis in Leiden, finishing revisions of Mortonagrion and of the Coeliccia species of Borneo. My plans for the next year are still in their infancy, but are likely to include further fieldwork in Malaysia generally, and Sarawak in particular, and hopefully also elsewhere in SE Asia.

Work on dragonflies of Peninsular Malaysia by Universiti Kebangsaan Malaysia
Choong Chee-Yen [cychoong@ukm.my] & Ng Yong-Fong [ng_yf@ukm.my]
Centre for Insect Systematics, Faculty of Science & Technology, Universiti Kebangsaan Malaysia

In the last ten months, we conducted a few surveys on dragonfly diversity and distribution in a few lowland and highland habitats in the Peninsular Malaysia. These included the botanical garden in Melaka, Sungai Tekala Recreational Forest (Selangor), Cameron Highlands (Pahang) including the adjacent areas in the state of Perak, Fraser's Hill (Pahang), Chini Lake (Pahang), Paya Indah Wetlands (Selangor), and Bangi Forest Reserve (Selangor). For the survey of highland habitats, the altitudinal data is always taken.

The quite recent survey was done in Cameron Highlands on 17-27 September, 2008, and we were delighted to have Rory Dow to join us for the fieldwork. The fieldwork has been successful and interesting. A few larvae of Aeshnidae, Corduliidae and Chlorogomphidae were also sampled for rearing. Revisits to Cameron Highlands will be carried out in future for a more thorough sampling and survey. We will produce a full checklist for Cameron Highlands.

Together with Zainal Abidin we have secured a small research grant on the study of dragonflies in Chini Lake. Fadilawati Ali (MSc. student) has been doing the fieldwork in Chini Lake since November 2007. We try to understand the biology and ecology of the newly described *Chalybeothemis chini.*

The survey on dragonflies of Bangi Forest Reserve is still on-going. Since the last report of the checklist for Bangi Forest Reserve in ECHO No. 5, a few more species have been recorded i.e. *Vestalis amoena*/ *amethystina* (female), *Cratilla lineata* and *Zyxomma obtusum.* Therefore, this will add up the Bangi Forest Reserve checklist to 77 species in total. In October 2008 the first author found many matured *Gynacantha basiguttata* larvae at a shady pond in the Bangi Forest Reserve, and he managed to catch a few and successfully reared them. The larval emergence of *G. basiguttata* has been documented in a series of photos. The first author maintains a blog on dragonflies at http://odonata-malaysia.blogspot.com/.

Activities of Reagan Villanueva with a list of species recorded from Balut Island, Philippines
Reagan Villanueva [reaganjoseph@lycos.com]

In the last year I expended my work to ecological aspect of odonates. Currently I am finishing a study to the impact of chrome ore mining on adult odonata composition and density and I am still working on the impact on larvae. I am also in the initial phase of a study on the odonata communities in monoculture farm (banana). I am finishing the description of several new zygopteran species but have trouble making good illustrations. In 2008 I did fieldwork on the Babuyan and Batanes group of islands to the north of island of Luzon and in the Northern Sierra Madre Park. Both expeditions were successful and resulted in the discovery of several new species. The results of the former will be published this year in IDF-reports.

I received some samples of odonata from Dr. Alma Mohagan (Lepidoptera-Central Mindanao University, Bukidnon) from their chiropteran and lepidopteran study at Balut Island. This small island is volcanic in origin and situated southeast of Mindanao between Halmahera and Saranggani Province, Mindanao Island. The list of species recorded is given below. These records are the first dragonflies to be published for this island.

Chlorocyphidae
Rhinocypha colorata (Hagen in Selys, 1869)
Coenagrionidae
Pseudagrion p. pilidorsum (Brauer, 1868)
Teinobasis samaritis Ris, 1915
Corduliidae
Idionyx philippa Ris, 1937 – The Balut island population has very extensive markings on the thorax.
Protoneuridae
Prodasineura integra (Selys, 1882)
Libellulidae
Agrionoptera insignis (Rambur, 1842)
Neurothemis r. ramburii (Brauer, 1866)
Neurothemis t. terminata Ris, 1911
Orthetrum t. testaceum (Burmeister, 1839)
Potamarcha congener (Rambur, 1842)
Trithemis festiva (Rambur, 1842)

The Geelvinkbaai island and the Star Mountains revisited
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In 2006 I made my first trip to the Indonesian part of Papua. During that trip I collected dragonflies on Japen Island in the Geelvinkbaai and at Borme, a small village in the Star Mountains of central Papua. In October 2008 I returned to Papua. I visited the sister islands of Biak-Supiori, which are also part of the Geelvinkbaai islands and visited two other areas in Star Mountains. Based on this new material a faunistic paper on the odonates of the Geelvinkbaai will be made. The material I now have from the Star mountains still only gives a scanty impression of the dragonflies of this part of the central mountain range. The 2008-fieldwork in the Star Mountains resulted in the discovery of at least three new species (*Indolestes, Palairgia* and *Synthemis*) showing that much remains to be discovered.

Libellago indica (Fraser, 1928) deleted from the list of Sri Lankan Odonata (Chlorocyphidae)

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Fraser (1928) described a new subspecies *Micromerus lineatus indica*, with type specimens from Poona, peninsular India. Discussing the distribution of *indica* Fraser wrote: "Laidlaw reports it from Ceylon, Haragama, July, and remarks on its difference from type *lineatus lineatus* Burm., from Burma and Siam". An almost identical text was included in Fraser's (1934) Odonata volume in the Fauna of British India series. Thereafter, this taxon (either as a subspecies *Libellago lineata indica* or as a full species *Libellago indica*), has been included in all published checklists of dragonflies of Ceylon or Sri Lanka and in the recent books by de Fonseka (2000) and Bedjanič & al. (2007). However, nobody has reported seeing or studying specimens of this species from Sri Lanka in the last 75 years. The only published doubt regarding its presence in Sri Lanka was that implied by Lieftinck's (1971, p. 189) comment "*L. indica* (Fraser), which is said to occur in Ceylon as well".

The listing of *L. indica* as a Sri Lankan species has been based on the following specimens.

1) A male specimen collected at Haragama by E.E. Green on 10 July 1910 and identified by Laidlaw (1924) as *Micromerus lineatus* (Burm.). Laidlaw provided an illustration of the colour pattern of the first 4 abdominal segments (dorsal view) of this specimen and he wrote "This specimen, which I have compared with a series in Mr. E.B. Williamson's collection from Candervalay, lacks the yellow tinge of the base of the wing characteristic of the males of other species from Ceylon. The brilliant canary yellow of the abdomen (segments 2-5) renders this little species very conspicuous. This species is badly in need of careful examination. Specimens from Poona and Ceylon differ strikingly from examples from Burma and Siam, & c." Without studying the specimen himself Fraser (1928) considered it to represent his new subspecies *M. lineatus indica*. De Fonseka (2000) includes 'Haragama, (7m)' [July] in the species account of *L. indica*.

2) A teneral male specimen in The Sri Lanka National Museum in Colombo bearing the labels 'Madola near Opanayake. 16-23-II-33' [16-23 February 1933]. '*Libellago asiatica indica*. Det. Fraser'. [The incorrect name '*asiatica*' (pro. *lineata*) is presently crossed out]. 'Opanayake, (2)' which de Fonseka (2000) gives as a locality for *indica* refers to this specimen.

3) De Fonseka's (2000) *indica* account also gives 'Kantalai, (3, 7, 8)', 'Kottawa, (3)' and 'Nawalpitiya, (-)' as recorded localities for *indica*. These are the localities (and collecting months) presented by Kirby (1894) for specimens of '*Micromerus lineatus*' collected by J.W. Yerbury in 'Kanthalai, March 8, July 31, Aug. 8, 1892' and in 'Kottawa, April 24, 1892' and an additional specimen marked as 'Nawala-pittia (Green)'.

When the history of these '*indica*' records is evaluated, we must understand that the identifications were made before 1939 (or were simply assumptions based on earlier identifications before that date) when *Libellago adami* was recognized and described as a species.

Reidentifications

1) This old Haragama specimen is not in the collections of Natural History Museum, London (BMNH). If still available, it may be in the Indian Museum, Kolkata. Laidlaw's (1924) figure agrees with both *indica* and *adami*, but the sentence in the description: "lacks the yellow tinge of the base of the wing characteristic of the males of other species from Ceylon" points to *adami* rather than *indica*. In mature males of *indica* the base of wings is strongly tinted, whereas in *adami* it is markedly less so. The sentence "The brilliant canary yellow of the abdomen (segments 2-5) renders this little species very conspicuous" would characterize better the Burmese males of *lineata*, which Laidlaw also compared in the same connection, and he is unlikely to have stated this about the Haragama specimen. Thus we consider the Haragama specimen to represent *adami*. It should be noted that both F.C. Fraser and M.A. Lieftinck had collected long series of *Libellago* specimens at Haragama in 1932 and 1938, respectively (see Fraser 1939, Lieftinck 1940) and they both found *adami* (syn. *L. miae* Lieftinck, 1940), *greeni* and *finalis* there, but not *indica*.

2) We have recently studied the '*indica*' specimen from Opanayake preserved in The Sri Lanka National Museum in Colombo and reidentified it as *adami*. Although this teneral, incomplete specimen is in a poor condition and all natural colours have faded, the shape of the pale patches on abdominal segments 2-5 match better with *adami*; in *indica* the patches are larger in lateral view and less angular in shape.

3) We have located a number of Yerbury's specimens from Ceylon at BMNH and have found them to include male and female specimens of *L. adami* and a female specimen of an undescribed species, currently being described by Nancy van der Poorten. The specimen from Nawalapitiya (collected by Green) was not traced, but we do not believe it being different from the other specimens in the series studied by Kirby. In his *L. indica* account de Fonseka (2000) copied collecting data of the complete '*Micromerus lineatus*' series verbatim from Kirby (1894), apparently because some specimens from Ceylon collected by Yerbury had been misidentified and placed under the drawer label '*Libellago lineata indica*' at BMNH. However, most of the labels of Yerbury's specimens do not include collecting data as detailed as that given by Kirby (1894). In any case, linking these specimens to *indica* has proven incorrect.

We are now convinced that all Sri Lankan *Libellago indica* records are based on misidentified or

Fig. 1. Male of *Libellago indica*, Mattom, Thrissur District, Kerala, South India, 10 April 2007, Photo by F.K. Kakkassery.

misinterpreted specimens and that this species has never been collected in Sri Lanka. Consequently this species is deleted from the checklist of Sri Lankan odonates.

It this connection it is perhaps worth reporting that Matti Hämäläinen recently identified a number of old *Libellago* specimens from Ceylon in the Selysian collection in the Royal Belgian Institute of Natural Sciences in Brussels. Among the 22 pinned male specimens were 20 *adami* (from Candalay, Haragama, Kandis and 'Ceylon') and 2 *greeni* (Candalay and 'Ceylon'). (The 18 available female specimens were not identified due to lack of time). The specimens were without any identity labels, but in the *greeni* specimens the letter 'F.' had been added to the locality label. This might mean a preliminary identification as '*finalis*'. It should be noted that there are no specimens of *Libellago finalis* (Hagen in Selys, 1869) in Selys's collection.

Although the living males of *indica* and *adami* (Figs. 1-2) are easy to separate by the colour of the pale patches in the abdomen (citron-yellow in *indica* and grass-green in *adami*), in poorly preserved museum

Fig. 2. Male of *Libellago adami*, Hokandara, Colombo, Sri Lanka, 22 March 2007. Photo by Michael van der Poorten.

specimens the colour difference may be unclear. The known distribution of *L. adami* is presented in Fig. 3. *L. indica* occurs in peninsular India, where it still is a locally common stream species. Fraser (1934) wrote: "A very common insect throughout South India, especially in Western Ghats and Deccan".

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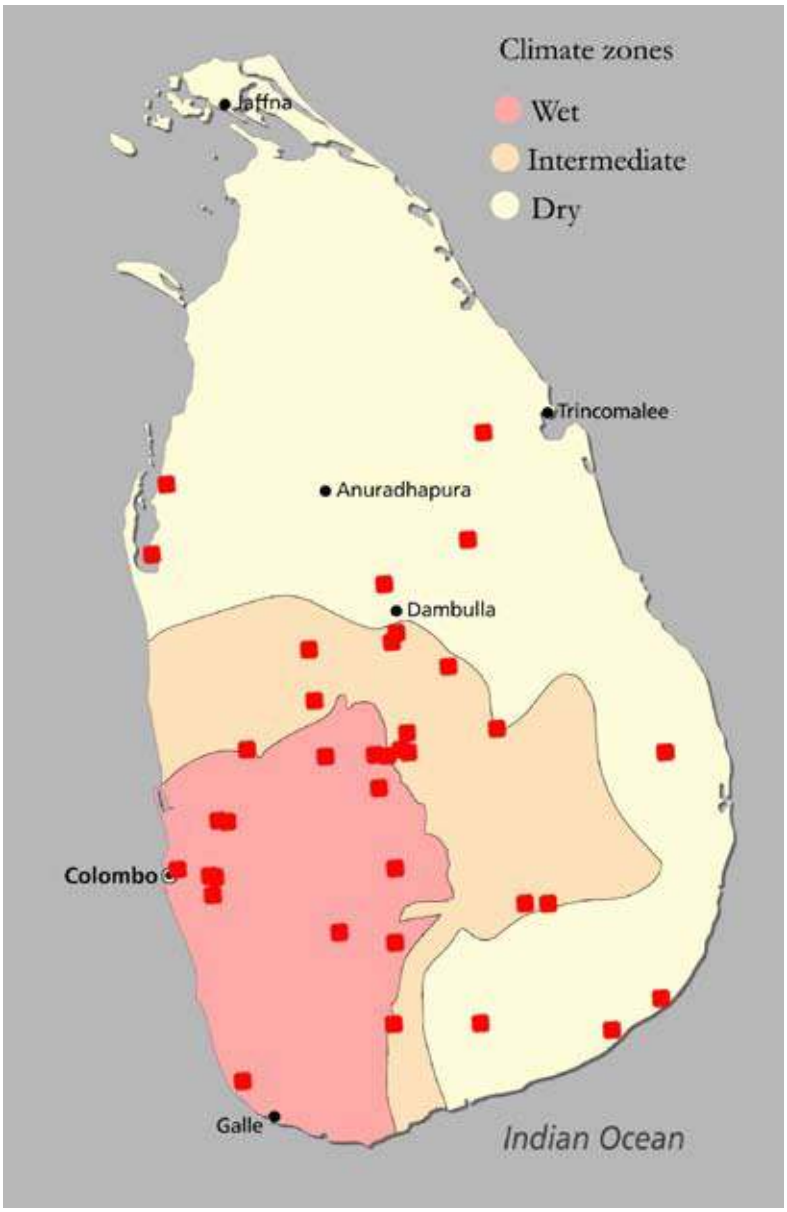

Fig. 3. Distribution of *Libellago adami* in Sri Lanka. The map combines data from Matjaž Bedjanič's database 'Distributional Atlas of the Dragonflies of Sri Lanka' which includes both published and unpublished records received from several observers and Nancy van der Poorten's database on Sri Lankan Odonata.

What is the enigmatic chlorocyphid
***Rhinocypha stygia* Förster, 1897**
from Mt Kinabalu, Borneo?

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Introduction

Rhinocypha stygia was described by Förster (1897) based on a male and a female specimen from Mt Kinabalu in northern Borneo. These specimens, as well as the type series of the conspicuous calopterygid *Matronoides cyaneipennis* Förster, 1897, were received from the insect dealers Staudinger & Bang-Haas who had acquired them from John Waterstradt. Waterstradt had visited Mt Kinabalu briefly in March 1895 and in March 1896 sent local people to collect a large number of insects from the mountain. The male specimen of *stygia* is described as having an entirely shining black body: "*Téte et thorax noir de velóurs, abdomen noir chatoyant, surtout à la fin des segments*." The female has quite a typical chlorocyphid colour pattern, with yellow stripes on thorax and a row of yellow lateral markings along the abdomen.

Laidlaw (1915) described another *Rhinocypha* species, *R. moultoni*, from Mt Kinabalu based on a series of 4 males and 2 females collected by J.C. Moulton in September-October 1913. The male was described as having conspicuous brick-red markings on the dorsum of the abdomen and yellow lateral markings, but on the female abdomen the dorsal markings are lacking. Subsequently, in Laidlaw (1920) four additional females from the same series were discussed, at least one of them being teneral with conspicious broad yellow markings on the abdomen. The abdomen of this teneral female was illustrated. Laidlaw wrote: "The adult female of this species resembles that of *R. stygia* Förster very closely, to judge at least by Förster's rather brief description. But the fully adult male is so brightly coloured about the body – much more so than the female – that I do not think it possible that *stygia*, which is entirely black about the body, can be merely a very adult specimen of the same species. The four males of *moultoni* that I have been able to examine are fully mature, and it is interesting to find that they retain on the abdomen the colour-pattern characteristic of the teneral female, which is lost in the mature female. For whereas the male retains the paired dorsal spots of the abdomen from segment 2 to 9 as rich orange-red marks in addition to the yellow paired lateral marks, these dorsal marks are entirely lost in the fully adult female, but are very conspicuous in newly-emerged females as large lemon-yellow areas covering about three-quarters of the dorsum of each segment from 2 to 8; fused at their bases with the lateral system.... So that, whilst not refusing to admit the possibility of *R. stygia* being the extremely adult stage of *R. moultoni*, I do not think it at all likely, and retain here the latter species as distinct."

Another North Bornean species, the description of which includes comparison with *stygia*, is *Rhinocypha cognata* Kimmins, 1936. Kimmins' (1936) description was based on two males from Mt Dulit on 10 August 1932. Kimmins wrote: "Among the Oxford University Expedition material are two males which Dr. Laidlaw suggested might be Foerster's *stygia*. They agree admirably in size but differ in colour in one or two respects. The types should be, I believe, in the Williamson Collection at Michigan, but Mrs. Gloyd, to whom I wrote, informs me that only the female type can be found. Under the circumstances, I think it wiser to describe the Oxford University Expedition material as new." He writes further: "This species very closely resembles *Rh. stygia* Foerster, but assuming his description to be accurate, I think that the differences are sufficient to warrant the erection of another species. Foerster is very insistent that the body of *stygia* is entirely black, and unless his example was very badly discoloured, he could scarcely have failed to notice the lateral thoracic bands which are present in *cognata*."

As can be seen from the quotations above, both Laidlaw and Kimmins were somewhat hesitant with

Fig. 1. The labels of the syntype male of *Rhinocypha stygia* found wrongly associated with an incomplete male specimen of *Rhinocypha cucullata* in Coll. Selys.

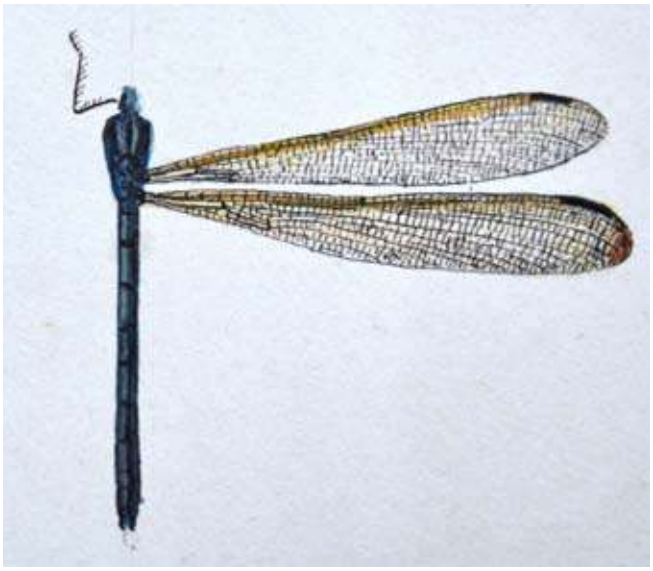

Fig. 2. Painting of the syntype male of *Rhinocypha stygia* by Guill. Severin.

their taxonomic decisions. Lieftinck (1954) listed *stygia*, *moultoni* and *cognata* as good species without comments on their status. Thereafter the first doubts on their status may have been presented by Huisman & van Tol (1989), who wrote on *stygia* and *cognata*: "both enigmatic taxa, and not unlikely synonyms". More recent publications, raising the need to resolve the mutual status of *stygia* and *cognata*, include Orr (2001) and Orr (2003). Indeed Orr only used *cognata* in those publications, because the identity of this taxon could be readily confirmed, whereas that of *stygia* remained uncertain. Dow and Reels (2008) include *R. stygia*, but not *R. cognata* in their list of Odonata from Gunung Mulu National Park, Sarawak.

During my recent visit to the Royal Belgian Institute of Natural Sciences in Brussels for the purpose of studying the type material of Calopterygoidea in the collections of Edmond de Selys Longchamps (1813-1900), I made some interesting discoveries. I found the labels of the lost syntype male of *R. stygia* associated with a wrong specimen and a mature pair of *R. moultoni* from Mt Kinabalu, both sexes with brick-red patches on the abdomen. I also discovered a revealing colour painting made of the lost syntype male specimen of *stygia*. These findings seem finally to solve this longstanding problem on the mutual status of these three taxa.

Fig. 3. The syntype female of *Rhinocypha stygia*. Photo by Mark O'Brien.

Fig. 4. Female of *Rhinocypha stygia* from Poring, Kinabalu national park, 18 April 1994, M. Hämäläinen leg.

Lost syntype male of *R. stygia*

As already pointed out by Kimmins (1936) and confirmed by Garrison & al. (2003), Förster's collection (now at UMMZ, Michigan) includes only the female syntype specimen of *stygia*.

Rather unexpectedly I found in the Selys collection a badly broken male specimen of *Rhinocypha cucullata* Selys, 1873 incorrectly associated with the original labels of the type male of *R. stygia* (Fig. 1); the labels are in Förster's handwriting. This specimen consists only of abdominal segments 1-8 and one wing glued to the label. It was placed under the identity label '*Rhinocypha stygia*' together with two other specimens, which bear Selys' identification label 'près. [near] *stygia*'; neither of them, however, being real *stygia*.

Selys and the young German zoologist Friedrich Förster (1865-1918) collaborated closely during the last few years of Selys' life. Their mutual interest focussed on Indo-australian dragonflies, and both had independently purchased material from this region from Staudinger & Bang-Haas. Förster's (1897) paper also included the description of the first female of *Matronoides cyaneipennis*, written by Selys as well as Selys' footnote comparing *stygia* with its congeners. Evidently Selys had received the male specimen of *stygia* from Förster for study and illustration, as indicated by the presence of the specimen's labels misplaced in the Selys collection. Unfortunately this specimen seems to have been permanently lost at some phase, perhaps during illustration (see below for the lost painted female). The type labels must have been associated to the wrong specimen sometime after Selys' death in 1900.

However, the story is not as grim as it might have been. Indeed it evokes a curious and ironic serendipity, for if the type specimen was indeed lost while being illustrated, we have now at least a good informative illustration of what was lost. Apparently it is not yet widely known among odonatologists that Selys commissioned colour paintings of all odonate species in his collection, except of Libellulidae (sensu stricto). A part of this prodigious portfolio (mainly 'Agrioninae' in the old Selysian sense) was executed by Selys himself, but the greater part of the remainder was painted by Guill. Severin. The portfolio includes paintings of *R. stygia* male and female (by Severin). The male illustrated (cropped in Fig. 2) undoubtedly depicts the lost syntype male of *stygia*. Some remnants of obscure bluish dorsal markings can be seen, so it could well be a somewhat discoloured mature specimen, and conspecific with *cognata*. The size of *stygia* and *cognata* male given in their descriptions is exactly the same: hindwing 21 mm, abdomen 16 mm. The painted female *stygia* specimen (also without a head) seems not to belong to the type series, since the female syntype still has its head. The illustrated female *stygia* could not be traced in the collections, but it is known that Selys also received specimens from Mt Kinabalu from Staudinger & Bang-Haas; see below.

Syntype female of *stygia*

Mark F. O'Brien kindly sent me some photographs of the syntype female of *stygia* in UMMZ (Michigan); one of them is presented here (Fig. 3). The syntype is identical with a series of 4 females, which I collected at

Fig. 5. Male of *Rhinocypha moultoni* from 'Kina Balu, Borneo, Stdg.' in Coll. Selys, furnished with identity label '*Rhinoc. tenera*, S.' by Selys (labels not shown).

Fig. 6. Female of *Rhinocypha moultoni* from 'Kina Balu, Borneo, Stdg.' in Coll. Selys, furnished with identity label '*Rhinoc. tenera*, S.' by Selys (labels not shown).

Poring in Mt Kinabalu National Park in April 1994 and April 2000 (Fig. 4). I had earlier compared my specimens with the 'allotype' of *R. moultoni* at BMNH (London), the other mature female specimen in Laidlaw's original type series and found them to agree in all respects. Thus, I am inclined to conclude that the *stygia* female and the mature female of *moultoni* (sensu Laidlaw) must refer to the same species – *stygia*.

Stygia, moultoni and _cognata_: connections revealed

Laidlaw's (1920) conclusion (see above) that the colour of the dorsal side of abdomen in *moultoni* female changes to black during maturation does not seem to be correct. In Selys' collection there are a male (Fig. 5) and a female specimen (Fig. 6) of *moultoni* from Mt Kinabalu (also received from Staudinger & Bang-Haas, and undoubtedly originally acquired from John Waterstradt). These specimens bear Selys' manuscript name *Rhinocypha tenera*, but placed under an incorrect drawer label '*Libellago tenuis*, Selys n.sp.' (in Selys' handwriting). The male is fully mature and the female at least 'nearly' mature. In spite of this, the female has conspicuous brick-red patches on the dorsum of the abdomen, as in the male. There is no sign of the reddish dorsal colouring disappearing in this female specimen approaching full maturation. The colour pattern of head and thorax are almost identical to that in *stygia*, but the pterostigmata are distinctly paler than in *stygia* female (and in *moultoni* male), especially in the hindwing.

Kimmins (1969) selected a male specimen as the lectotype of *moultoni*. Thus there are no direct taxonomic consequences of the fact that the two female specimens in the original type series of *moultoni* studied by Laidlaw (1915) are not conspecific with the male, but belong to *stygia*. One of these females in the collections of BMNH (London) is labelled as 'allotype' of *moultoni*. On the other hand the teneral female(s) listed and illustrated in Laidlaw (1920) is (are) real *moultoni*. My published record of 'apparent *moultoni*' from Poring at Mt Kinabalu (Hämäläinen 1994) is herewith corrected to represent *stygia*. Also my photo of '*moultoni*' female laying eggs (at Poring in April 2000) in Orr's (2003, p. 52, Fig. 57) book *Dragonflies of Borneo* shows *stygia*.

So it seems that Huisman & van Tol (1989) were correct in assuming that *stygia* and *cognata* might be synonyms. Orr (1996) used the name *stygia* for this species while describing the territorial behaviour of some chlorocyphids in

Fig. 7. *Rhinocypha stygia* male. Borneo, Sarawak, Mt Dulit, Sg. Nuam, 30 March 2006. Photo by Graham Reels.

Brunei. Unfortunately, he did not observe any courtship or mating, neither has anyone else reported seeing male and female *stygia* together. Based on the small number of specimens studied, the sexes appear to differ in size to some extent, females (hindwing 22.5-24 mm) being considerably larger than males (hindwing 19-21 mm). This is typical for most chlorocyphids. Photographs of male and female *stygia* taken in the field are presented in Figs. 7-8.

The known range of *Rhinocypha stygia* (= *cognata*) covers north-eastern Sarawak, Brunei and Sabah. The southern- and westernmost records are from the eastern slopes of Mt Dulit. It is rather common at some locations on Gunung Mulu. In Brunei it is known only from Kuala Belalong Field Studies Centre. In Sabah it is known from Poring at Mt Kinabalu, the Danum Valley and Tabin. The known altitude range is 100 – 800 m. *Rhinocypha moultoni* is much rarer species, so far it has been recorded only at Mt Kinabalu, at the altitude range 1000-1550 m. The few known records have been made in August and September.

Fig. 8. *Rhinocypha stygia* female. Borneo, Sabah, Mt Kinabalu, Poring, 29 April 2005. Photo by Rory Dow.

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