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A CHECKLIST OF DRAGONFLIES IN SINGAPORE PARKS (ODONATA: ANISOPTERA, ZYGOPTERA)

Robin W. J. Ngiam* and **Geoffrey W. H. Davison**
National Biodiversity Centre, National Parks Board
1 Cluny Road, Singapore 259569
*(*Corresponding author: ngiam_wen_jiang@nparks.gov.sg; yanrobin@hotmail.com)*

INTRODUCTION

The National Parks Board (NParks) of Singapore is responsible for the management of more than 300 regional and neighbourhood parks which total about 1763 ha. This is about 2.5% of the land areas of Singapore. Many of these parks are very small, positioned amongst high density urban residential development, bordered by busy roads, and catering to the recreational needs of the urban population. Such parks typically contain extensive mown lawns, scattered mature trees and hard-surfaced pedestrian pathways. Some include fragments of natural ecosystems such as mangrove or secondary woodland. About two dozen of the parks contain freshwater bodies of significant size. As part of its responsibility for the conservation of biological diversity nationwide, NParks is aware of the significance of parks for nature in an urban setting, specifically those with water bodies for the conservation of Odonata (dragonflies and damselflies).

In an effort to understand the diversity of Odonata in an urban environment, NParks initiated a two-year Dragonfly Project to survey and obtain baseline data of odonates in ponds and wetlands in urban parks under its management. From 2008 to 2010, as many as 19 parks with at least 30 ponds, lakes, and streams were investigated. This paper thus reports the results of the Dragonfly Project in the form of a checklist for all the 19 parks. The public outreach efforts on odonates are also discussed.

METHODS

Surveys for all 19 parks (Fig. 1) were carried out between Feb.2008 and Aug.2010. Sampling sites were concentrated within the vicinity of the ponds or wetlands present in each park. Sampling was conducted during sunny weather in the morning from 0800 hrs to 1200 hrs, and afternoon samplings from 1400 hrs to 1800 hrs at some parks. Odonates were surveyed at each sampling session by walking slowly around a pond/wetland and visually identified using close-focus binoculars. Species identification was based on Orr (2005). As most of the species were common and easily identified, specimens were usually not collected. When voucher specimens of rare species were collected from a particular locality, they were deposited in the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR), National University of Singapore. Due to time and manpower constraints, not all parks were sampled equally with regards to the number of surveys. However to achieve some form of consistency, a minimum of two half-day surveys were conducted for each park. Species recorded by fellow researchers or nature enthusiasts that came to the attention of the authors during the project timeline were also included in this checklist.

RESULTS AND DISCUSSION

In total, 51 species of odonates from six families were recorded from the 19 parks surveyed, accounting for 42% of odonate species extant in Singapore (Ngiam, 2011). Almost all the common species were found in the parks. The presence of forests and back mangroves in some less manicured parks allowed species that can otherwise only be found in the nature reserves to exist. *Onychargia atrocyana*, *Prodasineura notostigma*, and *Gynacantha subinterrupta* are species more associated with forest habitats in the nature reserves (Tang et al, 2010) but are now recorded from small forest patches in Kent Ridge Park and Singapore Botanic Gardens. Similarly, the back mangrove area of Admiralty Park has allowed the rare *Mortonagrion arthuri* and uncommon *Raphismia bispina* to thrive. In Singapore's context, of the 51 species recorded 13 are considered uncommon, five are considered rare, and one considered very rare according to Tang et al. (2010). Moreover according to Davison et al. (2008), 10 species of the 51 are considered Critically Endangered. This proves that urban parks play a very important role in the conservation of odonates in Singapore.

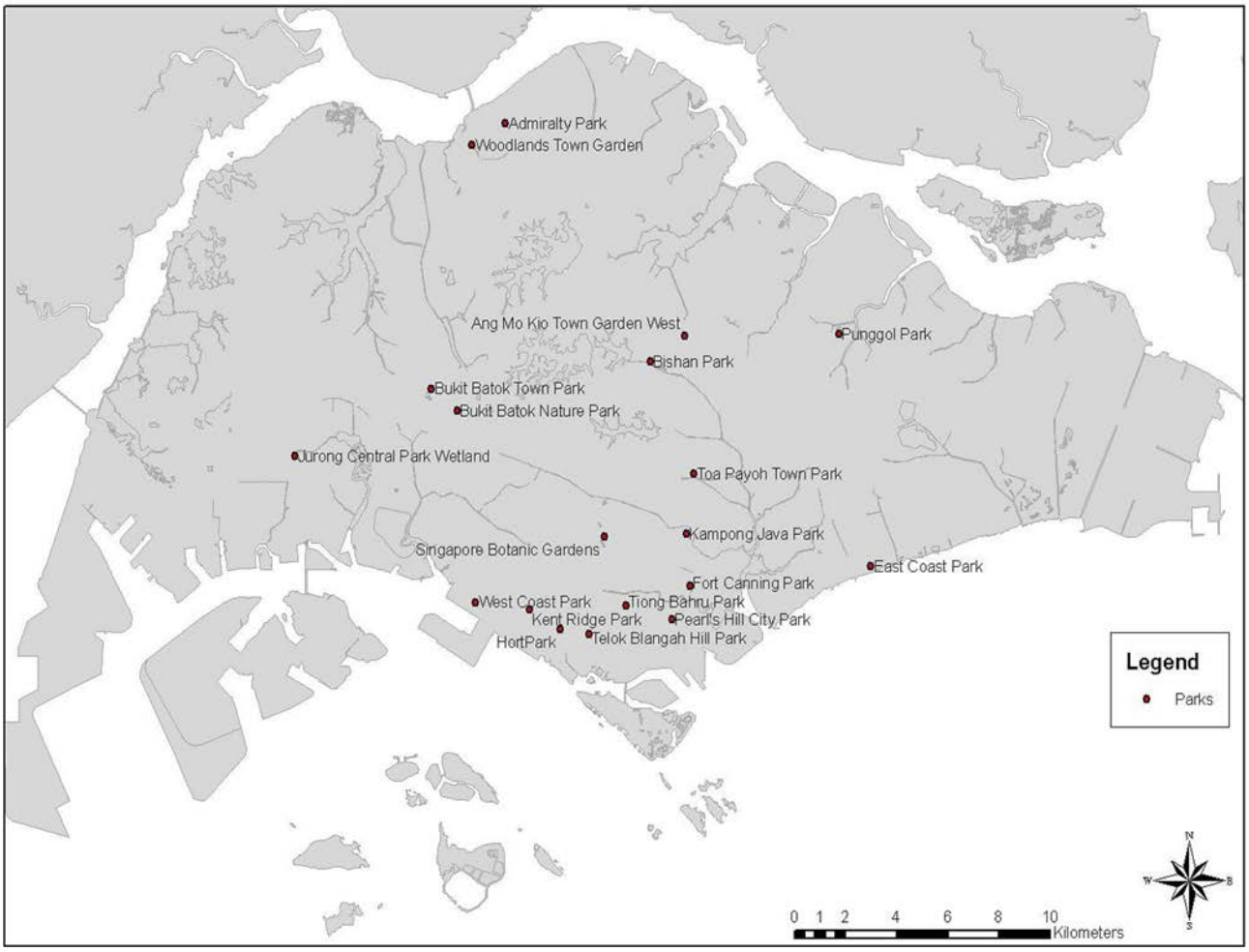

Fig.1. Map of Singapore showing the location of 19 parks sampled for Odonata.

The results also clearly show a stark difference in odonate diversity between parks. For example, Kent Ridge Park with its forest patch and healthy pond ecosystem has a total of 33 species. The same number also exists at the weedy ponds in Bishan Park. On the other extreme, ponds bereft of lush water plants or pond side vegetation, such as Woodlands Town Garden, are poor in odonate diversity. Toa Payoh Town Park is notable for the presence of the very rare *Pseudagrion rubriceps*. This species had not been collected in Singapore since 1993, and its occurrence in Toa Payoh Town Park makes this site an important refuge (Ngiam, 2009).

Obtaining odonates baseline data is just one of the objectives in the Dragonfly Project. Outreach in nature conservation is of utmost importance in urbanised Singapore where most of its people are hardly exposed to nature. Hence results from the project have been published in a dragonfly book of which the targeted audience is the general public (Ngiam, 2011). The book highlights six parks with good odonate diversity, with the main aim of fostering and facilitating growth and interest in the leisure activity of odonate watching. Lemelin (2009) found that conspicuous, colourful, and aerial insects like odonates are excellent subjects in public outreach programmes. It is hoped that odonates existing in Singapore urban parks can fulfil that role.

Due to space constraints, a species checklist of only six parks is published in Ngiam (2011). Hence the entire species list from all the 19 parks investigated during the Dragonfly Project is herein presented in Table 1. This checklist is certainly not exhaustive as some of the parks which are deemed not ideal for rich odonate diversity are only surveyed twice minimally. Therefore the odonate diversity recorded from these parks might not be complete. Although the checklist is correct as of Aug.2010, it is already outdated in some cases. For example, a recently completed stream garden at HortPark in Oct.2010 has added six more species to the site (Alvin Francis Lok, in litt.). Despite these limitations, this checklist is still the most comprehensive one that covers the major parks in Singapore. It is hoped that this checklist can act as one of the means to encourage more people to take up ‘dragonfly watching’; and to arouse curiosity among nature lovers to visit these 19 parks. That in turn, may contribute additional species to the list, and thus further our understanding of urban odonate diversity. Scientifically, this checklist holds baseline data for researchers investigating urban freshwater ecosystems in Singapore.

In a typical pond, larvae of different odonate species occupy different microhabitats provided by floating, emergent, and submerged water plants. Leaf litter at the bottom of a pond is also an important ecological niche for certain species. The use of odonate larvae as indicators of freshwater ecosystem health has been well documented and practised overseas (Simaika & Samways, 2009). In Singapore, Blakely & Harding (2010) proposed the use of The SingScore as a macroinvertebrate biotic index to assess local streams and canals. Currently there are efforts to produce an index of similar framework for assessing park ponds. Odonate larvae are less well-studied and more difficult to identify than the adults. For most common species, larvae can be identified confidently to the genus level, but less so to the species level. Thus, this checklist can be a handy cross-reference for researchers of macroinvertebrates in urban parks.

CONCLUSIONS

In Singapore, urban parks with freshwater bodies form a useful adjunct to the conservation of dragonflies in the more forested Nature Reserves. They increase the number of sites at which dragonflies can occur, and therefore enhance total population size. They also enable dragonflies to penetrate into the more urban environment where they enhance visitors' experience of nature.

Table 1. Checklist of odonate species recorded for each of the 19 parks, as of Aug.2010.

Species \ **Parks**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
ZYGOPTERA																			
Coenagrionidae																			
Agriocnemis femina (Brauer, 1868)	+	+	+						+	+	+			+		+	+	+	
Argiocnemis rubescens rubeola Selys, 1877			+																
Ceriagrion cerinorubellum (Brauer, 1865)	+	+	+	+						+	+			+	+		+		
Ceriagrion chaoi Schmidt, 1964			+																
Ischnura senegalensis (Rambur, 1842)	+		+					+	+	+	+		+	+			+	+	
Mortonagrion arthuri Fraser, 1942	+																		
Onychargia atrocyana (Selys, 1865)											+			+					
Pseudagrion australasiae Selys, 1876			+																
Pseudagrion microcephalum (Rambur, 1842)	+	+	+	+	+	+		+		+	+		+	+		+	+	+	
Pseudagrion rubriceps Selys, 1876																	+		
Protoneuridae																			
Prodasineura notostigma (Selys, 1860)				+															
ANISOPTERA																			
Aeshnidae																			
Anax guttatus (Burmeister, 1839)			+								+		+	+					
Gynacantha subinterrupta Rambur, 1842											+								
Corduliidae																			
Epophthalmia vittigera (Rambur, 1842)											+			+					

Species \ Parks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Gomphidae																			
Ictinogomphus decorates melaenops (Selys, 1858)		+	+	+	+	+		+			+		+	+		+	+	+	
Libellulidae																			
Acisoma panorpoides Rambur, 1842		+	+								+		+	+					
Aethriamanta aethra Ris, 1912		+	+																
Aethriamanta brevipennis (Rambur, 1842)		+	+																
Aethriamanta gracilis (Brauer, 1878)			+	+							+			+					
Agrionoptera insignis (Rambur, 1842)			+		+		+				+			+					
Brachydiplax chalybea Brauer, 1868	+	+	+						+	+	+	+		+	+	+	+	+	
Brachythemis contaminata (Fabricius, 1793)	+		+			+		+		+			+	+			+		+
Camacinia gigantea (Brauer, 1867)				+			+				+			+					
Chalybiothemis fluviatilis Lieftinck, 1933								+											
Crocothemis servilia (Drury, 1773)	+	+	+						+		+			+		+	+		
Diplacodes nebulosa (Fabricius, 1793)											+								
Diplacodes trivialis (Rambur, 1842)	+								+										
Hydrobasileus croceus (Brauer, 1867)			+								+			+					
Lathrecista asiatica (Fabricius, 1798)			+			+					+								
Macrodiplax cora (Brauer, 1867)								+	+					+					
Neurothemis fluctuans (Fabricius, 1793)	+	+	+	+	+			+	+		+	+	+	+	+		+	+	
Orthetrum chrysis (Selys, 1891)		+	+	+	+		+				+			+	+		+		
Orthetrum glaucum (Brauer, 1865)			+	+	+		+				+	+			+				
Orthetrum luzonicum (Brauer, 1868)				+															
Orthetrum sabina (Drury, 1773)	+	+	+					+	+	+	+		+	+		+	+	+	
Orthetrum testaceum (Burmeister, 1839)		+	+		+						+	+		+	+	+	+		
Pantala flavescens (Fabricius, 1798)							+	+	+					+			+		
Potamarcha congener (Rambur, 1842)			+			+			+				+	+		+			
Pseudothemis jorina Förster, 1904				+	+	+				+	+		+	+		+	+	+	
Raphismia bispina (Hagen, 1867)	+																		
Rhodothemis rufa (Rambur, 1842)		+	+	+						+	+			+					
Rhyothemis obsolescens Kirby, 1889											+								
Rhyothemis phyllis (Sulzer, 1776)	+	+	+	+			+			+	+	+		+			+	+	
Rhyothemis triangularis Kirby, 1889		+	+								+								
Tholymis tillarga (Fabricius,	+	+	+						+	+	+			+	+	+	+	+	

Species / **Parks**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1798)																			
Tramea transmarina euryale Selys, 1878			+								+			+					
Trithemis aurora (Burmeister, 1839)			+	+	+		+	+			+			+			+	+	
Trithemis festiva (Rambur, 1842)				+	+						+				+				
Trithemis pallidinervis (Kirby, 1889)														+					
Urothemis signata insignata (Selys, 1872)		+	+	+							+			+				+	
Zyxomma petiolatum Rambur, 1842	+	+	+											+					

Locations: 1 = Admiralty Park (2 families 15 species); 2 = Ang Mo Kio Town Garden West (3 families 19 species); 3 = Bishan Park (4 families 33 species); 4 = Bukit Batok Nature Park (4 families 16 species); 5 = Bukit Batok Town Park (3 families 10 species); 6 = East Coast Park (3 families 6 species); 7 = Fort Canning Park (1 family 7 species); 8 = Hort Park (3 families 10 species); 9 = Jurong Central Park (2 families 11 species); 10 = Kampong Java Park (2 families 11 species); 11 = Kent Ridge Park (5 families 33 species); 12 = Pearl's Hill City Park (1 family 5 species); 13 = Punggol Park (4 families 10 species); 14 = Singapore Botanic Gardens (5 families 32 species); 15 = Telok Blangah Hill Park (2 families 8 species); 16 = Tiong Bahru Park (3 families 10 species); 17 = Toa Payoh Town Park (3 families 18 species); 18 = West Coast Park (3 families 12 species); 19 = Woodlands Town Garden (1 family 1 species).

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