
Article

A survey of the dragonflies in the Klias and Binsulok Forest Reserves, Sabah, Malaysia

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Abstract

In the Klias-Binsulok Scientific Expedition and Inventory 1999 jointly organized by Universiti Malaysia Sabah and the Sabah Wildlife Department, a total of 28 species representing 5 families of dragonflies were recorded. Twenty-two species were recorded from the Klias Forest Reserve and its surroundings, while 21 species were from the Binsulok Forest Reserve. Two types of dragonfly fauna were recognized in the Klias region as a result of the classification of collecting sites by the distribution pattern of the dragonflies. One is a type that developed in the forest area, the other is a type that developed on open land. In the Binsulok Forest Reserve, these two types of fauna were found coexisting.

Key words: dragonfly, fauna, Borneo, Sabah, peat swamp forest

Introduction

The Klias-Binsulok Scientific Expedition and Inventory 1999 jointly organized by Universiti Malaysia Sabah and the Sabah Wildlife Department was held in March and April 1999. Its purpose was to collect, curate, and produce an inventory of the flora and fauna of both the Klias Forest Reserve and Binsulok Forest Reserve. The dragonfly, one of the most popular insects, is not so well investigated in Borneo and has never been recorded from the Klias and Binsulok Forest Reserves. In this report we examine the results of our survey to demonstrate an outline of the dragonfly fauna in the reserves and discuss their characteristics.

Locations and Methods

The Klias Forest Reserve and the Binsulok Forest Reserve are closely located at 70-80 km southwest of Kota Kinabalu, the capital of Sabah, in the northern part of Borneo Island (Fig. 1). The ecological environment of the two reserves are similar, i.e., forest

area covered with similar vegetation, primarily peat swamp forest, with poor topography varying in elevation, and altitude nearly at sea level.

For faunal comparison of dragonflies, several collecting sites were designated for the survey. In the Klias region (Fig. 2), the following four sites were designated: site A, an area inside the legal boundary of the forest reserve, well developed peat swamp forest without any water; site B, surrounding forest and trails approaching the boundary of the reserve (Fig. 3); site C, an adjacent cutover area along an artificial channel with some small ponds and wetland (Figs. 4, 5); and site D, a domestic area around the village Kg. Pulai Manang, located on the opposite bank of the river Sungai Klias (Fig. 6). In the Binsulok region, three sites were designated: site E, an area in the forest reserve (Fig. 7); site F, approaching river and riverside area surrounded by site E (Fig. 8); and site G, meadowland of small puddles near the village Kg. Pulai Binsulok about 10 km away from the forest reserve, surveyed for its contrast with the fauna of the two reserves.

Collecting was carried out on March 23-27, 29, and

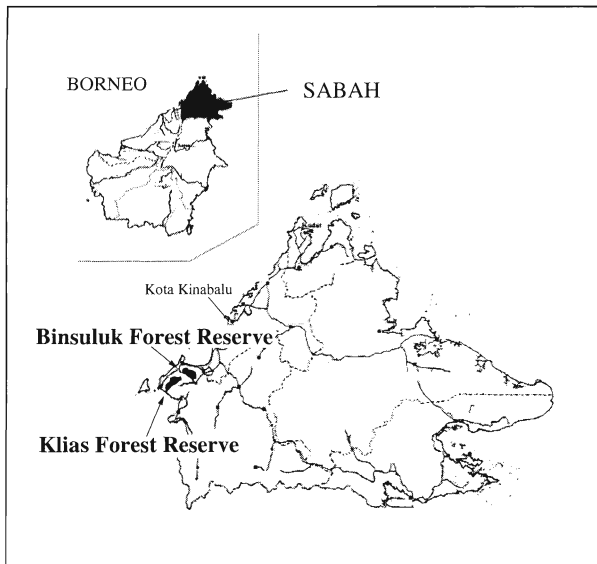


Fig. 1. Locations of the Klias Forest Reserve and Binsulok Forest Reserve.

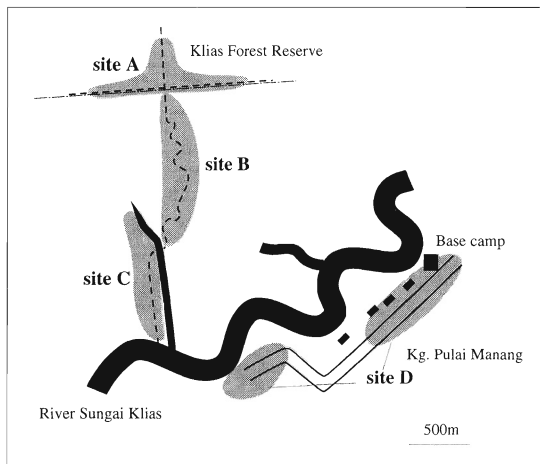


Fig. 2. Designated collecting sites in the Klias region. **site A:** the area inside the legal boundary of the Forest Reserve. **site B:** surrounding forest and trails approaching the boundary of the Reserve (Fig. 3). **site C:** adjacent cutover area along an artificial channel with some small ponds and wetland (Figs. 4, 5). **site D:** domestic area around the village Kg. Pulai Manang on the opposite bank of the Klias Forest Reserve (Fig. 6).

30 in the Klias region, and April 1-3 in the Binsulok region. We mainly surveyed during the daytime, although we also collected at dusk at site D. We spent a total of about 32 hours collecting in the Klias Forest Reserve and its surroundings (sites A, B, and C), 4 hours in Kg. Pulai Manang (site D), 9 hours in the Binsulok Forest Reserve (sites E and F), and about 30 min. in Kg. Pulai Binsulok (site G).

Insect netting was used to collect the dragonflies. They were kept alive in envelopes until we came back to the base camp each day, then were killed and

preserved in 70% ethyl-alcohol before being taken back to Japan. In the laboratory of the Museum of Nature and Human Activities in Hyogo, the dragonflies were dehydrated with 95% ethyl-alcohol and dried at room temperature for several weeks. All specimens are temporarily stored at the Museum of Nature and Human Activities, Hyogo, Japan.

At the same time collecting was carried out, a number of individuals were also observed at each site and recorded according to the following three categories: +, one or two individuals observed; ++, up to ten individuals; +++, more than ten individuals.

Results and Discussion

Specimens collected

Except for *Neurothemis* sp., which can be hybrid of *N. terminata* and *N. fluctuans*, 28 species (162 specimens) representing 5 families with 4 unidentified species were collected. In the Klias region, 5 species (5 specimens) were obtained from the Klias Forest Reserve (site A: described with [Klias Res.] in the following list), 16 species (41 specimens) from the adjacent area (sites B and C: [Klias]), 9 species (31 specimens) from Kg. Pulai Manang (site D). In the Binsulok region, 16 species (82 specimens) and 2 species (3 specimens) were from Binsulok Forest Reserve (sites E and F: [Binsulok Res.]) and from Kg. Pulai Binsulok (site G). All the specimens listed below were identified by author K. Kitagawa, referring to Fraser (1933, 1936), Laidlaw (1912), Lieftinck (1932, 1935, 1937, 1940, 1949, 1950, 1954), Matsui and Kitagawa (1992, 1993), Ris (1909-1919), and Tsuda and Kitagawa (1989).

Family Coenagrionidae

1. *Agriocnemis femina femina* (Brauer) (Fig. 9)
[Kg. Pulai Manang] 1 ♂, 23.III.1999; 2 ♂, 24.III.1999; 2 ♂ 1 ♀, 29.III.1999.
2. *Amphicnemis* sp. (can be new species) (Fig. 10)
[Klias Res.] 1 ♂, 25.III.1999.
3. *Archibasis viola* Lieftinck (Fig. 11)
[Klias] 1 ♂, 25.III.1999.
4. *Ceriagrion cerinorubellum* (Brauer) (Fig. 12)
[Kg. Pulai Manang] 1 ♂, 23.III.1999. [Klias] 1 ♂, 25.III.1999; 3 ♂ 1 ♀, 29.III.1999. [Binsulok Res.] 5 ♂ 1 ♀, 1.IV.1999; 1 ♂, 2.IV.1999; 1 ♀, 3.IV.1999.
5. *Ischnura senegalensis* (Rambur) (Fig. 13)
[Kg. Pulai Binsulok] 2 ♂, 2.IV.1999.

Table 1. Dragonflies observed in the Klias Forest Reserve and the Binsulok Forest Reserve.

No.	Family	Species	Collecting sites						
			Klias region				Binsulok region		
			A	B	C	D	E	F	G
1	Coenagrionidae	<i>Agriocnemis femina femina</i> (Brauer)				++			
2		<i>Amphicnemis</i> sp.	+						
3		<i>Archibasis viola</i> Lieftinck		+				+	
4		<i>Ceriagrion cerinorubellum</i> (Brauer)		++	++	+		+++	+++
5		<i>Ischnura senegalensis</i> (Rambur)							+ ++
6		<i>Onychargia atrocyana</i> Selys			+				
7		<i>Pseudagrion microcephalum</i> (Brauer)							+++
8		<i>Teinobasis rajah</i> Laidlaw		+				++	+
9	Megapodagrionidae	<i>Podolestes orientalis</i> Selys						+	
10	Chlorocyphidae	<i>Libellago hyalina</i> (Selys)	+	+				++	+++
11	Aeshnidae	<i>Gynacantha</i> sp.	+	+	++	+++		+	
12	Libellulidae	<i>Brachydiplax chalybea chalybea</i> -Brauer			++	+			+++
13		<i>Brachygonia oculata</i> (Brauer)		+				++	
14		<i>Lathreciasta asiatica asiatica</i> (Fabricius)	+						
15		<i>Nannophya pygmaea</i> Rambur						+	+++
16		<i>Nosoxenia lineata</i> (Selys)		+					
17		<i>Neurothemis fluctuans</i> (Fabricius)	++	++	+++	+++		+++	+++
18		<i>Neurothemis terminata terminata</i> Ris	+	++				++	
19		<i>Orthetrum chrysis</i> (Selys)	+	++					+
20		<i>Orthetrum testaceum testaceum</i> (Bürmeister)					++		+
21		<i>Orthetrum sabina sabina</i> (Drury)	+	+	+++	++		++	+++
22		<i>Rhyothemis obsolescens</i> Kirby			++			+	++
23		<i>Rhyothemis phyllis phyllis</i> (Sulzer)			+++	+++		++	+++
24		<i>Rhyothemis atterima</i> ?			++				
25		<i>Tholymis tillarga</i> (Fabricius)					++		
26		<i>Tramea</i> sp.			++	++			++
27		<i>Tyriobapta kuckenthali</i> (Karsch)						+	
28		<i>Zyxomma petiolatum</i> Rambur						++	
Number of species observed			8	11	10	10	15	13	2

+ : one or two individuals observed; ++ : up to ten individuals; +++ : more than ten individuals

6. *Onychargia atrocyana* Selys

[Klias] 1 ♂, 26.III.1999.

7. *Pseudagrion microcephalum* (Brauer) (Fig. 14)

[Binsulok Res.] 2 ♂, 1.IV.1999; 1 ♂, 2.IV.1999.
[Kg. Pulau Binsulok] 1 ♂, 2.IV.1999.

8. *Teinobasis rajah* Laidlaw (Fig. 15)

[Klias] 1 ♂, 25.III.1999; 1 ♂, 29.III.1999; 1 ♂, 30.III.1999. [Binsulok Res.] 1 ♀, 1.IV.1999; 3 ♂ 1 ♀, 2.IV.1999; 1 ♂, 3.IV.1999

Family Megapodagrionidae9. *Podolestes orientalis* Selys

[Binsulok Res.] 1 ♂, 2.IV.1999; 1 ♂, 3.IV.1999.

Family Chlorocyphidae10. *Libellago hyalina* (Selys) (Fig. 16)

[Klias Res.] 1 ♂, 25.III.1999. [Klias] 1 ♂, 29.III.1999. [Binsulok Res.] 1 ♂, 1.IV.1999; 3 ♂ 3 ♀, 2.IV.1999; 4 ♂ 2 ♀, 3.IV.1999.

Family Aeshnidae11. *Gynacantha* sp.

[Kg. Pulau Manang] 1 ♀, 24.III.1999; 4 ♀, 25.III.1999.

Family Libellulidae12. *Brachydiplax chalybea chalybea* Brauer (Fig. 17)

[Kg. Pulau Manang] 2 ♂, 23.III.1999. [Klias] 2 ♂, 25.III.1999; 1 ♂, 26.III.1999. [Binsulok Res.] 1 ♂, 2.IV.1999; 1 ♂, 2.IV.1999.

13. *Brachygonia oculata* (Brauer) (Fig. 18)

[Klias] 1 ♂, 30.III.1999. [Binsulok Res.] 1 ♂, 2.IV.1999; 5 ♂, 3.IV.1999.

14. *Lathrecista asiatica asiatica* (Fabricius) (Fig. 19)

[Klias Res.] 1 ♂, 29.III.1999.

15. *Nannophya pygmaea* Rambur (Fig. 20)

[Binsulok Res.] 7 ♂, 1.IV.1999; 7 ♂ 1 ♀, 2.IV.1999; 4 ♂ 5 ♀, 3.IV.1999.

16. *Nesoxenia lineata* (Selys)

[Klias] 1 ♀, 24.III.1999.

17. *Neurothemis fluctuans* (Fabricius) (Fig. 21)

[Klias] 1 ♂ 1 ♀, 23.III.1999; 2 ♂ 1 ♀, 24.III.1999; 1 ♂ 2 ♀, 25.III.1999; 1 ♂, 29.III.1999. [Kg. Pulau Manang] 3 ♂, 23.III.1999; 1 ♂, 24.III.1999; 4 ♂ 1 ♀, 29.III.1999. [Binsulok Res.] 1 ♀, 1.IV.1999; 2 ♂ 1 ♀, 2.IV.1999; 2 ♂, 3.IV.1999.

18. *Neurothemis terminata terminata* Ris (Fig. 22)

[Klias Res.] 1 ♂, 25.III.1999. [Binsulok Res.] 1 ♀, 2.IV.1999.

Neurothemis sp. (can be hybrid of *N. terminata* and

N. fluctuans)

[Binsulok Res.] 1 ♂, 2.IV.1999.

19. *Orthetrum chrysis* (Selys)

[Klias Res.] 1 ♀, 29.III.1999. [Klias] 1 ♀, 23.III.1999; 1 ♂, 24.III.1999; 1 ♀, 26.III.1999; 1 ♂; 27.III.1999.

20. *Orthetrum testaceum testaceum* (Bürmeister)

[Klias] 1 ♂, 23.III.1999; 1 ♂, 25.III.1999.

21. *Orthetrum sabina sabina* (Drury)

[Klias] 1 ♂, 29.III.1999. [Kg. Pulau Manang] 1 ♂, 23.III.1999. [Binsulok Res.] 1 ♀, 1.IV.1999.

22. *Rhyothemis obsolescens* Kirby (Fig. 23)

[Klias] 2 ♂, 27.III.1999. [Binsulok Res.] 2 ♂ 1 ♀, 3.IV.1999.

23. *Rhyothemis phyllis phyllis* (Sulzer) (Fig. 24)

[Klias] 1 ♂, 25.III.1999; 1 ♂, 26.III.1999. [Kg. Pulau Manang] 1 ♀, 27.III.1999. [Binsulok Res.] 1 ♂, 1.IV.1999; 1 ♀, 2.IV.1999.

24. *Rhyothemis atterima* ? rare species, temporary identification (Fig. 25)

[Klias] 1 ♂, 25.III.1999; 2 ♂, 26.III.1999; 2 ♂, 27.III.1999.

25. *Tholymis tillarga* (Fabricius)

[Kg. Pulau Manang] 2 ♂, 23.III.1999; 1 ♂, 29.III.1999; 1 ♀, 30.III.1999.

26. *Tramea* sp.

[Kg. Pulau Manang] 1 ♂, 27.III.1999; 1 ♀, 25.III.1999.

27. *Tyriobapta kukenthali* (Karsch) (Fig. 26)

[Binsulok Res.] 1 ♂, 2.IV.1999.

28. *Zyxomma petiolatum* Rambur

[Binsulok Res.] 1 ♀, 1.IV.1999; 2 ♂, 3.IV.1999.

Faunal comparison of the two reserves

The distribution pattern of insects in small areas such as in the present survey is generally reflected in their habitat range and population size. Table 1 shows the list of dragonflies with estimated numbers of individuals observed at each collecting site. The numbers of species observed were not so different between the two regions; 22 species were from the Klias region and 21 from the Binsulok region. However, dragonflies recorded at each site were different in their characters and constitution. Therefore, we focused our attention on that in analyzing the faunal characteristics of the sites.

It is believed that similarity among fauna is caused by similarities among the environments they live in. In this study, we first focused on overlapping of the dragonfly distribution among the sites (Table 2). In site A, each of 6 species are in common with those of

Table 2. Number of species in common and Jaccard's coefficient of community index (CC) between 7 sites surveyed Klias Forest Reserve and the Binsulok Forest Reserve.

		Collecting site							
		Klias region				Binsulok region			
		A	B	C	D	E	F	G	
		8	11	10	10	15	13	2	Number of species
A			0.75	0.38	0.38	0.63	0.38	0.00	Jaccard's CC Index
B		6		0.40	0.40	0.82	0.45	0.50	
C		3	4		0.70	0.60	0.70	0.00	
D		3	4	7		0.50	0.70	0.00	
E		5	9	6	5		0.54	0.50	
F		3	5	7	7	7		0.50	
G		0	1	0	0	1	1		

Table 3. Distributional pattern of dragonflies based on the species observed at two or more sites. Collecting sites, A + B: Klias Forest Reserve and adjacent forest area, C + D: cutover area and domestic area near the Klias Forest Reserve, E + F: Binsulok Forest Reserve.

Species	Collecting sites		
	A+B	C+D	E+F
<i>Ischnura senegalensis</i> (Rambur)			■
<i>Pseudagrion microcephalum</i> (Brauer)			■
<i>Nannophya pygmaea</i> Rambur			■
<i>Archibasis viola</i> Lieftinck			■
<i>Teinobasis rajah</i> Laidlaw			■
<i>Libellago hyalina</i> (Selys)			■
<i>Brachygonia oculata</i> (Brauer)			■
<i>Neurothemis terminata terminata</i> Ris			■
<i>Orthetrum chrysis</i> (Selys)	■		
<i>Brachydiplax chalybea chalybea</i> Brauer		■	
<i>Orthetrum testaceum testaceum</i> (Bürmeister)		■	
<i>Rhyothemis obsolescens</i> Kirby		■	
<i>Rhyothemis phyllis phyllis</i> (Sulzer)		■	
<i>Tamea</i> sp.		■	
<i>Ceriagrion cerinorubellum</i> (Brauer)	■		
<i>Gynacantha</i> sp.	■		
<i>Neurothemis fluctuans</i> (Fabricius)	■		
<i>Orthetrum sabina sabina</i> (Drury)	■		

site B, but only 3 species are in common with sites C, D, and F. This suggests that the environment of site A should be more similar to that of site B than other sites. It is natural, then, that sites A and B are located contiguously. In contrast, the fauna of site B are closely related to the fauna of site E, although the two sites belong to different reserves. This suggests that these two sites also have common environmental factors.

When we examined the fauna of three pairs from adjacent sites, the characteristics are distinctly greater (Table 3). In the Klias region, fauna of sites A+B and sites C+D did not overlap in their components except for 4 common species. These two fauna, however, were included with the Binsulok fauna (sites E+F). This

suggests that, for the species observed at two or more sites, a species found in the Klias region was always also observed in the Binsulok Forest Reserve. Three times as much time was spent for observation in the Klias region as for the Binsulok region, suggesting that the richness of dragonfly species in the Binsulok reserve must be higher than that in the Klias reserve.

Second, we tried to focus upon the characteristic species. Eleven species out of 28 were observed exclusively on one site. *Tholymis tillarga*, observed exclusively at site D, is a species active only at dusk, making it difficult to see except around the base camp. The other ten species (e.g., *Agriocnemis femina femina*, *Podolestes orientalis*, *Lathrecista asiatica asiatica*, and *Rhyothemis aterrima*) could be representatives specialized to the particular environment at each site. *Nannophya pygmaea*, which is characteristic to sites E and F, is so abundant in its number of individuals that it may also be an indicator for the peat-swamp forest of the Binsulok Forest Reserve. On the other hand, *Neurothemis fluctuans*, *Orthetrum sabina sabina*, and *Ceriagrion cerinorubellum* could be abundantly observed at almost any site. This suggests that the habitat range of these species is probably very wide.

We were also able to recognize at least two types of dragonfly fauna from these results. One type is those developed in the forest area, the other type those that developed in more open habitat. In the Klias region the former was developing at sites A and B, while the latter was at sites C and D. The species richness of the Binsulok Forest Reserve certainly seems to have resulted from the fact that these two types of fauna are merging together, with some characteristic species such as *Nannophya pygmaea* distributed as well. It is possible that the Binsulok forest is in an earlier stage of ecological succession of peat swamp forest than that of the Klias forest. Therefore, the Binsulok Forest Reserve would have a greater variety of water patches suitable for many kinds of dragonfly habitats.

To obtain more detailed information about dragonfly fauna and their characteristics, research on the peripheral area with a greater variety of habitats is needed. Investigating the immature stages of dragonflies and the distribution of other aquatic insects such as diving beetles and water bugs, is also required to further reveal the biological diversity of the peat swamp forest on Borneo Island.



Fig. 3. On the trail near the boundary of the Klias Forest Reserve (site B).



Fig. 4. Cutover area around the Klias Forest Reserve (site C).



Fig. 5. Wetland in the cutover area around the Klias Forest Reserve (site C).



Fig. 6. Landscape of the village Kg. Pulai Manang (site D).



Fig. 7. Vegetation in the Binsulok Forest Reserve (site E).



Fig. 8. The river penetrating into the core area of the Binsulok Forest Reserve (site F).

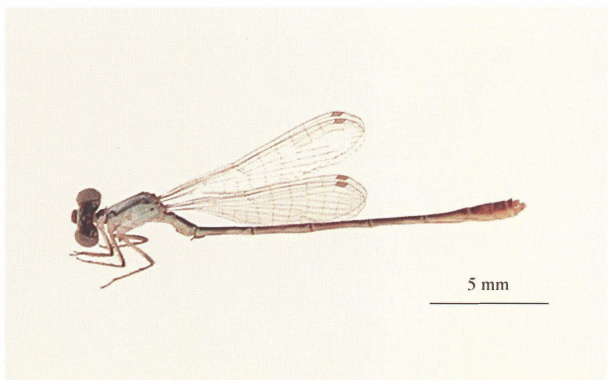


Fig. 9. *Agriocnemis femina femina* (Brauer)

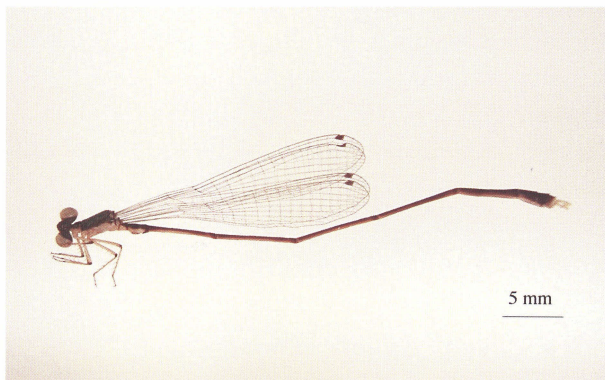


Fig. 10. *Amphicnemis* sp.

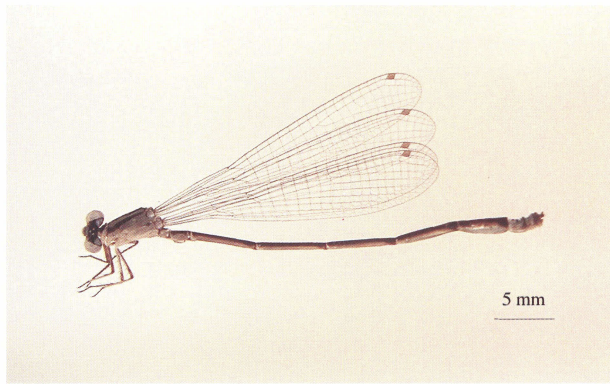


Fig. 11. *Archibasis viola* Lieftinck

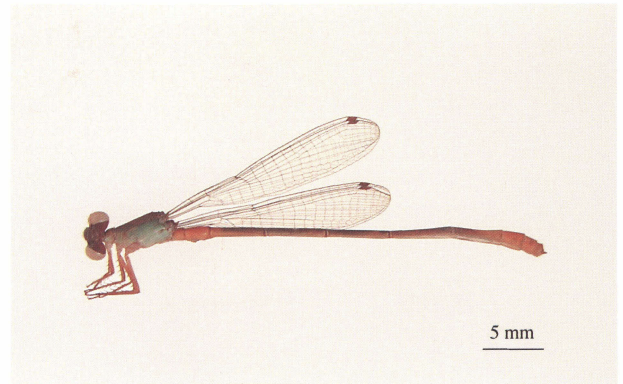


Fig. 12. *Ceriagrion cerinorubellum* (Brauer)

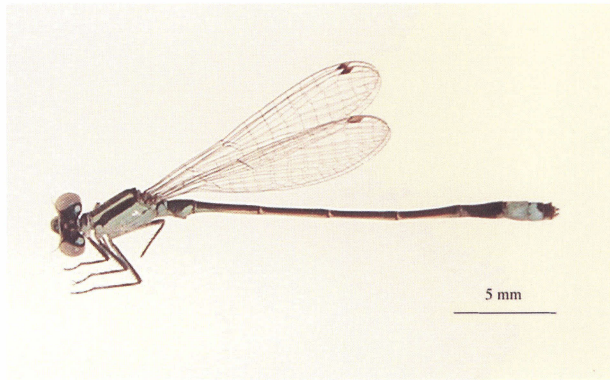


Fig. 13. *Ischnura senegalensis* (Rambur)

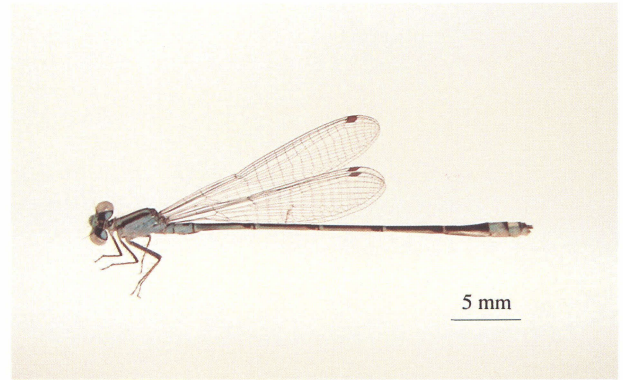


Fig. 14. *Pseudagrion microcephalum* (Brauer)

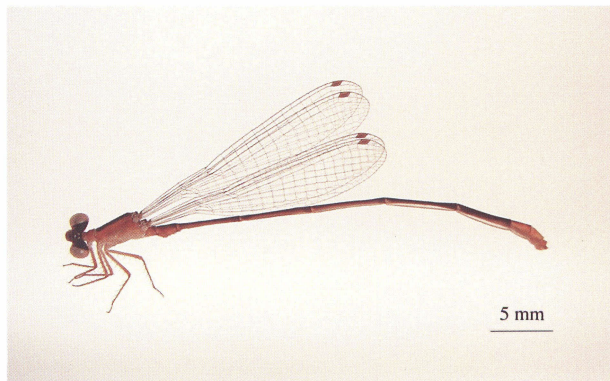


Fig. 15. *Teinobasis rajah* Laidlaw

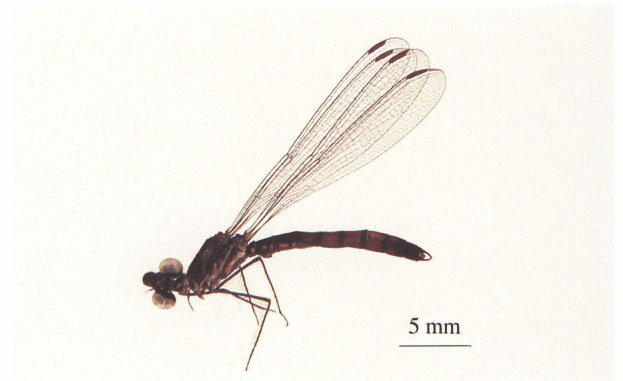


Fig. 16. *Libellago hyalina* (Selys)



Fig. 17. *Brachydiplax chalybea chalybea* Brauer



Fig. 18. *Brachygonia oculata* (Brauer)

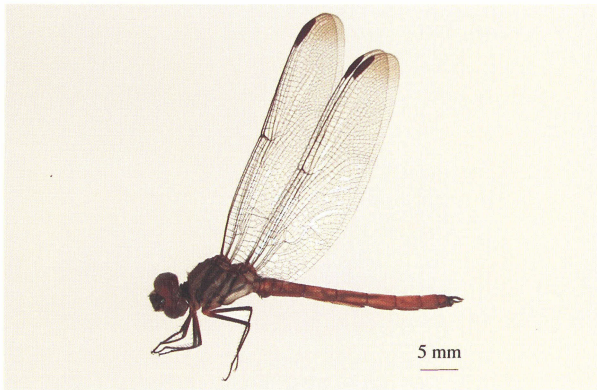


Fig. 19. *Lathrecista asiatica asiatica* (Fabricius)

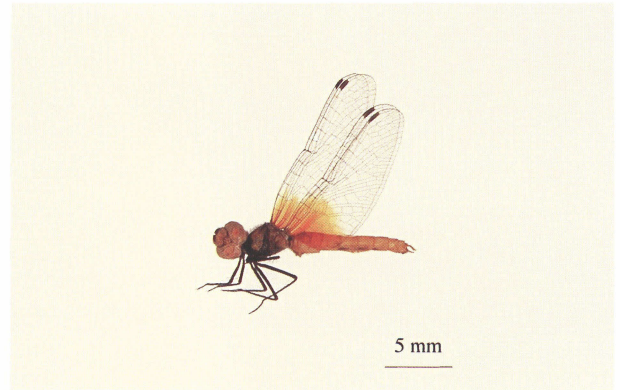


Fig. 20. *Nannophya pygmaea* Rambur



Fig. 21. *Neurothemis fluctuans* (Fabricius)



Fig. 22. *Neurothemis terminata terminata* Ris

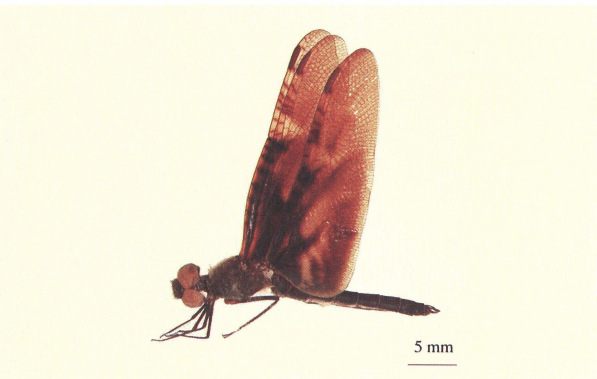


Fig. 23. *Rhyothemis obsolescens* Kirby



Fig. 24. *Rhyothemis phyllis phyllis* (Sulzer)

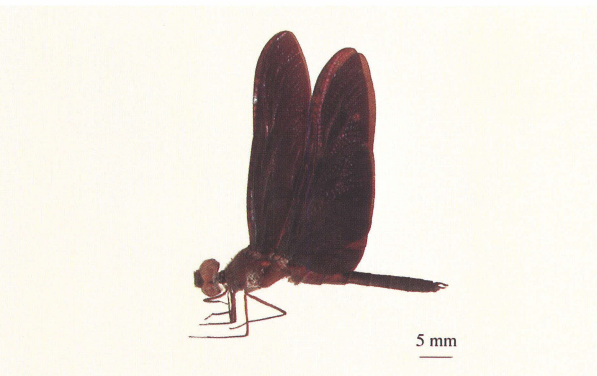


Fig. 25. *Rhyothemis atterima* ?

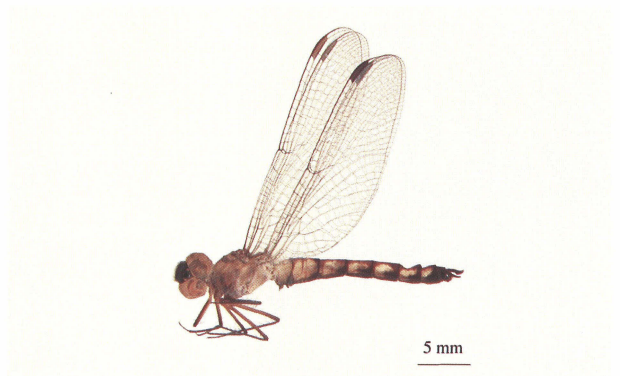


Fig. 26. *Tyriobapta kukenthali* (Karsch)

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