New data about the mayflies (Ephemeroptera) from Borneo

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Abstract

We report new data about mayfly diversity from a 85 km^2 area in East Kalimantan (Borneo, Indonesia). More than 40 mayfly genera have been collected in a lowland Dipterocarpaceae forest. They belong to the following families (by decreasing diversity order): Baetidae (12), Leptophlebiidae (7), Caenidae (6), Heptageniidae (5), Ephemerellidae (2), Potamanthidae (2), Teloganodidae (2), Isonychiidae (1), Neoephemeridae (1), Teloganellidae (1), Euthyplociidae (1) and Prosopistomatidae (1). The last family is recorded for the first time in Borneo. At least 10 taxa have not been assigned to known genera, especially within Baetidae and Caenidae. This incredible mayfly diversity is among the highest ever reported so far for an area of less than 10x10 km.

Keywords: Indonesia, primary forest, tropical streams.

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Introduction

With an area of 736,000 km^2 Borneo is the third largest island in the world and the largest of the Sunda Islands. It is politically shared by three states, Indonesia, Malaysia and Brunei Sultanate. From a biogeographical point of view, it is situated quite close to the Wallace line that separate the Oriental (Borneo, Java, Sumatra, Bali…) from the Australasian realm (Sulawesi, Timor, Lombok, Papua New Guinea…). Located on the equator, with important altitudinal gradient, its hydrographic network is highly diversified.

Surprisingly, Borneo received little attention on a mayfly point of view. The first species described were *Rhoenanthus speciosus* (Potamanthidae) and *Atopopus tarsalis* (Heptageniidae) at the end of the 19th century (Eaton, 1881). Ulmer's famous work on mayflies of the Sunda islands focused mainly on Java and Sumatra, with sparse data on Borneo (Ulmer, 1939). Nevertheless, he described 9 new genera and 12 new species from this island. Since that time, a few contributions have brought some new data (Demoulin, 1953, 1954; Peters, 1972; Allen and Edmunds, 1976; Müller-Liebenau, 1984; Grant and Peters, 1993; Wang and McCafferty, 1995; Wang *et al.*, 1995).

Aquatic insect diversity and ecology in tropical Asian streams has been the subject of a very useful and up to date book (Dudgeon, 1999). The only supraspecific modern synthesis of mayflies found on the Sunda Islands has been the publication by Edmunds and Polhemus (1990), as well as the recent survey of Ephemeroptera from the Oriental region (Soldán, 2001). At the end of the 20th century, 35 genera and 44 species were recorded (table 1).

Study site

Our results are part of a broader research on the impact of logging activities on macroinvertebrate community structure led by one of us (Derleth *et al.*, 2001). The study site covers 85 km^2 in a Dipterocarpaceae forest in the Northeast of East Kalimantan (Malinau District, Indonesia). Elevation ranges from 100 to 300 m a.s.l. The whole area is very hilly, allowing a dense and rich hydrological network (Fig. 1). For methodological consistency, only 3rd and 4th order streams have been investigated. Quantitative and qualitative samples were carried out in 19 localities in 2000 and in 15 in 2001. When possible, evening and morning light traps were also performed.

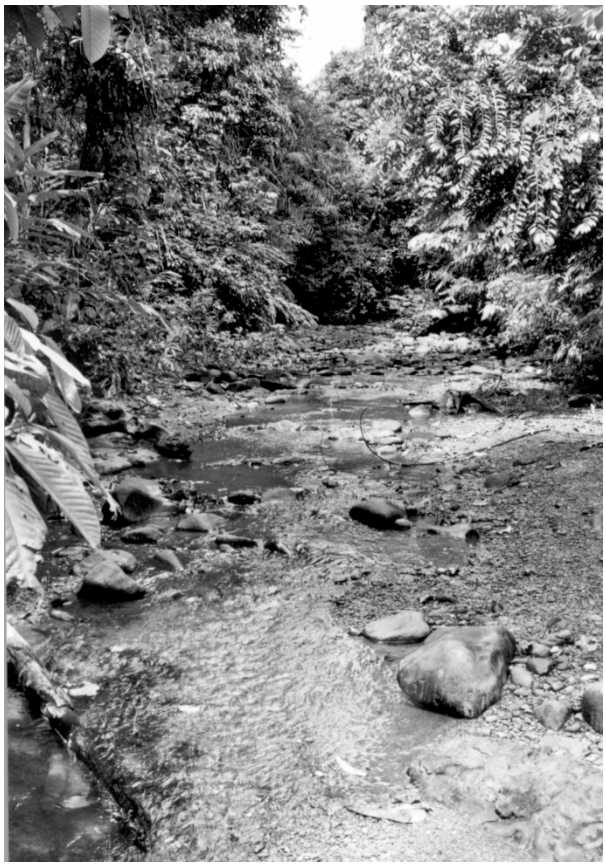

Fig. 1 - Example of a 3rd order stream in primary rain forest (photo M. Sartori)

Results

All in all, more than 40 mayfly genera and about 50 species have been identified from that area (Table 1). This represents broadly the same diversity as we previously knew for the whole island!

Polymitarcyidae (*Ephoron, Povilla*), Ephemeridae (*Eatonigenia*) and Palingeniidae (*Anagenesia*) are lacking in our samples. This is not surprising since these burrowing mayflies probably cannot find suitable habitats in the headwaters we investigated. The absence of Tricorythidae (*Tricorythus*) is less clear. Based on our knowledge of the ecology of this family in Africa and Madagascar, it could be present in the prospected streams. But data on the distribution of this genus in Borneo are still fragmentary.

Here are some details for each of the other families.

Baetidae

This family is the most diverse since 12 genera have been recognised. Most abundant are *Labiobaetis, Platybaetis and Jubabaetis* that are represented by several species. Noteworthy is also the presence of *Cloeodes* and *Liebebiella*. The genera *Alainites, Jubabaetis* and *Pseudocentroptiloides* are recorded for the first time from Borneo. At least 5 other taxa could not be placed in any known genus. The *Baetis* lineage (i.e. *Platybaetis, Liebebiella* and allied genera) exhibits the highest diversity.

Table 1 - Comparison of diversity for known families between data obtained from the literature and those of the present study.

	Literature		Present study	
Family	Genera	Species	Genera	Species
Palingeniidae	1	5	0	0
Polymitarcyidae	2	3	0	0
Ephemeridae	1	1	0	0
Potamanthidae	2	2	2	2
Euthyplociidae	1	2	1	1
Leptophlebiidae	7	7	7	>7
Baetidae	7	9	12	>13
Isonychiidae	1	1	1	1
Heptageniidae	6	7	5	7
Ephemerellidae	2	2	2	3
Teloganodidae	1	1	2	2
Teloganellidae	1	1	1	1
Tricorythidae	1	1	0	0
Neoephemeridae	1	1	1	1
Caenidae	1	1	6	>6
Prosopistomatidae	0	0	1	1
TOTAL	35	44	41	>45

Heptageniidae

The most common and diversified genus has been identified as *Cinygmina*, although this and related genera are in great need of a global revision. At least 3 different species have been found. *Atopopus* nymphs are also relatively abundant in the investigated area; based on the capture of male imagoes, they have been identified as *Atopopus tarsalis* EATON, 1881. Only the nymph of *A. edmundsi* (WANG & McCAFFERTY, 1995) was previously known. Three other taxa were not identified with certainty and are related to *Asionurus, Trichogenia* or even *Notacanthurus*.

Leptophlebiidae

Choroterpes (Euthraulus) is the most common genus among the identified Ephemeroptera. Other Leptophlebiidae are less abundant, although *Isca* and *Habrophlebiodes* (both recorded for the first time from Borneo) are not rare. *Dipterophlebioides* and *Thraulus* have been found in a few localities, whereas an unknown genus could perhaps represent the nymphs of *Simothraulus* and/or *Sulu* that are only known at the adult stage.

Isonychiidae

Some nymphs of *Isonychia* have been collected that could represent the unknown immature stage of *I. winkleri* ULMER, 1939, the only species so far known from Borneo. Correspondence with

adults caught by light traps will probably bring soon an answer.

Potamanthidae

Two species have been found, belonging to the genera *Rhoenanthus* and *Potamanthus* (subgenus *Stygifloris* endemic to Borneo). But at the moment, we are not convinced our specimens are conspecific with the two potamanthid mayflies known from Borneo: *Potamanthus (Stygifloris) sabahensis* BAE, McCAFFERTY & EDMUNDS, 1990 and *Rhoenanthus speciosus* EATON, 1881.

Euthyplociidae

Several nymphs belonging to the genus *Polyplocia* have been collected. Here again, specific attribution will need further studies. Two species have been described by Ulmer at the adult stage (*P. campylociella* ULMER, 1939 and *P. crassinervis* ULMER, 1939) but only one is known at the larval stage (Demoulin, 1966), and its specific attribution is uncertain.

Ephemerellidae

Two genera have been found that match the descriptions of *Uracanthella* and *Hyrtanella*. This later is most likely endemic to Borneo. The nymphs we collected are very different from those of the single species known, *H. christinae* ALLEN & EDMUNDS, 1976. *Uracanthella* is probably represented by two species.

Teloganodidae

The genus *Teloganodes* is quite common in the area, as is another and yet undescribed genus. The concept of *Teloganodes* needs anyway a careful revision. Described from Sri Lanka on female subimagoes, *Teloganodes tristis* HAGEN, 1858 has been subsequently reported from Borneo by Ulmer (1939) as nymphs and later on in other countries from South East Asia (Hubbard and Pescador, 1978; Hubbard and Peters, 1984; Soldán, 1991; Tong and Dudgeon, 2000). The fact that the populations from Sri Lanka and Borneo belong to the same species, or even to the same genus needs to be fixed.

Teloganellidae

This family has been erected recently for the monotypic *Teloganella umbrata* ULMER, 1939 (McCafferty and Wang, 2000). We collected very few males with light traps and a single nymph of this species. Anyway, all stages need to be correctly redescribed before any phylogenetic relationship or family assessment could be completed.

Neoephemeridae

The few nymphs that were caught fit the description of the single species known from Borneo and described by Ulmer as *Neoephemeropsis caenoides* (ULMER, 1939). This genus has been recently put in synonymy with *Potamanthellus* (BAE & McCAFFERTY, 1998). *Potamanthellus caenoides* has also been recorded from continental Asia.

Caenidae

The study of this family has brought a lot of surprises. Only *Caenis* and/or *Caenodes* were previously known. They are the most abundant in our samples. Besides, we collected *Clypeocaenis* nymphs (first record for Borneo), as well as what seems to be *Brachycercus*. If the latter identification is correct, it would extend the known distribution of this holarctic genus far to the East since the only Oriental species is known from Sri Lanka. Two different taxa could not be assigned to anything and probably represent new genera. With at least 5 genera, the Caenidae is surprisingly one of the most diversified family in Borneo.

Prosopistomatidae

This monogeneric family is recorded for the first time in Borneo. The species of *Prosopistoma* we collected is very rare and has only been found in the most remote places with intact primary forest. Our first analyses show it to belong to a new species sharing more affinities with some continental species than with *P. wouterae* LIEFTINCK, 1932 from Java and Sumatra.

Discussion

With ca 40 genera found in 3rd and 4th order streams in an area of less than 10x10km, the mayfly diversity we recorded is among the highest found in the world. Among them, almost 10 are probably new to science. Undoubtedly, they will bring consistent new data for our understanding of tropical Asian mayflies. A further step will be the description of these new taxa, as well as their phylogenetic and biogeographical affinities. These preliminary results stress, if necessary, the unique value of primary rain forests in our appreciation of global biodiversity. How this ecosystem vanishes under human pressures gives us an idea of what we loose even before being aware of its existence.

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