

# THE MACROINVERTEBRATE COMMUNITY OF THE FAST FLOWING RIVERS IN THE CROCKER RANGE NATIONAL PARK SABAH, MALAYSIA.

Shabdin Mohd. Long, Fatimah Abang and Khairul Adha A. Rahim<sup>1</sup>

## ABSTRACT

*The macroinvertebrate community of the fast flowing rivers of the Crocker Range Park examined consists mainly of insects. All the six rivers surveyed demonstrated excellent water quality. The assemblages of taxa reported from the study sites are considered as that typical of the macroinvertebrate fauna in tropical rivers. Out of the existing ten orders of insects that contain aquatic species, a total of 7 orders of aquatic insect species were encountered in the rivers surveyed. These are Ephemeroptera, Odonata, Plecoptera, Hemiptera, Coleoptera, Trichoptera and Diptera. In addition to these insects, the hexapodan Collembola was also encountered. The overall macroinvertebrate density ranges from 71 to 303 individuals per  $lm\ sq$  and all sampling sites were found to sustain at least three groups of taxa with the exception of Sg. Tikolud, which only contains the dipteran chironomids. The dipteran chironomid fauna was dominant and found at all stations and forms the highest density of up to 250 individuals per  $m^2$  in Sg. Tandulu and Balayo.*

## INTRODUCTION

The Crocker Range is a tropical highland dividing the west coast and the interior regions of Sabah. This mountainous range is the home of the famous Mount Kinabalu (13,455ft), the highest mountain in Southeast Asia. Crocker Range Park (CRP) was enacted as a conservation area (National Park) in 1984 covering an area of 139,919 hectares. The CRP serves to preserve and protect the watershed of four main rivers in the west coast and 8 rivers from the interior plains. The climate of Sabah is equatorial, that is: relatively uniform temperatures in the range 23 to 28<sup>0</sup>C, high humidity (80-85%) and abundant rainfall, e.g. 1800mm from 1950 to 1963 measured at the Tambunan climate station within the flood plain.

Aquatic habitats are known to support an extraordinary array of species. Most of the aquatic faunas are small invertebrates. As compared to the fish fauna, the invertebrate species diversity in most part of the world, particularly the tropics, is poorly known. The lack of knowledge is caused by a number of factors such as the great diversity of invertebrates and their numerical abundance has contributed to their neglect. In addition to this, invertebrates are small and difficult to identify. In spite of the dearth of studies on the invertebrate fauna, many of the aquatic invertebrates are being lost as their habitats deteriorate; some without ever being discovered and made known to science.

Very few studies on the lotic invertebrates in Borneo have so far been reported. Such reports include that of SAMA Consortium (1982) on the molluscs in the Pelagus area, Sarawak. Abang et al. (1995) reported on the current status of the lotic invertebrate diversity of the upper Balui River, Sarawak. Five orders of macrobenthos, mainly insects were reported from the rivers in Bario, Kelabit Highlands of Sarawak (Shabdin & Abang 1998). Although the physical environment and the biological diversity of Kinabalu Parks have been much studied and documented, studies on the community structure of invertebrates of the Crocker Range Parks are still lacking. Our primary objective was to record the density and number of taxa found in the Crocker Range Parks and the results presented here will serve as baseline documentation on the current status of the invertebrates from the rivers in Crocker Range Parks.

## METHODOLOGY

**Habitat types:** The upper parts of the rivers studied were located in the CRP area and generally fast flowing water. Rivers such as Sungai Mawau, Sungai Ulu Senagang, Sungai Balayo, Sungai Liawan, Sungai Tandulu and Sungai Tikolud all fed into Sungai Padas (Figure 1). All rivers studied had clear water during the study period in October 1999. Three of the sampling stations were shaded areas beneath the jungle canopy of the forest vegetation (Table 1).

*Table 1: Types of habitat in the study area.*

<b>River</b>	<b>Date</b>	<b>Habitat description</b>
Sg. Mawau	16 Oct. 99	Sampling station: covered by jungle canopy. Water: fast flowing and clear. Sediment: stony + sandy.
Sg. Tandulu	16 Oct. 99	Sampling station: covered by jungle canopy. Water: fast flowing and clear. Sediment: stony + sandy
Sg. Liawan	17 Oct. 99	Sampling station: exposed to direct sunlight. Water: fast flowing and clear. Sediment: stony + rubble
Sg. Ulu Senagang	17 Oct. 99	Sampling station: exposed to direct sunlight. Water: fast flowing and clear. Sediment: stony +sandy
Sg. Tikolud	18 Oct. 99	Sampling station: covered by jungle canopy. Water: fast flowing and clear. Sediment: stony + rubble
Sg. Balayo	18 Oct. 99	Sampling station: exposed to direct sunlight. Water: fast flowing and turbid.



Fig 1: Map showing the location of stations in the CRP study area

**Sampling procedures:** Six stations were selected in the study area (Fig.1). Two methods of collecting freshwater invertebrates have been used. Firstly, the sediment samples were taken at the euphamiolittoral habitat and below the edge of the water level of the streams. At each sampling station, sediment was sampled in a  $0.25\text{m}^2$  quadrat. Sediment was scooped to a depth of 5cm. It was then sieved through 0.5mm and  $45\mu\text{m}$  mesh size. The organisms retained on both sieves were preserved in 5% formalin. Secondly, the invertebrates were collected by using plankton net with a mesh size of  $100\mu\text{m}$ . The net was placed in the streams just beneath the surface of the water for two hours and the volume of the water that passed through the net was recorded by flow-meter fixed in front of the net. The invertebrates caught in the net were then preserved with 5% formalin. The insects were preserved by placing them in a jar containing 70% ethanol. Soft-bodied adults were preserved in ethanol. Identification to species level was not immediately possible as keys and published descriptions to most major groups of freshwater invertebrates encountered were still lacking. The samples were brought to the laboratory for counting and identification under stereomicroscope by using various keys available in the literature.

## RESULTS AND DISCUSSION

During the present study, 5 water quality parameters were studied for six locations in the watershed. The results of the water quality examination are given in Table 2. As expected for fast flowing streams, the dissolved oxygen level of the water in CRP area was found to be generally high (> 8 mg/l). The amount of oxygen dissolved in the water was also elevated by the lower temperature of the water (Manahan 1991). The water was generally well aerated.

*Table 2: Physico-chemical parameters of water in the upper river system of the Crocker range Parks.*

River	Temperature	Diss. oxygen	Conductivity	pH	Turbidity
Sg.Mawau	18.3	8.5	0.1	7.7	45.5
Sg.Tandulu	19.9	8.9	0.1	8.3	59.6
Sg.Liawan	26.0	8.3	0.1	8.3	38.9
Sg.Ulu Senagang	23.3	8.6	0.1	8.1	71.9
Sg.Tikolud	21.2	8.3	0.1	8.0	44.2
Sg. Balayo	25.3	8.3	0.1	8.7	105.3

The invertebrate community encountered in the present study consists mainly of macroinvertebrates, particularly insects. In all rivers surveyed, none of the meiobenthos was sampled. The absence of this fauna could be possibly due to sampling being mainly done in the fast flowing water, with a current flow of about 1m per second. The meiobenthos fauna is normally not sampled in such a situation as indicated in the present study.

As in the systematics studies of most insect taxa, the deficiency in knowledge of the systematics of most aquatic insect fauna posed as the major obstacle to studies on the benthic fauna of this region. Not much work has been done on the aquatic groups, notably the Diptera and the Trichoptera. The difficulty in discussing the aquatic insects was the inability to satisfactorily identify and separate the larval stages of the taxa encountered. Published work on the group for Borneo was generally poor.

Out of the existing ten orders of insects that contain aquatic species, a total of 7 orders of aquatic insect species were encountered in the rivers of the CRP. These are Ephemeroptera, Odonata, Plecoptera, Hemiptera, Coleoptera, Trichoptera and Diptera (Tables 3 and 4). In addition to these insects, the hexapodan Collembola was also encountered. The remaining three groups of aquatic insects unrepresented were Megaloptera, Neuroptera and Lepidoptera. However, the assemblages of taxa reported from the study area can be considered as that typical of the macroinvertebrate fauna in tropical rivers (Bishop 1963).

The macroinvertebrate density ranges from 71 to 303 individuals per 1m<sup>2</sup> (Table 3). All sampling sites were found to sustain at least three groups of taxa with the exception of Sg. Tikolud, which only contain the dipteran chironomids. A considerably low density of chironomids was found there as compared to the other rivers. Distribution of the macroinvertebrates is effected by many factors. However, this aspect is beyond the scope of this study. Based on our observations, the

poorly represented macroinvertebrates in Sg. Tikolud could be apparently associated with the occurrence of agricultural activities in the areas of close proximity to the river. The main crops planted are ginger and paddy. With the ongoing agricultural activities at both sides of the river, it is expected that traces of insecticides used by the farmers could obviously be found in the water. Where heavy metals and insecticides are found, elimination of the fauna is often unselectively complete with only a few very tolerant groups remaining (Bishop 1963).

*Table 3: Density (average number of individuals per m<sup>2</sup>) of the macroinvertebrates in the rivers of the Crocker Range Park, Sabah in October 1999 (Quadrat Methods)*

Taxa/Order/Fainily	Mawau	Tandulu	Liawan	Ulu Senagang	Tikolud	Balayo
1. Odonata						
Libellulidae	8	-	-	-	-	-
2. Ephemeroptera						
Baetidae	-	-	6	-	-	-
Caenidae	-	-	4	4	-	16
Heptageniidae	14	8	16	-	-	-
Ephemeridae	-	4	-	-	-	-
Ephemerellidae-	-	-	-	-	-	4
3. Plecoptera						
Pteronarcidae	-	12	4	-	-	-
Perlidae	-	8	-	-	-	-
4. Hemiptera						
Belostomatidae	-	-	-	-	-	4
Gelastocoridae	-	8	4	-	-	-
Notonectidae	16	-	-	-	-	14
5. Trichoptera						
Philopotamidae	-	4	-	-	-	-
6. Coleoptera						
Elmidae	-	-	-	14	-	8
7. Diptera						
Chironomidae	186	257	57	94	71	25
<b>TOTAL</b>	<b>224</b>	<b>301</b>	<b>91</b>	<b>112</b>	<b>71</b>	<b>303</b>

*Table 4: Relative abundance of the insect taxa encountered in the rivers of CRP, Sabah in October 1999*

Taxa	Relative abundance*
1. Collembola	+
1. Isotomidae	
2. Ephemeroptera	
1. Baetidae	++
2. Heptageniidae	+++
3. Ephemeridae	+
4. Ephemerellidae	+
5. Caenidae	++
3. Odonata	
1. Libellulidae	++
4. Plecoptera	

1.Pteronarcidae	++
2.Perlidae	++
5. Hemiptera	
1.Notonectidae	++
2.Belostomatidae	+
3.Gelastocoridae	++
6. Coleoptera	
1.Elmidae	+++
7. Trichoptera	
1.Philopotamidae	+
2.Hydropsychidae	++
3.Leptoceridae	+
8. Diptera	
1.Ceratopogonidae	+++
2.Chironomidae	+++
3.Simuliidae	+

+: Present; +±: Common; +++: Abundant

Table 5: Density (average number of individuals per litre) of the macroinvertebrates in the rivers of the Cracker Range Park, Sabah in October 1999 (via plankton nets).

Taxa/Order/Family	Mawau	Tandulu	Liawan	Ulu Senagang	Tikolud	Balayo
1. Collembola						
Isotornidae	2	-	-	-	-	-
Ephemeroptera	-	-	-	-	-	-
Baetidae	-	-	6	-	-	-
Heptageniidae	-	-	3-	13	-	2
2. Diptera						
Chironomidae	14	8	29	-	13	13
Simuliidae	-	-	-	2	-	2
Ceratopogonidae	-	-	-	35	-	-
3. Trichoptera						
Hydropsychidae	-	2	6	13	-	-
Leptoceridae	2	-	-	-	-	-
4. Coleoptera						
Elmidae	-	-	6	17	-	2
<b>TOTAL</b>	<b>18</b>	<b>10</b>	<b>50</b>	<b>80</b>	<b>13</b>	<b>19</b>

Among the macroinvertebrates encountered in this study, the dipteran chironomid fauna was dominant and found at all stations. They form the highest density of up to 250 individuals per 1-meter sq. in Sg.Tandulu and Balayo. Overall, they also represent the highest density in all rivers surveyed. This is in accordance to their being by far the largest family of aquatic insects. The chironomid larvae are an extremely important part of the aquatic food chains, serving as prey for many other insects and food for most species of fish (Hilsenhoff 1991). Apart from that, larval chironomid species track ecological conditions closely and their distributions have long been used to assess water quality. Many environmentalists in the temperate region have thus noted the importance of these taxa as bioindicators of water quality.

The second most abundant group of aquatic insects in the CRP rivers studied is the Ephemeropterans. Most of the mayflies found in these rivers belong to families that are widespread and abundant such as the Baetidae and Heptageniidae. Among the five families of Ephemeroptera encountered, the heptageniids were found to be abundant, in particular in Sg. Liawau, Mawau and Tandulu. Most species of this family occur on the underside of stones and some in sandy rivers. Almost all mayfly larvae are herbivores and detritivores with only a few species known to be predators on other invertebrates.

The elmid beetle larvae were also found in abundance. However, they were only present in Ulu Senaggang and Sg. Balayo. As with the adults, population density of this group normally reached a peak in the open, unshaded reaches where algal growth were abundant and the larvae possibly also utilised algae as food source (Bishop 1963).

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<sup>1</sup> Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak.