

Anthropogenic impacts on the distribution and biodiversity of benthic macroinvertebrates and water quality of the Langat River, Peninsular Malaysia

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Abstract

A study of the impacts of anthropogenic activities on the distribution and biodiversity of benthic macroinvertebrates and water quality of the Langat River (Peninsular Malaysia) was conducted. Four pristine stations from the upstream and 4 stations at the downstream receiving anthropogenic impacts were selected along the river. For 4 consecutive months (March–June 1999), based on the Malaysian DOE (Malaysia Environmental Quality Report 2000, Department of Environment, Ministry of Science, Technology and Environment Malaysia. Maskha Sdn. Bhd. Kuala Lumpur, 86pp; Malaysia Environmental Quality Report 2001, Department of Environment, Ministry of Science, Technology and the Environment Malaysia) water quality index classes, the upstream stations recorded significantly ($P < 0.05$) higher Biological Monitoring Working Party scores and better water quality indices than those of the downstream. The total number of macrobenthic taxa and their overall richness indices and diversity indices were significantly ($P < 0.05$) higher at the upstream stations (54 taxa) than at the downstream stations (5 taxa). The upstream of the Langat River was dominated by Ephemeroptera and chironomid dipterans while other orders found in small quantities included Trichoptera, Diptera, Plecoptera, Odonata, Ephemeraoptera, Coleoptera, and Gastropoda. On the other hand, the downstream of the river was mainly inhabited by the resistant Oligochaeta worms *Limnodrilus* spp. and *Branchiodrilus* sp. and Hirudinea in small numbers. The relationships between the physicochemical and the macrobenthic data were investigated by Pearson correlation analysis and multiple stepwise regression analysis. These statistical analyses showed that the richness and diversity indices were generally influenced by the total suspended solids and the conductivity of the river water. This study also highlighted the impacts of anthropogenic land-based activities such as urban runoff on the distribution and species diversity of macrobenthic invertebrates in the downstream of the Langat River. The data obtained in this study supported the use of the bioindicator concept for Malaysian rivers. Some sensitive (Trichopteran caddisflies and Ephemeraoptera) and resistant species (Oligochaeta such as *Limnodrilus* spp.) are identified as potential bioindicators of clean and polluted river ecosystems, respectively, for Malaysian rivers.

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1. Introduction

Studies of river macrobenthic invertebrates as biological monitoring techniques have been widely reported and described in the literature (Cairns and Der Schalie,

1980; Cairns, 1981; Matthews et al., 1982; Herricks and Cairns, 1982; Buikema et al., 1982; Cherry and Cairns, 1982; Ogbeibu and Oribhabor, 2002; Mason and Parr, 2003). This is due to the fauna organisms being found along the river continuum. Most interestingly, freshwater macroinvertebrate species vary in sensitivity to organic pollution and, thus, their relative abundances have been used to make inferences about pollution loads. In natural pristine rivers, high diversity and

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richness of species could be found (Armitage et al., 1983). However, high impact due to human activities caused many changes to the assemblages and biodiversity of the river fauna (Hellowell, 1986; Metcalfe, 1989; Wright et al., 1993; Pinel-Alloul et al., 1996; Nedeau et al., 2003).

The anthropogenic impacts on water quality and the distribution and diversity of macrobenthic invertebrates had been reported in the literature. Arienzo et al. (2001) studied the impact of land use and urban runoff on the contamination of the Sarno river basin in southern Italy and their results indicated a degradation in the river water quality, especially near the river mouth. Bustos-Baez and Frid (2003) used the concept of indicator species using presence and/or absence of dominance of characteristic taxa to determine the degree of community change due to the effects of pollution. MacNeil et al. (2002) proposed that the ratio of two freshwater macroinvertebrate species (crustacean genera), *Gammarus* (Amphipoda):*Asellus* (Isopoda) may be useful as a crude measure of organic pollution for monitoring purposes over a period of time. Fialkowski et al. (2003) suggested the use of mayfly larvae as biomonitors of heavy metal pollution in streams since they can provide information on the different sources of bioavailable trace metals present in aquatic ecosystems. All the above studies indicated the potential use of macrobenthic invertebrates as bioindicators of pollution. According to Jiongxin (2004), the lower Yellow River, the lower Yongdinghe River, and the lower Hutuohe River were categorized as anthropogenic seasonal rivers owing to strong human activities.

Nonetheless, the use of macrobenthic invertebrates for bioindication purposes seems not to be popular or widespread in the Asian ecoregion although this technique provides a cheaper but good methodology in river classification and they are widely used in the Northern American and European ecoregions. Perhaps, owing to the lack of expertise and information, the DOE (2001, 2002) of Malaysia has not yet employed macrobenthic invertebrates as bioindicators of pollution for river pollution studies. Currently, the DOE (2002) of Malaysia only uses water quality index for monitoring purposes. Perhaps, the argument that water quality index is still a preferred methodology in comparison to monitoring benthic organisms for the study of river pollution could be due to (1) delays in the prevention and remediation of the polluted river ecosystem until a time when only the resistant bioindicators were found there, (2) measurement of water quality characteristics being a conventional technique which can give direct results on the pollution status of the water quality at the time of sampling, and (3) lack of established taxonomical keys for the Malaysian macrobenthic invertebrates especially to the species level. However, we argue that water quality does not reveal the “health” of river

ecosystems when the impacts of pollutants on the macrobenthic invertebrates of the river ecosystem are concerned (Cairns and Der Schalie, 1980).

The objectives of this study are (1) to present a comparative account of the physicochemical parameters and the species diversity of the macrobenthic invertebrates between upstream and downstream stations of the Langat River and (2) to investigate the relationships between the physicochemical parameters and the biodiversity of macrobenthic invertebrates of the Langat River, by using multiple stepwise regression analysis and correlation analysis, with a view toward identifying physicochemical parameters that could cause significant changes in the distribution and biodiversity of macrobenthic invertebrates attributable to anthropogenic activities. In Malaysia, Sarmani (1988) documented the water quality of the Langat River, Lim (1987) documented the water quality and faunal composition in the Johor State of Peninsular Malaysia, and Yap et al. (2003) documented the species diversity of the Semenyih River. However, the distribution of benthic macroinvertebrates in Langat River has not yet been reported in the literature.

2. Materials and methods

2.1. Description of the study area

Surveys and samplings were conducted from March to June 1999 at the Langat River basin which is located in Selangor, Peninsular Malaysia (Fig. 1). The water flows from the upstream area in Hulu Langat to Kuala Selangor at the downstream area where the Langat River becomes the main river in the basin which flows in a southwesterly direction and drains into the Straits of Malacca. The Langat River basin is located between 101°25' and 101°54' of the Greenwich meridian. The river basin has an area of about 2423 m².

2.1.1. Upstream stations (stations 1–4)

The first station was located in Chongkak River. This river is used for recreational activities (i.e., camping and picnic activities) especially during weekends. The second station was located near the Orang Asli village in Hulu Langat. The third and fourth stations were located at the Lopo River and Kampung Batu 17 in Hulu Langat, respectively. The water was clean and clear and it was used by some villagers for washing and bathing. The common characteristics of stations 1–4 were the presence of cobbles and pebbles and sometimes sand and gravel. There was generally high vegetation coverage at the four upstream sampling stations.

2.1.2. Downstream stations (stations 5–8)

The fifth station was located at Section 4 of the township of Bandar Baru Bangi while the sixth station

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