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Mercury Concentration of Four Dominant Species in the Bebar Peat Swampy Forest River, Malaysia

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Abstract: Muscle, stomach and gill from four dominant fish species, *Mytus nemurus*, *Pristolepis fasciata*, *Ompok bimaculatus* and *Osteochilus hasseltii*, caught from Bebar peat swamp forest river were analyzed for mercury (Hg). The concentration of Hg was measured with a fast and sensitive Flow Injector Mercury Spectrometer (FIMS). The average Hg concentration of all species caught was 0.169 $\mu g\ g^{-1}$ dry weights, lower than a limit for human consumption recommended by the World Health Organization, 0.5 $\mu g\ g^{-1}$ dry weights. The mean concentration of Hg was relatively high in stomach (0.28±0.12 $\mu g\ g^{-1}$ dry weights) followed by gill (0.17±0.06 $\mu g\ g^{-1}$ dry weights) and lowest in muscle (0.05±0.02 $\mu g\ g^{-1}$ dry weights). The positive relationship of Hg with fish length and weight suggesting that the accumulation of Hg were formed in the fish.

Key words: Muscle, stomach, gill, peat swamp forest, Hg,

INTRODUCTION

In undeveloped areas, elevated mercury concentrations in piscivorous fish have been associated with a broad combination of physical, chemical and biological features of the lakes and watersheds. Physical factors which have been shown to be linked to higher mercury concentrations in fish include wetland areas, small lake size and warmer water temperature (Miskimmin *et al*., 1992; Bodaly *et al*., 1993), while important chemical factors include high background concentrations of mercury, low p humic-stained waters and moderately high Dissolved Organic Carbon (DOC) concentrations (Lange *et al*., 1993; Shilts and Coker, 1995; Wescott and Kalff, 1996). Higher mercury concentrations in fish also are associated with various biological properties of the fish. Mercury, because it bioaccumulates, generally increases in concentration with fish length and age (MacCrimmon *et al*., 1983). It also biomagnifies and generally increases in concentration with increasing food chain length (Vander Zanden and Rasmussen, 1996).

Human activities, such as deforestation and agriculture, along with geochemistry, are associated with natural-Hg release from soil, Hg atmospheric transport and redistribution, as well as Hg methylation potential of ecosystems (Roulet *et al*., 1999). Mercury acquisition, accumulationand biomagnification in fish are associated with both Hg chemical form and fish feeding-behavior (Hoyle and Handy, 2005; Klinck *et al*., 2005). Due to its reactivity with sulfur containing amino acids, Hg is stored in fish protein matrices, rather than in fatty tissues (Harris *et al*., 2003). Carnivorous fish at the top of the food chain acquire large amounts of monomethylmercury that are bioaccumulated as a function of fish size (Barbosa *et al*., 2003).

In freshwater ecosystems, fish play a key role in the distribution of mercury between the different biotic compartments. They represent a wide variety of trophic levels, from strictly herbivorous species to carnivorous species of the third or fourth orderand occupy virtually all ecological niches (demersal, benthopelagic and pelagic species). Mercury biomagnification along the food webs, principally based on cumulative transfers of the methylated form of the metal monomethylmercury, can lead to extremely high concentrations in piscivorous species at the top of the trophic networks (Boudou and Ribeyre, 1996; Morel *et al*., 1998; Wiener *et al*., 2003) and to considerable mercury burdens in the whole fish biomass.

MATERIALS AND METHODS

Study area background: The study was located within the South East Pahang Peat Swamp Forest which situated in Pekan district area (Fig. 1). A limited extent of freshwater

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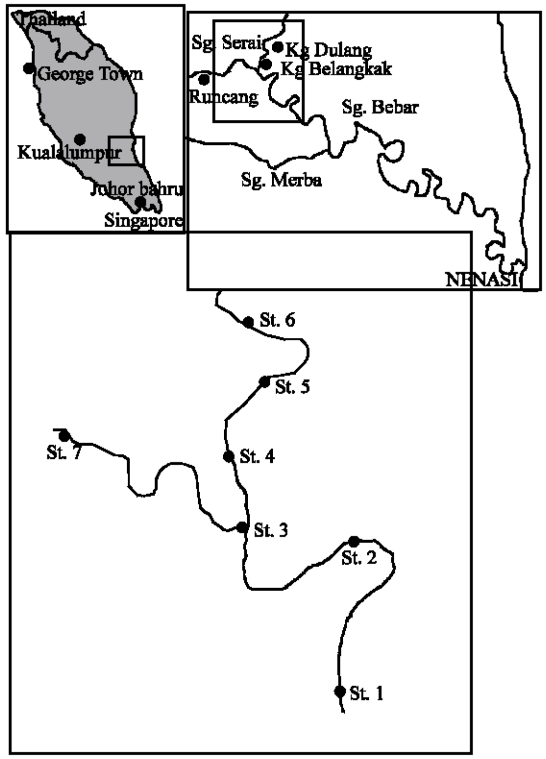

Fig. 1: The study area and sampling locations at Bebar River (5 stations) and Serai River (2 stations)

alluvial swamp forest dominated by *Campnosperma macrophylla* and *Durio carinatus* occurs between Pekan and Nenasi town. The margins of much of the area are under threat from encroachment of logging and clearance, especially near the coast from just north of Nenasi town to around Rompinand along the major rivers and roads. The lower reaches of rivers are brackish; the swamp forest contains freshwater, presumably acidic.

Sampling: Sampling was carefully planned so that the number fish caught are sufficient and representative. In this study, 5 stations are located along Sungai Bebar and 2 stations along Sungai Serai (Fig. 1). The fish were caught with a beam trawl at 7 locations which were accessed by boat. The fish were sampled at each station over 24 h until a sufficient number of individuals, at least 5-10 fishes, were caught. The fish samples were transported to the laboratory and stored at -20°C prior to analysis. Fish samples were thawed at room temperatureand their length and weight were recorded using the callipers and 3 decimal points of measuring weight, respectively. They were dissected using stainless steel scalpels and Teflon forceps using a laminar flow bench. Biological samples such as fish, craband mollusk were separated from the body and transferred into polypropylene vials. Before acid digestion, a porcelain mortar was employed to grind and to homogenise the dry tissue samples.

Hg analysis: The fish samples were digested according to the methods (Hirokatsu *et al*., 2000) with some modifications. A Flow Injector Mercury Spectrometer (FIMS) was used for the quick and precise determinations of Hg in the digested samples. Briefly, the digestion method involved the heating of 50 mg of sample in a sealed teflon vessel with mixed concentrated acids of HNO_3 and $HClO_4$ H_2SO_4 and H_2O_2. The teflon vessels were kept at 90°C for 45 min. After cooling, a mixed solution of $SnCl_2$ was added. The content of the vessel was thoroughly transferred into a 10 mL polypropylene test tube and was diluted to 10 mL with deionized water. A clear solution with no residue should be obtained at this stage. The precision assessed by replicate analyses was within 3%.

RESULTS AND DISCUSSION

A total of 20 fishes were analyzed for Hg concentration with a mean size from 94 to 383 mm. Two species dominantly caught were two-spotted glass catfish (*Ompok bimaculatus*) and long whisker catfish (*Mytus nemurus*). Other species caught were banded leaf (*Pristolepis fasciata*) and hard-lipped barp (*Osteochilus hasseltii*). The biggest fish caught was the *Mytus nemurus* (383 mm) and the smallest fish was *Pristolepis fasciata* (94 mm).

Table 1 shows the concentration of Hg in fish at Bebar peat swamp forest river. In this study, a bigger fish like *Mytus nemurus* and *Ompok bimaculatus* had higher concentrations of Hg, compared to smaller fishes such as *Pristolepis fasciata* and *Osteochilus hasseltii*. Average concentration of Hg in *Mytus nemurus* was 0.28±0.02 μg g^{-1} dry weights, ranged from 0.26 to 0.29 μg g^{-1} dry weights and *Ompok bimaculatus* ranging from 0.08 to 0.27 μg g^{-1} dry weights with average 0.18±0.06 μg g^{-1} dry weights. For small fishes, *Pristolepis fasciata*, the average concentration was 0.09±0.02 μg g^{-1} dry weights, ranged from 0.07 to 0.11 μg g^{-1} dry weights and *Osteochilus hasseltii* has Hg concentration of 0.07 μg g^{-1} dry weights. Averaging across species, the mean Hg concentration in the study area was comparable to the concentration obtained in other studies elsewhere in Malaysia (Table 2).

The mean concentration of Hg was relatively high in fish stomach (0.28±0.13 μg g^{-1} dry weights, ranged from 0.01 to 0.17 μg g^{-1} dry weights) followed by gill (0.17±0.10 μg g^{-1} dry weights, ranged from 0.05 to 0.42 μg g^{-1} dry weights) and lowest in muscle (0.05±0.05 μg g^{-1} dry weights, ranged from 0.09 to 0.52 μg g^{-1} dry weights). In this study, it is interesting to note that the mean Hg concentrations in all fish species behave in a similar way in the examined tissues. It appears that the mean concentrations were high in stomach followed by gill and muscle tissue. The higher Hg concentration in fish is due to their dietary habits, where species like *Ompok bimaculatus* and *Mytus nemurus*, represented by bottom sediments and predatory behaviour. Hg is known to be easily accumulated in aquatic organisms of marine, fluvial and lacustral ecosystem (Porcela *et al*., 1995).

The well relationship formed between the Hg concentration and the fish size suggesting that Hg bioaccumulation has occurred and many results for different species in other studies indicating the occurrence of bioaccumulation (Marcovecchio *et al*., 1986). In this study, a statistically

Table 1: Concentration of Hg in fish at Bebar peat swamp forest river

	Length (mm)		Hg (μg g^{-1} dry weights)	
Fish species	Mean	Range	Mean	Range
Ompok bimaculatus (Butter catfish)	261	174-334	0.18±0.06	0.08-0.27
Pristolepis fasciata (Banded leaf fish)	136	94-152	0.09±0.02	0.07-0.11
Mytus nemurus (Catfish)	289	194-383	0.28±0.02	0.26-0.29
Osteochilus hasseltii (Hard-Lipped Barb)	153		0.07	

Table 2: The comparison of previous study to the current study in Bebar river

Location	Common name	Min	Max	
Cabang Tiga	Fork-tailed threadfin bream	1.3	3.6	
Kelantan	Kawakawa	0.07	0.17	
	Torpedo scad	0.07	0.32	
Kuala Terengganu,	Bigeye	0.1	0.15	
Terengganu	Retail scad	0.07	0.37	
Mersing Johor	Bigeye scad	0.17	0.37	
	Indian mackerel	0.06	0.27	
	Javelin grunter	<0.05	0.1	Agusa *et al.*
Parit Jawa, Johor	Bigeye scad	0.05	0.27	(2005)
	Doublespotted queenfish	0.18	2.23	
Port Dickson, Johor	Bigeye scad	<0.05	0.06	
	Black pomfret	0.12	0.57	
	Torpedo scad	0.12	0.27	
Langkawi	Bigeye scad	<0.05	0.08	
	Doublelined tonguesole	0.02	0.27	
	Redtail scad	<0.05	0.12	
	Shortfin scad	<0.05	0.06	
	Torpedo scad	0.07	0.11	
	Yellowfin seabream	n.a	n.a	
Peat Swampy Area,	Two-spotted Glass Catfish	0.05	0.32	Current study
Bebar River	Long wisker catfish	0.12	0.43	
	Banded leaf fish	0.01	0.14	
	Hard lipped barb	0.05	0.09	

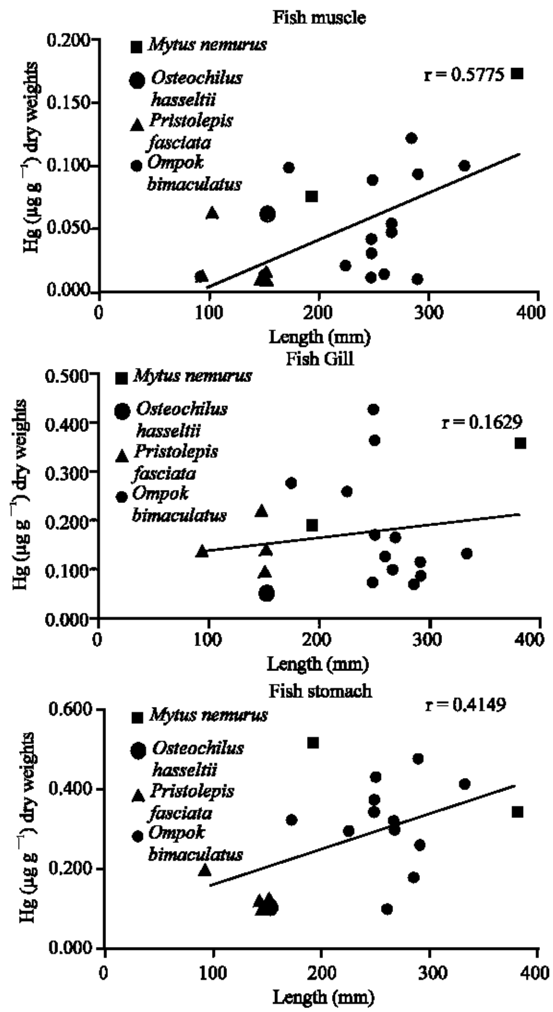

Fig. 2: Relationship of Hg concentrations in muscle, gill and stomach versus length of fish caught in the study area

significant correlation was also observed between metal concentrations in fish with the length of the fish (Fig. 2). In the fish muscle, the correlation between length and Hg concentration in gill was not significant (r = 0.1629), probably of the low Hg concentration found in gill. But on contrary, the correlation of the Hg concentration in muscle and stomach were fairly significantly with r = 0.5775 and r = 0.4149, respectively.

Health Canada's guideline for total methyl Hg content in most fishes both marine and freshwater fish that can be consume be human is 0.5 $\mu g\ g^{-1}$ dry weights. However in many other countries like United States and the ASEAN countries, the limits set for total Hg content is slightly higher of about 1.0 $\mu g\ g^{-1}$ dry weights. In this study, this observation suggests that the average methyl Hg content 0.17±0.07 $\mu g\ g^{-1}$ dry weights (ranged 0.07 to 0.29 $\mu g\ g^{-1}$ dry weights) in most fish in the peat swamp forest river are lower compared to the limit for human consumption recommended by the World Health Organization, 0.5 $\mu g\ g^{-1}$ dry weights (WHO, 1972).

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