

Cadmium concentration in three species of freshwater fishes from Keuretoe River, Northern Aceh, Indonesia

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Abstract. The objectives of present study was to evaluate cadmium (Cd) concentration in some freshwater fishes found in Keuretoe Rivers and to determine the most effective freshwater fishes (*Osphronemus goramy*, *Anguilla marmorata* and *Hemibagrus nemurus*) in accumulating of cadmium. A total of three sampling locations were determined using the purposive of random sampling. A total of three individual fishes at every sampling location were collected, the tissues were processed for Atomic Absorption Spectrophotometry (AAS) and data were analyzed by Anova followed by Duncan multiple range test. The result revealed that the cadmium concentration ranges between 0.0064 ppm and 0.0260 ppm. Anova test showed that the sampling locations did not significantly affect the cadmium accumulation in fishes, but the fish species gave significantly effect on the cadmium accumulation in their tissue. The Duncan test showed that high cadmium accumulation was found in gourami at Station 2 and in mottled eel at Station 1, the concentrations were significantly different from Cd content in bagrid catfish at all sampling locations. The higher of cadmium pollution was recorded in Station 3 and gourami accumulated higher cadmium than other fishes studied. Keuretoe River is contaminated with cadmium and the fishes should not be consumed.

Key words: *Osphronemus goramy*, *Hemibagrus nemurus*, *Anguilla marmorata*, fertilizer, pesticide.

Introduction. Keuretoe River is situated in northern Aceh Province, Indonesia. The river plays an important role in the livelihood of the local people by providing water resources for domestic needs, agricultural and fisheries as well as industries. Upstream and downstream of river are settlement areas, industries, plantations and paddy fields that produce both domestic and non-domestic wastes that suspected to contain heavy metals.

Heavy metal contaminants are often occurring in open waters due to industrial activities, agricultural, horticultural and domestic wastes (Amin et al 2007, 2009; Rahman et al 2010; Petrescu-Mag et al 2010; Al-Baggou et al 2011; Mohammed et al 2011). One of the heavy metals that frequently polluted the waters is cadmium (Cd). Cadmium is a type of non-essential metal, which is heavy metal that is toxic to humans even in low levels. Cadmium that pollute water would deposited in the sediment and contaminate the organisms through food chains in the waters (Wardhana 1995). In the rural areas the largest source of Cd contamination is derived from fertilizers and pesticides used by farmers to eradicate pests in crops (Agustina 2010).

Fish has been used as bio-indicator for heavy metal (Playle et al 1993; Sofia 2005; Petrescu-Mag & Petrescu-Mag 2010; Taweel et al 2013) or pesticide contamination (Georgescu & Georgescu 2012; Jălu et al 2012) in the waters; for example the walking catfish *Clarias batrachus* (Linnaeus, 1758) has been used as bio-indicator for mercury (Hg) contamination (Siregar et al 2010), the three-spots-gourami *Trichopodus trichopterus* (Pallas, 1770) and the common carp *Cyprinus carpio* Linnaeus, 1758 have been used for monitoring contamination with Fe and Pb, respectively (Wati et al 2009; Siregar et al 2012). According to Supriatno & Lelifajri (2009) the level of heavy metals accumulation in fish tissue depends on characteristics of chemical compound, the concentration and fish species. Hence, the objective of the present study was to evaluate

Cd contamination in the three species of freshwater fish that commonly found in the Keureto River and to examine which fish species accumulate the higher concentration of Cd. This information is crucial for management program strategy of the Keureto River.

Materials and Methods

Time and location. The study was conducted for two months from March to April 2013. The sampling location was determined based on river zonation and characteristic of its vicinity i.e. Station 1 is located in Blang Pante Vilagge (97°11'35.889"E, 4°57'51.46"N) has agricultural activities such palm oil, cacao and rubber plantations; Station 2 was located in Meria Village (97°14'10.989"E, 5°0'49.941"N) has a waste treatment facility of Exxon Mobile; and Station 3 at Parang IX village (97°16'2.642" E, 5°2'6.011"N) is a paddy field area (Figure 1).

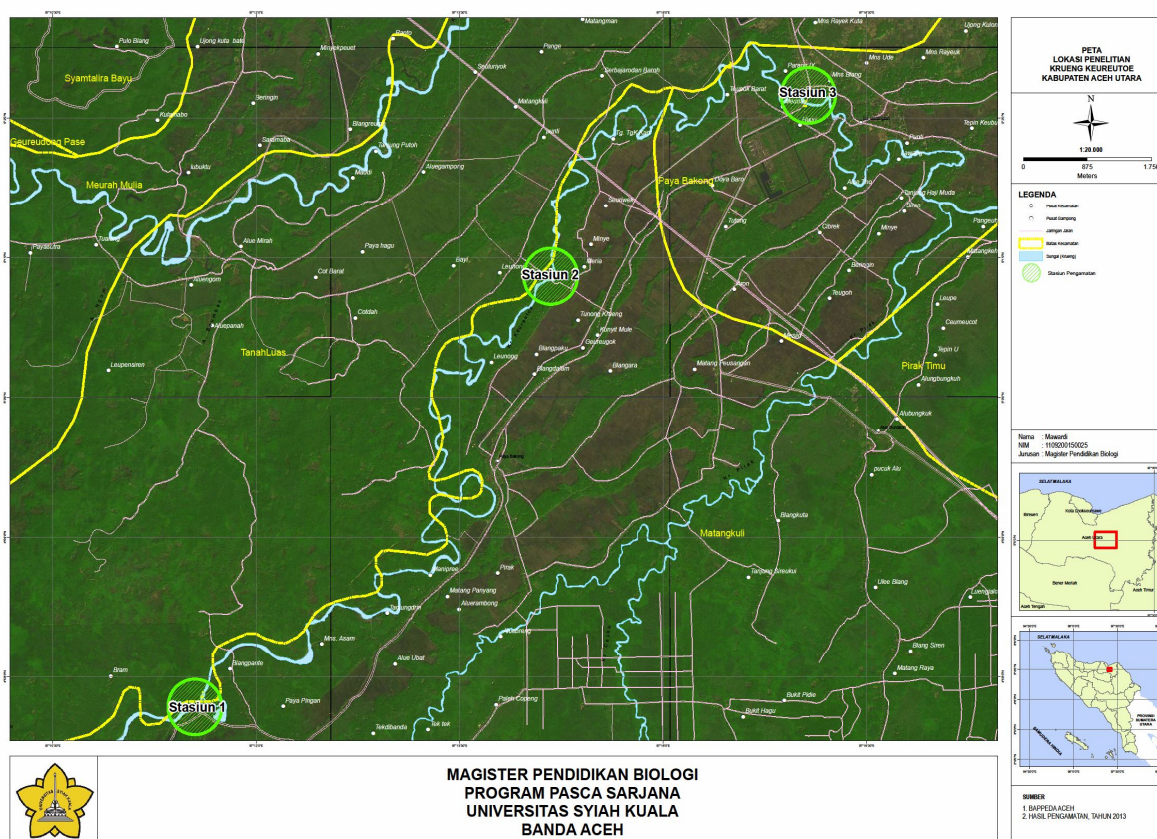


Figure 1. The map of northern Aceh showing the Keuretoe Rivers and sampling location. The sampling locations are indicated by green circles.

Fish target and sampling. The fish target is the common fish consumption by local people and abundance in the Keureto River. The fish species was determined based on their feeding habits i.e. herbivorous was represented by giant gourami *Osphronemus goramy* Lacepède, 1801, omnivorous was represented by river-bagrid catfish *Hemibagrus nemurus* (Valenciennes, 1840) and carnivorous was represented by giant mottled eel *Anguilla marmorata* Quoy & Gaimard, 1824. The eel and catfish were caught using hooks with chicken intestine and earth-worm baits, while the gourami was caught using a gillnets. The caught fishes were measured and weighed prior to preserve on the crush ice in the cool box then transported to the laboratory for further analysis.

Cadmium analysis. The fish muscle was used for Cd analysis using a standard procedure for Atomic Absorption Spectrophotometry (AOAC, 1999; Petrovici & Pacioglu 2010; Grd et al 2012). The data were subjected to Analysis of Variance (ANOVA) followed by Duncan multiple range test.

Results and Discussion. The ANOVA test revealed that cadmium accumulation in the fish flesh was not significantly affected by the sampling location ($P > 0.05$), but it was significantly affected ($P < 0.05$) by the fish species, while the interaction between sampling location and fish species had a significant effect on the cadmium concentration in the fish flesh ($P < 0.05$). The Duncan test showed that Cd concentration recorded in eel at Station 1 and in gourami at Station 2 were significantly different compared to those recorded in bagrid catfish at all stations (Table 1). Based on sampling location, Cd concentration recorded at Station 3 was not significantly different from those recorded in other locations (Figure 1a). Meanwhile based on fish species, Cd concentration found in the gourami fish was not significantly different from one recorded in the eel, while the lower concentration found in river-bagrid catfish was significantly different from those found in the other two species (Figure 1b).

Table 1
Average Cd concentration recorded in three freshwater fishes from Keureto River, Aceh Province, Indonesia. The value in the same column and row with different superscript was significantly different ($P < 0.05$)

Fish species	Cadmium concentration (ppm)		
	Station 1	Station 2	Station 3
Giant mottled eel	0.026 ^b	0.018 ^b	0.018 ^b
River bagrid catfish	0.014 ^a	0.007 ^a	0.016 ^a
Gourami	0.017 ^b	0.026 ^b	0.025 ^b

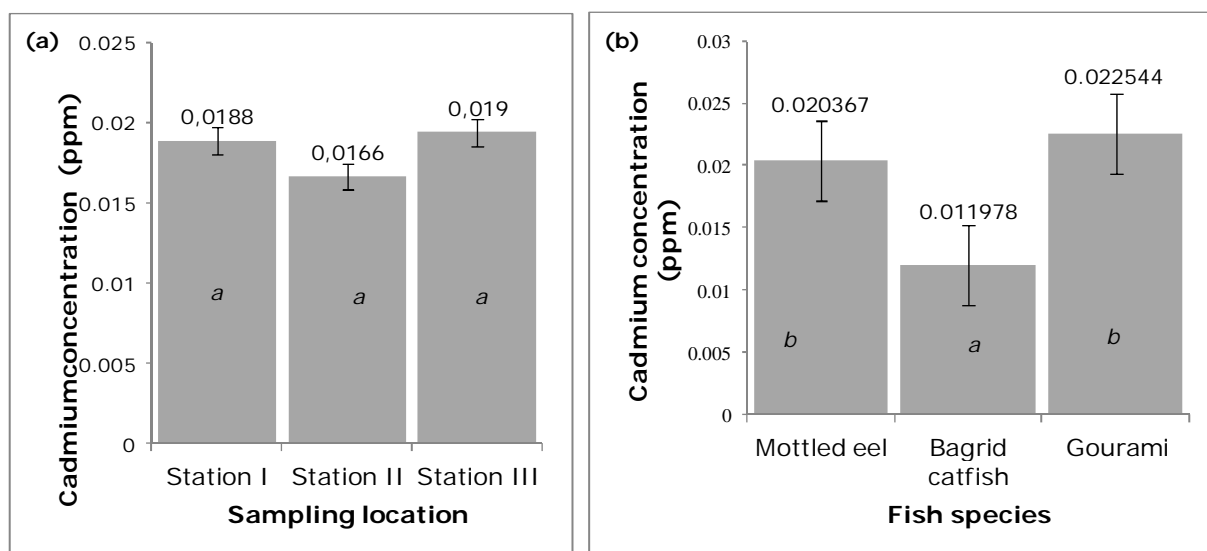


Figure 2. (a) Average of cadmium concentration at every sampling location for all fish species; (b) Average cadmium concentration in each fish species (*Anguilla marmorata*, *Hemibagrus nemurus*, *Osphronemus goramy*) for all sampling location. Bars with different italic letter were significantly different ($P < 0.05$).

In general, Cd concentration values recorded in fish ranged between 0.0064 ppm and 0.0260 ppm, indicating that the concentration has been passed the allowed limit for aquatic organisms. The study revealed that the cadmium concentration was higher in the fish caught upstream and downstream, and it was speculated that this is closely related to source of pollutants in vicinity of river at those area. It was assumed that the source of pollution was mostly the agricultural activity, for example there were palm oil, cocoa and rubber plantations in upstream area, while in the downstream there was a paddy field. It was strongly suspected that the source of pollution came from fertilizers and pesticides used in agricultural activities. This is in agreement with Huamain et al (1999) who stated that fertilizers and pesticides have contributed greatly to soil fertility but are also major sources of pollution to farmland. Similarly Cyrille et al (2012) reported that the source of Cd is mostly came from industrial and domestic wastes, fertilizers and pesticides used in

plantations. These fertilizers move from the surface of application when they are dissolved in runoff water or when they percolate down through the soil to river (Usmano & Dosumu 2007). Cadmium from waters and sediments can be taken up by the aquatic plants in sufficient quantities to be of concern for human health before it impacts on plant growth. This statement is in agreement with Murniasih & Taftazani (2013) who reported that cadmium was accumulated easily by plants compared to other heavy metals.

Furthermore Usmano & Dosumu (2007) stated that the farmland contamination by heavy metals pose a threat in two ways (i) directly through their toxic effect on the growth of crops thereby reducing crop yield and quality and (ii) indirectly by entering the animal and human food chain that could adversely impact on human health. In addition, Cyrille et al (2012) stated that cadmium-containing fertilizers and pesticides were absorbed by plant and accumulated in the primary consumers of the chain, such as herbivorous fishes.

As observed in the three species of fish samples, the gourami accumulated higher concentration of Cd compared to mottled eel and bagrid catfish. Observation on the stomach content and analysis of preponderance index revealed that gourami fed green algae as primary food, while insects and small fishes were the primary food for bagrid catfish (*H. nemurus*) and giant mottled eel (*A. marmorata*), respectively. This observation is in agreement with Aslamsyah et al (2009) who reported than gourami consumed the green algae at the bottom waters. It was suspected that the gourami fed contaminated algae, and this was the cause of the high Cd concentration accumulated. The bagrid catfish and mottled eel accumulated lower concentrations due to different feeding habits.

Cd is toxic not only for aquatic organisms, but also for humans. According to Alina et al (2012), the presence of cadmium disrupts vascular system, heart, kidney, lung and brain as a central nervous system. Handajani (2011) reported that at higher concentration the cadmium would kill the aquatic organisms, for example at concentration of 0.003 ppm to 0.18 ppm would kill the crustacea and insecta in 24 to 600 hours. However, the concentrations recorded in this study was not lethal to the fish. Cyrille et al (2012) stated that cadmium in fish carcass could contaminate other aquatic organisms through food webs in the waters and possibly contaminate human when this consume the contaminated fish.

Based on this study, we showed that the fish samples from Keureto River have been contaminated with cadmium and the concentrations recorded there have been over the threshold. According to Indonesian regulation, the acceptable level of cadmium in aquatic organisms including fish is ≤ 0.001 ppm, therefore fish in this river is not safe for human consumption. It was presumed that other herbivorous fishes such as mahseer (*Tor tambra* (Valenciennes, 1842) and *Neolissochilus* sp.) might have been contaminated by the heavy metal. Therefore further study is crucial to evaluate this speculation because freshwater fish from the Keureto River is an important and high economic value of the community in the region. In addition, it was noted that the gourami (*O. gouramy*) was the most effective fish in accumulating the cadmium compared to giant mottled eel (*A. marmorata*) and river bagrid catfish (*H. nemurus*), therefore this gourami species could be used as a bio-indicator for cadmium contamination.

Conclusions. The cadmium concentration in the fish samples was between 0.0064 ppm and 0.0260 ppm. The higher concentration of heavy metal was recorded in gourami (*O. gouramy*) and this indicated the fact gourami was the most effective fish in accumulating the cadmium compared to mottled eel (*A. marmorata*) and bagrid catfish (*H. nemurus*). The fish samples from Keureto River have been contaminated with cadmium and they are not safe for human consumption.

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Received: 04 August 2013. Accepted: 23 August 2013. Published online: 24 August 2013.

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How to cite this article:

Sarong M. A., Mawardi A. L., Adlim M., Muchlisin Z. A., 2013 Cadmium concentration in three species of freshwater fishes from Keuretoe River, Northern Aceh, Indonesia. *AACL Bioflux* 6(5): 486-491.