Morphometric variations of fish from Brantas river, East Java, Indonesia

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ABSTRACT

The present study aimed to investigate the morphometric measurements and body weight of fish that live in the Brantas River, East Java. The sampling method of fish was done by capturing fish using nets, then morphometric measurements including fish weight. Sampling was carried out in two locations, including upstream and downstream of Brantas River in 2016. Furthermore, sampling for each location was repeated twice with 100 m distance differ. All data analysis were performed using SPSS version 21. The results showed that there was no significant difference ($P > 0.05$) from morphometric measurements to body weight of fish, except *Barbonymus gonionotus* and *Barbonymus balleroides* in both locations. In addition, the fish that live upstream of the river have a higher morphometric measurements than those living downstream of the Brantas river.

Key words: *Morphometric, Fish, Upstream, Downstream, Brantas River*

Introduction

Brantas River is located in East Java, Indonesia. This river is very important for the communities. The water from the river was used for many activities including a place to catch fish which can be consumed by the people. The river also becomes a water source for industries and public water supply. However, water quality of Brantas river was decline in the last few decades, both in the upstream (Karangkates reservoir) and downstream (flow to Surabaya) (Hayati *et al*., 2017[a]). A lot of anthropogenic pressures from settlements and industries along streams such as paper, ceramics, bicycles, nuts and bolts causing high concentrations of contaminants like heavy metals.

The heavy metals are toxic, thus disrupting the health of freshwater fish (Jia *et al*., 2017). The impact of exposure to heavy metals causes the damage and death (apoptosis) of fish cells and tissues that can lead to fish death. For example, Pb and Cr at low concentrations lead to liver cell necrosis, while at high concentrations cause damage to gills (Hayati *et al*., 2017[b]).

The contamination of heavy metals (Pb, Cr, Cu, and Cd) in Brantas River has exceeded the quality standards. Their concentrations were higher in downstream than in upstream (Hayati *et al*., 2017[a]). Several species of fish in the Brantas River were often found dead. The death of the fish in the river is suspected caused by dangerous chemicals produced by industries that was dumped on the river bank. Furthermore, the high contamination of heavy metals in the river can decrease the diversity of fish. Therefore,

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it was shown that there is a direct relationship between water quality and fish diversity. The presence of heavy metal pollution can affect to the histological structure of fish tissues and organs (Hayati *et al.*, 2017[c]) and contributes to the decrease in size, weight, and total length of fish. There were a positive relationship between the size of the fish and the concentration of heavy metals in the river and then negatively correlated with fish health (Yia *et al*., 2012; Kasimoglu, 2014).

Fish have different morphometric characteristic (shapes, sizes and colors) depending on the species and habitat. Fish are very sensitive to environmental changes and quickly adapt to changing the necessary morphometric (Mojekwu and Anumudu, 2015). Morphometric of fish were very important way to understand the effect of metals pollution on health and abundance of fish. Morphometric studies were considered an easy and effective way to characterize the morphological of fish (Pant *et al*., 2018). This study examined the morphometric characteristic of fish living in Brantas River where the threats of heavy metals contamination become a serious challenge to water quality.

Materials and Methods

Research area was in Brantas River, East Java. The fish were collected from upstream (Karangkates Reservoir) and downstream (Kali Surabaya) Brantas in 2016 (Figure 1).

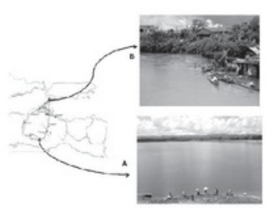

Fig. 1. Sampling location up and downstream of Brantas River. A, upstream and B, downstream.

Collection and morphometric measurements of fish

Fish from Brantas River was collected by using fish nets. Fish samples were identified and morphometric measurements included body length (BL), body width (BW), total body length (TBL), and weight (W). Body length was measured along the axis of the body from the snout to the folding of the base of the caudal fin. Body width was measured at the highest point between the dorsal and ventral parts. Total body length, taken along the anterior-posterior axis from the tip of the mouth to the tip of the caudal fin. All measurements of length were recorded in centimeters (cm) and taken by measured meter. Weight was measured using a weighing device in grams (g).

Data analysis

The fish identification was done descriptively based on the reference book of identification (Kottelat *et al.*, 1993), while the morphometric data were analyzed by analysis of variance and Pearson correlation (SPSS version 21.

Results

Fish Identification

Twenty five species of fish were found in Brantas River from both locations. There were some species that only found in upstream but not found in downstream and vice versa. Upstream area consisted of 14 species, while in downstream area was 21 species (Table 1). Moreover, only 10 fish species were noted in both locations i.e. *B. gonionotus*, *B. balleroides*, *O. mossambicus*, *O. hasseltii*, *C. striata*, *O. marmorata*, *M. aculeatus*, *H. planiceps*, *L. pardalis*, *O. mossambicus* and *T. trichopterus*.

Fish Taxonomic Classification

Based on taxonomic classification, there were four orders namely Cypriniformes, Synbranchiformes, Perciformes, and Siluriformes. It was predicted that there were many more types of fish that cannot be caught with a net, which live in both the upstream and downstream. However, we only identified ten species that able to adapt to environmental conditions contaminated by waste from households, rice fields, or industry. From the identified nine species, each species that has been caught varies (Figure 2). It showed that in upstream sampling locations was dominated by *O. mossambicus* followed by *B. balleroides* and *Barbonymus gonionotus*, respectively. For other seven fish species were found in relatively small number. Moreover, it appeared that *B. balleroides* became the highest fish species found in downstream sampling locations, followed by *Barbonymus gonionotus* and *O. hasseltii* while the other fish species were also found in small number.

Table 1. Fish species in upstream and downstream of the Brantas River.

No	Fish Species	Up stream	Down stream	No	Fish Species	Up stream	Down stream
1	*Barbonymus balleroides*	√	√	14	*Clarias batrachus*	0	√
2	*Barbonymus gonionotus*	√	√	15	*Liposarcus pardalis*	√	√
3	*Osteochillus hasseltii*	√	√	16	*Hemibragus nemurus*	0	√
4	*Systomus rubripinnis*	0	√	17	*Oreochromis mossambicus*	√	√
5	*Anabas testudineus*	0	√	18	*Amphilophus labiatus*	√	0
6	*Channa striata*	√	√	19	*Pangasius humeralis*	√	0
7	*Oxyeleotris marmorata*	√	√	20	*Trichogaster trichopterus*	√	√
8	*Notopterus notopterus*	0	√	21	*Rasbora argyrotaenia*	√	0
9	*Pseudolais micronemus*	0	√	22	*Osphronemus gouramy*	√	0
10	*Macrognathus aculeatus*	√	√	23	*Oreochromis niloticus*	0	√
11	*Hemibragus planiceps*	√	√	24	*Clarias gariepinus*	0	√
12	*Hampala macrolepidota*	0	√	25	*Lates calcalifer*	0	√
13	*Monopterus albus*	0	√				

Note: √ = found; 0 = not found

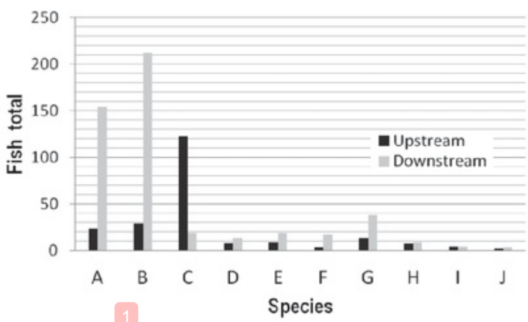

Fig. 2. The number of each fish species that found in both sampling locations (upstream and downstream) of Brantas River. A, *Barbonymus gonionotus;* B, *B. balleroides;* C, *O. mossambicus;* D, *O. marmorata;* E, *C. striata;* F, *H. planiceps;* G, *O. hasseltii;* H, *T. trichopterus;* I, *L. pardalis;* and J. *M. aculeatus*

Morphometric Measurements

After fish collection and identification, the measurement of fish morphometric and body weight were performed. The results were showed in Table 2.

Table 3 showed the morphometric measurements of ten fish species found in upstream-downstream. Total length, body length, and body width of fish appear to have significant differences (P<0.05) in each sampling location. However, compared to fish body weight, there was no significant difference (P> 0.05), except for *B. balleroides* and *B. gonionotus* which have a significant difference (P <0.05). The morphometric measurements and fish weight of both species were found higher in the upstream than in the downstream.

Discussion

Based on the results of sampling, it can be seen that there were differences in the number of fish species found in the upstream and downstream of the river (Table 1). Four species of fish (*A. labiatus, P. humeralis, R. argyrotaenia*, and *O. gourami*) were not found in the downstream but only found in the upstream. They live in shallow water with a lot of plants, clear water, slow water flows, and rocky rivers (Baensch and Fischer, 2007). This was compatible with the habitat in upstream of the river. This is due to the different types of waters upstream and the downstream of the River. Upstream is a type of standing water, while on the downstream is a type of flowing waters. On the contrary, eleven species were found only in downstream. For *S. rubripinnis* and *H. macrolepidota* were not found in the upper reaches of standing water because both of species prefer to live in river with heavy current. Adaptation to strong currents are performed with the ability for fast swimming. The ability to swim fast is owned by species like Cyprinidae. This fish capable to resist the current and strong enough to pass the fish ladder. The cyprinidae fish has an aerodynamic body shape to be able to move its position in a heavy current to get food in the form of invertebrates that drift with water (Cummins and Wilzbach, 2008).

In this study, it was found that only ten species found in both upstream and downstream (Fig. 3).

Table 2. The fish morphometric in upstream and downstream of Brantas River

Fish Species	Upstream of Brantas River				Downstream of Brantas River			
	Total length (cm)	Body length (cm)	Body width (cm)	Body Weight (g)	Total length (cm)	Body length (cm)	Body width (cm)	Body Weight (g)
B. balleroides	32 ± 2	24 ± 2	8 ± 1	337 ± 40	28 ± 2	26 ± 1	7 ± 1	263 ± 40
B. gonionotus	35 ± 2	29 ± 1	10 ± 1	473 ± 51	27 ± 6	26 ± 5	7 ± 1	257 ± 102
O. mossambicus	28 ± 4	20 ± 5	7 ± 1	217 ± 100	32 ± 2	26 ± 3	8 ± 2	335 ± 85
O. marmorata	20 ± 0	15 ± 0	4 ± 0	70 ± 0	26 ± 1	26 ± 2	5 ± 0	168 ± 32
C. striata	63 ± 12	28 ± 11	5 ± 1	500 ± 183	30 ± 4	26 ± 1	4 ± 0	220 ± 57
H. planiceps	27 ± 0	23 ± 0	6 ± 0	230 ± 0	17 ± 0	12 ± 0	4 ± 0	40 ± 0
O. hasseltii	20 ± 0	15 ± 0	4 ± 0	100 ± 0	20 ± 3	15 ± 3	5 ± 1	87 ± 15
T. trichopterus	16 ± 0	13 ± 0	4 ± 0	50 ± 0	15 ± 0	13 ± 0	4 ± 0	40 ± 0
C. striata	35 ± 0	26 ± 0	5 ± 0	290 ± 0	35 ± 9	26 ± 8	5 ± 1	313 ± 141
O. mossambicus	26 + 4	26 ± 5	7 ± 2	183 ± 73	21 ± 0	26 ± 0	6 ± 0	120 ± 0
L. pardalis	29 ± 0	15 ± 0	4 ± 0	80 ± 0	34 ± 0	28 ± 0	10 ± 0	580 ± 0
B. balleroides	32 ± 2	26 ± 2	9 ± 1	353 ± 37	27 ± 5	26 ± 5	7 ± 2	257 ± 102
B. gonionotus	33 ± 3	26 ± 3	8 ± 2	390 ± 108	31 ± 3	26 ± 3	8 ± 2	357 ± 80
O. mossambicus	26 ± 4	26 ± 5	7 ± 2	183 ± 73	21 ± 0	26 ± 0	6 ± 0	120 ± 0
O. marmorata	20 ± 2	26 ± 2	4 ± 1	73 ± 25	24 ± 4	26 ± 4	5 ± 0	133 ± 58
C. striata	35 ± 0	26 ± 0	5 ± 0	290 ± 0	35 ± 9	26 ± 8	5 ± 1	313 ± 141
H. planiceps	0 ± 0	0 ± 0	0 ± 0	0 ± 0	17 ± 1	14 ± 2	4 ± 1	45 ± 7
O. hasseltii	25 ± 3	21 ± 3	6 ± 1	210 ± 85	24 ± 6	19 ± 5	6 ± 2	200 ± 125
T. trichopterus	14 ± 0	10 ± 0	4 ± 0	30 ± 0	17 ± 0	14 ± 0	4 ± 0	55 ± 0
L. pardalis	38 ± 0	33 ± 0	13 ± 0	700 ± 0	23 ± 4	27 ± 4	11 ± 1	530 ± 113

Fish belonging to the order have fan-shaped fins, no or have scales, can adapt to almost all aquatic ecosystems. *B. gonionotus* and *B. balleroides* (Cyprinidae) are most widely found in the downstream, this is because these species are adaptable and can survive in extreme environments. In contrast, *L. pardalis* and *M. aculeatus* were immigrant fish which less able to adapt with polluted waters than other species. However, the ten fish species which survive in a river environment were contaminated by heavy metals, although there is a decreased in morphometric measurements in both upstream and downstream (Table 3).

Furthermore, it was clear that there was a relationship between Brantas river waters contaminated with metals and morphometric measurements of fish. At high concentration, metals can reduce growth and metabolic activity of fish cells. It even can cause fish death. Continuation of metals accumulation can occur, and a positive relationship can be seen between animal size and the level of heavy metals contamination in water. Morphometric reduction was occurred in all (ten) fish species which live in both sampling locations (upstream and downstream). This was due to heavy metal toxicity (Hayati *et al.*, 2017[b]; Yia and Zhang. 2012). Based on statistical tests it was known that morphometric of fish that live in upstream was higher than downstream. Although the two sampling locations were contaminated by metals, the highest concentration was in the downstream. There was a negative correlation between the levels of metals with fish morphometric.

Conclusions

The morphometric of fish in Brantas River had significant differences in both sampling locations and total length, body length, and body width fish on the upstream were higher than downstream.

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