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Diversity and longitudinal distribution of freshwater fish in Klawing River, Central Java, Indonesia

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Abstract. *Suryaningsih S, Sukmaningrum S, Simanjuntak SBI, Kusbiyanto. 2018. Diversity and longitudinal distribution of freshwater fish in Klawing River, Central Java, Indonesia. Biodiversitas 19: 85-92.* The aims of this study were to evaluate the diversity and longitudinal distribution of fish in Klawing River, Purbalingga (Central Java). The survey was performed using a clustered random-sampling technique. The river was divided into upstream, midstream and downstream regions. Species diversity was measured as the number of species, and the longitudinal distribution was assessed by determining the fish species present in each of the three regions. Eighteen fish species of eleven families were identified in the Klawing River: Cyprinidae, Bagridae, Mastacembelidae, Anabantidae, Cichlidae, Channidae, Eleotrididae, Beleontinidae, Osphronemidae, Poecilidae, and Siluridae. Cyprinidae exhibited the highest number of species (six), followed by Bagridae and Cichlidae (two species each). The other families were represented by one species each. A single cluster analysis showed that the upstream population had a similarity of 78% and 50% with the midstream and downstream populations, respectively. Species and family diversities were higher in the midstream populations than in the upstream and downstream populations. This longitudinal distribution may be due to differences in environmental conditions and suggests that management of the land surrounding the Klawing River is a key factor in the conservation of freshwater fish.

Keywords: cluster analysis**,** freshwater fish, longitudinal distribution, Klawing

INTRODUCTION

The Klawing River is located in Purbalingga, Central Java and is one of the tributaries of the Serayu River. The Klawing River is an important freshwater fish habitat in Java. In total, Java has 213 species of freshwater fish, several of which are endemic (Hubert et al. 2015). However, Javanese ecosystems and biotas are currently threatened. Recent research on freshwater fish species diversity and distribution in Javanese rivers has yielded various results. In the Brantas River (East Java), Suharijanti et al. (2008) found nine species of fish, while Djumanto and Probosunu (2011) found 12 species in upstream Opak River, Yogyakarta. In the lakes of the Cisadane River basin (West Java), Hadiaty (2011) found a total of 32 fish species belonging to 19 families.

Land use differs along the Klawing River, with plantation forests and intensive agriculture systems in the headwaters area, settlements in the midstream area, and agriculture in the downstream area. Such differences in land use result in different fish macro- and microhabitats. According to Mercado-Silva et al. (2012), the vegetation, land use, and topographic conditions in a basin determine the hydrology and chemistry of receiving waters and exert direct effects on resident organisms. However, other factors such as water temperature, channel depth, and biological interactions determine the species present in a particular river region. As mentioned by Atkore et al. (2011), the distribution patterns of fishes are generally controlled by the dispersal mechanism, historical factors, and tolerance of environmental factors.

There is a significant drop in elevation along the Klawing River, from 247m asl upstream to 36m asl downstream, which is a major factor affecting water flow. Water flow represents the main force behind freshwater ecosystems determining the distribution, abundance, and diversity of fish. The movement of water across the landscape influences the ecology of rivers across a broad range of spatial and temporal scales. River flow strongly influences the ichthyofauna. By regulating the input of organic matter, it affects the phenology of reproduction and spawning behavior of local fish assemblages, and determines habitat diversification. Diversity and distribution of freshwater fish assemblages are generally influenced by water levels and flow variability (Bradford and Heinonen 2008), geo-hydrological features of the river (Angermeier and Davideanu 2004), and microhabitat heterogeneity (Shervette et al. 2007). To varying degrees, the diversity of freshwater assemblages is aggravated by urbanization, habitat alteration, anthropogenically-induced climate change (Vescovi et al. 2009; Paller et al. 2011) and the presence of invasive alien fish species (Guerrero 2002).

Determining the longitudinal profile of the fish assemblage along the Klawing River should provide information to detect relationships between coarse gradients in the assemblage structures and factors such as temperature and stream flow (Vannote et al. 1980). In general, fish assemblage structure is thought to change predictably from headwaters to downstream reaches, with biotic zones in which species are added or replaced in response to continuous gradients in temperature, channel morphology, and water velocity. It is important to describe the fish species diversity and longitudinal distribution in the Klawing River, in order to develop conservation strategies. This study aimed to determine the fish diversity and longitudinal distribution along the Klawing River and to describe the effects of physicochemical parameters on these variables.

MATERIALS AND METHODS

Study site

In general, the study site was chosen to reflect the variety of land uses found along the Klawing River, such as forest, secondary forest, agriculture, and human settlement. The Klawing River is 55.5 km long, 15.6-47.3 m wide and 0.65-2.16 m deep. The substrate composition changes gradually along the river. The survey employed a clustered random sampling technique: we divided the river into three regions, upstream, midstream and downstream, and then collected fish samples at three sampling sites per area. The three upstream sampling sites were at Tlahab Kidul (256 m asl.), Plumbungan and Banjarsari), the three midstream sites were at Onje (96 m asl.), Sindang, and Lamongan, and the three downstream sites were at Jetis, Bokol, and Kedungbenda (at 36.3 m asl.).

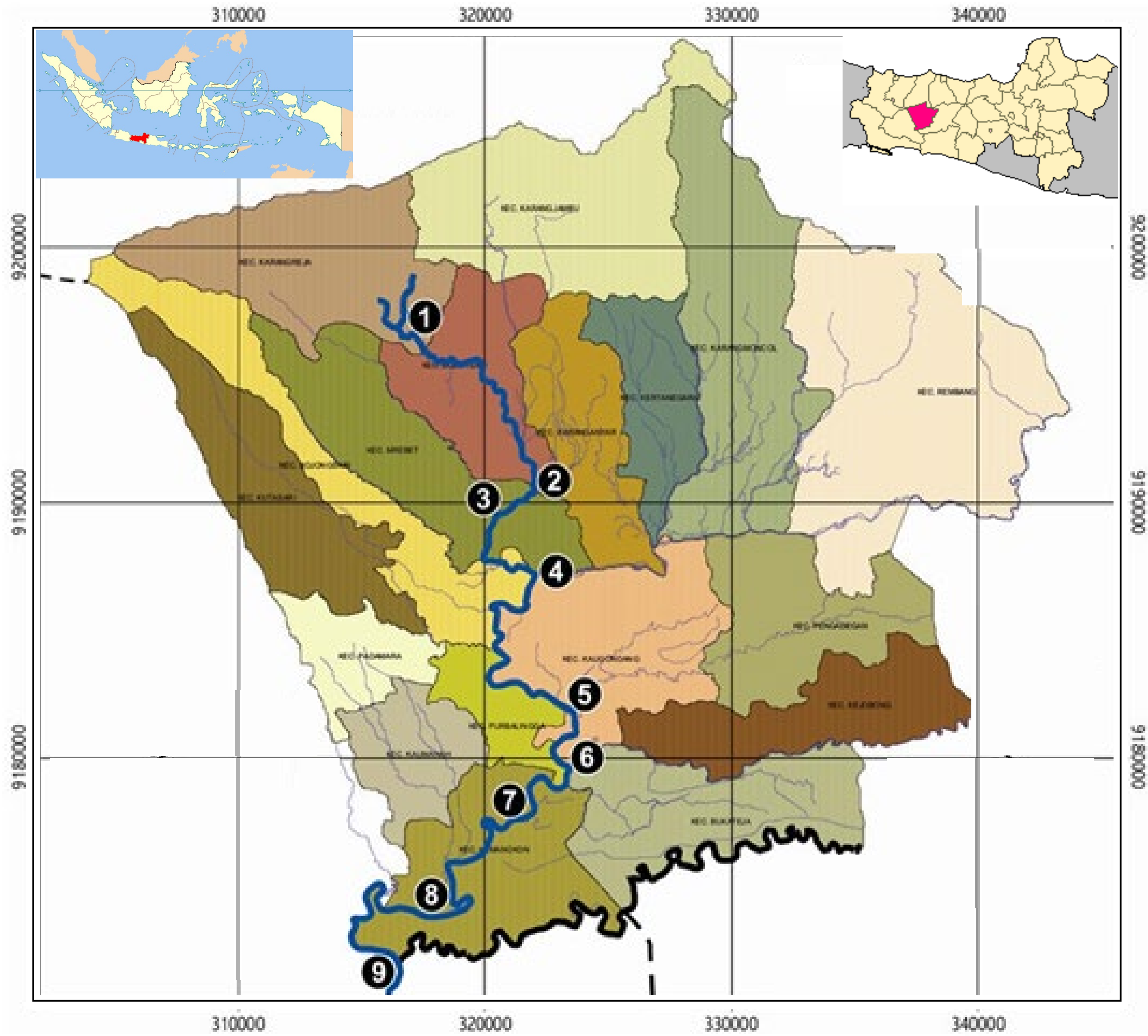

Figure 1. Sampling sites along the Klawing River, Purbalingga, Central Java, Indonesia (07^{0}16’520”S and 109^{0}21’209”E to 07^{0}28’827” S and 109^{0}19’270”E). Note: No. 1 to 9, see Table 1.

Table 1. Habitat description of study site, along Klawing River, Purbalingga, Central Java, Indonesia

Region category	Location		Coordinate	Habitat description	Water quality
Upstream	1.	Tlahab Kidul	(07^{0}16’520’’S, 109^{0}21’209”E)	Elevation: 256 m asl. Land use system : Secondary forest Depth (m): 0.45-0.6 Width (m): 16-22 Substrate: rock, big stones	Temperature (^{0}C): 26-27 Depth of visibility (m): 0.55-0.70 Velocity (m/s) : 1.4-1.5 pH: 7-8 O_2 : 9.2-14.5 CO_2: 1.9-3.1
	2.	Plumbungan	(07^{0}16’934”S) 108^{0}22’340”E)	Elevation: 174 m asl. Land use system: Secondary forest Depth (m): 0.45-0.60 Width (m): 18-25 Substrate: rock, big stones	Temperature (^{0}C): 27-28 Depth of visibility (m): 0.50-0.70 Velocity (m/s) : 1.2-1.36 pH : 6.9-7.5 O_2 : 10.0-13.6 CO_2: 2.1-3.3
	3.	Banjarsari	(07^{0}18’247”S) 108^{0}22’749”E)	Elevation: 134 m asl. Land use system: Agricultural areas Depth (m): 0.55-0.75 Width (m): 27-30 Substrate: rock, big stones	Temperature (^{0}C): 24-29 Depth of visibility (m): 0.51-0.70 Velocity (m/s) : 1.1-1.4 pH: 7-8 O_2 : 12.6-15.2 CO_2: 1.4-3.3
Midstream	4.	Onje	(07^{0}20’050”S 109^{0}22’291”E)	Elevation: 96 m asl. Landuse system: Agricultural areas Depth (m) : 0.6-0.9 Width (m): 25-33 Substrate: small stones, gravel	Temperature (^{0}C): 26-31 Depth of visibility (m): 0.42-0.54 Velocity (m/s): 0.78-0.92 pH: 7-7.5 O_2 : 9-13.8 CO_2: 1.9-5
	5.	Sindang	(07^{0}21’940”S 109^{0}23’070”E)	Elevation: 71 m asl. Landuse system: Agricultural areas Depth (m): 0.65-1.0 Width (m): 33-45 Substrate : small stones, gravel	Temperature (^{o}C): 26 -31 Depth of visibility (m): 0.56-0.54 Velocity (m/s): 0.80-0.92 pH: 7-7.5 O_2: 8.5-13.5 CO_2: 2.1-4.5
	6.	Lamongan	(07^{0}24’355”S 109^{0}24’154”E)	Elevation: 43.2 m asl. Landuse system: Agricultural areas and human settlements Depth (m): 0.7-1.1 Width (m): 40-58 Substrate: small stones, gravel	Temperature (^{0}C): 26-31 Depth of visibility (m): 0.50-0.60 Velocity (m/s): 0.80-0.92 pH: 7-7.5 O_2: 8.0-13.8 CO_2: 2.0-4.6
Downstream	7.	Jetis	(07^{0}25’448”S 109^{0}23’187”E)	Elevation: 40 m asl. Land use system: Agricultural areas, human settlements and sand mining Depth (m): 0.8-1.0 Width (m): 42-52 Substrate: sand, mud	Temperature (^{0}C): 27-32 Depth of visibility (m): 0.37-0.50 Velocity (m/s) : 0.63-0.75 pH: 7-7.5 O_2: 8.3-12.5 CO_2: 2.4-6.9
	8.	Bokol	(07^{0}28’365”S 109^{0}21’090”E)	Elevation: 38 m asl. Land use system: Agricultural areas and sand mining Depth (m): 1.1-1.3 Width (m): 42-55 Substrate: sand, mud	Temperature (^{0}C): 27-32 Depth of visibility (m): 0.35-0.45 Velocity (m/s): 0.60-0.78 pH: 7-7.5 O_2: 7.9-12.5 CO_2: 2.1-7.1
	9.	Kedungbenda	(07^{0}28’370”S 109^{0}19’625”E)	Elevation: 36 m asl. Land use system: Agricultural areas, and sand mining Depth (m): 42-60 Width (m): 1.3-1.9 Substrate: gravel, sand, mud	Temperature (^{0}C): 24-29 Depth of visibility (m): 0.51-0.70 Velocity (m/s): 1.25-1.42 pH: 27-31 O_2: 8.0-12.0 CO_2: 2.3-8

Fish collection

Fish samples were collected using electric fishing (Gorman and Karr 1978; Lestari 2006) and seine nets with 0.5 and 1-inch mesh size. Fish samples were collected during the months of June to September 2016, once a month with four replications. Sampling efforts were performed for one hour at each site.

Fish identification

Fish samples were preserved using formalin 10 %, and then alcohol 70% for the permanent collection in bottles. The fresh fish samples from the sampling area were taken to the laboratory using an ice box; then the fish specimen was washed with running water before being preserved by formalin 10%. Next, the fish specimens were preserved in a 10% formalin solution for fixation, after that, they were moved into 70% ethyl alcohol storage. The fish specimens were identified based on Saanin (1984), Kottelat et al. (1993), Froese and Pauly (2012), and FishBase (2017a,b,c). Fresh fish samples were transported to the laboratory in an ice box, washed in running water, preserved in 10% formalin, and transferred to 70% alcohol (Haryono et al. 2012).

Environmental parameters measurement

Physicochemical parameters measured were water depth, river width, water temperature, depth of visibility, water velocity, acidity (pH), oxygen, carbon dioxide, and river substrate. The physicochemical parameters for the different sampling sites are presented in Table 1.

In the upstream region, the riparian zone was vegetated with secondary forest while the bottom substrate comprised large and medium-sized stones. In the midstream, the land use in the riparian zone comprised open fields, rice fields, and human settlement, while the bottom substrate consisted of medium stones and gravel. In the downstream, the land use of the riparian zone comprised open fields, rice fields, sand mining and human settlement, while the substrate of the bottom was gravel, sand, and mud.

Data analysis

The mean number of individuals, species abundance, diversity, evenness, and dominance were compared between regions and seasons by two-way analysis of variance and a *post-hoc* Fisher LSD test. Diversity was estimated using the Shannon index (Magurran 1988). Evenness was calculated as Shannon diversity divided by the logarithm of the number of species. The values for Dominance were expressed as the complement of the Simpson's index (D = 1 - S). These indices were analyzed using the statistical package PAST (Hammer et al. 2001).

RESULTS AND DISCUSSION

Species diversity and abundance

A total of 472 individuals belonging to 18 species and 11 families (Table 2) were collected from the Klawing River. Cyprinidae with 6 species had the highest number of individual fish caught (82.6% of the total catch), followed by Bagridae and Cichlidae each with two species (3.2% and 2.5% of the catch, respectively), and Anabantidae, Chanidae, Eleotridae, Belontiidae, Mastacembelidae, Poeciliidae, Osphronemidae, and Siluridae each represented by only one species (Figure 2a). The eighteen species are listed in Table 2. Our result showed quite a low species diversity when compared to the other rivers in Java.

The Logawa River, which is located in the same biogeographic region, reportedly harbors 33 fish species of 11 families (Lestari 2004). Nuryanto et al. (2012) detected 22 fish species belonging to 10 families in the Cileumeuh River (Cilacap, Central Java). Roesma et al. (2016) detected 24 fish species belonging to 10 families in the Batangtoru River, South Tapanuli, North Sumatra. Yustina (2001) detected 70 species of fish along the Rangau River, Riau, and Sumatra. In a different biogeographic region, Pathak et al. (2013) detected 33 fish species belonging to 14 families in the Gangga River basin, India. Thus, differences are observed not only in species richness but also in composition. This may result, in part, from differences in the land use systems around the rivers (Humpl et al. 2006).

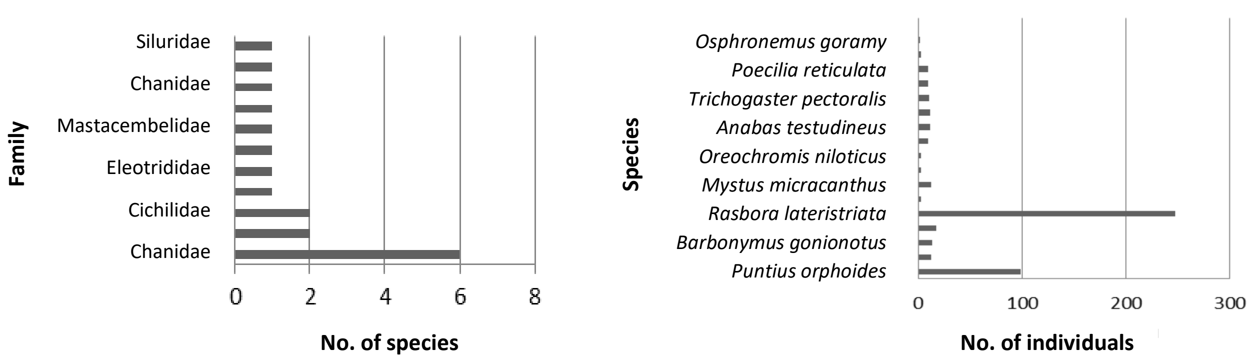

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Figure 2. A. The number of families and species of fish in the Klawing River. B. Abundance of each species

Table 2. Fish abundance and species diversity according to their longitudinal distribution in the Klawing River, Purbalingga, Central Java, Indonesia

Families	Species	Number of individual fish			
		Upstream	Midstream	Downstream	Total
Cyprinidae	*Puntius orphoides*	31	45	22	98
	Hampala macrolepidota	5	7	0	12
	Barbonymus gonionotus	6	4	3	13
	Osteochilus vittatus	0	8	9	17
	Rasbora lateristriata	87	124	36	247
	Cyprinus carpio	0	3	0	3
Bagridae	*Mystus micracanthus*	0	5	7	12
	Hemibagrus nemurus	0	2	0	3
Cichlidae	*Oreochromis niloticus*	0	3	0	3
	O. mossambicus	0	4	5	9
Anabantidae	*Anabas testudineus*	0	2	9	11
Eleotrididae	*Oxyeleotris marrmorata*	0	4	7	11
Belontiidae	*Trichogaster pectoralis*	0	4	6	10
Mastacembelidae	*Macrognathus aculeatus*	3	6	0	9
Poecilidae	*Poecilia reticulata*	3	6	0	9
Chanidae	*Chana striata*	0	0	3	3
Osphronemidae	*Osphronemus goramy*	0	2	0	2
Siluridae	*Ompok hypothalamus*	0	1	0	1
	Number of individuals	135	230	107	472
	Number of species	6	17	10	18
	Dominance_D	0.4724	0.3347	0.1851	
	Shannon_H	1.051	1.691	1.97	
	Simpson_1-D	0.5276	0.6653	0.8149	
	Evenness_e^H/S	0.4766	0.3192	0.7171	

Within the body of the river our results showed that the diversity of fish was significantly different between upstream, midstream and downstream ($F_{2,9}$ = 13,73. p =0,002). Species abundance was highest in the midstream (17 species and 230 individuals) followed by downstream with (10 species and 107 individuals) and the lowest was in the upstream (46 species and 135 individuals). Species composition of the fish between sampling sites was different, with upstream having the lowest diversity index (H = 1.051; E =0.476), then midstream (H= 1.691; E = 0.319), and with downstream having the highest (H = 1.97; E = 0.717). The distribution of freshwater fish assemblages showed low dominance (0.18 - 0.47) and relatively high evenness (0.312 - 0.71), which means that the allocation of niche space is distributed fairly equitably for most dominant and non-dominant fish species thriving in the river. Our results were consistent with those of Torgesen et al. (2006), Rahim et al. (2009), Nautiyal et al. (2013), Paller et al. (2013), and Pathak et al. (2013). Their studies, like ours, found that fish diversity of the rivers gradually increased from upstream to downstream with the lowest diversity occuring upstream. But our findings differed from the other studies in the geohydrological and physicochemical factors that affected the diversity and distributions of the fish. In previous research, differences in diversity and distribution of fish were found to be affected especially by differences in temperature and flow between sections of the rivers, but in our research the important variation in environmental factors was in velocity ($F_{2,9}$ = 86,841p = 0,001) and light of the river waters, ($F_{2,9}$ = 8,487p = 0,008), while other environmental factors analyzed did not show any significant differences (Table 1). Water temperature and rainfall were found as major influential factors for species distribution. Fish communities respond significantly and predictably to almost all kinds of anthropogenic disturbances, including eutrophication, acidification, chemical pollution, flow regulation, physical habitat alteration and fragmentation, human exploitation and introduced species (Li et al. 2010).

There were temporal variations in the fish assemblage we observed in the Klawing River; H differed significantly between months ($F_{2,9}$ = 13.73 p = 0.002), as did abundance ($F_{2,9}$ = 13.03, p = 0.002). The highest abundance was in June and then it gradually decreased until September. In contrast, diversity increased from June through to September (Figure 3 a, b). This difference was likely caused by water flow. Paller et al. (2013) found that water level fluctuation and dissolved oxygen concentrations exert marked effects on fish assemblage structure. In Central Java, the water level is significantly lower during the dry season (April to October). The lower diversity and equitability during the dry season serve as indicators of water and habitat qualities. Increase in fish diversity in the rainy season is attributed to the diverse riverine habitats formed by rising water levels. During rainy months, the volume of aerated water (Dissolved Oxygen) is sufficient to replenish the watersheds, which increases the nutrient-carrying capacity of the river water, leafding to greater diversity in the aquatic biota (Vescovi et al. 2009).

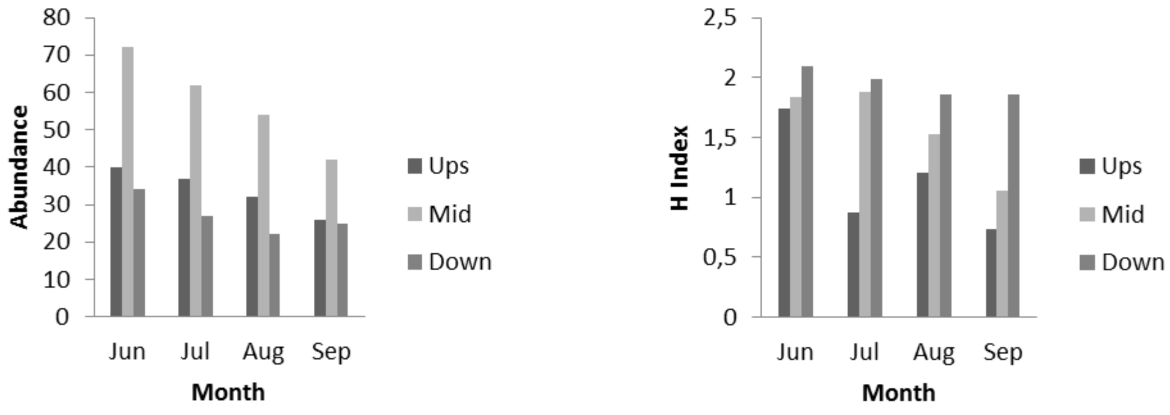

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Figure 3. A. Abundance, and B. H-index of fish in the Upper, Middle, and Lower reaches of the Klawing River, Purbalingga, Central Java, Indonesia from June to September 2016

Fish distribution

Six species were found upstream (Table 1), but none were unique. The species found upstream and midstream included *Hampala macrolepidota, Poecilia reticulata*, and *Macrognathus aculeatus.*

Hampala macrolepidota was also found in the Batang Toru River (Roesma et al. 2016), which differs from the Klawing River only in its flow velocity. The Batang Toru River reportedly had clear water, a flow velocity of 0.85-0.88 m/s, and a substrate of rocks, sand, and gravel; however, the altitudes of the sampling sites were not stated. *H. macrolepidota* is considered an ecological indicator species. *P. reticulata* was found in the upstream and midstream areas. Similarly, Rachmatika et al. (2002) found this species in the upstream areas of the Cibareno River of Mount Halimun National Park, which has a similar water temperature 20-29°C, pH (6.0-7.5) and dissolved oxygen content (8-10 ppm); however, the altitude of the sampling sites in that study was not mentioned. In contrast to Nuryanto et al. (2012), this species was found upstream, but whether the conditions were similar to those in our study is unclear. Roesma et al. (2016) identified *M. aculeatus* at the Simajambu sampling site upstream in the Batangtoru River, South Tapanuli, North Sumatra. This site is characterized by clear water, a flow velocity of 0.85-0.88 m/s, and a substrate comprising rocks, sand, and gravel.

In our study, seventeen species were identified in the midstream, some of which - *Cyprinus carpio, Oreochromis niloticus, Osphronemus gourami*, and *Ompok hypothalamus*, - were unique to the midstream region.

In general, these four species are considered to occur midstream in rivers. In our study, *C. carpio* was found only in the midstream at an altitude of 43.2-96 m asl. This is in accordance with the findings of Lestari (2004) in the Logawa River, Banyumas, Central Java. Nuryanto et al. (2012) reported that *O. niloticus* was present only in upstream, in the Cilemeuh River, Majenang, Cilacap. Similarly, this species was found at the Simajambu sampling site upstream in the Batangtoru River, South Tapanuli, North Sumatra (Roesma et al. 2016). There are potential differences in the physicochemical parameters between the two rivers. In this study, *O. gourami* was found midstream but was not detected in other studies. The area around the Klawing River is fundamental for the cultivation of gourami. In this study, *O. hypothalamus* was found only in midstream, but it has also been found on the Sei Jaya River (a tributary of the Barito River) and downstream on the Sebangau River, East Kalimantan, which has a water temperature of 29.6. -31.4°C, a light intensity of 0.34-0.53m depth, pH of 4.31-5.20 and dissolved oxygen content of 3.76-6.74ppm. However, the altitude of the sampling sites was not mentioned (Haryono 2012). The pH and oxygen levels differ significantly from those of our study, probably because the research site was a river located in peat soil. According to FishBase (2017b), *O. hypothalamus* lives in medium to large-sized, slow-flowing, lowland rivers, streams, and lakes with peat soil. It feeds on fish, prawns, and crustaceans. It moves to seasonally flooded habitats during high tide periods and is generally found around submerged woody vegetation.

In this study, *Osteochilus vittatus* was found only in midstream and downstream. Djumanto et al. (2011) reported this species at stations 2-5 located downstream on the Opak River, which is near the midstream region of the river and is characterized by a water temperature of 28.8-29.2°C, light intensity of 0.20-0.90 m depth, flow velocity of 0.49-1.13 m/s, and pH of 7.0-7.3. Again, the altitude of the sampling sites was not provided. Nuryanto et al. (2012) detected this species in all areas; however, the physicochemical parameters and the altitudes of the sampling sites were not provided. This species was found only in the midstream and downstream in our study, but upstream in the Cileumeuh River.

Trichogaster pectoralis, found midstream and downstream in our study, was detected in the Batang Kerang floodplain, Balai Ringin, Sarawak, by Rahim et al. (2009), at sampling sites characterized by brown or black water, a water temperature of 25.6-26.6°C, a light intensity of 0.63-1.26 m, pH of 4.55-5.45, and a dissolved oxygen content of 1.55-1.66 ppm; however, the altitude of the sampling sites was not specified. According to FishBase (2017c), this species is found in shallow, sluggish or standing-water habitats with abundant aquatic vegetation. *T. pectoralis* can breathe air directly and absorb oxygen from water and thus is well adapted to poor-quality habitats. This species originates from the Mekong basin in Laos, Thailand, Cambodia, and Vietnam and from the Chao Phraya basin. At least one country has reported that the introduction of this species has had an adverse ecological impact.

In our study, the downstream area harbored 10 fish species. *Channa striata* was found at an altitude of 36-40 m asl., compared with 51 m (site 13) and 81 m (site 6) in the study of Ohee et al. (2016); the differences are possibly due to the different biogeographies of Papua and Java. Our results are consistent with the findings of Lestari (2004) in the Logawa River, Banyumas, Central Java, in that *C. striata* was found at similar altitudes (*i.e.*, 25-40 m asl.).

Cyprinus carpio was found in midstream regions at 36-40 m asl. Rachmatika et al. (2002) found this species in the midstream and downstream regions, which had water temperatures of 22-29°C, pH of 6.5-7.5, and dissolved oxygen content of 8-10 ppm; however, the altitude of these sampling sites was not mentioned. According to FishBase (2017a), adult *C. carpio* inhabits warm, deep, slow-flowing, and still waters such as lowland rivers and large, well-vegetated lakes. The species is hardy and tolerant of a wide variety of conditions, but generally favors large bodies of water with stagnant or slow-flowing water and soft-bottom sediments. *C. carpio* thrives in large turbid rivers and is more active at dusk and dawn. Adults and juveniles feed on a variety of benthic organisms and plant material. The species develops along shores or in backwaters. Adults often engage in considerable spawning migration to suitable backwaters and flooded meadows. In this study, *Mystus micracanthus* and was found midstream and downstream,while *Hemibagrus nemurus* was found only in midstream , which is in agreement with the findings of Nuryanto et al. (2012) in the Cileumeuh River, Majenang, Cilacap Regency. Rahim et al. (2009) detected *M. micracanthus* only at sampling sites with brown water, while *H. nemurus* was found at sites with brown or black water; both have poor physicochemical parameters. These two species can survive under such conditions because of their ability to take in oxygen directly from the air.

In general, our results show that certain species of fish are distributed in particular river regions. Oberdroff et al. (1993) reported a similar longitudinal zoning of fish species, such zoning may be associated with differences in the relative ease of laying eggs on appropriate spawning substrates, usually gravel or submerged plants. Such a pattern was evident in the Klawing River.

A Bray-Curtis dendrogram of the fish species distribution in the upstream, midstream, and downstream regions of Klawing River is shown in Figure 5. The highest species richness was observed midstream, and the fish assemblage shifted from tolerant to thermally inclined groups in the upstream and downstream reaches. The altitude gradient (driving water velocity and river substrate variations) exerts a major influence on fish assemblage pattern. Our findings, therefore, support the pattern of an ecological guild structure inferred from predictions of the river continuum concept (Bhat et al. 2012). According to Alabaster and Lloyd (1982), variations in water chemistry can influence fish diversity and distribution.

The distribution of fish families differs between this and prior studies. The number of families detected in this study (11) was lower than those reported by Azmir et al. (2010) (14 families) at Gunung Machinchang, Pulau Langkawi, Malaysia; by Sjafei et al. (2001) (20 families) in the Cimanuk River; by Hadiaty (2011) (19 families) in the Cisadane River basin, Jabodetabek. The number we detected is smaller than that reported by Lestari (2004) (11 families) in the Logawa River, Banyumas, but higher than that reported by Roesma et al. (2016) (10 families) in the Batangtoru River.

Cyprinidae was the largest family seen in the Klawing River (82.6%) and was detected in all regions of the river. This is in agreement with the findings of Rahim et al. (2009) (79.8-63.8%), Lestari (2004) (65%), Atkore et al. (2011) (53.48%), Nuryanto et al. (2012) (45.45%), Roesma et al. (2016) (45.83%), Ibarra et al. (2005) (42.5%), and Azmir et al. (2010) (29.36%).

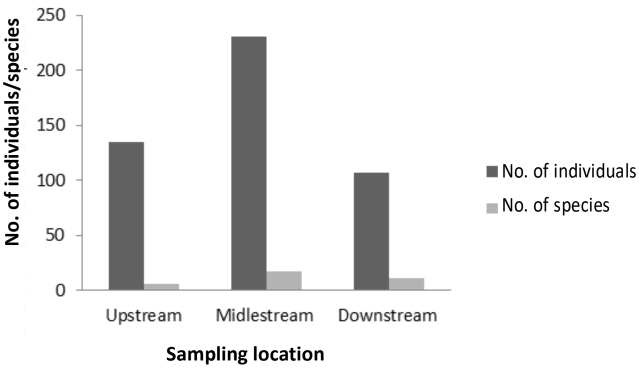

Figure 4. Fish species distribution along a longitudinal gradient in Klawing River, Purbalingga, Central Java, Indonesia

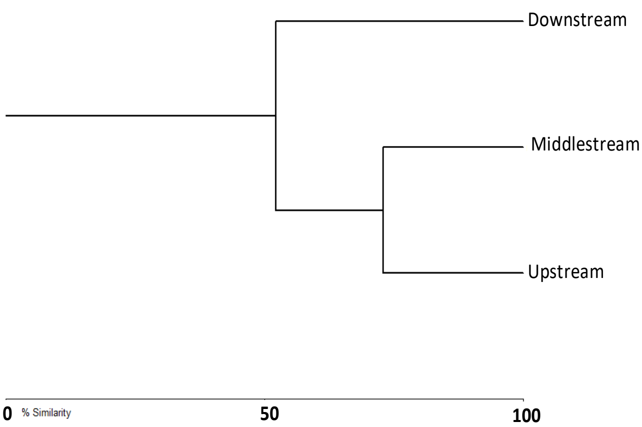

Figure 5. Bray-Curtis Cluster Analysis Dendrogram shows the distribution pattern of the species in the Klawing River, Purbalingga, Klawing River, Central Java, Indonesia

In conclusion, 18 fish species belonging to 11 families were found in the Klawing River, which indicates that the river has low fish species diversity. The family Cyprinidae had the largest number of species (six). Some species were distributed along the length of the river, while others were limited to certain areas. The fish species distribution was linked to variations in physicochemical parameters along the river, especially light, water velocity, and substrate.

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