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Monitoring Anurans Diversity along Code River, Province of Daerah Istimewa Yogyakarta, Indonesia

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ABSTRACT

The research about frogs and toads diversity in the Code River, Province of Daerah Istimewa Yogyakarta (DIY) had been done in 2012 (Yudha *et al*., 2013). Now, after five years passed, we conduct monitoring activities for updating its diversity and distribution. After five years, we consider that there are many changes along the river that influenced habitat condition for frogs and toads which live along and near the river. Some of the changes are unused land became human settlement or paddy fields and wasteland. The purpose of this research is to monitor the diversity of frogs and toads after five years along Code River. The method used was acoustic and visual encounter survey (VES). We have done total of 10 days of sampling. Each day we did two times sampling, during the day and night. Results show that the species number of frogs and toads found in 2012 were slightly higher compare to 2017. The frogs and toads on upstream part were diverse in 2017 compare to 2012 due to natural restoration of riparian vegetation occur on upstream. The frogs and toads on midstream part were less diverse in 2017 compared to 2012 due to increasing human activities near the river and less riparian vegetation. The frogs and toads on downstream part were also less diverse in 2017 compared to 2012 due to increasing human activities near the river and more household waste stuck on riparian vegetation. There was variation of anurans diversity after five years due to changing on physical condition of the river and human activities near the river.

Keywords: Code River; distribution; diversity; frogs; toads

INTRODUCTION

Anurans are vertebrates that require moist or damp habitat such as near ponds, swamps, streams, and rivers. Frogs differ from toads since frogs have smoother and moister skin, frogs usually have longer hind limbs and can jump or leaps to 10 times their body length. While toads have warty and drier skin and usually have shorter hind limbs and can only jump in short distance around 1 to 2 times of their body length (Kargo *et al*., 2002; Reilly *et al*., 2016; Shine, 2014; Iskandar, 1998; Das *et al*., 2000). Code River is the most dynamics rivers in DIY due to its function as channel for volcanic materials of Mount Merapi, water source for people and it passes the city therefore its bank is often modified. Some of the modifications were: increased river base and its gradient, unused land became urban landscape, paddy fields, and wasteland (Solikha & Rivai, 2012; Soemardiono & Gusma, 2014).

An anuran survey in the Code River, Province of Daerah Istimewa Yogyakarta, was done in 2012. The research in 2012 was done in 10 localities, using Visual Encounter Survey and acoustic methods. It was found 10 species of frogs and toads (Yudha *et al*., 2013). After a five years period, carrying out monitoring activities could provide updated information on the diversity and distribution of anuran species in the area, and also denote possible effects (if any) of human activities upon the anuran community. The purpose of this research is to monitor the diversity of frogs and toads after five years along Code River.

MATERIALS AND METHODS

Specimens of frogs and toads (anurans) were collected from its habitat in and along Code River from upstream to downstream. The river is divided into three part i.e., upstream, midstream and downstream to facilitate sampling time and collection. Chemicals (ethanol 70%, formaldehyde 4%, distillated water, and chloroform) were used to preserve the specimens. Collected specimens were

euthanized with chloroform, fixed in formalin 4%, and preserved in ethanol 70%. Specimens are housed in Laboratory of Animal Systematics. Legal permits for collecting were provided by Bappeda DIY.

Data collection was done from July to November 2017. The method used was line transect along 500 m per sampling point (location) with a combination of visual encounter surveys (VES) and acoustic. Transect line along 500 m was made on middle part of water body. Transect line was also made virtually using the handheld GPS. After line transect established, one team observed frogs and toad along the transect line using visual encounter survey method, and other team observed it along the riverbank using riverbank cruising method. Amphibians encountered during the survey were recorded. Observation was administered for both middle part of water body and the riverbank area. Only individuals' spotted within the river area, viz riverbank and middle part of water body were used for the analysis. Data collection was done twice, during the day from 7.30 to 11.00 and night at 19.30 to 22.30 for each sampling point. Despite most anurans are nocturnal, there are diurnal species, so it was done to maximize the number of species found in the area (Pizzatto *et al*., 2008; Crump & Scott Jr, 1994; Kusrini, 2009). All specimens collected were georeferenced, identified and documented. One individual of each species was taken as voucher specimen.

Identification was done based on Iskandar (1998), Kurniati (2003) and van Kampen (2017). Data acquired was analyzed with Shannon-Weiner Diversity Index and Pielou Evennes Index to (Türkmen & Kazanci, 2010; Bibi & Ali, 2013; Suprapto, 2015).

RESULT AND DISCUSSION

In 2012, our research successfully recorded 10 species of frogs and toads while in 2017 we recorded 9 species frogs and toads. There were three species viz. *Occidozyga lima* (green puddle frog or pearly skin puddle frog), *Lithobates catesbianus* (American bullfrog or common bullfrog), and *Kaloula baleata* (flower pot toad, smooth-fingered narrow-mouthed frog) were not found in 2017, while two species *Limnonectes* sp., and *Microhyla orientalis* were not found in 2012 (Table 1). Meanwhile, frogs commonly found along Code River in 2012 and 2017 were *Chalcorana chalconata* (brown stream frog) and *Duttaphrynus melanostictus* (Asian common toad) (Figure 2).

Table 1. Number of individual species frogs and toads found along Code River in 2012 and 2017

No	Classification		Boyong-Code 2012			Boyong-Code 2017		
	Family	Species	up-stream	mid-stream	down-stream	up-stream	mid-stream	down-stream
1	Ranidae	*Chalcorana chalconota*	21	11	2	11	9	-
2		*Occidozyga sumatrana*	5	-	2	2	-	-
3		*Occidozyga lima*	-	-	49	-	-	-
4		*Lithobates catesbeianus*	-	2	-	-	-	-
5	Dicroglossidae	*Fejervarya limnocharis*	27	-	5	8	-	-
6		*Limnonectes* sp.	-	-	-	1	-	-
7	Rhacophoridae	*Polypedates leucomystax*	5	1	-	1	-	-
8	Bufonidae	*Duttaphrynus melanostictus*	5	2	5	1	3	3
9		*Phrynoidis aspera*	4	-	-	3	-	-
10		*Ingerophrynus biporcatus*	1	-	1	2	-	2
11	Microhylidae	*Microhyla orientalis*	-	-	-	1	-	-
12		*Kalaoula baleata*	-	-	1	-	-	-
Number of individual			68	16	65	30	12	5
Number of species			7	4	7	9	2	2
Total number of species			10 species in 2012			9 species in 2017		

The number of frogs and toads species found on upstream of 2012 was 7 species, while in 2017 there were 9 species. It was lower than in 2017. The research conducted in 2012 was done two years after the eruption of Merapi Volcano. The Boyong-Code River is one of the rivers that were highly affected by volcanic materials carried into rivers by rainfall. This material flood (volcanic black sand and volcanic rocks) destroyed the river body and banks, especially on the upstream part, reducing potential anurans habitat. Two years after the eruption is not yet enough for natural environment to restore itself. Anurans need wealth environmental conditions to thrive, such as dense riparian vegetation, slow or stagnant water, clean lotic water and less excess of volcanic material. These conditions were not present in 2012 but it is present in 2017 (Figure 1). This condition probably caused *Limnonectes* sp., and *Microhyla orientalis* was not found on the upstream of 2012. *Limnonectes* prefer riverine habitat, with shallow, clear, slow or stagnant water. While *Microhyla orientalis* prefer swampy areas on primary or secondary forest. Those conditions needed by *Limnonectes* and *Microhyla orientalis* were present in 2017.

Figure 1. Upstream of Boyong-Code River: a. Upstream Sampling Point (SP) 1 in 2012; b. Upstream SP 1 in 2017; c. Upstream SP 2 in 2017; d. Upstream SP 3 in 2017

Species richness in the midstream during the 2017 survey (n= 2) is lower than in 2012 (n= 4) (Table 1). The physical condition of the midstream was not different between the surveys, but in 2017 more people were using the river for purposes such as sand mining and fishing. Such increased human activity on the riverbank may have affect species richness.

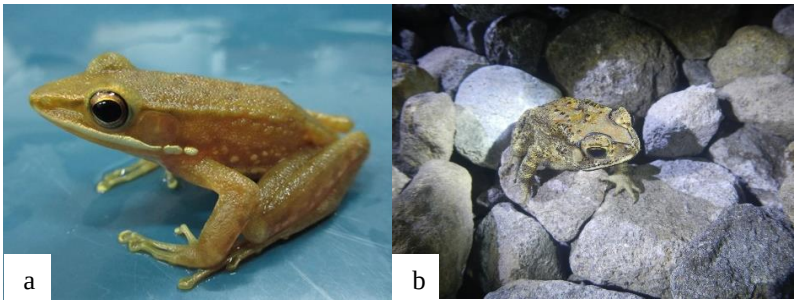

Figure 2. Frogs recorded along the Boyong-Code River in 2012 and 2017: a. Brown stream frog *Chalcorana chalconata*; b. Asian common toad *Duttaphrynus melanostictus*

The number of species found downstream in 2017 (n= 2) is also far less diverse than in 2012 (n= 7) (Table 1). Physical condition of the downstream during 2012 and 2017 was not significantly different, but in latter survey, more household waste was being discarded along the riverbank, and there were more human activities like fishing, clearing trees and bushes along riverbanks during the day (Figure 3). Some accumulated household waste downstream was probably carried away from upstream which are usually stuck on riverbank trees. Household waste, especially those stuck on riverbank trees, could minimize inhabitable areas for anuran species.

Figure 3. Downstream of Boyong-Code River in 2017: a. Accumulated household waste stuck on riparian vegetation; b. Human activities on riverbanks such as cutting trees and burning bushes

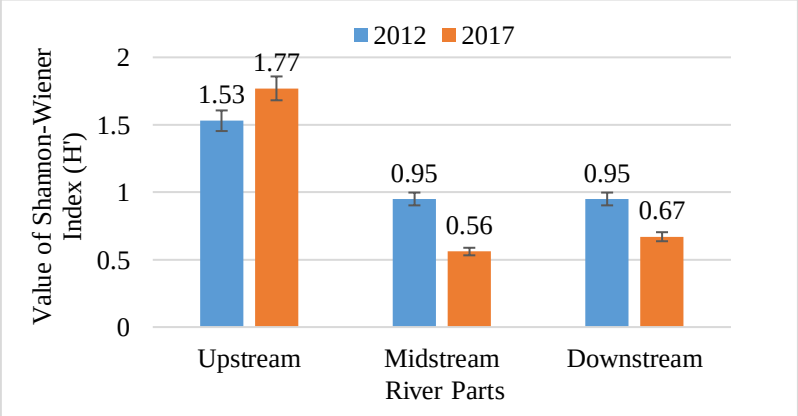

Figure 4. Shannon-Wiener Diversity Index of anuran species along the Code River

Based on the Shannon-Wiener Index values (Figure 4), the species diversity on upstream was not different between year 2012 (H= 1.53) and 2017 (H= 1.77). The value of Pielou Evenness Index on upstream in 2012 is 0.788 and in 2017 is 0.803 (Figure 5), both values indicating that there was no species domination. The species diversity on midstream was not different between year 2012 (H= 0.95) and 2017 (H= 0.56), and indicates the diversity is low. The value of Pielou Evenness Index on midstream 2012 is 0,685 and in 2017 is 0.811, both values indicate that there was no species domination. The species diversity on downstream was not different between year 2012 (H= 0.95) and 2017 (H = 0.67), and indicate the diversity is low. The value of Pielou Evenness Index on downstream 2012 is 0.488 and in 2017 it is 0.970. Low values on downstream in 2012 indicate dominance of some species, which is probably *Occidozyga lima* with 49 individuals found. Values downstream in 2017 indicate that there was no species domination. The domination of *Occidozyga lima* in downstream is probably due to the characteristics of the area, which is mostly composed of muddy paddy field, ponds and low riparian vegetation near the riverbank, the preferred habitat type for this species.

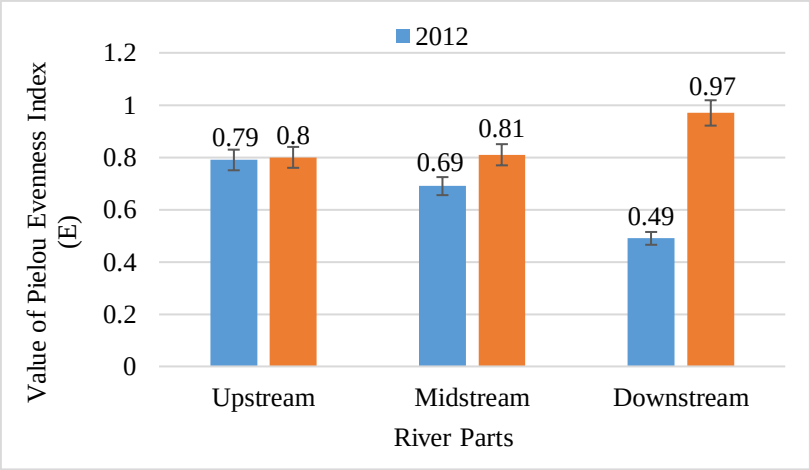

Figure 5. Pielou Evenness Index of anuran species along the Code River

Four frogs found were generalist species (Iskandar, 1998). Those six species tend to stay close to water source i.e pools, rivers, paddy fields, and others. *Polypedates leucomystax* was the only member of the Rhacophoridae capable to live in disturbed areas. They usually found in gardens, low vegetation or around marshes, and shrubby areas (Muslim *et al*., 2017; Muslim *et al*., 2018; Márquez & Eekhout, 2006; Peralinda *et al*., 2012). Whereas, the member of Dicroglossidae (*Occidozyga sumatrana*, *Fejervarya limnocharis*, *Limnonectes* sp.) commonly inhabit puddles or flooded areas. Meanwhile *Chalcorana chalconota*, inhabit around water system or water resources.

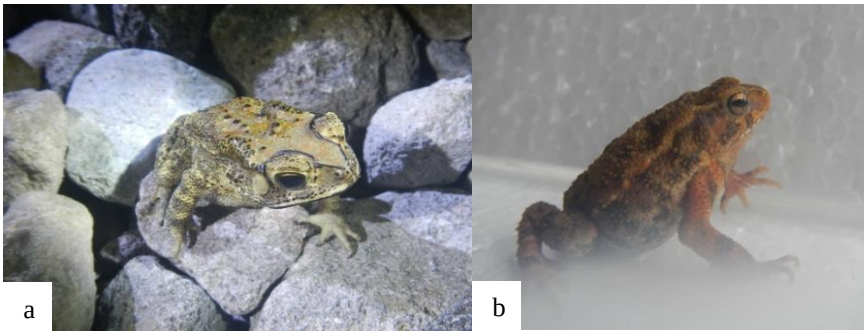

Figure 6. Toads found on along the Boyong-Code River in 2012 and 2017: a. Asian common toad *Duttaphrynus melanostictus*; b. Crested toad *Ingerophrynus biporcatus*

Two toads found in 2017 are *Duttaphrynus melanostictus* and *Ingerophrynus biporcatus* (Figure 6). *D. melanostictus* is capable to live near human settlement, agricultural land, oil palm plantations or in the disturbed area (Iskandar, 1998; Muslim *et al*., 2018; Karraker *et al*., 2018). *Ingerophrynus biporcatus* prefer primary forest habitat, but much less in secondary and degraded habitats (Iskandar, 1998; Kurniati, 2013) such as the upstream part of the Code River and some areas downstream, which have more dense riparian vegetation but also more dense household waste. Both toads have parotoid glands on their skin that could protect them from potential predators (e.g., x, y, z) and also microbial infections (Neerati & Yanamala, 2013; Mariano *et al*., 2019; Wulandari *et al*., 2013), which are likely to be found on disturbed areas or areas with many household wastes. *Phrynoidis asper* is commonly found in the upstream area (Subeno, 2018). Adult and tadpole of *Phrynoidis asper* inhabit lotic waters, possibly because of its larvae which could be up against the fast-flowing water in the upstream as a strategy of reproduction of the species.

Two species not found in 2017 were not important to be the indicator of the river changes. The reasons were *Lithobates catesbianus* is an introduced species and

Kaloula baleata is fossorial species. *Lithobates catesbianus* is native from eastern United States of America. This frog was introduced in several regions worldwide primarily as food source and is considered an alien invasive species because it is highly adaptive, has generalized diet, and a high reproductive success (Giovanelli *et al*., 2008; Laufer *et al*., 2018; Burgin & Schell, 2005).

Microhyla orientalis was only found in 2017 on the upstream area and highlights that natural condition of upstream part in 2017 is better compared to 2012 (Figure 1). Frogs in the genus *Microhyla* inhabit wet or moist areas with grass and primary or secondary forest in high altitudes. In 2017 there is more grass and bushes grow along the riverbanks.

CONCLUSION

Anurans found along the Code River in 2012 were slightly higher in number of species compared to 2017. Species richness upstream in 2012 was lower compared to 2017, but higher on midstream and downstream. After five years, there are variations of anuran diversity. These variations occur probably due to changing on physical condition of the river as human activities nearby increase annually.

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