

Study of Species Richness and Structure Community of Herpetofauna on Kondang Merak Forest, Malang, Indonesia

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Abstract: Kondang Merak Forest was known for its tourism destination, despite this area being the only coastal protected forest in Malang. Because of tourism demand, several anthropogenic activities were recorded and threatening the ecological balances of the forest including herpetofauna in it. Hence, we provide the information on the herpetofauna diversity completed with the habitat type on the Kondang Merak forest. A survey was conducted from November 2018 to June 2019 on each 6 different site points according to a specific habitat. We analyzed the data using the importance value index and Jaccard similarity to better known the herpetofauna community structure. A total of 38 species of herpetofauna were recorded consists of 8 amphibians (Anura), 15 lizards (Sauria), and 15 snakes (Serpentes) species. Based on the habitat type, we concluded that the distribution pattern and herpetofauna composition may be reflected by the biological adaptation, environmental carrying capacity, and different landscape vegetation such as coastal area, stream, temporary pond, secondary forest and monoculture plantation. These findings can be used as baseline data for further study on genetic study and management strategies on the Kondang Merak forest.

1 INTRODUCTION

Kondang Merak beach was known for its tourism spot destination in Malang by having big tides and white-clear sand as its main attractions (Aunurohim, 2013). This destination is located in the Bantur district, Malang Regency (Malangkab.go.id, 2017), and categorized as a protected forest region (Luthfi *et al.*, 2016) comprise of mangrove ecosystem, sea-grass vegetation, and coral reefs. However, the previous study shows that anthropogenic activity in a form of beach tourism, snorkeling activity, and sea biota exploration is threatening the ecological balance on the Kondang Merak forest (Luthfi *et al.*, 2016). These threats are exaggerated by the conversion of land into agricultural plantations and roadways crossing through the natural forest habitat as a result of tourism demand to boost the economic values. These threats are affecting the herpetofauna diversity, which plays an important role in the ecosystem as a predator of invertebrate dan small vertebrate, and also serves as prey for birds and mammals (Howell, 2002).

Despite of the habitat landscape conversion, another factors such as habitat loss (Goode *et al.*, 2005), unsustainable removal, environmental contamination, climate change, invasive species, amphibian declines (Todd *et al.*, 2010), animal trade (Kusrini, 2009), disease and fungal parasitism on frog (*Batrachochytrium dendrobatidis*) (Kusrini *et al.*, 2011) are also threatening the herpetofauna population. The investigation through systematics identification, taxon distribution, and habitat association are considered key information to face the threats and serves as baseline data (Gillespie *et al.*, 2005). However the data on the herpetofauna is still lacking in a certain region.

Further, the effort on exploring the herpetofauna diversity especially in East Java is considered lacking. Several inventory of herpetofauna diversity are limited to Meru Betiri National Park (Kurniawan *et al.*, 2018), Alas Purwo National Park (Broto & Subeno, 2012), Ironggolo waterfall in Kediri (Hanifa *et al.*, 2016), Putri waterfall in Batu (Hidayah *et al.*, 2018), and Bromo Tengger Semeru National Park and surroundings (Erfanda *et al.*, 2019; Septiadi *et al.*, 2018). Several efforts to discover the diversity

on Kondang Merak were previously carried out such as avifauna (Aunurohim, 2013). But still, the information related to herpetofauna diversity in Kondang Merak is lacking, resulting in forest management inefficiency. The information about diversity and abundance of herpetofauna can provide basic information for a crucial decision on the management of the Kondang Merak forest in the future. (Riyanto, 2011). Hence, in this study, we provide the information on the herpetofauna diversity associated with habitat type on the Kondang Merak forest.

2 MATERIALS & METHODS

2.1 Study Area

The survey was conducted on Kondang Merak Beach, Bantul district, Malang Regency, East Java (S 8°23'47", E 112°31'08"). The region is categorized as a protected forest consist of a terrestrial ecosystem including lowland rainforest, mangrove vegetation, and coastal ecosystem including estuary zones, sea-grass vegetation, and also coral reefs. We surveyed 6 sites that have characteristics and potential microhabitat for herpetofauna (Figure 1).



Figure 1: A surveyed sampling site of herpetofauna in the Kondang Merak forest.

2.2 Habitat Characteristics

The characteristics of Kondang Merak forest consist of site point A, an area comprised of timber (teak) production forest (monoculture) with only a little vegetation such as shrubs and ground cover vegetations. Site point B, an area comprised of temporary ponds only filled during rainy season covered by large trees and shrubs on the side of it.

Site point C, an area comprised of tree vegetation, shrubs, and forest floors covered by leaf litter and small open area. Site point D, an area consists of habitat corridors between bamboo plant and open area. Site point E, an area comprised of karst formation covered by tree canopies and shrubs. Site point F, an area comprised of canopies along the streams into the estuary zones. The documentation of various habitat is shown in (Figure 2).



Figure 2: Documentation of various habitat that we documented on Kondang Merak forest, A) a primary forest disturbed by a lane crossing, B) a temporary pond close to the forest area, C) water stream with a canopies coverage and D) karst formation covered by small vegetation on the coastal area.

2.3 Data Collection

The survey was conducted from November 2018 to June 2019. We used the *Visual Encounter Survey* (VES), modified with active exploration methods on our survey (Crump & Scott, 1994). We documented and identified an encountered herpetofauna species following references from Das (2015), Reptile Database (Uetz *et al.*, 2019), and Iskandar (1998), and count every individual that was found on each site. We divided the species based on the conservation status following the IUCN Redlist of Threatened Species (IUCN, 2019), a list of Appendices following Convention on International Trade in Endangered Species (2016), and national laws (PERMEN 92/ MENLHK/ SETJEN/ KUM1.8/ 2018).

2.4 Data Analysis

The data were analyzed to estimate the importance index value (INP) and the Shannon-Winner diversity index (Magguran, 1988) to know the community structure on each different habitat (Clarke & Warwick, 2001; Bibi & Ali, 2013). The grouping of

each species associated with the related habitat was analyzed using the presence or absence matrix by the Jaccard similarity index by UPGMA (Unweighted pair group method with arithmetic mean) on MVSP 3.22 software, forming a dendrogram.

3 RESULT AND DISCUSSION

3.1 Herpetofauna Composition

Based on our survey on Kondang Merak forest in regard to each site point and different habitat, we successfully record as much as 38 herpetofauna species including 8 amphibians species divided into 4 Family (Dicroglossidae, 1 species; Microhylidae, 3 species; Ranidae, 4 species; and Rhacoporidae, 2 species) and 30 reptiles species divided into 10 Family (Colubridae, 7 species; Elapidae, 4 species; Natricidae, 1 species; Paretidae, 1 species; Pythonidae, 1 species; Viperidae, 1 species; Agamidae, 1 species; Gekkonidae, 8 species; Scincidae, 4 species; Varanidae, 2 species). The result of abundance and frequency, indicated by importance value index, shows that a species of *R. reindwardtii* are dominating on site point B and C. A species of *C. marmoratus*, *C. chalconota*, and *P. leucomystax* are able to adapt on 3 different site point, with the remaining species can only be encountered on 1 or 2 site point. The detailed about the species that we found were shown in Figure and Table below (Figure 3, Figure 6, and Table 1 on Appendix).

The species richness on each site were observed as follows; amphibians species on site point B (6 species), C (5 species), F (3 species), D (2 species), E (1 species), with no encountered amphibians species on site point A, reptilians species on site point E (11 species), D (10 species), F (7 species), C (5 species), A (2 species), and B (1 species). The highest value of diversity index was showed by site point E (3.7), then D (3.46), C (3.32), F (3.32), B (2.81), while the lowest value of diversity index was showed by site point A (1). The site points E, D, C, and F showed the value above 3 that indicated the high diversity, while for site points F and A indicated the moderated diversity (Krebs, 1994). The species richness correlated to diversity index due to more species discovered on site, the more higher diversity index values, vice versa. The detailed about the value index was shown in the graphic below (Figure 4).

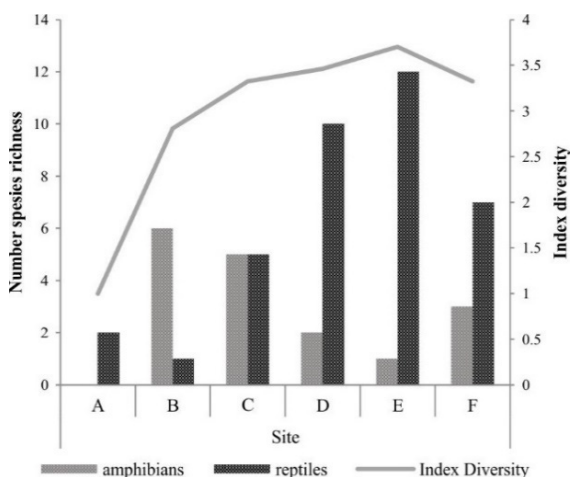


Figure 3: Species richness and diversity index of herpetofauna in Kondang Merak forest based on encountered species on each site point habitat.

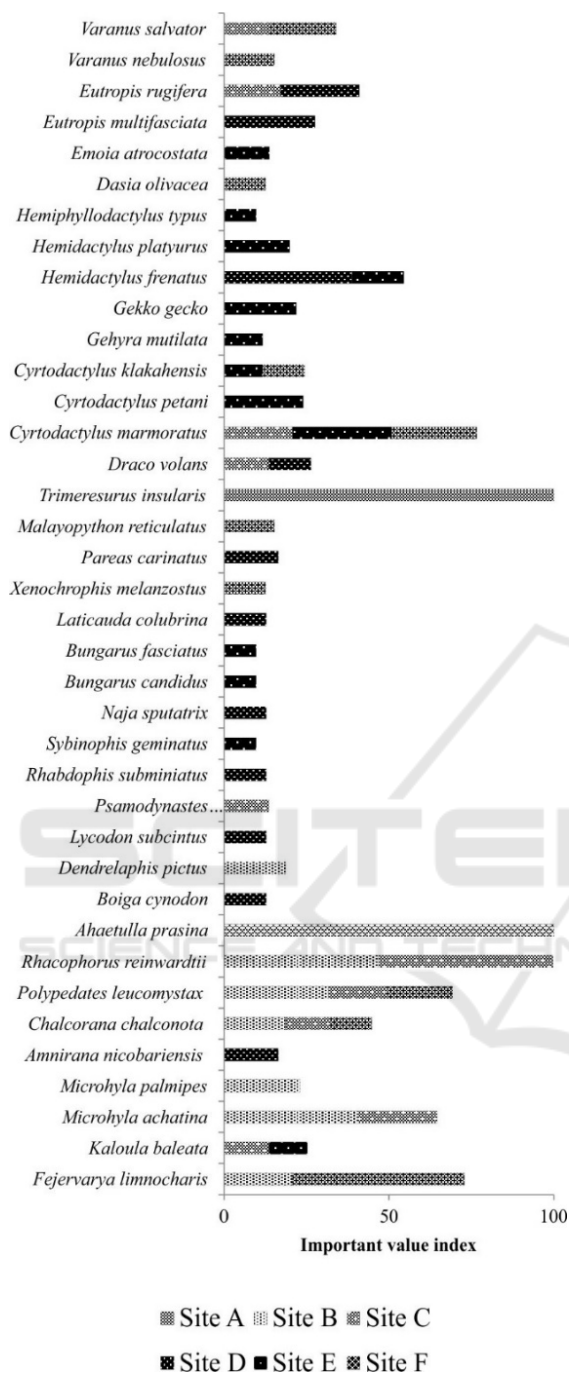


Figure 4: Important value index of herpetofauna on Kondang Merak associated with different surveyed sites point.

Based on the grouping of herpetofauna on each site point by using the Jaccard similarity index, it was shown that site point A indicated a different grouping in regard to another site. On site point A, we only found 2 species of herpetofauna on the habitat which was covered by monoculture

plantation teak (*Tectona* sp.), that tend to be dry. While on another site point, it showed that site point B has the similarity to site point C, it may be due to the closely-distance between those sites and similar canopies with only difference microhabitat which is temporary ponds which only possessed by site point B. The detailed of the dendrogram can be seen below (Figure 5)

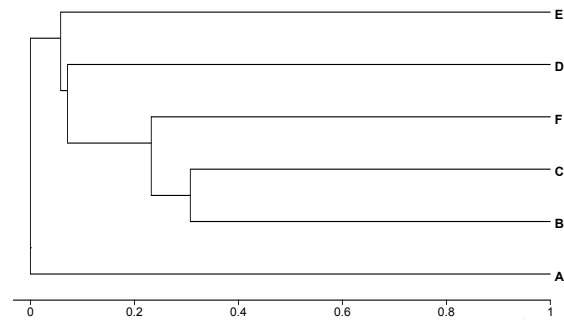


Figure 5: Dendrogram showing the clustering of herpetofauna based on each site on the Kondang Merak forest using the Jaccard similarity index.



Figure 6: Several documentation of encountered herpetofauna species in Kondang Merak forest, A) *P. leucomystax*, B) *F. limnocharis*, C) *R. reinwardtii*, D) *M. achatina*, E) tadpole *M. achatina*, F) *A. nicobariensis*, G) *V. nebulosus*, H) *V. salvator*, I) *C. marmoratus*, J) *Hemidactylus* found guarding their eggs, K) *D. volans*, L) *M. reticulatus*, M) *T. insularis*, N) *P. carinatus*.

3.2 The Implication of The Herpetofauna Conservation Status

Kondang Merak forest as a habitat of various herpetofauna plays a role in fulfilling the needs of foods, shelter, and reproduce (Goode *et al.*, 2005). Based on the diversity of herpetofauna species, several site point needs to be maintained and sustained, because several species is concluding into a threatened species such as *R. reindwartii* (IUCN: Near threatened), *V. nebulosus* (CITES: Appendix I; protected), *V. salvator* (Appendix II), *M. reticulatus* (Appendix II), and *N. sputatrix* (Appendix II). The specific distribution pattern on different site points in the Kondang Merak forest may be due to the adaptation (physiology and behavior ecology) and environmental carrying capacity of herpetofauna (Vitt & Caldwell, 2013). The management of the Kondang Merak forest mainly focused on the spot as tourism sites. The officials are responsible to maintain the Kondang Merak forest and give more attention to the diversity in this area because this protected forest is possessed a unique species especially on the lowland forest ecosystem that close to coastal vegetation (Aunurohim, 2013).

4 CONCLUSIONS

A total of 38 amphibians and reptile species were recorded in this study, consists of 8 amphibians (Anura), 15 lizards (Sauria), and 15 snakes (Serpentes) species. To understand the differences in distribution pattern and herpetofauna composition. The differences in distribution pattern and herpetofauna composition may be reflected in biological adaptation, environmental carrying capacity, and different landscape vegetation such as coastal area, stream, temporary pond, secondary forest and monoculture plantation. These findings can be used as baseline data for further study on genetic study and management strategies on the Kondang Merak forest.

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APPENDIX

Table 1. Species list of Amphibia and Conservation status , **Notes:** herpetofauna in site point, [presence; (+), absent: (-)]; **IUCN** (International Union for Conservation of Nature) LC: Least Concern, NT: Near Threatened; **CITES** (Convention on International Trade in Endangered Species of Wild Fauna and Flora) (-): non appendix, (I): Appendix I, (II): Appendix II.

Species	Habitat Type						IUCN	CITES	PP No. 20 tahun 2018
	A	B	C	D	E	F			
Amphibia									
Dicroglosidae									
<i>Fejervarya limnocharis</i> (Gravenhorst, 1829)	-	+	-	-	-	+	LC	-	NP
Microhylidae									
<i>Kaloula baleata</i> (Müller In Oort and Müller, 1833)	-	-	+	-	+	-	LC	-	NP
<i>Microhyla achatina</i> (Tschudi, 1838)	-	+	+	-	-	-	LC	-	NP
<i>Microhyla palmipes</i> (Boulenger, 1897)	-	+	-	-	-	-	LC	-	NP
Ranidae									
<i>Amnirana nicobariensis</i> (Stoliczka, F., 1870)	-	-	-	+	-	-	LC	-	NP
<i>Chalcorana chalconota</i> (Schlegel, 1837)	-	+	+	-	-	+	LC	-	NP
Rhacophoridae									
<i>Polypedates leucomystax</i> (Gravenhorst, 1829)	-	+	+	-	-	+	LC	-	NP
<i>Rhacophorus reinwardtii</i> (Schlegel, 1840)	-	+	+	-	-	-	LC	-	NP
Reptilia									

Colubridae

<i>Ahaetulla prasina</i> (Boie, 1827)	+	-	-	-	-	-	LC	-	NP
<i>Boiga cynodon</i> (Boie, 1827)	-	-	-	+	-	-	LC	-	NP
<i>Dendrelaphis pictus</i> (Gmelin, 1789)	-	+	-	-	-	-	LC	-	NP
<i>Lycodon subcinctus</i> (Boie, 1827)	-	-	-	+	-	-	LC	-	NP
<i>Psamodynastes pulverulentus</i> (Boie, 1827)	-	-	+	-	-	-	LC	-	NP
<i>Rhabdophis subminiatus</i> (Schlegel, 1837)	-	-	-	+	-	-	LC	-	NP
<i>Sybinophis geminatus</i> (Boie, 1826)	-	-	-	-	+	-	LC	-	NP

Elapidae

<i>Naja sputatrix</i> (Boie, 1827)	-	-	-	+	-	-	LC	II	NP
<i>Bungarus candidus</i> (Linnaeus, 1758)	-	-	-	-	+	-	LC	-	NP
<i>Bungarus fasciatus</i> (Schneider, 1801)	-	-	-	-	+	-	LC	-	NP
<i>Laticauda colubrina</i> (Schneider, 1799)	-	-	-	+	-	-	LC	-	NP

Natricidae

<i>Xenochrophis melanostictus</i> (Gravenhorst, 1807)	-	-	-	-	-	+	LC	-	NP
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Pareatidae

<i>Pareas carinatus</i> (Boie, 1828)	-	-	-	+	-	-	LC	-	NP
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Pythonidae

<i>Malayopython reticulatus</i> (Schneider, 1801)	-	-	-	-	-	+	LC	II	NP
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Viperidae

<i>Trimeresurus insularis</i> (Kramer, 1977)	+	-	-	-	-	-	LC	-	NP
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Agamidae

<i>Draco volans</i> (Linnaeus, 1758)	-	-	+	+	-	-	LC	-	NP
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Gekkonidae

<i>Cyrtodactylus marmoratus</i> (Gray, 1831)	-	-	+	-	+	+	LC	-	NP
<i>Cyrtodactylus petani</i> (Riyanto, Grismer, & Wood, 2015)	-	-	-	-	+	-	LC	-	NP
<i>Cyrtodactylus klakahensis</i> (Hartmann, Mecke, Kieckbusch, Mader, & Kaiser, 2016)	-	-	-	-	+	+	LC	-	NP
<i>Gehyra mutilata</i> (Wiegmann 1834)	-	-	-	-	+	-	LC	-	NP
<i>Gekko gecko</i> (Linnaeus, 1758)	-	-	-	-	+	-	LC	-	NP
<i>Hemidactylus frenatus</i> (Schlegel, 1836)	-	-	-	+	+	-	LC	-	NP
<i>Hemidactylus platyurus</i> (Schneider, 1797)	-	-	-	-	+	-	LC	-	NP
<i>Hemiphyllodactylus typus</i> (Bleeker, 1860)	-	-	-	-	+	-	LC	-	NP

Scincidae

<i>Dasia olivacea</i> (Gray, 1839)	-	-	-	-	-	+	LC	-	NP
<i>Emoia atrocostata</i> (Lesson, 1830)	-	-	-	-	+	-	LC	-	NP
<i>Eutropis multifasciata</i> (Kuhl, 1820)	-	-	-	+	-	-	LC	-	NP
<i>Eutropis rugifera</i> (Stoliczka, 1870)	-	-	+	+	-	-	LC	-	NP

Varanidae

<i>Varanus nebulosus</i> (Gray, 1931)	-	-	-	-	-	+	LC	I	P
<i>Varanus salvator</i> (Laurenti, 1768)	-	-	+	-	-	+	LC	II	NP