Diversity of Amphibians Using a Transect Method Implemented in Three Different Habitat

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Abstract. This study was conducted in three different habitat types consisting of (1) forest, (2) rivers, and (3) paddy fields. We used transect lines with a length of 50 m with a distance of 1 m right and left. The number of transects in each habitat was 10. We found 148 individuals with 13 species belonging to 6 families. The value of species richness in each habitat is classified as low, namely 2,0020 in forest habitat, 2,2260 in river habitat, and 0,9851 in paddy fields with species diversity in each habitat type including moderate, namely 1,7718 in forest habitat, 1,7897 in river habitat, and 1,0978 in paddy fields. The calculation of the evenness value in river habitat is 0,7773 and 0,8520 which is classified as stable while in paddy field habitat is 0,6821 which is classified as unstable. The highest level of habitat similarity is river habitat with forest habitat which is 0,6667 and the smallest is river habitat with paddy field habitat which is 0,4000. It can be concluded that the amphibian community in the river habitat is almost the same as the forest habitat, and the amphibian community in the paddy field habitat were different from the river habitat.

Keywords: Diversity · Amphibians · Transect · Different · Habitat

1 Introduction

The composition of Anura species that live in various habitat types is influenced by the character of the habitat itself [1, 2]. The existence of Anura in a habitat can be seen from the structure of the Anura community and its distribution in that habitat. Community structure and distribution patterns are influenced by the physical and chemical properties of the environment as well as the biological features of the organisms themselves [3].

Differences in habitat that occur naturally affect the diversity of Anura. As aquatic habitats and forests are equally important for Anura at this stage in the Anura life cycle [1]. Changes in the habitat environment that affect Anura's life [4], one of which is changes in landscape structure [5]. Landscapes that are converted to semi-natural [6], as well as human activities, have an impact on habitat quality and landscape connectivity [7]. Over the last two decades, Sumatra has experienced forest loss. However, it is not known with certainty the extent of Anura's tolerance for this impact [8].

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So far there are 6 families with 116 species of Anura in Sumatra [9]. The high number of species found reveals that Anura diversity in Sumatra is still poorly documented [10]. Compared to the islands of Java [11] and Borneo [12], the study of Anura in Sumatra is still less studied [13].

Several studies of Anura species in different habitat types; Hutan Harapan Jambi [14], PT. BLP Central Borneo [15], and Balik Bukit Resort [16]. Each Anura has a minimum geographic range to survive and reproduce [17]. The existence of human activities such as mountain rock mining which is the livelihood of the community at the research site can be a threat to Anura. According to [18], the impact of mountain rock mining on the environment is the risk of landslides and irregular land due to ex-dug holes. This initiates the destruction and fragmentation of Anura's habitat [8]. Anura is vulnerable to environmental changes and disturbances [4]. Therefore, it is important to conduct this research as an effort to conserve Anura in order to maintain the population, environmental conditions and habitat of Anura.

2 Materials and Methods

The research was conducted from December 2020 to February 2021 in Supayang village, Payung Sekaki District, Solok Regency, with coordinates 0°52′27.9″S - 100°45′16.3″E with an altitude of 686 masl. Based on a preliminary survey, the research location passed the Lubuk Talang bridge.

Sampling was done by transect method [19]. There are 10 transects used in each location, each transect is 50 m long with an observation distance of 1 m right and left [20]. The distance between transects is 5 m [21], the distance between transects in paddy fields and rivers is 20 m, and the distance between forest transects and rivers is 20 m [22]. The transect is roamed at night from 20.00 h to complete. At each research location, environmental parameters were measured. The environmental parameters taken were air temperature, humidity, soil temperature, soil pH, water temperature, water pH, and water clarity. The identification process begins with photographing the dorsal, ventral, lateral, and webbing specimens. Identification of Anura using the Java and Bali Amphibian Field Guide book [11]; West Java Amphibian Identification Picture Guide [21]; Borneo Amphibian Field Guide; Inger & Stuebing [23] Inger & Iskandar [24]; Teynie *et al.* [10]; Munir *et al*. [25] and a website (www.amphibiaweb.org) conducted at the Ecology, Biology Laboratory, Faculty of Mathematics and Natural Sciences, Padang State University.

Specimens were put into an anesthetic solution of MS-222 or Clorobutanol (Hidrous) which was mixed with one liter of water until it died. After the specimen dies, the sample is labeled and the tissue is removed for DNA analysis. The tissue taken was the liver which was inserted into a microtube containing 96% alcohol. If the sample is small, then the muscle is taken. The tissue samples that had been taken were put into a box containing 4% formalin. Samples are stored for 1 to 2 days. Selatah specimens are formed followed by rinsing with running water until the rest of the formalin is gone. Specimens are stored in glass bottles containing 70% alcohol [26].

3 Result and Discussion

The number of Anura found was 148 individuals with 13 species belonging to 6 families. The distribution of Anura in three habitats, namely 8 species in the forest, 10 species in rivers, and 5 species in paddy fields. Several species spread exclusively in one habitat type, such as *F. cancrivora* in paddy fields habitat, *L. laticeps, L. microdiscus, L. kuhlii* in river habitat, and *M. nasuta* in forest habitat. Several species were distributed in the three habitats, namely *Amnirana nicobariensis* and *Polypedates leucomystax* (Fig. 1). The most common species found were in river habitats with 10 species, and the least found in paddy fields with 5 species. Complete data can be seen in Table 1.

The most species found in forest habitats, namely *W. sumatrana*, amounted to 10. According to Inger [27] *W. sumatrana* is a species that lives on the banks of rivers and can adapt to various microhabitats. The most species found in river habitats were *O. hosii* with 18 individuals. *O. hosii* species have habitats on the banks of rivers, usually found on rocks and low shrubs [28]. In the paddy field habitat, the most common species was *F. limnocharis* with 31 individuals. Conditions support the existence of *F. limnocharis* because the paddy fields have a muddy structure and open areas and include species that are able to associate with human activities [27].

The value of species richness in the study area showed that the three habitats were classified as low (R $<$ 2.5) as described in Table 2. The low species richness of Anura is due to human activities [29] in research locations such as mountain rock quarries, paddy fields, and research locations adjacent to vehicle paths that affect Anura's survival. Species richness was influenced by canopy cover, herbaceous layer, and leaf litter [6, 30].

Diversity values in the three habitat types were classified as moderate (1 $<$ H' $<$ 3) as described in Table 2. This shows that ecologically the three habitats are quite supportive of Anura's diversity. Species diversity depends on the number of species and the number of individuals [31]. The stability of an ecosystem can be seen from its diversity [32]. If the condition of the ecosystem is relatively stable, the diversity is high. Disturbed ecosystem environment, the diversity tends to be moderate, and polluted ecosystem environment, the diversity is low. Humidity, temperature, wide variation, and habitat of an area such as shrubs, litter, canopy cover, and standing water are some of the factors that can affect Anura's diversity [33, 34]. Wildlife will be diverse if the habitat structure is also diverse [35].

Table 3 informed calculation of the evenness value of species in forest and river habitat types is classified as stable (0.75 $<$ E $<$ 1) and paddy field habitats are classified as unstable (0.5 $<$ E $<$ 0.75). This indicates that the distribution of Anura in forest and river habitats tends to be even and no species dominates. Evenness of species is indicated by the presence or absence of the dominant species [36].

On the other hand, in the paddy field habitat there is a species that dominates, namely *F. limnocharis* totaling 31 individuals. This species is very well known to live in paddy fields and is very tolerant of human activities [11, 21].

Table 3 informed the highest species density was found in the paddy fields habitat, namely *F. limnocharis* with 3.1 individuals/m^2. The high density of *F. limnocharis* was because *F. limnocharis* was the most dominant species among other Anura. Factors that

Table 1. The species and number of Anura found at the research site

No	Family	Species	Habitat			Total
			Forest	river	paddy fields	
1	Bufonidae	*Phrynoidis aspera* (Gravenhorst, 1829)	1	2	0	3
2	Dicroglossidae	*Fejervarya cancrivora* (Gravenhorst, 1829)	0	0	5	5
3		*Fejervarya limnocharis* (Gravenhorst, 1829)	0	2	31	33
4		*Limnonectes laticeps* (Anderson, 1871)	0	8	0	8
5		*Limnonectes kuhlii* (Tschudi, 1838)	0	1	0	1
6		*Limnonectes microdiscus* (Boettger, 1892)	0	1	0	1
7	Megophrydae	*Megophrys nasuta* (Schlegel, 1858)	1	0	0	1
8	Microhylidae	*Microhyla heymonsi* (Vogt, 1911)	2	0	2	4
9	Ranidae	*Amnirana nicobariensis* (Stoliczka, 1870)	3	4	19	26
10		*Chalcorana chaconota* (Schlegel, 1837)	9	3	0	12
11		*Odorrana hosii* (Boulenger, 1891)	2	18	0	20
12		*Wijayarana sumatrana* (Yang, 1991)	10	17	0	27
13	Rhacophoridae	*Polypedates leucomystax* (Gravenhorst, 1829)	5	1	1	7
	Number of individuals		33	57	58	148
	Number of species		8	10	5	13

cause differences in Anura density are food availability factors, such as the abundance of arthropods [37] and population characteristics of each species itself [38].

The similarity value of Anura community in river habitat and forest habitat has the highest similarity value, which is 0.6667 (Table 5). Based on the similarity index, the Anura community tends to have similarities. This community similarity occurs because the habitats are close together [39]. These two habitats have a high degree of similarity in accordance with the conditions of forest and river habitats that are close together. The

Table 2. Species richness in three habitat types

No	Habitat types	Specific Richness Index
1	Forest	2,0020
2	River	2,2260
3	Paddy fields	0,9851

Table 3. Diversity and evenness of Anura species in three habitat types

No	Habitat types	Species Diversity	Evenness of Species
1	Forest	1,7718	0,8520
2	River	1,7897	0,7773
3	Paddy fields	1,0978	0,6821

condition of the forest at the study site has a sloping topography, there is no water source other than rivers While, Anura is very dependent on the presence of water [40] (Table 4).

Based on Table 6, abiotic factors such as temperature, pH, humidity, and water clarity did not have a major effect on the Anura community in each habitat in the study site. A comparison of the values of each factor is not much different. The air temperature

Table 4. Density of each population in each habitat

Species	Habitat		
	Forest	River	Paddy fields
Phrynoidis aspera (Gravenhorst, 1829)	0,1	0,2	0
Fejervarya cancrivora Gravenhorst, 1829	0	0	0,5
Fejervarya limnocharis Gravenhorst, 1829	0	0,2	3,1
Limnonectes laticeps (Anderson, 1871)	0	0,8	0
Limnonectes kuhlii (Tschudi, 1838)	0	0,1	0
Limnonectes microdiscus (Boettger, 1892)	0	0,1	0
Megophrys nasuta (Schlegel, 1858)	0,1	0	0
Microhyla heymonsi (Vogt, 1911)	0,2	0	0,2
Amnirana nicobariensis (Stoliczka, 1870)	0,3	0,4	1,9
Chalcorana chaconota (Schlegel, 1837)	0,9	0,3	0
Odorrana hosii (Boulenger, 1891)	0,2	1,8	0
Wijayarana sumatrana (Yang, 1991)	1	1,7	0
Polypedates leucomystax (Gravenhorst, 1829)	0,5	0,1	0,1

Table 5. Similarity of Anura community in three habitat types

Habitat	Forest	river	Paddy field
Forest	-	0,6667	0,4615
River		-	0,4000
Paddy fields			-

Table 6. Physical conditions in each habitat type

Factor		Habitat		
		Forest	River	Rice fields
Relative Temperature (°C)	Air	21,2–22,8	22,9–23,1	20,6–21,3
	Soil	23	24	23
	Water	-	20,1	-
pH	Soil	7	6,5	5
	Water	-	8,2	-
Relative Humidity (%)		95–98	93-97	89–95
Water Clarity		-	0,24	-

in the forest is 21.2–22.8°C, in the river, it is 22.9–23.1°C, and in the rice fields, it is 20.6–21.3°C. The water temperature in the river is 20.1°C, this temperature is the ideal temperature for Anura. The optimum temperature for Anura to survive is between 20–35°C [41]. Humidity at the study site ranged from 89–98%. Anura requires sufficient moisture to prevent the body from drying out [11]. The temperature and humidity at the research site indicate that Anura can still carry out its activities.

The range of soil pH in the three habitats is 5–7, where this pH is neutral and common to most living things, the pH of water in rivers is 8.2. One of the causes of high pH is rainfall [42]. The optimum pH range of aquatic animals is 6.5–8.5 [43], thus the pH of the water is suitable for Anura's survival. The low pH can cause a slowdown in the growth and development of Anura [43]. The water clarity at the research site is 0.24. This figure shows that the waters in the study area are very good and there is no pollution [45]. The effect of turbidity affects the abundance of Anura [46], and a decrease in the quality of life, as well as the foraging ability of Anura larvae, is reduced [47].

4 Conclusions

The value of species richness in each habitat is classified as low, and the species diversity in each habitat type including moderate. The calculation of the evenness value in river habitat was classified as stable while unstable in paddy. The highest level of habitat similarity is in river and forest habitats which is 0,6667 and the smallest is river habitat with paddy field habitat which is 0,4000. It can be concluded that the amphibian community in the river habitat is almost the same as the forest habitat, and the amphibian community in the paddy field habitat were different from the river habitat.

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References

1. D.H. Olson, P.D. Anderson, C.A. Frissel, H.H. Wels, D.F. Bradford, Biodiversity management approaches for stream-riparian areas: perspectives for pacific northwest headwater forest, microlimates and amphibian. Forest Ecology And Management 246, 2007, pp. 81-107.
2. S.A. Huda, Jenis herpetofauna di cagar alam dan taman wisata alam Pengandaran Jawa Barat, Pendidikan Sains 6(1), 2017, pp. 41-46.
3. K.R. Putra, D.H. Tjong, Komunitas Anura (Amphibia) pada tiga tipe habitat perairan di kawasan Hutan Harapan Jambi, Biologi 1(2), 2012, pp. 156-165.
4. Y.O.C. Bitar, L.P.C. Pinheiro, M.C. Santos, Species composition and reproductive modes of anurans from a transitional amazonian forest Brazil, Zoologia 29 (1), 2012, pp. 19-26.
5. S.S. Lieberman, Ecology of the leaf litter herpetofauna of a neotropical rain forest: La Selva Costa Rica, Acta Zool. Mex. Nueva Scr.15, S. S. 1986, pp. 1–72.
6. J.N. Urbina-Cardona, M. Olivares-Perez, V.H. Reysono, Herpetofauna diversity and microenvironment correlates across the pasture-edge-interior gradient in tropical rainforest fragment in the region of los tuxtlas Veracruz, Biological Conservation 132, 2006, pp. 61-75.
7. J.N. Urbina-Cardona, Conservation of neotropical herpetofauna: research trends and challenges. tropical consevation science 1(4), 2008, pp. 359–375.
8. D.T. Iskandar, W.R. Erdelen, Conservation of amphibians and reptiles in Indonesia: issues and problems, Amphibian and Reptile Conservation 4(1), 2006, pp. 60-87.
9. M. Kamsi, Survei amfibi reptilia di provinsi aceh pulau sumatera, Yayasan Ekosistem Lestari. Prosiding Seminar Nasional Biotik, 2017, ISBN: 978-602-60401-3-8.
10. A. Teynie, P. David, A. Ohler, Note on a collection of amphibians and reptiles from western sumatra(indonesia) with the description of a new species of the genus bufo, Zootaxa 2416, 2010, pp. 1-43.
11. D.T. Iskandar, Panduan lapangan amfibi Jawa dan Bali, Bogor: Puslitbang Biologi LIPI, 1998.
12. R.F. Inger, The systematics and zoogeography of the amphibia of Borneo, Chicago: Field Museum Of Natural History, 1966.
13. A. Hamidy, H. Kurniati, A new species of tree frog genus Rhacophorus from Sumatra (Amphibia: Anura), Zootaxa 3947 (1), 2015, pp. 49–66.
14. Y.S. Ariza, B.S. Dewi, A. Darmawan, Keanekaragaman jenis amfibi (Ordo Anura) pada beberapa tipe habitat di Youth Camp Desa Hurun Kecamatan Padang Cermin Kabupaten Pesawaran. Bandar Lampung, Jurnal Sylva Lestari. Vol 2. No. 1, 2014, pp. 21-30.
15. R.T. Kwatrina, Y. Santosa, P. Maulana, Keanekaragaman spesies herpetofauna pada berbagai tipe tutupan lahan di lanskap perkebunan sawit: studi kasus di PT.BLP Central Borneo, Journal Of Natural Resources And Environmental Management Vol. 9 (2), 2018, pp. 304-313.
16. R. Mardinata, G.D. Winarno, N. Nurcahyani, Keanekaragaman amfibi (Ordo Anura) di tipe habitat berbeda Resort Balik Bukit Taman Nasional Bukit Barisan Selatan, Jurnal Sylva Lestari 6 (1), 2018, pp. 58-65.

17. H.S. Alikondra, Teknik pengelolaan satwaliar dalam rangka mempertahankan keanekaragaman hayati Indonesia, Bogor: IPB Press, 2010.
18. M. Yuliani, Dampak penambangan batu gunung di desa merangin kecamatan kuok ditinjau menurut ekonomi Islam, Jurnal Rumpun Ekonomi Syariah 1 (2), 2018.
19. W.R. Heyer, M.A. Donnelly, M.C. Diarmid, L.C. Haek, M.S. Foster, Measuring and monitoring biological diversity: standard methods for amphibians, Washington: Smithsonia Institution Press, 1994.
20. M. Veith, S. Lotters, F. Andreone, M.O. Rodel, M. O, Measuring and monitoring amphibian diversity in tropical forest. estimating species richness from standardized transect censing, Ecotropica Vol (10), 2004, pp. 85-99.
21. M.D. Kusrini, Panduan bergambar identifikasi amfibi Jawa Barat, Bogor: Fakultas Kehutanan IPB dan Direktorat Konservasi Keanekaragaman Hayati, 2013.
22. P.B. Pearman, A.M. Velasco, A. Lopez, Tropical Amphibian monitoring: a comparison of methods for detecting inter-site variation in spesies comparison, Herpetological Vol 51 (3): 325337, 1995.
23. R.F. Inger, R. B. Stuebing, A field guide to the frog of Borneo, Sabah (MY): Natural History Publication, 2005.
24. R.F. Inger, D.T. Iskandar, A Collection Of amphibians from west sumatra with description of a new species of meghophrys (Amphibia: Anura). The Raffles Bulletin Of Zoology 53(1), 2005, pp. 133-142.
25. M. Munir, A. Hamidy, A. Farajallah, E.N. Smith, A new megophys kuhl and van hasselt (Amphibian: Megophrydae) from southwestern Sumatra, Indonesia, Zootaxa 4442(3), 2018, pp. 389- 412.
26. M.D. Kusrini, Pedoman Penelitian Dan Survey Amfibi Di Alam. Bogor(ID): Fakultas Kehutanan IPB, 2008.
27. R.F. Inger, Organization of communities of frogs along small rain forest streams In Serawak. Journal Animal Ecology, 1969, pp. 123–148.
28. M. Kamsi, Panduan Lapangan Amfibi Kawasan Ekosistem Leuser., Jakarta: Perpustakaan Nasional, 2003.
29. A. Hillers, M. Veith, M.O. Rodel, Effects of forest fragmentation and habitat degradation in african leaf litter frogs wes, Conservation Biology 22, 2008, pp. 762-772.
30. S.M. Rovito, G. Parra-Olea, C.R. Vasquez-Almazan, T.J. Papenfuss, D.B. Wake, Dramatic declines in neotropical salamander populations are an important part of the global amphibian crisis, Proceedings of the national academy of sciences 106 (9), 2009, pp. 3231-3236.
31. S. Soegianto, Ekologi kuantitatif metode analisis populasi dan komunitas, Surabaya: Usaha Nasional, 1994.
32. E. Odum, Dasar-dasar ekologi, Yogyakarta: Gadjah Mada University Press, 1996.
33. A.P. Dharma, M. Meitiyani, Inventarisasi amfibi Resort Cisarua Taman Nasional G\unung Gede Pangrango berdasarkan musim yang berbeda, Jurnal Biosilampari 2(1), 2019, pp. 1-5.
34. D. Samitra, Z.F. Rozi. Amphibian diversity in the hill and waterfall of Lubuklinggau City South Sumatra, Jurnal Biodjat 5(1), 2020, pp. 153-163.
35. M. Rahayuningsih, M. Abdullah, Persebaran dan keanekaragaman herpetofauna dalam mendukung konservasi keanekaragaman hayati di kampus Universitas Negeri Semarang, J. Indonesian Of Conservation 2 (1), 2012, pp. 144-159.
36. M. Sardi, S. Erianto, Keanekaragaman herpetofauna di resort lekawai kawasan Taman Nasional Bukit Baka Bukit Raya Kabupaten Sintang Kalimantan Barat, Jurnal Hutan Lestari. Vol 2.No 1, 2014, pp. 126-133.
37. C.A. Toft, Feeding ecology of panamanian litter anurans: patterns in diet and foraging mode, Journal of Herpetology 15(2), 1981, pp. 139-144.
38. M, Handayani, Struktur populasi limnonectes kadarsani di TWA kerandangan, Skripsi S1 Universitas Mataram, 2011.

39. S.C. Kendeigh, Ecology with special reference to animal and men. New Delhi (IN): Prentice Hall Of India Private Limited, 1980.
40. M.F. Yanuarefa, H. Gendut, U. Joko, Panduan lapangan herpetofauna (amfibi dan reptil) Taman Nasional Alas Purwo. Banyuwangi: Balai Taman Nasional Alas Purwo. 2012.
41. M. Wati, Spesis dicroglossidae (amphibian) pada zona pemanfaatan TNKS di wilayah Solok Selatan, Bioconcetta 2(2), 2016.
42. W. Sadinski, W.A. Dunson, A Multilevel study of effects of low ph on amphibians of temporary ponds, Journal Of Herpetology 26, 1992, pp. 413-422.
43. N. Nasaruddin. Karakteristik habitat dan beberapa aspek biologi kodok raksasa (Limnonectes cf. grunniens), Jurnal Veteriner Vol. 9 No. 4, 2008, pp. 182-187.
44. C.L. Rowe, W.J. Sadinski, W.A. Dunson, Effect of acute and chronic acidification on three larval amphibians that breed in temporary ponds. Arc. Environ contam toxicol. 23, 1992, pp. 339-350.
45. W. Hilsenhoff, Rapid field assessment of organic pollution with a family-level biotic index, J.N. Am. Benthol. Soc. 1988.
46. R. Brodman, J. Ongger, T. Bogard, A.J. Long, R.A. Pulver, K. Mancuso, D. Falk, Multivariate analyses of the influences of water chemistry and habitat parameters on the abundances of pond-breeding amphibians, Journal Of Freshwater Ecology Vol 18 No. 8, 2011, pp. 425-436.
47. A.C. Schmutzer, M.J. Gray, E.C. Burton, D. L. Miller, Impact of cattle on amphibian larvae and the aquatic environment, Freswater Biol. Vol.53 (12), 2008, pp. 2613-2625.

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