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Full Length Research Article

Diversity, Evenness, and Dominance Index of Amphibians in Lowland Rain Forest: A Case of Anura Ordo in Way Kambas National Park, Indonesia

Bainah Sari Dewi[1,*], Azalia Zania[1], Evi Damayanti[2], Kuswandono[2], Rudi Hilmanto[1]

[1] Department of Forestry, Faculty of Agriculture, University of Lampung, Bandar Lampung, Indonesia
[2] Way Kambas National Park (TNWK), East Lampung, Indonesia
[*] Corresponding Author. E-mail address: bainah.saridewi@fp.unila.ac.id

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ABSTRACT

Amphibian is a vertebrate animal whose life is always associated with water. Anura ordo has the most extensive spread in Indonesia. A study on amphibians in Way Kambas National Park has never been conducted. Therefore, the purpose of this research was to find out the diversity, evenness, dominance, temperature, and humidity of three various habitats of amphibians of Anura ordo in Rawa Bunder National Park Management Resort (RPTN Rawa Bunder), Way Kambas National Park, Indonesia. Amphibian data was collected using the visual encounter survey and line transect methods. The results of this research discovered amphibians in 6 families, which consisted of 13 species of amphibians based on observations in three different habitat types. The Shannon-Wiener diversity index (H') was categorized as moderate with the H' of 1.91–2.27. The evenness index (E) was considered stable, ranging between 0.87–0.91. The dominant index (D) falls into the low dominance group, with the D value ranging between 0.13–0.19. This shows that no dominant species is present.

1. Introduction

Global biodiversity is degrading at a decreasing rate. Daily changes in the climate, pollution, and industrialization are the leading causes of the decline in vertebrate biodiversity (Hassan et al. 2020). Biodiversity is a biological and alternative natural resource for living things (Anggraini 2018). A study from the World Resources Institute found that Southeast Asia has the last most extraordinary biodiversity, with natural forest ecosystem units that are relatively undisturbed and large enough to support human life; therefore, biodiversity trends and gaps must be studied (Basnet et al. 2019). Unfortunately, there is currently a decline in amphibians due to degradation and environmental pollution (Abaire et al. 2018).

Amphibian is a vertebrate animal whose life is always associated with water. The amphibians were the first vertebrate animals and had two stages of life, namely tadpoles (in the water) and adults (on land) (Pradhan et al. 2018). Amphibians are also one of the components of the ecosystem that play a vital role both ecologically and economically (Setiawan et al. 2016). In terms of ecology, amphibians can be used as bio-indicators in an area that has experienced degradation of environmental quality due to the density of human activity (Dewi et al. 2022). Ecologically, amphibians can be found in various types of habitats (Onadeko 2016). Habitat types

for amphibian life are terrestrial and aquatic, forest and non-forest, as well as urban and non-urban (Băncilă et al. 2017; Ecrement and Richter 2017; Hartel et al. 2020; Syazali et al. 2019). Additionally, amphibians are herpetofauna essential in energy flow and biogeochemical cycles in aquatic and terrestrial habitats (Syazali et al. 2017).

Amphibian diversity significantly impacts an ecosystem and the diversity of other animals living in that habitat. Like frogs and warts, amphibians are vulnerable to water pollution, changes in environmental quality, and climate change. Apart from that, amphibians consist of three ordos, including Cecilia, Caudata, and Anura, with the most widespread ordo being Anura (Irwanto et al. 2019). The Anura ordo has a head directly connected to the neck, and its legs are developed with longer hind legs (Ichbal et al. 2019; Jusmaldi et al. 2019). Anura are frogs and toads with 6525 species, more than 500 species in Indonesia, ranging from Sumatra to Papua (Kamsi et al. 2017; Subeno 2018). As explained above, amphibians are an essential ecosystem element for ecological and economic reasons. This trend also shows the need to study the conditions of their existence in Indonesian national parks, especially in Lampung Province.

Several studies on the diversity, evenness, and dominance of amphibian species in several national parks or lowland rainforest areas in the world have been conducted (Fukuyama et al. 2021; Kabanze et al. 2023; Kennedi et al. 2024; Mouane et al. 2024). Kennedi et al. (2024) conducted amphibian diversity surveys in the Bukit Baka Bukit Raya National Park (Tanakaya) in West Kalimantan Province, recording 50 amphibian species from nine families. Fukuyama et al. (2021) found 108 amphibians in Gunung Mulu National Park, showing that several species are exclusive to particular environments in many habitat types. Mouane et al. (2024) reported the findings of the amphibians of Anura ordo from three families, including *Bufotes boulengeri*, *Discoglossus pictus*, and *Pelophylax saharicus,* in the Sahara Desert of Algeria. Kabanze et al. (2023) reported 1649 individuals of amphibians from 21 species belonging to nine different genera and nine families in Kingwal Swamp and North Nandi Forest Reserve, Kenya.

As explained above, some studies have observed the diversity of amphibians in several national parks and lowland rainforest areas around the world. However, a few studies have still been conducted in the tropical rainforest of Sumatra. Mainly, there is still no observation of amphibians in Rawa Bunder National Park Management Resort (RPTN Rawa Bunder) of TNWK in East Lampung Regency, Lampung, Indonesia. Therefore, this study aimed to determine the diversity, evenness, and dominance of amphibian species of the Anura ordo in RPTN Rawa Bunder, TNWK as the amphibian study area using three different habitat types.

2. Materials and Methods

2.1. Time and Place

The research was conducted from February to March 2023 at Rawa Bunder Management Resort (RTPN Rawa Bunder), Way Kambas National Park, Indonesia. Observation was done in the evening from 19.00–22.00 and in the morning from 04.00–06.00 with 100 hours of observation. This study was conducted for 20 days (5 hours/day). The observation locations studied consist of three habitats: canal and pond, forest, and swamp. A map of the location of the research on amphibian diversity is presented in **Fig. 1**.

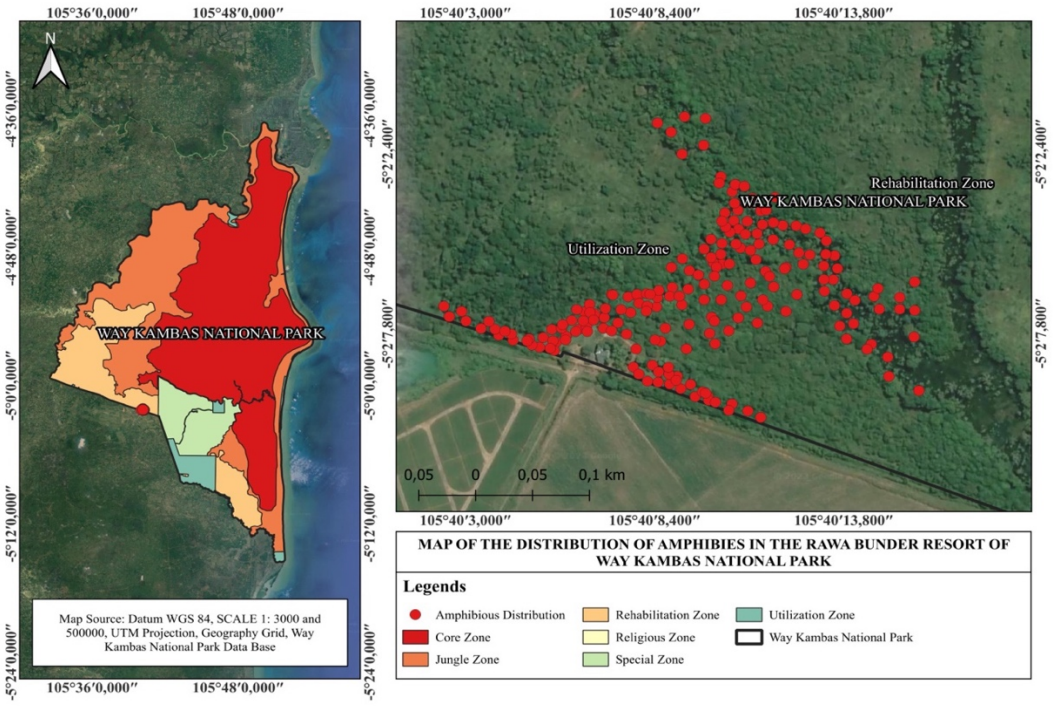


Fig. 1. Map of Research Locations in RPTN Rawa Bunder, Way Kambas National Park, East Lampung.

The Way Kambas National Park (TNWK) in East Lampung Regency is one of the areas of the National Park in the Province of Lampung that has three national park management sections (SPTN). The national park management resort (RPTN) is part of the SPTN. The area of this National Park is approximately 125,631.31 ha and is defined by the Decision of the National Park Number 670/Kpts-II/1999. The TNWK has an RPTN region called Rawa Bunder, with an area of 9,824.47 ha.

2.2. Methods

The data collection method used a combination of visual encounter survey (VES) and line transect. The combination between VES and line transect was carried out by carefully observing the research area to obtain types of amphibious existence. The transect line was a narrow path that crossed the location to be observed. The transect of the path was used as a boundary line to quickly know the object's condition, while the VES method was used to determine the wealth of the type in a research area. This study measured the temperature and humidity every day (22 February 2023 to 29 March 2023) during the study by using a thermohygrometer (Digital Thermohygrometer HTC-1, Equipslab, China).

The track used for research was 500 m. The location study consisted of forest areas with dominant habitats, including canals and ponds, forests, and swamps. Before observation, the habitat path was determined to adjust the bees (stations) that were 4 m away. Data was captured and collected by coming to the observation path in the morning and afternoon for 3 repetitions on each path. Each captured amphibian individual was recorded by the type of species, type of habitat, and quantity. The temperature and humidity were also included. The method was carried out along paths within observation paths, on river banks, on pond sides, and along transect paths (Arista et al. 2017).

2.3. Data Analysis

2.3.1. Species diversity index

Guidelines for the species of amphibians were taken based on the field guide for the diversity of herpetofauna types. The diversity of amphibian species was calculated using the Shannon-Wiener diversity index (*H'*) (Brower and Zar 1997).

$$H' = -\Sigma Pi\ (ln\ Pi) \quad (1)$$

where *H'* is the species diversity index, and *Pi* is the proportion of species. Criteria *H'* is as follows: $H' \leq 1$ is low diversity, if the $1 > H' \leq 3$ is medium diversity, and $H' > 3$ is high diversity.

2.3.2. Evenness index

Evenness was calculated to find out the level of evenness of the species on the research site (Brower and Zar 1997):

$$E = \frac{H'}{ln\ S} \quad (2)$$

where *E* is the evenness index, *H'* is the species diversity index, and *S* is the number of species. The evenness index values range from 0–1 with the following categories: $E \geq 0.5$ is under pressure, $0.5 > E \leq 0.75$ is labile, and $0.75 > E \leq 1$ is stable.

2.3.3. Dominance index

The dominance index of amphibians was calculated using Equation 3.

$$D = \Sigma(Pi)^2 \quad (3)$$

where *D* is the dominance index, and *Pi* is the proportion of species. The criteria for the Dominance Index are as follows: $0 > D \leq 0.5$ is low dominance, $0.5 > D \leq 0.75$ is medium dominance, and $0.75 > D \leq 1$ is high dominance.

3. Results and Discussion

3.1. Amphibians Habitat

The Way Kambas National Park (TNWK) has an area of approximately 125,631.31 ha, established by the Decision of the Minister of Forestry Number 670/Kpts-II/1999 dated 26 August 1999. TNWK has three sections of national park management (SPTN). SPTN 1 has several national park management resorts (RPTN), including RPTN Rawa Bunder. The three habitat types in the research location at RPTN Rawa Bunder, Way Kambas National Park, have different characteristics and compositions. The differences in these habitat characteristics cause the different types of amphibians found at each location. Amphibians select habitats based on various aspects of the ecological behavior of their environment and then use them to carry out their behavior according to these aspects (Prabhath et al. 2018). The three study habitat types are canal and pond, forest, and swamp (**Fig. 2**). The canal at RPTN Rawa Bunder is an artificial waterway constructed to prevent or limit elephants from leaving the forest area to the community's agricultural land. The canal has a size with a width of 2 m, a depth of 4 m, and a length of 500 m. The canal becomes a place for growing vegetation; it can collect rainwater if it rains.

Additionally, the pond is a small body of still water formed naturally and has a depth of 4 m, with growing various vegetation. The forest is a large area covered chiefly with trees. The swamp is a wetland often partially or intermittently covered with water. There are many trees with large diameters in swamps, which is the difference between water bodies (canals and ponds) and swamps.

Fig. 2. Three types of research habitats, including (a) canal, (b) pond, (c) forest, and (d) swamp.

Some species of Anura can only be found in specific habitat types, such as *Limnonectes kuhlii* and *Ingerophrynus biporcatus,* which are only found in canal and pond habitats. At the same time, Anura can be found in all habitats, such as *Fejervarya limnocharis* and *Hylarana erythraea,* because these two types of frogs have the most populations. Likewise, Hendri (2015) also stated that *Fejervarya limnocharis* and *Hylarana erythraea* are included in the abundant category, showing the easy species to find in any habitat. This might be due to environmental factors, as amphibians are one of the components of the ecosystem. Syazali et al. (2017) also explained that amphibian is a component ecosystem that interacts with the surrounding environment. These results also indicate a deficient presence of amphibians. The existence of these few species is most likely the result of disturbances produced by frequent public visits to RPTN Rawa Bunder. The habitat degradation could be due to the high adaptability of the species to the environment (Koirala et al. 2019).

3.2. Amphibian Diversity

This study found 6 families: the Bufonidae, Dicroglossidae, Ranidae, Rhocophoridae, Microhylidae, and Megophriyidae. The families consist of 13 species. The first family is Bufonidae, as shown in **Fig. 3**.

Fig. 3. Species of the Bufonidae family: (a) *Duttaphrynus melanostictus,* (b) *Ingerphrynus biporcatus.*

The Bufonidae family has a prominent characteristic: its rough skin is equipped with nodules all over the body and grooves that distinguish the species. *Duttaphrynus melanostictus* has a supraorbital groove, while Ingerphrynus biporcatus has a groove extending near the eye. This family was found in two research habitats, namely canals, ponds, and forests, with 26 individuals. According to Syazali et al. (2017), the activity of the species in this family occurs on land and in areas with stagnant water. This result discovered two species of the Bufonidae family in habitats with water bodies and forests. According to Huda (2018), this frog species has a brown back. The habitat of this species of frog is in waters such as paddy or water flows (Akhsani et al. 2021). The second family is Dicroglossidae; the species of this family are presented in **Fig. 4**.

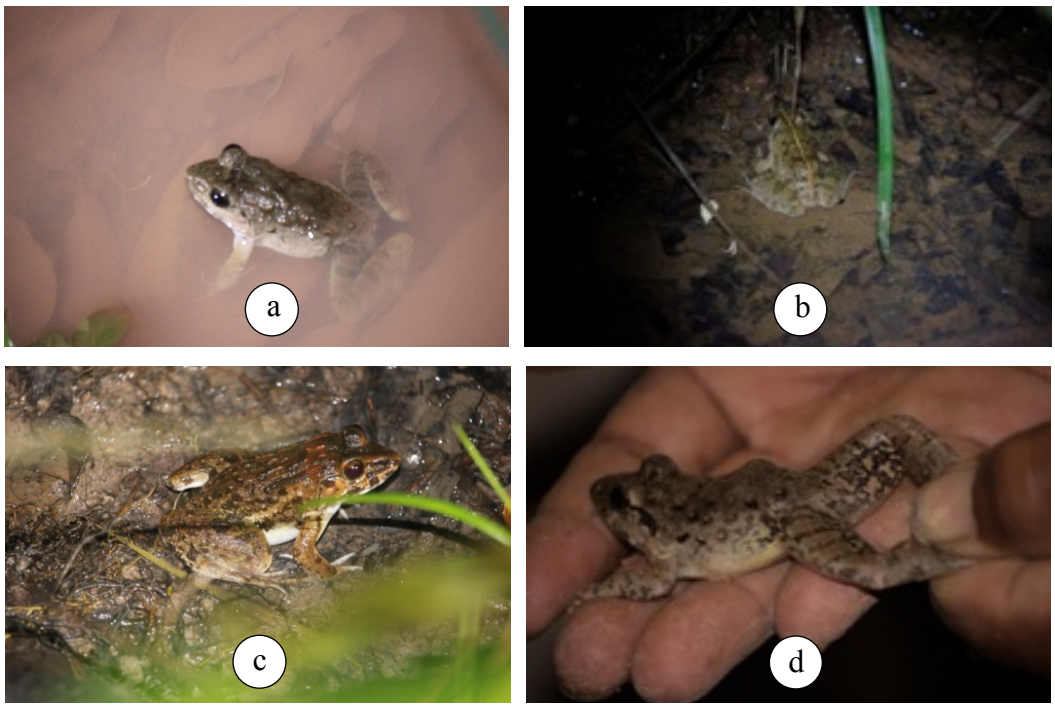


Fig. 4. Species of the Dicroglossidae family: (a) *Limnonectes kuhlii,* (b) *Fejervarya limnocharis,* (c) *Fejervarya cancrivora*, (d) *Limnonectes macrodon.*

The Dicroglossidae family is commonly found in water bodies and forests, where this species has 78 individuals. This family has a body that is dark brown and slender. Four species are found in this family, namely *Limnonectes kuhlii*, *Fejervarya limnocharis*, *Fejervarya cancrivora*, and *Limnonectes macrodon*, according to Yudha et al. (2014). This family has characteristics such

as a slender body, dorsal pattern, and dark brown. The third family, namely Ranidae, the species of this family is presented in **Fig. 5**.

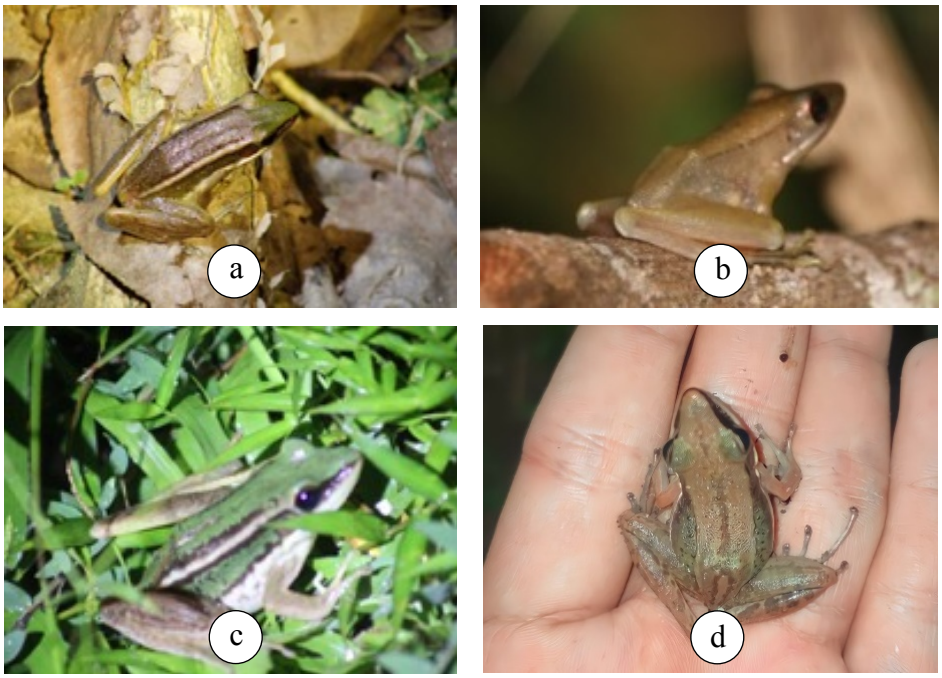


Fig. 5. Species of the Ranidae family: (a) *Odorrana hosii,* (b) *Chalcorana chalconota,* (c) *Hylarana erythraea*, (d) *Hylarana nicobariensis.*

Species in the Ranidae family are found in three types of habitats. The most common habitat with this family is the habitat of canals and ponds. This result is supported by Sanhayani et al. (2019) statement that this family is active mainly in the aquatic environment. There were 4 species found consisting of *Odorrana hosii*, *Chalcorana chalconota*, *Hylarana erythraea*, and *Hylarana nicobariensis*. The total finding of this species was 72 individuals. The Ranidae family is generally found to be green to brownish. The fourth family is Rhocophoridae; the species of this family are presented in **Fig. 6**.

Fig. 6. Species of the Rhocophoridae family: *Polypedates leucomystax.*

The Rhocophoridae family obtained one species of frog, namely *Polypedates leucomystax*. This species was found in three types of habitat with a total of 12 individuals. The habitat where most of these species were found is the habitat of water bodies. There are many plants in the habitat of water bodies (canals and ponds); therefore, this type of frog is found in many places. According to Ace et al. (2015), the habitat of these frogs is generally among plants around swamps and

secondary forests. The fifth family is Microhylidae; the species of this family are presented in **Fig. 7**.

Fig. 7. Species of the Microhylidae family: *Kaloula pulchra.*

The Microhylidae family is a species of frog with a small body size, head shape, and a small, narrow mouth. The species found is from the Microhylidae family, namely *Kaloula pulchra*. This species is found in two habitat types, namely water bodies and forests, with 9 individuals. This species has a dark brown body with light brown stripes on the sides of the body. When held, this frog has sticky and slightly brown mucus. This is in line with the statement of Qomaruddin et al. (2022) that this species is dark brown with light brown stripes, the skin surface is smooth and slimy and has invisible supratympanic and dorsolateral folds. The sixth family is Megophryidae; the species of this family are presented in **Fig. 8**.

Fig. 8. Species of the Megophryidae family: *Leptobrachium haseltii.*

Leptobrachium haseltii is found in the family Megophryidae. These frogs are found in two habitats, namely forests and swamps, but these frogs are found more in forest habitat types. The type of habitat that is highly favored by this species of frog is a habitat where there is much litter. This species has a brown-black body and rough spots all over its back. This type of frog has a slow response or can be said to be obedient. According to Ace et al. (2015), litter frogs are usually found in the lowlands or mountains, living among the litter on the forest floor.

3.3. Diversity Index

A species diversity index (H') can describe a species community's stability level. Biodiversity can measure a community's stability, that is, the community's ability to maintain its stability despite the disruption of its parts. The higher the value of *H'*, the higher the level of strength of the animal community (Yoga 2016). The species diversity index was produced based on species discovery in RPTN Rawa Bunder, Way Kambas National Park, East Lampung, and is presented in **Fig. 9**.

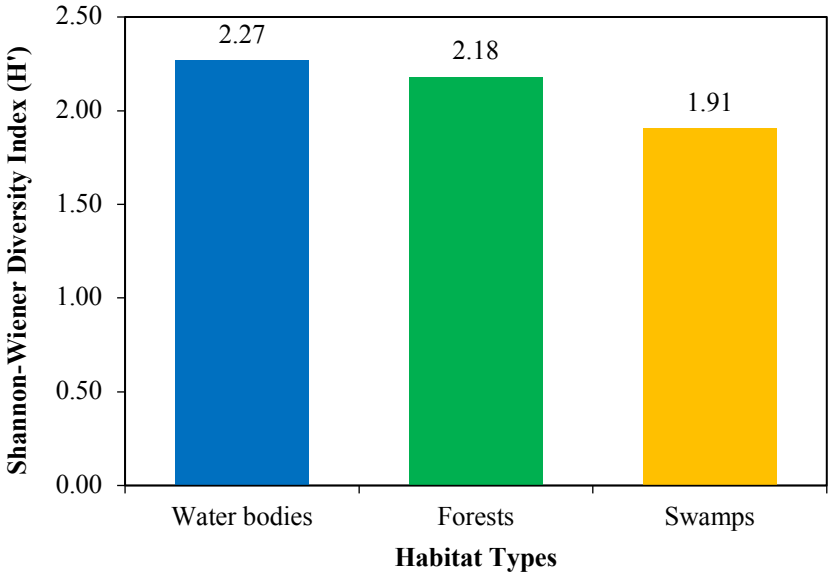


Fig. 9. Amphibian Shannon-Wiener diversity index (H') in forest areas with a dominant habitat of water bodies, forests, and swamps.

The H' values in three habitat types, including water bodies (canal and pond), forests, and swamps, are 2.27, 2.18, and 1.91, respectively. The H' generated on the three habitat types has a value with a medium category, where the value of the index on each habitat obtains a value of $1 > H' \leq 3$. When the H' of amphibian species reaches the threshold for a medium criterion, it indicates that the habitat conditions for amphibians have been disturbed. In the meantime, a high amphibian diversity indicates favorable habitat conditions. Rahman et al. (2020) also conducted a study in South-Eastern Nigeria, showing that an analysis of the amphibian diversity in the forest area is higher than that in the swamps area. Rumanta et al. (2019) also observed amphibians in Telaga Warna, West Java, finding the same number of families, namely six families, including Dicroglossidae, Microhylidae, Megophyidae, Ranidae, Rhacophoridae, and Bufonidae with different species. The difference in number of amphibians found at the Rawa Bunder Management Resort of Way Kambas National Park is different from the study of amphibians at the Balik Bukit Resort of Bukit Barisan Selatan National Park, where research conducted by Mardinata et al. (2018) found the number of individuals in the entire species as many as 149 individuals. The results obtained a relatively low diversity index ($H' \leq 1$). At the same time, at the Rawa Bunder Resort of Way Kambas National Park, there were 213 individuals, so the diversity index was classified as moderate because of $1 > H' \leq 3$. The number of amphibian discoveries can also be attributed to land cover conditions and varying microhabitat composition (Kwatrina et al. 2019). In this study, water bodies (canal and pond) have higher diversity index values than the other two habitat types. The different diversity index values are due to differences in findings for each number of individuals and number of species. The existence of amphibians in this type of aquatic habitat is more prevalent than in forests and swamps. This tendency could be because amphibians favor environments with an abundance of water.

The diversity of amphibians significantly affects ecosystems and the diversity of surrounding species. Nevertheless, the findings of this study indicated that there are fewer amphibian species. Many factors, including the release of hazardous waste into the environment, have contributed to the loss of amphibian species by destroying their habitat. This trend leads to a decrease in the frog

population, posing an increasingly significant threat to their survival (Syarif and Maulana 2018). Damage to forests or water pollution causes or even causes the loss of frogs' natural habitat (Setiawan et al. 2019). According to Irham (2017), there has been a current degradation in the population of amphibian species; the number of species shortages in amphibians also began to gain in some places caused by the loss or change of habitat, contamination of substances in the waters, changes in environmental conditions as well as damage to ecosystems.

3.4. Evenness Index

The evenness index (*E*) shows the value of the degree of individual abundance in each species. This index can be used as a parameter of the presence of dominance in a species on three types of research habitat. The evenness index on the three types of habitats produced is presented in **Fig. 10**.

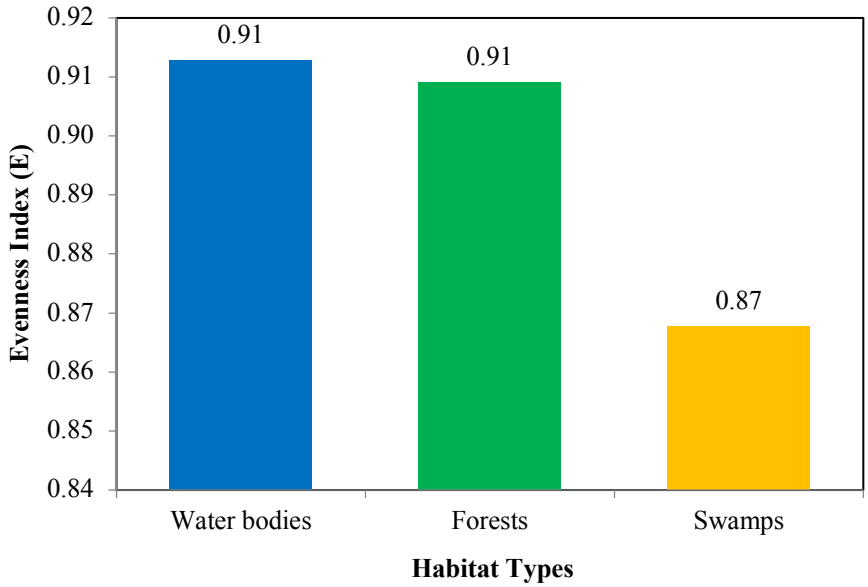


Fig. 10. Amphibian evenness index (*E*) in forest areas predominating water bodies, forest, and swamp habitats.

The result of the calculation of the evenness index on the habitat of water bodies (canal and pond), forests, and swamps are 0.91, 0.91, and 0.87, respectively. From the obtained values, the evenness in the three habitat types is categorized as stable. The frequency tends to be stable if the value reaches $0.75 > E \leq 1$. The high evenness factor results from the relatively equal distribution of individuals among different types of amphibians. The species exhibits a high evenness index if each kind has a similar number of individuals. The evenness index serves as a metric for assessing species balance, as it is influenced by the number of animal populations within a given ecosystem. Goudarzian and Erfanifard (2017) stated that relying solely on the evenness index is insufficient for assessing species diversity. Utilizing the Simpsons analysis to calculate a reliable index if needed is advisable.

The high-value evenness index includes the water bodies (canals and ponds) and forests. According to Primiani (2020), the first vertebrates to make the transition from aquatic to terrestrial existence were amphibians. Because they cannot appropriately adapt to the land and its surroundings, these animals exist in a state between that of water and land. Members of the Anura

ordo live in various habitats, such as terrestrial, aquatic, arboreal, and fossorial. The supportive factors of members of the Anura ordo found in those habitats are temperature and humidity, which enable them to live in that habitat (Siahaan et al. 2019).

3.5. Dominance Index

The dominance index (*D*) determines the concentration and distribution of dominant species in an area. The species dominance index is inversely proportional to the species diversity index. According to Rianto and Darmawan (2022), the higher the dominance index value in a community, the more species there are that influence that community. The dominance index for the three habitat types is presented in **Fig 11**.

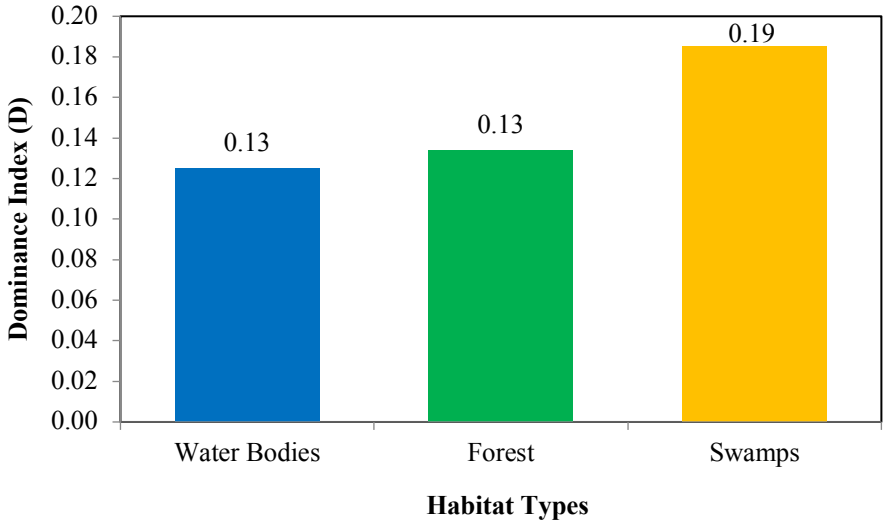


Fig. 11. Amphibian dominance index (*D*) in forest areas predominating water bodies, forest, and swamp habitats.

The results of calculating the dominance index in the three types of habitat obtained the value for water bodies (canal and pond), forest, and swamp are 0.13, 0.13, and 0.19, respectively. The result shows that the swamp habitat type has a higher dominance index than the other two habitats. However, the results are included in the low criteria where the value range is $0 > D \leq 0.5$. These results indicate that no single species dominates or does not dominate a habitat type in the RPTN Rawa Bunder, Way Kambas National Park. The small dominance index value indicates that there is no dominant species.

The dominance index value for the three habitat types was less than 0.5. The low value of this dominance index might be due to the high value of abundance at each habitat type. Likewise, Sulistyani et al. (2014) also stated that a low dominance index indicates an abundance in each species more evenly. Hence, the index of evenness and diversity in each habitat is higher. The diversity and evenness index values obtained follow the statement that the lower the level of dominance of a community, the higher the degree of diversity of each species (Rianto and Darmawan 2022).

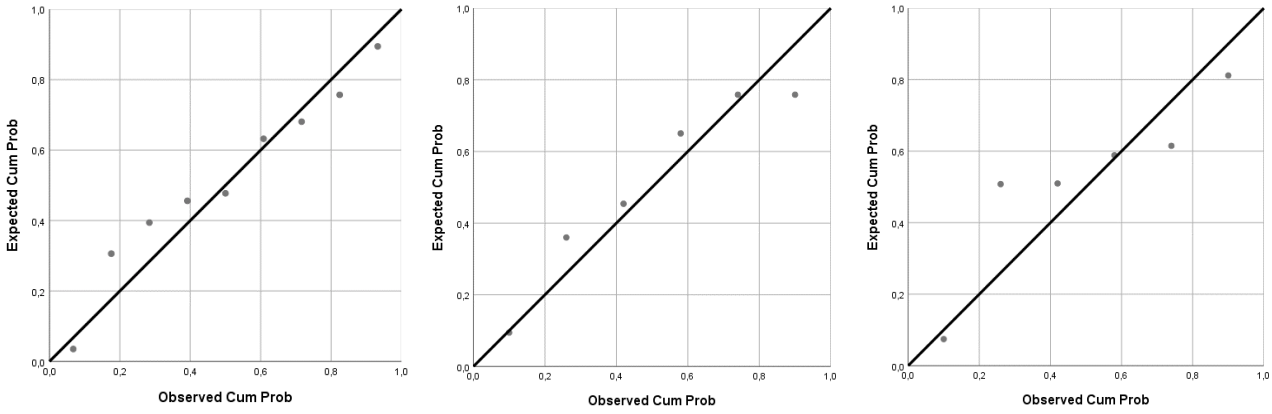
3.6. Temperature and Humidity

The environment encompasses both biotic and abiotic components, including live organisms. Temperature and humidity are environmental elements that affect the organization of

amphibian communities. Amphibians are ectothermic animals, meaning their body temperature is regulated by the temperature of their surroundings. There is a strong correlation among the number of species discovered, temperature, and humidity (**Fig. 12**). Measurements of temperature and humidity in each habitat are presented in **Table 1**.

Table 1. The temperature and humidity in each habitat with the diversity of species of amphibians of the Anura ordo at RPTN Rawa Bunder, Way Kambas National Park

Type of Habitat	Average		Diversity index
	Temperature	Humidity	
Water bodies	30°C	90%	2.27
Forests	28°C	90%	2.18
Swamps	29°C	86%	1.91



(a) **(b)** **(c)**

Fig. 12. Scatter log relation temperature and humidity in each habitat: (a) water bodies (canal and pond), (b) forests, and (c) swamps with diversity index.

The average temperature calculation in water body habitats (canals and ponds), forests, and swamps were 30°C, 28°C, and 29°C, respectively. In addition, the average humidity values obtained in the habitats of water bodies (canal and pond), forests, and swamps were 90%, 90%, and 86%, respectively. The weather conditions at the beginning of the observation were generally rainy, but in the middle and end of the observations, the weather was typically clear. Water bodies (canal and pond) and forest habitat types have a more excellent diversity value than swamp habitats. It could be caused by the water bodies (canal and pond) and forests, which are the most suitable habitats for amphibians, especially Anura ordo. Siahaan et al. (2019) explained that environmental conditions, including inappropriate temperature and humidity, cause frogs' habitat to decrease.

The suitability of a habitat has a significant impact on amphibian life. The three habitats that can be contrasted are water bodies (canals and ponds), forests, and swamps. Water bodies (canals and ponds) and forests are habitat types with favorable environmental or physical characteristics for amphibians. This tendency is corroborated by the abundance of specific observations for each category since amphibians prefer habitats with high moisture levels. Adhiaramanti and Sukiya (2016) explained that the supporting factors for the discovery of the Anura ordo in a habitat are

temperature and humidity. Amphibian diversity in swamps is low because temperature and moisture significantly affect amphibian diversity in a habitat. Fragmentation in a habitat correlates with environmental changes, making many species more vulnerable to population degradation, including amphibians (Muslim 2017).

The existence of an amphibian species in a habitat is depicted through the structure of a community and its spread. The presence of a certain amphibian species has an impact on the occurrence of other species as well. Amphibians necessitate a habitat with optimal humidity levels. According to Iskandar (1998), large amphibians are found to live in the human area as they require a sufficiently high humidity between 75%–85% to protect the body from drought, which means that in the area of habitat moisture research for amphibians, life corresponds. Therefore, amphibian life depends on water availability in a habitat (Branelly et al. 2019). Amphibians, like frogs, have a high degree of sensitivity to alterations in the condition of their surroundings. In the event of pollution in a specific region, their population and survival become imperceptible.

4. Conclusions

The study found 13 species of 6 families of amphibian species of the Anura ordo in the RPTN Rawa Bunder, Way Kambas National Park. The diversity index was classified as medium with the Shannon-Wiener diversity index (H') of 1.91–2.27. The evenness index value (E) was categorized as stable because it is within the value of 0.87–0.91. The dominant index (D) had a low-value category, indicating that the final value falls within the range of 0.13–0.19, which suggests the absence of a dominant species. The management of RPTN Rawa Bunder in Way Kambas National Park, East Lampung Regency, should prioritize the preservation of amphibian habitats. Additionally, it is crucial to preserve the presence of trees to ensure the provision of shade. This has implications for the long-term viability of amphibians during periods of low precipitation. During the dry season, if there is a significant number of trees and a thick canopy, the humidity levels remain elevated, allowing amphibians to continue inhabiting the swamp.

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References

Abaire, T., and Worabai, M. S. 2018. Deskripsi Morfologi Jenis Ular dan Katak pada Kawasan Hutan Pulau Mansinam. *Jurnal Kehutanan Papuasia* 4(1): 57–64. DOI: 10.46703/jurnalpapuasia.vol4.iss1.91

Ace, Mulyana, A., and Syarifudin, D. 2015. *Mengenal Katak di Taman Nasional Gunung Gede Pangrango*. Balai Besar Taman Nasional Gunung Gede Pangrango. Jawa Barat.

Adhiaramanti, T., and Sukiya, S. 2016. Keanekaragaman Anggota Ordo Anura di Lingkungan Universitas Negeri Yogyakarta. *Kingdom (The Journal of Biological Studies)* 5(6): 62–72. DOI: 10.21831/kingdom.v5i6.6024

Akhsani, F., Muhammad, M., Sembiring, J., Putra, C. A., Alhadi, F., and Wibowo, R. H. 2021.

Analisis Ekologi Relung Katak Fejervarya, Dramaga, Jawa Barat: Ditinjau dari Waktu Aktif Makan. *Jurnal Ilmu Hayat* 5(1): 10–16. DOI: 10.17977/um061v5i12021p10-16

Anggraini, W. 2018. Keanekaragaman Hayati dalam Menunjang Perekonomian Masyarakat Kabupaten Oku Timur. *Jurnal Aktual* 16(2): 99–106. DOI: 10.47232/aktual.v16i2.24

Arista, A., Winarno, G. D., and Hilmanto, R. 2017. Keanekaragaman Jenis Amfibi untuk Mendukung Kegiatan Ekowisata di Desa Braja Harjosari Kabupaten Lampung Timur. *Biosfera* 34 (3): 103–109.

Băncilă, R. I., Cogălniceanu, D., Ozgul, A., and Schmidt, B. R. 2017. The Effect of Aquatic and Terrestrial Habitat Characteristics on Occurrence and Breeding Probability in a Montane Amphibian: Insights from a Spatially Explicit Multistate Occupancy Model. *Population Ecology* 59: 71–78. DOI: 10.1007/s10144-017-0575-4

Basnet, D., Kandel, P., Chettri, N., Yang, Y., Lodhi, M. S., Htun, N. Z., Uddin, K., and Sharma, E. 2019. Biodiversity Research Trends, and Gaps from the Confluence of Three Global Biodiversity Hotspots in the Far-Eastern Himalaya. *International Journal of Ecology* 2019: 1–14. DOI: 10.1155/2019/1323419

Brannelly, L. A., Ohmer, M. E., Saenz, V., and Richards-Zawacki, C. L. 2019. Effects of Hydroperiod on Growth, Development, Survival and Immune Defences in a Temperate Amphibian. *Functional Ecology* 33(10): 1952–1961. DOI: 10.1111/1365-2435.13419

Brower, J. E., and Zar, J. H. 1977. *Field and Laboratory Methods for General Ecology*. Brown Co. Publisher, Iowa.

Dewi, B. S., Harianto, S. P., and Iwai, N. 2022. *Identifikasi Amfibi*. Pusaka Media, Bandar Lampung.

Ecrement, S. M., and Richter, S. C. 2017. Amphibian Use of Wetlands Created by Military Activity in Kisatchie National Forest, Louisiana. *Herpetological Conservation and Biology* 12(2): 321–333.

Fukuyama, R., Fukuyama, I., Kurita, T., Kojima, Y., Hossman, Y., Noda, A., and Nishikawa, K. 2021. New Herpetofaunal Records from Gunung Mulu National Park and Its Surrounding Areas in Borneo. *Herpetozoa* 34: 89–96. DOI: 10.3897/herpetozoa.34.e63998

Goudarzian, P., and Erfanifard, S. Y. 2017. The Efficiency of Indices of Richness, Evenness, and Biodiversity in the Investigation of Species Diversity Changes (Case Study: Migratory Water Birds of Parishan International Wetland, Fars Province, Iran). *Biodiversity International Journal* 1(2): 41–45. DOI: 10.15406/bij.2017.01.00007

Hassan, H. U., Ali, Q. M., Ahmad, N., Attaullah, M., Chatta, A. M., Farooq, U., and Ali, A. 2020. Study of Vertebrate Diversity and Associated Threats in Selected Habitats of Sindh and Baluchistan, Pakistan. *International Journal of Biology and Biotechnology* 17(1): 163–175.

Hartel, T., Scheele, B. C., Rozylowicz, L., Horcea-Milcu, A., and Cogălniceanu, D. 2020. The Social Context for Conservation: Amphibians in Human Shaped Landscapes with High Nature Values. *Journal for Nature Conservation* 53: 125762. DOI: 10.1016/j.jnc.2019.125762

Hendri, W. 2015. Inventarisasi Jenis Katak (Ranidae) sebagai Komoditi Ekspor di Sumatera Barat. *Jurnal BioConcetta* 1(2) 74–86. . DOI: 10.22202/bc.2015.v1i2.1508

Huda, N. 2018. Inventarisasi Keanekaragaman Amfibi di Kawasan Wisata Air Terjun Bajuin Kabupaten Tanah Laut. *Jurnal Pendidikan Hayati* 4(2): 85–92. DOI: 10.33654/jph.v4i2.646

Ichbal, P., Citrawathi, D. M., and Dewi, N. S. R. 2018. Nilai Palatabilitas Serangga Hama bagi Kodok Buduk (*Bufo melanostictus*) serta Potensinya dalam Mengendalikan Hama Serangga.

Jurnal Pendidikan Biologi Undiksha 5(3): 146–155. DOI: 10.23887/jjpb.v5i3.21967

Irwanto, R., Lingga, R., Pratama, R., and Ifafah, S. A. 2019. Identifikasi Jenis-Jenis Herpetofauna di Taman Wisata Alam Gunung Permisan, Bangka Selatan, Provinsi Kepulauan Bangka Belitung. *PENDIPA Journal of Science Education* 3(2): 106–113. DOI: 10.33369/pendipa.3.2.106-113

Iskandar, D. T. 1998. *Seri Panduan Lapangan Amfibi Jawa dan Bali*. *Puslitbang Biologi LIPI*, Bogor.

Jusmaldi, J., Setiawan, A., and Hariani, N. 2019. Keanekaragaman dan Sebaran Ekologis Amfibi di Air Terjun Barambai Samarinda, Kalimantan Timur. *Berita Biologi* 18(3) 295–303. DOI: beritabiologi.v18i3.3730

Kabanze, J. M., Kimanzi, J., Malonza, P. K., and Rutina, L. P. 2024. Anthropogenic Effects of Habitat Modification on Anuran Species Diversity in a Swamp Forest Area, Kenya. *African Journal of Ecology* 62(1): e13245. DOI: 10.1111/aje.13245

Kennedi, U. F., Purwanto, S., Jakaria, M., Kusrini, M. D., Prabowo, O. J., Yanto, A. V., and Maddock, S. T. 2024. Amphibians and Reptiles Diversity in Bukit Baka Bukit Raya National Park, West Kalimantan. *Media Konservasi* 29(1): 1–12. DOI: 10.29244/medkon.29.1.1-12

Koirala, B. K., Cheda, K., and Penjor, T. 2019. Species Diversity and Spatial Distribution of Amphibian Fauna Along The Altitudinal Gradients in Jigme Dorji National Park, Western Bhutan. *Journal of Threatened Taxa* 11(10): 14249–14258. DOI: 10.11609/jott.4944.11.10.14249-14258

Kwatrina, R. T., Santosa, Y., and Maulana, P. 2019. Keanekaragaman Spesies Herpetofauna pada Berbagai Tipe Tutupan Lahan di Lansekap Perkebunan Sawit: Studi Kasus di PT. BLP Central Borneo. *Journal of Natural Resources and Environmental Management* 9(2): 304–313. DOI: 10.29244/jpsl.9.2.304-313

Mardinata, R., Winarno, G. D., and Nurcahyani, N. 2018. Keanekaragaman Amfibi (Ordo Anura) di Tipe Habitat Berbeda Resort Balik Bukit Taman Nasional Bukit Barisan Selatan. *Jurnal Sylva Lestari* 6(1): 58–65. DOI: 10.23960/jsl1659-66

Mouane, A., Harrouchi, A. K., Ghennoum, I., Sekour, M., and Chenchouni, H. 2024. Amphibian and Reptile Diversity in Natural Landscapes and Human-Modified Habitats of the Sahara Desert of Algeria: A Better Understanding of Biodiversity to Improve Conservation. *Elementa: Science of the Anthropocene* 12 (1): 00106. DOI: 10.1525/elementa.2022.00106

Muslim, T. 2017. Herpetofauna Community Establishment on the Micro Habitat as a Result of Land Mines Fragmentation in East Kalimantan, Indonesia. *Biodiversitas Journal of Biological Diversity* 18(2): 709–714. DOI: 10.13057/biodiv/d180239

Onadeko, A. B. 2016. Distribution, Diversity, and Abundance of Anuran Species in Three Different Vegetation Habitats in Southwestern Nigeria. *Ethiopian Journal of Environmental Studies and Management* 9(1): 22–34. DOI: 10.4314/ejesm.v9i1.3

Prabhath, M. C., Jayasekara, E. G. D. P., and Mahaulpatha, W. A. D. 2018. Habitat Preference of Endangered Frog *Fejervarya greenii* (Amphibia : Dicroglossidae) in Tropical Montane Cloud Forests of Sri Lanka. *International Journal of Zoology Studies* 3 (5): 5–11.

Pradhan, A., Yonle, R., and Bhutia, D. 2018. Observations and Documentation of Amphibian Diversity from a Human-Modified Ecosystem of Darjeeling, with Record Occurrence of *Polypedates himalayanus* from Darjeeling Hills, West Bengal. *Asian Journal of Conservation Biology* 7(1): 66–72.

Primiani, C. N. 2020. *Keragaman Katak dan Reptil Lokal*. UNIPMA Press, Madiun.

Qomaruddin., Prayogo, H., dan Muflihati. 2022. Identifikasi Jenis Amfibi Ordo Anura di Kawasan Hutan Kota Gunung Sari Kota Singkawang. *Jurnal Lingkungan Hutan Tropis* 1(1): 1–8.

Rahman, M., Nneji, L. M., Adeniyi, A. C., Chen, J., Eniang, E. A., Oladipo, S. O., Olatunder, O., Onadeko, A. B., Kilunda, F. K., Ayoola, A. O., Adedeji, B. E., Nnjeji, I. C., Akwaowo, U., Ugwumba, A. A. A., Jin, J. Q., Yin, T., Peng, M. S., Olory, C., Eninekit, N., and Che, J., 2020. Amphibian Assemblages, and Diversity Patterns in Two Forest Ecosystems of South-Eastern Nigeria. *African Journal of Ecology* 58(4): 815–827. DOI: 10.1111/aje.12776

Rianto, A., and Darmawan, A. 2022. Keanekaragaman Amfibi pada Lahan Agroforestry di Pekon Kotabatu, Tanggamus, Lampung. *Journal of Forest Science Avicennia* 5(1): 58–70. DOI: 10.22219/avicennia.v5i1.19941

Rumanta, M., Kunda, R. M., and Iryani, K. 2019. Diversity, and Species Composition of Anura in Telaga Warna Nature Conservation, West Java, Indonesia. *International Journal of Zoology Studies* 4(5): 35–40.

Sanhayani, R., Supartono, T., dan Hendrayana, Y. 2019. Keanekaragaman Jenis Ordo Anura di Blok Palutungan Seksi Pengelolaan Taman Nasional Wilayah I Kuningan Taman Nasional Gunung Ciremai. In: *Prosiding Semnas Pengembangan Sumber Daya Perdesaan Dan Kearifan Lokal Berkelanjutan IX Purwokerto* (1): 93–101.

Setiawan, D., Yustian, I., Prasetyo, C.Y. 2016. Studi Pendahuluan: Inventarisasi Amfibi di Kawasan Hutan Lindung Bukit Cogong II. *Jurnal Penelitian Sains* 18(2): 1–4.

Setiawan, W., Prihatini, W., and Widiarti, S. 2019. Keragaman Spesies Dan Persebaran Fauna Anura di Cagar Alam dan Taman Wisata Alam Telaga Warna. *Ekologia: Jurnal Ilmiah Ilmu Dasar dan Lingkungan Hidup* 19(2): 73–79.

Siahaan, K., Dewi, B. S., and Darmawan, A. 2019. Keanekaragaman Amfibi Ordo Anura di Blok Perlindungan dan Blok Pemanfaatan Hutan Pendidikan Konservasi Terpadu, Taman Hutan Raya Wan Abdul Rachman. *Jurnal Sylva Lestari* 7(3): 370–378. DOI: 10.23960/jsl37370-378

Subeno, S. 2018. Distribusi dan Keanekaragaman Herpetofauna di Hulu Sungai Gunung Sindoro, Jawa Tengah. *Jurnal Ilmu Kehutanan* 12(1): 40–51. DOI: 10.22146/jik.34108

Sulistyani, H. T., Rahayuningsih, M., and Partaya, P. 2014. Keanekaragaman Jenis Kupu-Kupu (Lepidoptera: Rhopalocera) di Cagar Alam Ulolanang Kecubung Kabupaten Batang. *Life Science* 3(1): 9–17.

Syarif, M. A., dan Maulana, F. 2018. Keanekaragaman Jenis dan Kemelimpahan Amfibi di Desa Muning Dalam Kecamatan Daha Selatan Kabupaten Hulu Sungai Selatan. *Jurnal Pendidikan Hayati*. 4(4):195–200. DOI: 10.33654/jph.v4i4.649

Syazali, M., Idrus, A. A., and Hadiprayitno, G. 2017. Analisis Multivariat dari Faktor Lingkungan yang Berpengaruh terhadap Struktur Komunitas Amfibi di Pulau Lombok. *Jurnal Pendidikan Biologi* 10(2) : 68–75. DOI: 10.20961/bioedukasi-uns.v12i2.12340

Syazali, M., Idrus, A. A., and Hadiprayitno, G. 2019. Habitat Characteristic and Conservation of Amphibians in Lombok Island. *Biota: Jurnal Biologi dan Pendidikan Biologi* 12(2): 98–107. DOI: 10.20414/jb.v12i2.210

Yoga. 2016. Cara Menghitung Indeks Diversitas, Indeks Kemerataan, Pit Fall Trap, dan Indeks Dominansi untuk Keanekaragaman Hayati. <http://www.Biologi_edukasi.com>

Yudha, D. S., Yonathan, Y., Eprilurahman, R., Indriawan, S., and Cahyaningrum, E. 2015. Keanekaragaman dan Kemerataan Spesies Anggota Ordo Anura di Lereng Selatan Gunung Merapi Tahun 2012. *Majalah Ilmiah Biologi BIOSFERA: A Scientific Journal* 32(1): 1–10.