

Diversity of Amphibians (Order Anura) in Cibodas Resort Tourism Route, Gunung Gede Pangrango National Park

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Abstract. Cibodas Resort is one of the protected areas in Gunung Gede Pangrango National Park which is capable of supporting amphibian life. Amphibians can be used as bioindicators of environmental quality, especially aquatic ones. Amphibian studies are found to be interesting, but publications on amphibian data, especially at Resort Cibodas, are still rare. The publications regarding amphibian data of the Anura order, especially in the Cibodas Resort, have not been found. This Study aimed to determine the diversity of amphibians of the Order Anura in the Cibodas Resort tourist route. This research was an exploratory research conducted from September to October 2021. The research method used the Visual Encounter Survey method combined with the Line Transect method by following a predetermined path. The data was retrieved through the form of primary data (number of species of the Order of Anura in the Cibodas Resort tourist route). Based on the results of research at 3 sites, 12 species from 6 families were found with 192 individuals. The diversity index is classified as moderate with a value of 2.15, the evenness index is classified as high with a value of 0.86, and the dominance index is classified as low with a value of 0.14. The species that dominate in the 3 observation sites are from the family Ranidae namely *Odorrana hosii* and *Huia masonii*, the family Rhacophoridae namely *Rhacophorus margaritifer* and the family Dicroglossidae namely *Limnonectes kuhlii* and *L. microdiscus*.

Keywords: Anura, Cibodas Resort, species, sites

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INTRODUCTION

Indonesia has a high diversity of flora and fauna, makes Indonesia is dubbed as a megobiodiversity country. The high number and uniqueness of diversity of flora and fauna from a total of 1.3% of all land on earth consists of 16% of reptile and amphibian species (Rosmalasari, 2017). One of the high faunal diversity is amphibian diversity. The amphibian

class is estimated to have 8.004 species distributed worldwide (Amaral et al., 2019). Amphibians are the smallest species in the vertebrate group (Hashim et al., 2016). Amphibians act as good bioindicators because they are sensitive to environmental variability, low metabolic rates, and play an important role in the food chain (Riyanto & Rahmadi, 2021).

Amphibians consist of three orders,

namely Order Anura, Order Gymnophiona and Order Caudata (Narayana et al., 2014). Two of them found in Indonesia are Anura and Gymnophiona Order (Siahaan et al., 2019). The Anura Order is a tailless amphibian consisting of frogs and toads (Prasetyo et al., 2020). Order Anura or amphibians act as middle-level consumers who help transfer energy produced by primary producers to higher trophic levels because amphibians act as predators in controlling insect populations (Rofiq et al., 2021). Amphibians in the balance of ecosystems play the role of biological control and nutrient cycle. Amphibians also play a role for humans, namely as a source of protein (food source) and medicine (Kusrini et al., 2020).

Amphibians are sensitive to environmental changes such as damage to natural habitats, water pollution, disease, and parasites (Triesita et al., 2016). The spread of amphibians is highly dependent on temperature and humidity conditions in an environment (Kurniati, 2011). In Java Island, especially West Java, there are seven families of Order Anura that includes: Ranidae, Bufonidae, Dicroglossidae, Rhacophoridae, Microhylidae, Megophryidae, and Ichthyophiidae (Kusrini, 2013). Several research on amphibians in West Java has been carried out in several locations but is still limited to species diversity (Agus & Meitayani, 2019; Leksono & Firdaus, 2017; Huda, 2017; Setiawan et al., 2019). It is estimated that there are 38 species of Anura order found in the West Java region. One of the tropical forests in West Java is the Gunung Gede Pangrango National Park (TNGGP), however, data on the the Anura order that is on the tourist route of the cibodas resort has not been found.

TNGGP is a tropical rainforest area that is divided into three vegetation zones, namely sub-montane, montane, and sub-alpine (Syar-

ifudin et al., 2015). Based on preliminary research, the number of amphibians found in TNGGP is around 25 species, six of which are endemic to the island of Java, namely *Rhacophorus margaritifer*, *Nyctixalus margaritifer*, *Huia masonii*, *Limnonectes microdiscus*, *Megophrys montana*, and one species endemic to West Java and has been designated as a national animal, that is *Leptophryne cruentata*. Amphibians live under tree roots, in leaves that float in water, on trees, in water bodies at the base of *Pandanus* sp leaves, and around swamps and rivers.

One of the tourist routes in the TNGGP area is the tourist route via Cibodas. This tourist route has the characteristics of rocky paths at an altitude of 1000-1500 meters above sea level with dense vegetation cover. Resort Cibodas has two waterfall areas, Curug Ciwalen and Curug Cibereum. Curug Ciwalen tourist route is located approximately 800 meters from Cibodas Resort. There is a stream of water which is a preferred habitat for amphibians and dense tree vegetation. The Curug Cibereum tourist route is located approximately 2.8 km from Cibodas Resort. The Cibereum waterfall area is formed by the confluence of Mount Pangrango and Mount Gede lava with three flowing waterfalls, namely Cikundul, Cidendeng, and Cibereum waterfalls which are located in the west, center, and east of the entrance of the waterfall area.

The purpose of this study was to determine the diversity of amphibian species from the Anura order in the Cibodas Resort tourist route. Research on the Anura order at this location is needed to record the species found to see the conservation status of the protected species, namely the red toad which is a national animal in West Java. The data in regards to the diversity of amphibian species from the Order Anura in this area has not yet been published. The condition of the unpub-

lished data makes it necessary to research the diversity of amphibians of the Order Anura in this area. This research is expected to provide benefits and information about the types of amphibians found in the Cibodas Resort area, especially the Ciwalen waterfall and Cibeureum waterfall tourism routes so that it can be used as a basis for amphibian conservation efforts in the area.

MATERIALS AND METHODS

The method used in this research was the Visual Encounter Survey (VES) method combined with the Line Transect method (Sihahan et al., 2019). Data collection was carried out directly by walking along a predetermined observation location. Identification of Anura orders found using identification books by essays (Kusrini, 2013) and (Syarifudin et

al., 2015). Measurement of environmental data included temperature and humidity. Data analysis used was the Shannon-Wiener diversity index. The observation was conducted in 3 sites, site 1 and site 2 were located on the Ciwalen waterfall tourist route. Site 1 (HM 0 - 3) has the characteristics of a rocky road with a thick litter cover, a fairly dense vegetation cover with small river flow that is favored by amphibians, site 2 (HM 4 - Curug Ciwalen) has the characteristics of a denser vegetation cover compared to site 1 which is dominated by taro trees with a fairly fast waterfall flow and station 3 located on the Curug Cibeureum tourist line (HM 25 – Curug Cikundul). The path created is 350 meters long with a left right width of 6 meters. The path was made 350 meters long with a width of 6 meters to right and left. (Figure 1).

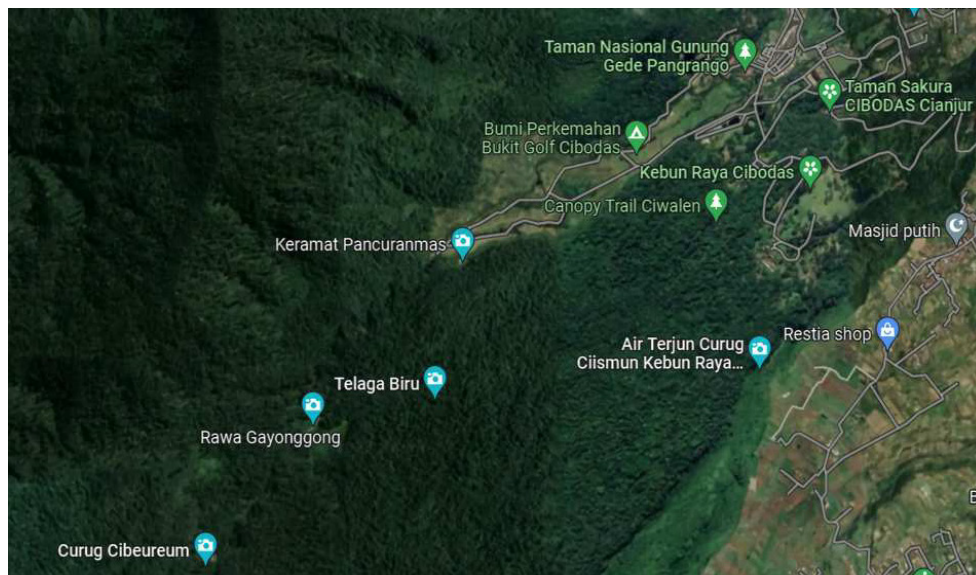


Figure 1. Reseach path map

The study was conducted in September – October 2021. Observations were carried out at night by walking along the land (terrestrial) and river flow (aquatic). Observations lasted for 3.5 hours from 19.30 to 23.00 on one observation line and were repeated twice

at each site.

These observations were focusing on locations that allow amphibians to be found, such as leaf litter, small streams, trees, weathered wood, and rocks. Observations were made by walking slowly along the transect.

If there were plant roots, then researchers observed the gaps. If there was rotten wood, it was dismantled to look for hidden animals. Environmental data collection was carried out simultaneously at the time of observation. Secondary data included temperature and humidity. Amphibian identification was carried out refers to an amphibious identification book written by (Kusrini, 2013), an identification book about frogs in the Gunung Gede Pangrango National Park written by (Syarifudin et al., 2015), and an essay identification book written by (Putra et al., 2019).

Sources of data collected are primary and secondary data. Primary data includes the scientific name of the species found, the number of individuals, time of encounter, activity when found, morphological conditions as well as humidity and temperature data. Data analysis used biological indices, namely diversity index (H'), evenness index (E), and dominance index (D).

Diversity Index (H')

The diversity of animal species was determined by using the Shannon diversity index (H') (Thukral et al., 2019):

Evenness Index (E)

The evenness index serves to determine the evenness of each type of individual in a community that the researcher encounters

(Thukral et al., 2019).

Dominance Index (D)

The dominance of the species was calculated using the dominance index with the Dominance of Simpson formula as follows:

$$D = \frac{\sum [ni]^2}{N}$$

D : Species Diversity

Ni : Number of individuals of each type

N : Total number of individuals of all species

The results of D could be concluded as follows:

≤ 0.50 : Low dominance

0.50 - 0.75 : Medium dominance

0.75 - 1.00 : High dominance

RESULTS AND DISCUSSION

There were 12 species belonging to 6 families with a total of 192 individuals found on the tourist route of Curug Ciwalen and Curug Cibeureum. The types of Order Anura found are listed in Table 1. There were 6 families of Anura order found, namely Ranidae, Megophryidae, Rhacophoridae, Bufonidae, Dicroglossidae, and Microhylidae. The Bufonidae family was only found at site 3 Curug Cibeureum, and Microhylidae family was only found at site 1 Curug Ciwalen.

Table 1. Species composition of Anura and their abundance

Family	Species	Status IUCN	St 1 Ciwalen	St 2 Ciwalen	St 3 Cibeureum	Total
Ranidae	<i>Chalcorana chalconota</i>	LC	14	33	0	47
	<i>Odorrana hosii</i>	LC	4	3	5	12
	<i>Huia masonii</i>	LC	3	3	13	19
Megophryidae	<i>Megophrys montana</i>	LC	2	2	1	5
	<i>Leptobrachium hasseltii</i>	LC	5	1	0	6

	<i>Rhacophorus margaritifer</i>	LC	10	3	2	15
Rhacophoridae	<i>Philautus aurifasciatus</i>	LC	0	7	2	9
	<i>Nyctixalus margaritifer</i>	LC	0	1	0	1
Bufonidae	<i>Leptophryne cruentata</i>	CE	0	0	17	17
	<i>Limnonectes kuhlii</i>	LC	5	4	14	23
Dicroglossidae	<i>Limnonectes microdiscus</i>	LC	28	7	1	36
Microhylidae	<i>Microhyla palmipes</i>	LC	2	0	0	2
Total individual/site			73	64	55	192

Of the 12 species found, the most abundant species were *Chalcorana chalconota* with 47 individuals, while the least abundance species were *Nyctixalus margaritifer* and *Microhyla palmipes*. The observation locations were dominated by 3 families, namely the Ranidae family with 12 species, with *Huia masonii* (19) and *Odorrana hosii* (12), the Rhacophoridae family with *Rhacophorus margaritifer* (15), and the Dicroglossidae family with 2 species, *Limnonectes kuhlii* (23) and *Limnonectes microdiscus* (36).

From the (IUCN, 2021) data, 11 species are in the low-risk level or the Least Concern (LC) category, and 1 species is in the critical level for extinction or the Critically Endangered (CE) category. The description of the identification of each family found is as follows:

The Bufonidae family is a unique amphibian group when compared to other Anura families due to the presence of a bidder organ, an ovary organ that develops at the anterior end of the male larva's testes. The species found in the family Bufonidae was *Leptophryne cruentata*. *Leptophryne cruentata* or the red toad is a species found only at site 3. It has a characteristic blackish-brown skin with shades of red and yellow colors scattered throughout the surface of the skin, the skin is spotted and

has a small to medium size. This species was only found at site 3 because this location is the natural habitat of the red toad. Red toads are found under the bridge of Curug Cibeureum and on the rocky cliffs near the waterfall flow of Curug Cikundul. Red toads love the rushing and cold flow of water, the location where at night the temperature reaches 18°C. Red toads are not found at site 1 and site 2 because this location has no heavy water flow and rocky walls covered with moss. Many red toads are found hiding in rocky walls that are difficult to distinguish by the color of their skin at night.



Figure 2. Bufonidae family (*Leptophryne cruentata*)

The Ranidae family is one of the most abundant families in nature. The Ranidae family is often found around the river. The species found from the Ranidae family were

Chalcorana chalconota, *Odorrana hosii* and *Huia masonii*. *C. chalconota* has a special characteristic of a line from the eye to the end. *C. chalconota* was found at site 1 and site 2 because the Curug Ciwalen tourist line has a characteristic of fairly dense vegetation cover dominated by taro trees, where this species was found in the trunk and on taro leaves. *C. chalconota* was not found at site 3 because the Curug Cibeureum tourist line has the characteristics of less dense vegetation cover and

there are no taro trees. In addition, site 3 has an altitude of 1600 – 1750 meters above sea level. This location is too high to be occupied by amphibian species. *H. masonii* and *O. hosii* were found on rocky walls near the flow of waterfalls and on the banks of streams. At all three observation sites there are streams that are the habitat of *H. masonii* and *O. hosii*. *H. masonii* is found in aquatic habitats while *O. hosii* is found in semi-aquatic habitats (Septiadi et al., 2018).



Figure 3. Ranidae family (1) *Chalcorana chalconota*, (2) *Huia masonii*, (3) *Odorrana hosii*

The Rhacophoridae family has a firmisternal shoulder bracelet type. Most of the Rhacophoridae Family occupy arboreal habitats. Some species of the Rhacophoridae family lay eggs in water and have aquatic tadpoles, but some genera such as Polypedates, Rhacophorus, and Chiromantis lay eggs by making foam nests in water or on vegetation located above water. The Rhacophoridae families found were *Nyctixalus margaritifer*, *Rhacophorus margaritifer*, and *Philautus aurifasciatus*. *N. margaritifer* has a special characteristic of pearl-like nodules scattered on the surface of the body. *N. margaritifer* was Rostikawati et al.

found only at site 2. This species is difficult to find because it lives inside the trunks of fallen trees. At the site 1, it has the characteristics of dense vegetation cover dominated by rattan trees, while at location of site 3 it has the characteristics of vegetation cover that is not too tight and there are no fallen trees. *R. margaritifer* was found at three sites because this species is found in primary forests above altitudes of 250 to 1700 meters above sea level and is usually found perched on leaves and tree stalks. *P. aurifasciatus* was not found at site 1 because this location is dominated by rattan trees, this species at site 2 and site 3 is

found in the leaves and stalks of taro trees and

bushes.



Figure 4. Rhacophoridae family (1) *Nyctixalus margaritifer*, (2) *Rhacophorus margaritifer*, (3) *Philautus aurifasciatus*

The Megophryidae family is often known as litter frogs because they are often found under litter or dry leaves. The species found from the Megophryidae family were *Leptobrachium hasseltii* and *Megophrys montana*. *L. hasseltii* has a special feature of large and rounded head, larger than its body, and large bulging eyes. *L. hasseltii* was only

found at site 1 and site 2 because this location has the characteristic of a denser litter cover compared to site 3. Dense litter cover is the habitat of *L. hasseltii*. *M. montana* has a special feature of eyelids resembling horns. *M. montana* is generally brown in color resembling the color of dry leaves making it difficult to find.



Figure 5. Megophryidae family (1) *Leptobrachium hasseltii*, (2) *Megophrys montana*

The Microhylidae family has normally separated fingers, the tips of the fingers do not form discs and do not form claws. It has a small body size and a narrow mouth. Most members

of this family are toothless. The species found from the family Microhylidae was *Microhylla palmipes*. *M. palmipes* was found only at site 1 because this location has the character-

istic thick litter cover according to its habitat. At site 1 *M. palmipes* were found on rocky roads covered with litter of dry leaves close to streams of water. At the 2nd site *M. palmipes* was not found because this location is a tourist location that is often visited by tourists so the habitat of *M. palmipes* is slightly disturbed by human activities. At the site 3 *M. palmipes* was not found because at this location has the characteristic of thin litter cover.



Figure 6. Microhylidae family (*Microhylla palmipes*)

The Dicoglossidae family is frogs with fat-shaped, large and round hind leg mu-



Figure 7. Dicoglossidae family (1) *Limnonectes kuhlii*, (2) *Limnonectes microdiscus*

Ecological Index

The ecological index is measured using the Shannon-Wiener diversity formula, the evenness index using the Evenness formula, and the dominance index using the Dominance of Simpson formula. The results of the calculations are presented in table 2.

According to the table of ecological index, it is known that the average diversity

scles, feet generally with rounded toes, the fores are generally not webbed, while the back toe membranes are generally half or extend to the tips of the fingers. Species the family Dicoglossidae found were *Limnonectes microdiscus* and *Limnonectes kuhlii*. *L. microdiscus* and *L. kuhlii* were found at 3 observation sites that are close to the water flow. These 3 observation sites have small to large water flows corresponding to the habitat of *L. kuhlii*. The number of *L. kuhlii* found at site 3 was more than that of site 1 and site 2 because site 3 has a fairly fast flow of water flowing from the cibeureum waterfall and there are rocks where this habitat is suitable for *L. kuhlii* to live. *L. microdiscus* was found in dry leaf litter close to water streams. *L. microdiscus* was most commonly found in site 1 because this location has a thicker leaf litter cover compared to site 2 and site 3. *L. microdiscus* was found only 1 individual at site 3 because this location has a vegetation cover that is not too tight so that the leaf litter cover is not too thick.

of Ordo Anura in the three observation sites is moderate, because the H' value obtained is 1.70 (<2). The evenness index of amphibians (Ordo Anura) in the three observation lines is high with an E value of 0.7 (>0.6). The dominance index in the three observation lines is low with a D value of 0.24 (<0.50) (Thukral et al., 2019).

Table 2. The ecological index

Path	Ecological Index					
	H'	Category	E	Category	D	Category
Site 1	1.81	Moderate	0.82	High	0.21	Low
Site 2	1.66	Moderate	0.72	High	0.30	Low
Site 3	1.65	Moderate	0.79	High	0.22	Low
Diversity Index in Cibodas Resort	2.15	Moderate	0.86	High	0.14	Low

Note. H' = Diversity Index, E = Evenness Index, D = Dominance Index

Diversity Index in the Cibodas Resort Tourism Route TNGGP

Based on the observations of diversity, 73 individuals found in site 1, 64 individuals found in site 2, and 55 individuals found in site 3. More amphibians were found in site 1 than other sites. This is because the topography in the site 1 tends to be flat with a thicker litter cover compared to sites 2 and site 3. In thick litter, there are many small invertebrates such as insects which are food for amphibians (Kusrini, 2013). In addition, on the site 1 the water flow is calmer, many amphibians were found sitting on rocks near the river. Anura needs water so that their skin does not dry out, and some Anura species have wet skin to help their breathing process because wet skin contains a lot of blood vessels and help oxygen diffuse through their skin.

On site 3, few amphibian individuals were found because the site 3 area is a tourist area visited by residents. Human activities can threaten habitat loss, fragmentation and habitat degradation which will affect the amphibian population (Hamer & McDonnell, 2008). Human activities in tourist attractions will also lead to the loss of amphibian habitats such as the loss of native habitats due to the logging of wild plants and bushes, the use of handwashing soap around the water flow, and the large amount of garbage found at tourist

sites due to the lack of education for the public regarding the importance of not throwing garbage near the water flow.

Based on the result, the diversity index in the site was 2.15, categorized as moderate diversity. The evenness index was indicated as high, with a value of 0.86. while the dominance index was found to be low at value of 0.14. This is because considering the condition of the community close to human activities passing by in the research area, it is possible to disturb the existence of the order anura., while the value of the type evenness index (E) is classified as a high category. This is because the evenness of the abundance of individuals of the order anura between each species has the same number, so the community has the maximum evenness of types. The dominance index value (D) is classified as low, indicating that at the three observation stations there is no dominating type. There are two types of species found for each station, namely the species *Odorrana hosii* and *Huia masonii*

Environmental Parameter Data

The environmental parameters measured were air temperature, water temperature, and humidity. These environmental parameters affect the diversity of Anura species. During the study, the temperature of the sites was in the normal range.. According to (Septiadi et

al., 2018) amphibians need a certain temperature to be able to live which is a maximum of 26-33°C. The humidity was high because the three observation locations have just rained. Humid places are ideal places for amphibians to live. With humidity in this range, amphibians are able to survive and adapt well. This is supported by research (Meliya, 2016) that most amphibians need water and high enough humidity ranging from 75-85% to protect the body's skin from drying out.

From the environmental parameter data

that has been measured, air temperature and humidity greatly affect the diversity of amphibians on the Cibodas resort tourist route. The temperature range at each observation site is relatively good for the growth and development of amphibians. Humidity at each observation site showed such a high value that it was enough to protect itself from the dryness of the skin of amphibians. Humidity in forest areas has a relatively higher, this is due to the closure of tree canopies that block sunlight.

Table 3. Temperature and humidity parameters

Environmental Parameter	Sampling Day								
	1	2	3	4	5	6	7	8	9
Air temperature (°C)	19	19	18	18	20	17	19	18	16
Water temperature (°C)	20	18	18	19	18	18	19	18	18
Humidity (%)	90	88	97	95	87	98	86	90	99

CONCLUSION

Based on the research that has been carried out on the Cibodas Resort tourist route, there were found 12 species belonging to 6 families with a total of 192 individuals. The species that dominate in the 3 observation sites are from the family Ranidae namely *O. hosii* and *H. masonii*, the family Rhacophoridae namely *R. margaritifer* and the family Dicroglossidae namely *L. kuhlii* and *L. microdiscus*. Species of the family Ranidae are species that occupy aquatic and semi-aquatic habitats corresponding to the observation site. A species of *R. margaritifer* lives arboreal, this species is widely found perched on trunks, stalks, and leaves on top of trees. The species *L. microdiscus* lives terrestrially, this species is widely found in dry leaf litter because there are many small invertebrates for this species to feed on. The species *L. kuhlii* occupies aquatic habitats around water bodies

by hiding behind stones. From the total family, there are 6 endemic to Java and West Java. The diversity index value on the Cibodas Resort tourist route is classified as moderate.

AUTHOR CONTRIBUTION

T.R. and D.P designed the research and supervised all the process, F.H. collected and analyzed the data and wrote the manuscript.

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CONFLICT OF INTEREST

The authors, that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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