Population Estimation and Habitat Characteristics *Rhacophorus reinwardtii* in the Secondary Forest Ranca Upas Ciwidey

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Abstract. This study aims to estimate population and describe the characteristics of the *Rhacophorus reinwardtii* habitat in the secondary forest of Ranca Upas. The Capture-Mark-Release-Recapture method was used in each region to collect population data. *Rhacophorus reinwardtii* habitat is rivers and puddles with a height of 1630-1680 m asl, the pH of the water was neutral and acid, the average speed of the river was 0 m/s and 0.04 m/s, water substrate is sand and mud, with an average of average temperature of 16.7ºC and 17ºC, average water temperature of 14.7ºC, average humidity of 94%. The type of plant that was often the habitat of *Rhacophorus reinwardtii* was *Brugmansia sp.* and Cyathea sp. The conclusion of this study was that the distribution of *Rhacophorus reinwardtii* populations in the heterogeneous forest area of Kampung Cai Ranca Upas tends to cluster.

Keywords: *Rhacophorus reinwardtii,* Amphibians, Morista Distribution Index

1 Introduction

Amphibians are one of the important components to maintain balance in the ecosystem. Amphibians are a key role in the flow of energy in ecosystems because they play a role as predators and prey [1]. Amphibians play a role in reducing the number of harmful insects from wetlands, as well as the potential to control populations of other pest insects [2]. If the number of amphibians in particular frogs decreases, it will affect the number of prey and predators in the ecosystem [1]. In addition, amphibians can also be used as an environmental bioindicator or health measure of an environment because of its sensitivity to changes in environmental factors [3].

Anura was a nation of the amphibian class who needs a natural environment to survive. Anura's main habitat was primary forest, secondary forest, swamp, river, lake, and pond [4]. The rain forest is a good place for Anura growth because its high humidity supports the survival of anura and other amphibians. At present, the natural forest environment has been widely used for the construction of settlements and the transfer of land use for plantations. This can cause damage to the natural environment, including loss of habitat due to changes in forest areas into campsites and tourist attractions. Damage due to the transition of land use can disrupt the survival of organisms in it, including anura.

In addition to habitat destruction, one of the factors that causes the Anura population to decrease is economic importance. Anura was known to be used as a material for human

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consumption. Every year, frogs can be consumed in the amount of tens of tons [5]. In addition to consumption materials, anura was traded between countries to be used as pet animals. The types of anura that are captured are generally brightly colored and beautiful frogs such as *Rhacophorus reinwardtii, Rhacophorus javanus*, and *Megophrys montana* [6]. In connection with the reduced habitat and population of the anura, researchers and experts conducted a study to determine the distribution of the population of several types of anura [7].

Rhacophorus reinwardtii was one of the frog species of the family Rhacophoridae which according to the International Union for Conservation of Nature (IUCN) status was Near Threatened (NT) or almost threatened (**Figure 1**). *Rhacophorus reinwardtii* has a length from the tip of the snout to the cloaca or Snout to Vent Length (SVL) in females reaching 76mm and in males reaching 52mm. scattered in several regions of the rainforest in Indonesia and Malaysia. Rhacophorus reinwardtii is usually found in primary and secondary forests, with an average height of 250 to 1200 masl [8]. The causes of *Rhacophorus reinwardtii* habitats loss were deforestation, land expansion, settlement construction in the natural environment and water and air pollution.

Fig. 1. Rhacophorus reinwardtii individual.

One of the known *Rhacophorus reinwardtii* habitat was the secondary forest of Ranca Upas, Ciwidey District, West Java. The Kampung Cai area in Ranca Upas has a campsite and one of the protected forests managed by PT. Perhutani Persero Bandung. The Kampung area in Ranca Upas has a forest area of about 215 hectares which includes primary forest, secondary forest and plantations. The Kampung Cai area in Ranca Upas has a natural forest in which there is a habitat of *Rhacophorus reinwardtii*. At present, The Kampung Cai area in Ranca Upas was used for tourism and camping ground, so it is feared that it will affect the habitat of various living things, especially *Rhacophorus reinwardtii*. This study aims to estimate population and describe the characteristics of the *Rhacophorus reinwardtii* habitats in the secondary forest of Ranca Upas, Ciwidey district, West Java.

2 Experimental Method

This research was conducted in a *heterogeneous* forest area in Kampung Cai, Ranca Upas Ciwidey district, West Java. The height of the study is 1660 to 1678 masl. The tools used in this research include GPS (Global Positioning Map), head lamp, thermohygrometer, thermometer, turbidity meter, and pH meter. Data on habitat characteristics taken were abiotic factors including temperature and humidity, water temperature, water turbidity, water pH, water flow velocity, and type of water substrate. Population data was taken by CMRR (Capture-Mark-Release-Recapture) technique from 19.00 to 23.00 West Indonesia Time using the Visual

Encountered Survey (VES) method or individuals who take direct discovery [9]. The observation area is divided into two, first is the river flow at an altitude of 1660 to 1663 masl with an area of 522 m2 and the second observation area is a puddle of water at an altitude of 1678 masl with an area of 528 m2. Each sample obtained is then measured in length from the tip of the snout to the cloaca (Snout - Vent Length). Samples were captured by hand and then marked using shoelaces (Figure 1), then released back at the original location [10]. At the end of the study, the search was carried out by recapturing the sample and then releasing the mark attached to the sample found [11].

Data Analysis

Estimation of Abundance

The estimated population abundance of Rhacophorus reinwardtii species is calculated using the Schnabel formula. Schnabel's formula (1938) is shown on Equation 1:

$$N = \frac{\sum Mt.Ct}{\sum Rt} \quad (1)$$

Annotation:
Mt = Total of individuals that have been tagged
Ct = Individual obtained on the t-day
Rt = Number of recaptures

The variant of the estimated density can be calculated from the estimator variants or derived from the estimation parameters on Equation 2:

$$\text{Var}\,\frac{1}{N} = \frac{\sum_{t=1}^{s} Rt}{(\sum_{t=1}^{s}(\text{CtMt}))^2} \quad (2)$$

The standard error of measuring population density can be determined by Equation 3:

$$\text{Standard error of } \frac{1}{N} = \sqrt{Variance\,\frac{1}{N}} \quad (3)$$

Estimation of Abundance

Population density indicates the number of individuals in unit area. Population density analysis is performed using the following formula in Equation 4:

$$Di = \frac{Ni}{A} \quad (4)$$

Annotation:
Di = density i
Ni = number of individuals i
A = total area (Krebs, 2009)

Estimation of Abundance

The *Rhacophorus reinwardtii* population distribution pattern used the Morista distribution index on Equation 5:

$$\text{Id} = \frac{ni(\sum X^2)-ni}{N\,(N-1)} \quad (5)$$

Annotation:
Id = Morista distribution index
ni = Number of plots
N = total number of individuals
$\sum X^2$ = sum of the squares of individual plots.

With the provision if the value of Id <1 then the distribution pattern is evenly distributed, if the value of Id = 1 then the distribution pattern is random and if the value of Id> the distribution pattern is clustered.

Habitat Characteristics

Rhacophorus reinwardtii habitat characteristics include the number of individuals found in a plant species and abiotic factors including air temperature, water temperature, air humidity, water pH, water turbidity, water substrate and water flow velocity. The formula for calculating the speed of water flow is shown on Equation 6:

$$V = \frac{S}{T}$$

Annotation:
V = Speed of water flow (seconds / meters or minutes / meters).
S = Distance (meters).
T = Time (seconds, minutes or hours).

3 Results and Discussion

3.1 Estimation of Population Abundance

Based on the estimated population abundance, it is estimated that there are 45 individuals in the observation area covering 522 m2 in the first observation area and 30 individuals in the observation area covering 528 m2 in the second observation area (Table 1 and Table 2). *Rhacophorus reinwardtii* was commonly found in plants or bushes near the water. This finding was completed with previous research [12].The habitat characteristics of *Rhacophorus reinwardtii* were the water source area and the settlement border with the primary forest [12]. This has similarities with research conducted on the same genus but a different type, namely *Rhacophorus margaritifer* in Gunung Gede Pangrango National Park, Bogor City [13]. Kusrini suggested that *Rhacophorus margaritifer* would be difficult to find farther from a water source.

Table 1. Estimated abundance of *Rhacophorus reinwardtii* population in the first area.

t-	Ct	Rt	Tt	Mt	N (Individuals)
1	1	0	1	0	
2	1	0	1	1	
3	1	1	0	2	
4	2	1	1	2	
5	1	1	0	3	
6	4	0	4	3	45
7	3	0	3	7	
8	4	1	3	10	
9	2	0	2	13	
10	2	0	2	15	
Total	21	4	17		

Table 2. Estimated abundance of *Rhacophorus reinwardtii* population in the second area.

t-	Ct	Rt	Tt	Mt	N (Individuals)
1	1	0	1	0	
2	1	0	1	1	
3	1	1	0	2	
4	2	1	1	2	
5	1	1	0	3	
6	4	0	4	3	45
7	3	0	3	7	
8	4	1	3	10	
9	2	0	2	13	
10	2	0	2	15	
Total	21	4	17		

Rhacoporus reinwardtii is an animal that is poikilothermic, so that environmental factors such as the intensity of sunlight or the surface of objects in the environment exposed to heat from the sun is very influential for regulating the temperature of *Rhacophrus reinwardtii*. When the high temperature of the animal that is polychothermic will look for a water source or a closed place to adjust its body temperature, so that the habitat of Rhacophorus reinwardtii will be near the waters [14].

Ectothermic physiology and behavior in animals are very influential for *Rhacophorus reinwardtii*. Ectothermic animals such as *Rhacophorus reinwardtii* utilize heat from the environment to regulate metabolic processes in the body, but if the ambient temperature is excessive, *Rhacophorus reinwardtii* will approach the water source to adjust its temperature. Some types of frogs can adapt to high ambient temperatures, such as the *Neobatrachus aquilonius* which forms a damp cocoon covering its body to avoid dampening due to rising temperatures.

3.2 Population Density

Data on population density was obtained after calculating the estimated population abundance. The average population density in the area of 100 m2 is 9 individuals in the first observation area and 6 individuals in the second observation area. The average number of individuals in the first observation area was more than the average number of individuals in the second observation area. This is related to the characteristics of the habitat in the second observation area with a pool of water that has a more acidic pH so it is not too good for the development of *Rhacophorus reinwardtii* tadpoles.

The population density of *Rhacophorus reinwardtii* was a small amount. This finding was completed with previous research, in a study conducted in the ecotourism area of Rorokuning Waterfall, Nganjuk City, and Ironggolo, Kediri City found 10 *Rhacophorus reinwardtii* individuals in the tourism area Ironggolo with a 200 m transect, and no *Rhacophorus reinwardtii* individuals were found in the Rorokuning tourist area [15]. This discovery was related to the conservation status of *Rhacophorus reinwardtii* which is almost threatened or Near Threatened. The observations regarding the population density of *Rhacophorus reinwardtii* with the conservation status of Near Threatened.

In 2009, the discovery of the *Rhacophorus margaritifer* species increased so that the conservation status was lowered to Least Concern or low risk , but the results of observations found that the number of *Rhacophorus reinwardtii*/m_2 individuals with conservation status Near Threatened or almost threatened compared to the number of individual/m^2 *Rhacophorus margaritifer* with conservation status Least Concern or low risk. Both of these findings can indicate the tolerance limit of *Rhacophorus reinwardtii* in certain abiotic conditions, so that the habitat of *Rhacophorus reiwardtii* was narrower than that of *Rhacophorus margaritifer* with a denser population.

3.3 Population Distribution

Population distribution was influenced by abundance in a population because distribution patterns and distribution index values are obtained by calculating an index of abundance [16]. The *Rhacophorus reinwardtii* distribution pattern in the Kampung Cai Ranca Upas area has an index value of 1.05 (Table 3). Morista index calculation results show the grouping distribution. The tendency of a population to group is influenced by the same need for abiotic factors such as air temperature, humidity, and foraging needs. This clustering distribution pattern is influenced by the temperature and humidity of the air in the observation area, air humidity ranges from 91% to 96% in both observation areas. Anuras tend to inhabit places with high humidity to keep their skin moist. Moisture on frog skin was needed for breathing for frogs. Respiration with skin takes place in amphibians while on land and in water. Frog skin is always wet so that it can function as a respirator. In addition, the frog's skin is very thin, contains blood capillaries, and is equipped with mucous glands in the dermis and under the skin [17].

The pattern of clustered distribution of a population is often found in nature, because of the need for the same environmental factors in their habitat [18]. This grouping population distribution pattern was supported by the findings of the population density of *Rhacophorus reinwardtii* of 9 individuals/m^2 in the first observation area and 6 individuals/m^2 in the second observation area not far from the waters.

Table 3. Distribution Patterns of *Rhacophorus reinwardtii* Using the Morista Distribution Index in the Heterogeneous Forest Area of Kampung Cai Ranca Upas.

Ranca Upas Heterogeneous Forest Area	Id	Distribution Pattern
	1,05	Horde

1.4 Population Distribution

Research carried out in the highlands starting from 1630 to 1678 masl. The river flow near the observation area has sandy rock substrate with a depth of 20 cm to 60 cm. Stagnant water in the observation area has a substrate in the form of mud and turbid water so that the bottom of the pool is not visible (**Figure 2**). *Rhacophorus reinwardtii* individuals in the first observation area were found above the *Brugmansia sp.* near ailran water with a total of 7 individuals while in the second observation area on average found in plants *Cyatea sp.* near a pool of 10 individuals.

Fig. 2. Habitat Conditions in observation area.

Rhacophorus reinwardtii individuals in the first observation area were found on the *Brugmansia sp.* near the flow of water with a total of 7 individuals while in the second observation area on average found in plants *Cyatea sp.* near a pool of 10 individuals (Table 4).

Table 4. Number of *Rhacophorus reinwardtii* found in the first and second observation area.

No.	The First Observation Area		The Second Observation Area	
	Plant Names	Number of Individuals	Plant Names	Number of Individuals
1	*Passiflora sp.*	6	*Cyatea sp.*	10
2	*Chromolena sp.*	4	*Ficus sp.*	3
3	*Brugmansia sp.*	7	*Angiopteris sp.*	2
4	*Musa sp.*	2	*Musa sp.*	2
5	Not a plant	2	Not a plant	2

Rhacophorus reinwardtii can also be found in banana leaves, and in forests close to standing water [19]. Amphibians are a group of animals that need two environments, water and land, and can survive in both environments. During the breeding season of frogs will find a place to lay their eggs, frog tadpoles need water for living media before finally moving to the mainland when it reaches the adult stage [5].

During the research, one foam nest shown in **Figure 3** was found in the first observation area. Foam Nest is attached to the plant *Strobilantes sp. Rhacophorus reinwardtii* forms a sticky foam on the leaves of plants on the surface of calm water or a river with low current velocity when breeding. Foam Nest is a way of reproducing that is done by several types of Anura. Usually, the egg is placed in a foamy lump that hangs over a puddle and the tadpoles will fall into the water. Breeding with foam nest occurs in Leptodactylidae, Hyperoliidae, Leiuperidae, Myobatrachidae and Rhacophoridae. The foam serves to protect the eggs, when they hatch into tadpoles, tadpoles will fall into the water and continue to develop into adult frogs [20]. Plant species in the *Rhacophorus reinwardtii* habitat in the Kampung Cai Ranca Upas area are generally plants with a wide leaf surface, so they can be used as a place to find food or put foam nest during the mating season.

Fig. 3. Foam Nest from *Rhacophorus reinwardtii*.

Based on the results of observations obtained, the most plants that become a place for *Rhacophorus reinwardtii* are *Brugmansia sp.* and *Cyathea sp.* with a total of 7 individuals and 9 individuals. This shows the preference of *Rhacophorus reinwardtii* to dwell on plants that are above or near the surface of the water to find food also breed and are strong enough to hold his body weight. The results are different from the previous findings in around the slopes of Mount Ungaran, Central Java [12]. Wening stated that the types of plants that became the habitat of *Rhacophorus reinwardtii* in the slopes of Mount Ungaran, Central Java included *Coffea arabica, Psidium guajava*, *Cordyline sp. Cananga odonata,* and *Camellia sp.* near the waters. The difference in the discovery of *Rhacophorus reinwardtii* habitat species indicates that there is no special plant as the Rhacophorus reinwardtii habitat preference, the plant species used as *Rhacophorus reinwardtii* habitat are plants that are near streams or puddles.

A population will live in habitats with environmental factors that meet their needs. The behavior of an individual is strongly influenced by the interaction of other individuals and the environment [21]. Humidity, air temperature and water temperature are very influential for the life of amphibians including *Rhacophorus reinwardtii* [22]. In addition to temperature, a factor influencing *Rhacophorus reinwardtii* habitat preferences is the pH, different degrees of acidity of the water in the two observation areas thought to cause differences in the number of individuals found. In the first observation area with an average water flow pH of 6.5, 8 individuals/100 m^2 were found. This amount is more than the number of individuals found in

the second observation area with an average pH of standing water of 3, 3 individuals/100 m^2. This is related to the resistance of tadpoles to a certain water pH. The number of eggs that hatch from *Bufo americanus* and *Rana sylvatica* will decrease at pH 4.1 [23]. In contrast to the tadpoles of *Rana lessonae* and *Rana esculenta* which survive on water pH 6.4 to 8.1 [25]. The experiment on *Rana temporaria* tadpoles which were given pH at various levels from 3.6 to 6.5 [25]. Low pH of water where the tadpoles live can reduce the maximum size of the tadpoles during the adult stage ([25]. *Hyla gratiosa* and *Hyla femoral* show negative responses to low pH, and decreased survival rate. These findings may indicate that the tadpole survival rate of *Rhacophorus reinwardtii* at pH 3 is smaller or that growth is stunted so that it takes longer to metamorphose into adult frogs.

4 Conclusion

Based on the results of research on the population and habitat characteristics of *Rhacophorus reinwardtii, t*he estimated abundance of *Rhacoporus reinwardtii* amounted to 45 individuals in the first observation area, and 30 individuals in the second observation area. The density of the first observation area was 9 individuals every 100 m^2 and the second observation area was 6 individuals every 100 m^2 related to the conservation status that is almost threatened or near threatened. The distribution of the *Rhacophorus reinwardtii* population in the heterogeneous forest area of Kampung Cai Ranca Upas tends to cluster. This illustrates the need for the same environmental factors for each individual *Rhacophorus reinwardtii*, so that the habitat of Rhacophorus reinwardtii tends to be narrow.

Rhacophorus reinwardtii habitat in the heterogeneous forest area of Kampung Cai Ranca Upas in the form of plants near the waters with calm currents. Vegetation in the *Rhacophorus reinwardtii* habitat in the Kampung Cai Ranca Upas area was a plant with a wide leaf surface. During the research, there were two types of plants that were most often used as a perch by *Rhacophorus reinwardtii*, namely *Brugmansia sp.* and *Cyatea sp.*

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