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Diversity and Species composition of anura in telaga warna nature conservation, west java, Indonesia

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Abstract
Frog and toad (Order: Anura) are very sensitive to environmental changes, because of their sensitivity, usually they can be used as indicators for environmental change. On the other hand, there is only limited data about the diversity and distribution of frog and toad in West Java. This study objectives to collected data on species diversity, species composition and distribution of frog and toad from Telaga Warna, West Java, Indonesia. This study was conducted from August to September 2018, used Visual Encounter Survey (VES) method, which combined with 100 m2 transects for sampling. Data retrieval morphology used digital camera, and refers to the West Java Amphibious Identification Picture Guid, followed by calculation of diversity index and environmental parameters (physic and biology). This study founded 13 species from six families, is Megophryidae, Microhylidae, Ranidae, Bufonidae, Dicroglossidae, and Rhacoporidae. Shannon-Wiener diversity index, is H '= 2.114. The results of species frequency analysis showed that *R. chalconota* was in the highest category (29%), and the Three lowest species each is *B. melanostictus* (1%), *N. margaritifer* (1%), and *M. monata* (1%). *Rhacophorus reinwardtii* is a anura have status of Near Threatened based on the IUCN Red List data. The results of this study indicated that the level of diversity of anura species in the Telaga Warna nature conservation is classified as "*moderate*".

Keywords: Conservation, Anura, Diversity, Species composition, Telaga Warna

Introduction
Frog and toad (Order: Anura), is tailless amphibians which life cycles included aquatic and terrestrial phases. Early in their development post-hatching, tadpoles survive by eating muck or small aquatic insects, until they finally metamorphose, and only then do they come into land (Heying, 2004) [7]. Study reported by Cushman (2006) [4], asserted that anura are highly sensitive to environmental changes, poorly habitat quality and are extremely sensitive to changes in temperature and moisture because of their have permeable skin structure. In Indonesia they are around 450 species of anura which represent around 11% of the whole world with 28 species of anura found in West Java consisting of 6 tribes, namely Bufonidae, Dicroglossidae, Microhylidae, Megophyridae, Ranidae, and Rhacophoridae (Kusrini, 2013) [10].

The breeding cycle of anuran is influenced by rainfall, humidity and temperature, so that if there is a change in the composition of abiotic factors it will cause a life cycle disruption. Research by Aureo and Bande (2017) [1], stated that, like other amphibian, the life cycle of an anuran is directly affected by any environmental pressure in its habitat, whether in terrestrial or aquatic. Study reported by Dey (2010) [5], asserted that anuran that lives and reproduced in polluted environment and experience disturbances will result in malformation of organs and other body parts. At present one of the amphibian conservation measures is more focused on protecting breeding habitats (such as ponds, Lake and river), as well as the environment around the main habitat used to support all stages of the amphibian metamorphosis and their life cycle (Ostergaard *et al*., 2008) [17].

Telaga Warna is one of the conservation areas that has the potential to be developed as an ecotourism area. Government Regulation No. 28 of 2011 (Republic of Indonesia) states that the main function of Nature Tourism Park is as a location for tourism, and natural recreation, but in all these activities it is feared that it can reduced the environment quality of Telaga Warna as a conservation area. Telaga Warna nature conservation has an abundant diversity of anuran species. However, there is a lack of available data that contributes accurately to the estimated abundance of amphibian species in the Telaga Warna ecosystem. The basic research on amphibian in the Telaga Warna ecosystem focused for species diversity, composition and distribution of frog and toad. Study reported by Duellman and Trueb (1994) [6], asserted that this approach is based on species identification, species composition in relation to diversity of certain species can provide valuable information about patterns of local diversity (wealth, abundance and evenness), and continue to spatial and temporal distributions of species.

Species diversity is one variable that is useful for management goals in conservation (Yani *et al*., 2015) [24]. The changes in diversity aspect and species composition can be used as a basis in predicting and evaluating the environments response to management activities in a particular regions. So far, data on the diversity and composition of anura found in Telaga Warna nature conservation area has not been done, so it is very necessary to do research to supported the knowledge of the existence of these wildlife. The study ware objectives to collected data on species diversity, composition and distribution of frogs and toads from Telaga Warna nature conservation, West

Java, Indonesia. It is expected that the results of this study will be obtained data on species of frog and toad (Order: Anura), and their distribution in Telaga Warna nature conservation. The data can be used as a scientific reference for the benefit of science, especially to understand herpetology studies.

Materials and Methods

Selection of Study Sites

This research was conducted at Telaga Warna nature conservation in West Java Province, Indonesia. The study sites was the remaining part of primary forest, as many as Three sites (Figure 1). The location selection of samples collection is expected to answer the objectives of this study is to evaluated the diversity of anuran species and composition along successional gradients; with transects (interval of each 100 m^2) established along the observation path.

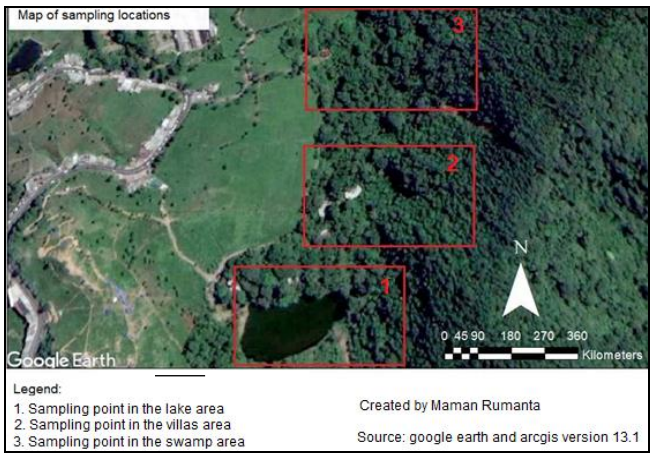

Fig 1: Location of the transect established along the primary forest gradient in Telaga Warna

Sampling Method

A 100 meters transect line was established along the observation track at each successional gradient. Anura were collected in the early morning at 6:00 - 9:00 am and in the evening at 7:00-10 pm (Warguez *et al.*, 2013) [25]. The Visual Encounter Survey (VES) method was used to search high potential areas throughout the sampling sites. These are on the surface and under rocks, logs, trees, and other debris along the transect line. All cover objects that were displaced from the area were returned to their original position to avoid disturbing the habitats. Anuran were captured directly by bare hands. After data collection, anuran were released back to their habitat.

Identification of Anura

Each individuals frog and toad captured is placed in a special receptacles for identifications. This was done to support the identification of anuran species. Likewise, photographs of each captured anuran were taken using a digital camera. Pre-identification in location observation was carried out used a field guide in the Two books is Frogs of Borneo (Inger and Stuebing, 2005) [8] and Picture Guide Identification Amphibian West Java (Kusrini, 2013) [10]. All photos during sampling were sent to a herpetologist of Department of Biology, Universitas Pakuan, Bogor, Indonesia for further identification. Final confirmation is made using the IUCN List of Threatened Species available in (https://www.iucnredlist.org).

Calculation of Diversity Index

Calculation of diversity index is carried out as a whole, by combining data from each plot from the research location, using formula which published by Brower *et al*. (1997) [3]:

a. Shannon's Diversity Index (H')

H' = -Σ pi (log *pi*).....(Eq. 1),

Where; H'= Shannon's Index, *pi* = total of species (i.e., total of individual for species relative to the total of individuals for all species).

b. Species Frequency (Ft)

$$Ft = \frac{St}{Sp} X\ 100\%$$

Where; Ft = Function of habitat for anuran "a" species in region A

St = The number of anuran "a" species found in region A

Sp = The number of all anuran species in region A

c. Environmental Parameters

Physical and biological data of the surrounding environment is carried out by measuring soil temperature, water temperature, soil pH, water pH, air humidity, and dissolved oxygen (DO) in water (Setiawan, 2003) [23].

Results

A. Species Diversity and Composition of Anura

The results of observation in Three sites within the Telaga Warna nature conservation area, obtained 13 anura species consisting of Six families, namely Megophryidae, Microhylidae, Ranidae, Dicroglossidae, Bufonidae and Rhacoporidae (Table 1).

Table 1: Species Diversity and Composition of Anura

Number	Families	Species	Site 1	Site 2	Site 3	Total of Individuals
	Dicroglossidae	*Fejervarya limnocharis*	12	1	6	19
		Limnonectes kuhlii	0	1	7	8
		Limnonectes microdiscus	28	5	10	43
2	Microhylidae	*Microhyla achatina*	32	8	16	56
		Microhyla phalmipes	9	0	0	9
3	Megophryidae	*Megophrys montana*	0	1	2	3
4	Ranidae	*Rana chalconota*	51	27	22	100
		Odorana hosii	5	2	0	7
		Nyctixalus margaritifer	0	3	2	5
		Philautus auriafasciatus	10	9	15	34
5	Rhacophoridae	*Rhacophorus margaritifer*	0	24	10	34

		Rhacophorus reinwardtii	4	2	10	16
6	Bufonidae	*Bufo melanostictus*	5	0	0	5
Total		13	156	83	100	339

Descriptions 1: Lake of Telaga Warna; 2 : Villa; 3 : Swamp

Based on data in table 1 showed that the total individuals be found in the Three collection sites in the Telaga Warna natural conservation area were 339 individuals. On site 1 (Lake Telaga Warna) there are 156 individuals, site 2 (Villa) there are 83 individuals, and site 3 (Rawa) there are 100 individuals. The percentage of individuals founded on sites 1, 2 and 3 respectively *R. chalconota* (100 individuals) and categorized as highest, followed by *M. achatina* (56 individuals), and *L. microdiscus* (43 individuals).

Figure 2 showed that of the 13 anura species founded in the Telaga Warna nature conservation area, the highest percentage was founded in *R. chalconota* (29%), *M. achatina* (17%), *L. microdiscus* (13%), *P auriafasciatus*, and *R. margaritifer* had the same percentage (10%), *F. limnocharis* (6%), *R. reinwardtii* (5%), *M. phalmipes* (3%), *L. kuhlii*, and *O. hosii* had the same percentage (2%), and Three species that have the lowest percentage (1%) is *B. melanostictus*, *M. montana*, and *N. margaritifer*.

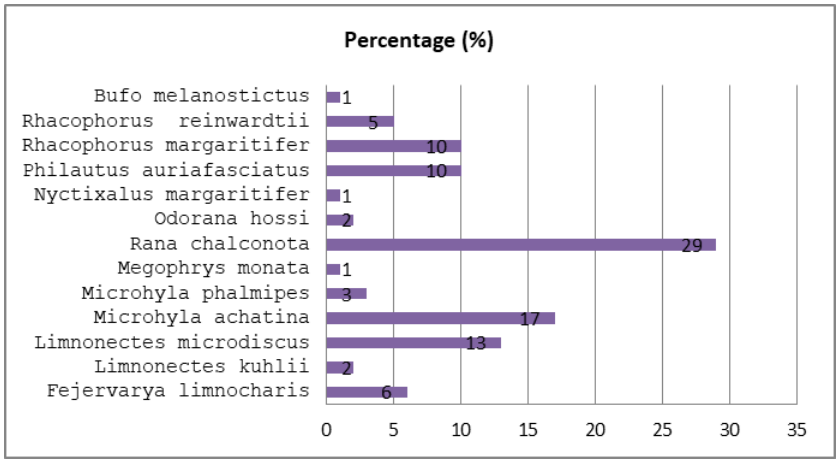

Fig 2: Percentage (%) of anura found in Telaga Warna nature conservation area

B. Environmental Factors on the Horizontal and Vertical Distribution of Anuran

The data of Table 2 showed that the horizontal and vertical distribution of anuran species in the Telaga Warna natural conservation area, and data on environmental factors are showed in Table 3. The results in Table 2 showed that 7 species from 4 families have a horizontal distribution pattern, 4 species from 2 families have a pattern vertical distribution, and 2 species from Ranidae have a horizontal and vertical mixed distribution types. The choice of distribution types (horizontal and/or vertical) of each anuran species has a positive correlation with environmental factors at each observation location which showed strong indications between distance and height.

There were 7 species that had horizontal distribution type are *F. limnocharis* (Dicroglossidae), *L. kuhlii* (Dicroglossidae), *L. microdiscus* (Dicroglossidae), *M. achatina* (Microhylidae), *M. phalmipes* (Microhylidae), *M. montana* (Megophryidae)), and *B. melanostictus* (Bufonidae). Four species that have vertical distribution type are *N. margaritifer* (Ranidae), *P. auriafasciatus* (Ranidae), *R. margaritifer* (Rhacophoridae) and *R. reinwardtii* (Rhacophoridae). Members of Ranidae (*R. chalconota*, and *O. hosii*) have horizontal and vertical mixed distribution types (Table 2). The results of this study stated that the horizontal distribution types of anura species in Telaga Warna nature conservation area consists of forest floor, lake of side, and irrigation areas, while vertical distribution included leaf surface, and/or under canopy.

Table 2: Horizontal and vertical distributions of anura in Telaga Warna nature conservation area

Number	Species	Horizontal Type	Vertical Type
1	*Fejervarya limnocharis*	Forest floor	-
2	*Limnonectes kuhlii*	Edge of Puddle	-
3	*Limnonectes microdiscus*	Edge of puddle, and forest floor	-
4	*Microhyla achatina*	Forest floor	-
5	*Microhyla phalmipes*	Edge of Puddle	-
6	*Megophrys montana*	Irrigation area	-
7	*Rana chalconota*	Forest floor, and Edge of puddle	Surface herbaceous leaves
8	*Odorana hosii*	Lakeside, Forest floor	Fallen tree branches
9	*Nyctixalus margaritifer*	-	Surface herbaceous leaves
10	*Philautus auriafasciatus*	-	Surface the leaves from Tea trees, and herbaceous leaves
11	*Rhacophorus margaritifer*	-	Surface the leaves from Tea tree
12	*Rhacophorus reinwardtii*	-	Palm tree
13	*Bufo melanostictus*	Lakeside	-

Based on the data in Table 3, stated that environmental parameters included humadity, soil pH, water temperature, and Dissolved Oxygen (DO) are quite different in the Three observation sites.

Table 3: Environmental parameters at Telaga Warna nature conservation area

Numbers	Parameters	Lake of Telaga Warna (1)	Villa (2)	Swamp (3)
1	Humidity (%)	70	72	72
2	pH of water	5	5	5
3	pH of soil	5	5	6
4	Water temperature (ºC)	21	21	19
5	Air temperature (ºC)	21	20	20
6	Dissolved Oxygen (DO) (mg/L)	20,3	24,5	26,1

Discussion

The results of this research showed that, overall the anuran diversity index in Telaga Warna nature conservation area is (H '= 2.114), and is categorized as medium. Odum (1971) [17], states that the standard diversity index values ; H' <1 is categorized as low, H' 1-3 is categorized as medium, and H' > 3, categorized as high. Research conducted by Qurniawan and Trijoko (2012) [20], reported that if diversity in one community is high, then the equilibrium between species is also high, but this does not apply otherwise. If the diversity and equilibrium of species is high, this indicates that the overall ecosystem of the habitat is in good condition.

The data of Table 1 showed that, in observation site 2 (Villa) has highest diversity anuran (11 species), although it has the smallest total of individuals (83 individuals) compared to two other observation sites. During the observation, the air temperature had a significant effect on the presence of *R. chalconota*, *M. achatina*, and *L. microdiscus* individuals, with the higher air temperature, the total of individual presence increased, while in *R. margaritifer* was negatively correlated. The lower the air temperature, the more then presence of *R. margaritifer* individuals. The increase in the number of individuals *R. chalconota, M. achatina*, and *L. microdiscus*, along with the increase in air temperature indicated that this type is actively spread at the location of the observed transect. The study conducted by Kurniati (2011) [11], concluded that air temperature greatly affects the horizontal and vertical distribution of frogs. In addition by Kurniati (2011) [11], that air temperature is very influential on the vertical and horizontal distribution of *R. erythraea* and *R. nicobariensis*, with higher air temperatures, the total of individual presence increases.

The high diversity index value at observation site 2 (Villa), is due to the fact that most of the active samples are in the subgrade vegetation that grows around the Villa area. There may be a positive correlation between the selection of subgrade vegetation clumps and the distribution of anuran species in the Telaga Warna area. It is thought that terrestrial vegetation groups act as a convenient microhabitat for anura species at this location with the aims of maintaining the stability of the microclimate temperature. Research by Beard *et al*. (2003) [2], stated that understanding amphibian habitat or knowledge about habitat preferences can be used to establish the ecological role of certain species and estimate the effects of habitat change. In contrast, Mckinney (2002) [13], asserted that low-quality habitats cannot support populations to the maximum and these habitats have the potential to cause populations to decreasing, resulting in large-scale population depletion.

Based on observations, showed that most active *R. chalconota*, *M. achatina*, and *L. microdiscus* individuals were active in the clump of *L. hexandra* wetland vegetation and *E. dulcis* which grew on the riverside. Generally, the Three species of anura are also seen actively voice between clumps of base land vegetation. Most likely this phenomenon is a strategy of the Three anura (*R. chalconota*, *M. achatina*, and *L. Microdiscus*), to minimize competition in obtaining a comfortable microhabitat in the preferred vegetation clump. Research by Johana *et al*. (2016) [9], reported that by understanding the distribution of anuran species and favored habitat types, then if there is a change in anuran habitat due to human intervention (example : deforestration), which can result in changes in the microhabitat and anuran behavior in response to these changes, it can predicted which species are susceptible to these impacts. The results of this study are consistent with the study by Kurniati (2010) [12], asserting that *M. achatina*, *A. compresus* and *L. hexandra* are associated to form a microhabitat that supports optimal growth of anura. Several studies showed that vegetation with high species diversity will contributed to the heterogeneity of anura because each anura will utilize various micro-habitats for optimal growth (Pombal, 1997; Oda *et al*., 2009) [19, 15].

The results of this research showed that environmental factors (water temperature, air temperature, humidity and moonlight) did not significantly affect the presence of anura species on 100-meter transects. Kurniati (2010) [12], stated that the condition of the moon greatly influences the existence of members from the Bufonidae and Ranidae tribes. The Bufonidae will be active during the full moon phase, while the Ranidae tribe will be in the dark moon phase (Kurniati, 2010) [12]. The results of this study asserted that the presence of members of the Bufonidae and Ranidae tribes in the conservation of Telaga Warna in general is not affected by the moon phase. Allegedly the distribution activities of members of the Bufonidae and Ranidae tribes around wetland vegetation are assisted by lights coming from buildings around the site. This has caused members of the Bufonidae and Ranidae tribes to adapted to conditions that always have a source of light even in the dark moon phase.

The results of the analysis of the diversity index values showed that 8 species of anuran with a low percentage distribution (<10%) (Figure 2) generally occupy a narrow ecological niche and are very dependent on water and have a small self-defense mechanism against predators. This is consistent with the results of research by Qurniawan *et al*. (2010) [21], stated that the species *L. kuhlii* was found with a percentage of 3% spread in the Sawangan ecotourism area, Magelang, Central Java. The results of the study by Qurniawan *et al*. (2010) [21], stated that there is a correlation

between the percentage of presence of anuran with ecological niches, the nature of dependence on water, and the defense mechanism against predators. Table 1 showed that *Megophrys montana* from the Megophryidae family was found with a very small number of individuals (3 individuals). Research by Johana *et al*. (2016) [9], asserted that the frog from the family Megophryidae is a type of burrow, and land dwellers from the litter layer and have faint body colors to blend well in their natural habitat. Therefore, they tend to be found on the forest floor and leaf litter. Factors such as this vague morphologys, elusive lifestyles and the fact that these species actually occur in low densities are some of the factors that can influence sampling, and thus affected the composition and abundance of anuran species (Duellman and Trueb, 1994) [6].

The results of this research are in accordance with research by Yani and Erianto (2015) [24], reported that found 18 anuran species in the Semahung Mountain Protected Forest area, West Kalimantan. Yani and Erianto (2015) [24], reported that from the 18 amphibian species it consisted of 6 families with a total of 357 individuals. The six families were Ranidae (n = 7 with 175 individuals), Bufonidae (n = 3 with 28 individuals), Dicoglossidae (n = 1 with 36 individuals), Rhacophoridae (n = 3 with 22 individuals), Megophryidae (n = 3 with 95 individuals), and the family Microhydae (n = 1 with 1 individual). Research by Oda *et al*. (2016) [16], reported that identified 19 anuran species forest remnants and agricultural landscapes in Southern Brazil, that belong to 11 genera and 5 families: Bufonidae (n = 1 species), Hylidae (n = 9), Leptodactylidae (n = 7), Microhylidae (n = 1), and Odontophrynidae (n = 1).

Research by Yani and Erianto (2015) [24], stated that the chance of meeting a species illustrated the amount of effort that must be done to find or search for a particular species. Study conducted by Mistar (2003) [14], asserted that each anuran has the same chance of meeting, therefore by understanding the living habits and habitat types of an anuran species comprehensively, can predicted the species that will be encountered during the observation. Heterogeneity in the distribution of anuran abundance in the study area may be a consequense of environmental characteristics at regional level (Werner *et al*., 2009) [26]. The higher species richness values reported by Oda *et al*. (2016) [16], this study may be related to differences in sampling methods (e.g., visual and acoustic search use of drift fences and pitfall traps) and sampling effort, as well as the area and type of habitat. However, the lower species richness in the present study may also be a consequence of habitat loss and fragmentation caused by the intense agricultural, tea plantations, making Villa for holidays, as well as various other activities. Based on data of IUCN Red List, 13 anuran species found in Telaga Warna nature conservation are into two categories, Near Threatened (n = 1) and Least Concern (n = 12). Species into in the Near Threatened category is *R. reinwardtii* while 12 another species fall into the Least Concern. The results of this study indicated that two species of anuran endemic from Java island were found in the Telaga Warna nature conservation area are *M. achatina* (Microhylidae) and *L. Kuhlii* (Dicroglossidae).

Conclusion

Based on observations on Three sites in the Telaga Warna areas, 13 anura species consist of Six families. The results of the analysis of species diversity based on the Shannon-Wienner index obtained a diversity index values is H'=2.114; which means the level of diversity of anuran species in the Three observation locations is classified as moderate. This research found two anuran species endemic from Java island are *M. achatina* (Microhylidae) and *L. kuhlii* (Dicroglossidae).

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