DIVERSITY AND DISTRIBUTION OF FROGS IN LAKE IPB DRAMAGA CAMPUS

KEANEKARAGAMAN DAN DISTRIBUSI KATAK DI DANAU IPB DRAMAGA

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ABSTRAK

Indonesia memiliki dua dari tiga ordo amfibi di dunia yaitu Gymnophiona dan Anura. Katak Indonesia memiliki 10 famili. Provinsi Jawa Barat terdapat 28 spesies katak dari enam famili. Umumnya habitat katak sangat beragam, bahkan dapat ditemukan di area urban. Distribusi katak di Kampus IPB Dramaga khususnya pada ekosistem danau masih belum diketahui. Sehingga penelitian ini bertujuan untuk mengetahui keanekaragaman dan distribusi katak di Ekosistem Danau IPB Dramaga. Metode yang digunakan yaitu Visual Encounter Survey (VES). Lokasi penelitian di tiga ekosistem IPB Dramaga (SDGs, Telaga Inspirasi dan LSI). Hasil penelitian menemukan delapan spesies yaitu *Duttaphrynus melanostictus, Ingerophrynus biporcatus, Fejervarya cancrivora, Limnonectes macrodon, Hylarana erythraea, Amnirana nicobariensis, Microhyla achatina*, dan *Polypedates leucomystax*. Spesies *D. melanostictus* dan *F. cancrivora* terdistribusi di seluruh danau. Penelitian ini menemukan bahwa keanekaragaman Shannon-Wiener di ekosistem danau IPB Dramaga (SDGs, Telaga Inspirasi, LSI) termasuk dalam kategori sedang (1.28–1.71). Indeks Keanekaragaman Brillouin termasuk dalam kategori tinggi (1.18–1.50). Indeks kemerataan (0.82–0.92) mendekati merata. Indeks Dominansi Simpson (0.21–0.30) dan Kekayaan Jenis Margalef (1.17–1.91) termasuk dalam kategori rendah.

Kata kunci: Amfibia, ekologi, keanekaragaman, perkotaan, Bogor.

ABSTRACT

Indonesia has two of the three amphibian orders, Gymnophiona and Anura. Frogs in Indonesia have ten families. In West Java, there are 28 Anura species from six families. In general, frog habitats are very diverse and can be found in urban areas. However, the distribution in the IPB Dramaga campus, especially in the lake ecosystem is still unknown. Therefore, this research aims to determine the diversity and distribution of the Anura order in the Lake Ecosystem of IPB Dramaga. The method used is the Visual Encounter Survey (VES). The research locations are the three lakes ecosystem at IPB Dramaga (SDGs, Inspirasi Lake, LSI). This research recorded eight species, including *Duttaphrynus melanostictus*, *Ingerophrynus biporcatus*, *Fejervarya cancrivora*, *Limnonectes macrodon*, *Hylarana erythraea*, *Amnirana nicobariensis*, *Microhyla achatina*, and *Polypedates leucomystax*. Species *D. melanostictus* and *F. cancrivora* are distributed throughout the lake. This study recorded that the Shannon-Wiener diversity in the IPB Dramaga Lake ecosystem (SDGs, Telaga Inspirasi, LSI) was in the medium category (1.28–1.71). Brillouin Diversity Index is in the high category (1.18–1.50). The evenness index (0.82–0.92) was close to even. Simpson's Dominance Index (0.21–0.30) and Margalef's Species Richness (1.17–1.91) were low.

Keywords: Amphibia, ecology, Bogor.

INTRODUCTION

Indonesia has two of the three orders of amphibians worldwide, namely Gymnophiona and Anura (frogs). Frogs spread almost all over the world. Indonesia has around 449 species from 10 families across various regions (Frost 2024). The West Java region is known to have 28 frog species from six families, including Bufonidae, Dicroglossidae, Microhylidae, Megophryidae, Ranidae, and Rhacophoridae. The tropical climate in Indonesia is very suitable as a habitat for various frog species (Maulana *et al.* 2023). Generally, they live in diverse habitats, and some species cannot be separated from water throughout their lives. This behaviour is a form of adaptation to maintain body moisture (Ardiansyah *et al.* 2014; Ra *et al.* 2008).

The distribution of frog species at IPB Dramaga Campus, one of the herpetofauna

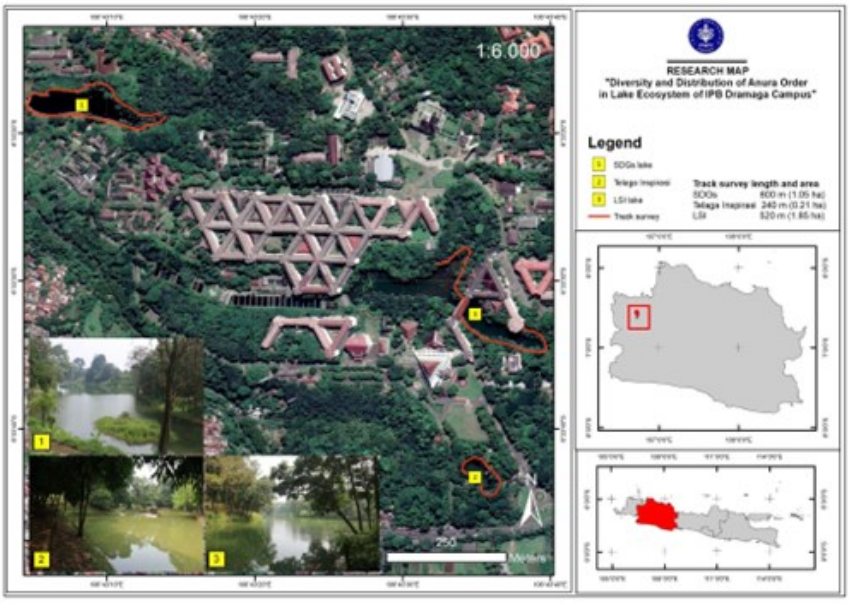

Figure 1. Research Location Map.

habitats in urban areas, has not been widely studied. The campus environment provides natural and artificial habitats such as ditches or gullies, ponds/lakes, experimental gardens, and rivers. Frog research in the IPB environment has been conducted several times, such as the inventory and composition of frog species which in 2020 there were ten species (Mustari 2020), an interspecific association of frogs with various habitats, recorded 13 frog species associated with rice fields, settlements, primary and secondary forests and the arboretum of the Faculty of Forestry of IPB (Yuliana 2000), An inventory conducted in the post-mining reclamation area resulted in widespread frogs data despite being in disturbed habitats such as the Ranidae family (Syoim 2020) and genetic analysis of frog species at IPB Dramaga (Ramdani 2023; Yulianti 2023).

Little research has been done on the diversity and distribution of frogs in the IPB Dramaga Campus. The distribution focused on the lake ecosystem has not been studied. Therefore, this study aimed to determine the diversity and distribution of frogs in the Lake Ecosystem of IPB Dramaga. It is expected that the data generated can be used to conserve frogs and their natural habitat at IPB Dramaga Campus, which is one of the green campuses in Indonesia.

RESEARCH METHODOLOGY

Data Collection

The research was conducted from March 07 to April 16, 2024, in three lake ecosystems of the IPB Dramaga campus (SDGs, Telaga Inspirasi, and LSI).

Materials and Methods

The tools that were used in this research are identification guidebooks of The Amphibian of the Indo-Australian Archipelago (Van Kampen 1923), The Amphibian of Java and Bali (Iskandar 1998), and Panduan Bergambar Identifikasi Amfibi Jawa Barat (Kusrini 2013), *AlpineQuest Off-Road Explorer* application, camera, measuring tape, Insize calliper (accuracy 0.01 mm), 4 in 1 environment meter Lutron Lm-8000, and digital pH meter. The material used was 70% alcohol.

Observations were conducted from 7:00 to 10:00 PM, using the Visual Encounter Survey (VES) method with four observers.

Observations were made along a transect line of ±0.3 – 0.6 km following the direction of the water body, with a width of 10 meters perpendicular to the water body. At each location, three observations were made as replicates, resulting in nine observations for the three locations.

During observations, individuals were photographed, captured, and measured for body length or Snout Vent Length (SVL). Individuals were distinguished between males and females based on the presence or absence of vocal saccular, vocal slits, and SVL. For each species, the number of individuals and the location of encounter points were recorded, and the distance from the water body was measured. Two individuals of each species, representing males and females, were collected and preserved using 70% alcohol. Specimens were deposited at the Laboratory of Animal Biosystematics and Evolution, IPB.

Environmental Factor Measurement

Environmental factors measured include air temperature, water temperature, air humidity, water pH, weather, and rainfall, measured periodically every 30 minutes during the sampling time. Measurements are taken at different points. Water pH measurements will be taken three times, near the inlet, in the center, and outlet.

Data Analysis

In this study, five types of ecological indices were used: the Shannon-Wiener Diversity Index (H'), Brillouin's Diversity Index (Hb), Simpson's Dominance Index (D), Shannon's Evenness Index (E), and Margalef's Species Richness Index (Dmg) which were calculated using the help of Microsoft excel applications. Distribution data or horizontal distance of species discovery with water bodies were visualised with the R Studio 12.1 program. Environmental parameters were analyzed descriptively.

1. Temporal α-diversity

a. Shannon-Wiener Diversity Index (H') (Magurran & McGill 2011)

$H' = - \Sigma\ pi\ In\ pi$ where pi=ni/N

Remarks:

H' : Shannon-Wiener Diversity Index

ni : Number of individuals of species

N : Number of individuals of all species

b. Brillouin's Diversity Index (Hb) (Pielou 1975)

$$Hb = \left(\frac{In\ N! - \Sigma In\ ni!}{N}\right)$$

Remarks:

Hb: Brillouin's Diversity Index

N : Number of individuals all species

ni : Number of individuals of species

c. Simpson's Dominance Index (D) (Magurran & McGill 2011)

$$D = \Sigma\left(\frac{ni}{Nl}\right)^2\ atau\ \Sigma\ (pi)^2$$

d. Shannon's Evenness Index (E) (Magurran & McGill 2011)

$$E = \frac{H'}{In\ S}$$

Remarks:

H' : Shannon-Wiener Diversity Index

S : Number of species

e. Margalef's Species Richness Index (Dmg) (Magurran & McGill 2011)

$$Dmg = \frac{S-1}{In\ N}$$

Remarks:

Dmg : Margalef's Species Richness Index

S : Number of species

N : Number of individuals of all species

2. Distribution

Ecological distribution was visualised in scatter plot graphs. These were created per species, male and female, and each research

Table 1. Species Composition of Frogs in Lake Ecosystem at IPB Dramaga .

Species	SDGs	Telaga Inspirasi	LSI	Σ
Bufonidae				
D. melanostictus	15	1	3	**19**
I. biporcatus	5	-	1	**6**
Dicroglossidae				
F. cancrivora	6	5	5	**16**
L. macrodon	4	-	7	**11**
Microhylidae				
M. achatina	-	3	-	**3**
Ranidae				
A. nicobariensis	-	4	3	**8**
H. erythraea	21	-	5	**26**
Rhacophoridae				
P. leucomystax	1	-	1	**2**
Totals	**52**	**13**	**23**	**91**

station. The species distribution of the three sites was visualised as a Venn diagram from the website https://bioinfogp.cnb.csic.es/tools/venny/.

RESULTS AND DISCUSSION

Species Composition

The frogs recorded in three IPB lake ecosystems (SDGs, Telaga Inspirasi, and LSI) consisted of five families and eight species. There were two species each for three families, including Bufonidae (*Duttaphrynus melanostictus, Ingerophrynus biporcatus*), Dicroglossidae (*Fejervarya cancrivora, Limnonectes macrodon*), and Ranidae (*Hylarana erythraea, Amnirana nicobariensis*). Two other families have only one species, including Microhylidae (*Microhyla achatina*) and Rhacophoridae (*Polypedates leucomystax*) (Table 1, Figure 4).

Temporal α-diversity

The Shannon-Wiener diversity index (H') values in Lake SDGs, Telaga Inspirasi, and Lake LSI are 1.46, 1.28, and 1.71 (Figure 2), respectively, with the highest diversity value in Lake LSI. The species diversity index value is included in the moderate category because it is in the range of values 1 < H' < 3 (Dharma *et al.* 2021). The moderate category has decreased from previous research by

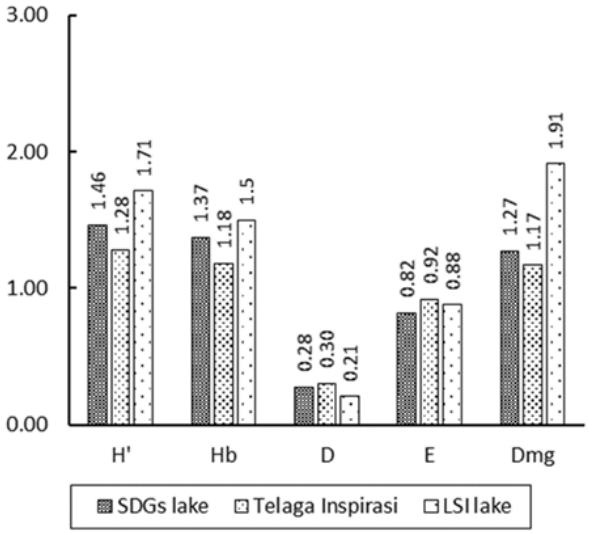

Figure 2. Ecological index value of Frogs in the lake ecosystem at IPB Dramaga.

Yuliana (2000), which found 13 species. Differences in diversity values can be caused by factors such as differences in plant diversity or habitat differences such as dense or not vegetation composition, the presence of streams, and many puddles (Burrow & Maerx 2022; Andreansyah *et al.* 2018). The diversity index is also closely related to the number of species and individuals in each species (Rohadian *et al*. 2022). Therefore, the diversity index has a complex relationship with vegetation composition, habitat conditions, and the presence of water.

The Brillouin's diversity value (Hb) of the three research sites, Lake SDGs, Telaga Inspirasi, and Lake LSI, are 1.37, 1.18, and 1.50 (Figure 2), respectively. Brillouin diversity value was highest in Lake LSI. This index is based on the distribution of the number of individuals of various species present in a sample. The Brillouin index provides information on the degree of irregularity or entropy in the distribution of such species. The Brillouin index is used primarily when the results of the non-random data collection of the sample are being analyzed or when the distribution of species in the sample is uneven. The Shannon-Wiener diversity index, therefore, is appropriate for randomly and evenly collected data (Irni 2021).

The Simpson's Dominance Index (D) values of the three study sites, SDGs, Telaga Inspirasi, and LSI, are 0.28, 0.30, and 0.21 (Figure 2), respectively. The highest dominance was at the Telaga Inspirasi study site. Based on the Simpson's Dominance Index category, dominance in the three research locations is included in the low category with values of 0.01– 0.30 (Wulandari *et al.* 2023). The range of values owned by each research location, Dharma *et al.* (2021) categorized it as a stable ecosystem because there were no dominating species.

The Shannon's Evenness Index (E) of the three research locations of Lake SDGs, Telaga Inspirasi, and Lake LSI are 0.82, 0.92, and 0.88 (Figure 2), respectively. The highest evenness value was at the Telaga Inspirasi study site. The evenness index value measures the evenness of species in a community. An index value close to zero indicates the evenness of species in the community is uneven, and a value of one indicates the evenness of species in the community is more even (Tantap *et al.* 2022). Based on the above categories, the species evenness index value is evenly distributed, resulting in Lake LSI being greater than Telaga Inspirasi and the species evenness value of Telaga Inspirasi being greater than Lake SDGs.

The Margalef Species Richness Index (Dmg) of the three research locations of Lake SDGs, Telaga Inspirasi, and Lake LSI are 1.27, 1.17, and 1.91 (Figure 2), respectively. Based on this value, the Lake LSI research site has the highest species richness. The Margalef Species Richness Index classifies species richness into low if the value is greater than or equal to 3.5, medium if the value is between 3.5 and 5, and high if the value is greater than 5 (Siahaan *et al.* 2019). The species richness index values of the three locations are in the low category. If the number of species is greater, then the richness index is greater (Ismaini *et al*. 2015). The more species there are in an ecosystem, the fewer individuals there are.

All three research sites had low species richness. In another study, the pond ecosystem was moderate, while the reservoir and rice

field ecosystems were low. Environmental factors and food availability influence this. The lack of environmental factors that support the survival of frogs in the three locations can be caused by high human activity or plant composition at the location (Agustina *et al.* 2023). Frogs rely on vocal communication, so noise pollution is a threat that can affect their life (Rafi & Nugraha 2022; Goutte *et al.* 2013). This follows the results of this study; the lowest species richness value is owned by Telaga Inspirasi, which is close to the main road of the IPB Dramaga Campus, so the noise level is very high at that location.

Distribution

The study recorded eight frog species across the three habitats of IPB Dramaga Lake. SDGs consisted of six species. Telaga Inspirasi had four species, and LSI had seven (Figure 3a).

Two frog species, *D. melanostictus* and *F. cancrivora*, were found to inhabit all three ecosystems of the lake (Figure 3a). The two species are widely distributed because they resist various habitat conditions such as anthropogenic environments, rivers, and roads (Mardinata 2017; Miftakhurrohmah *et al.* 2019; Adriadi *et al.* 2023). Research by Muslim *et al.* (2018) and Hasibuan *et al.* (2021) found it in mining areas.

Species *D. melanostictus* females horizontal distribution wider than males. Females (0 to 1500 cm, mean 284 cm, n=14) while males (0 to 1500 cm, mean 289, n=43). This suggests that females may occupy a more diverse range of habitats within the lake. (Figure 3b). *Fejervarya cancrivora* females had lower ranges than males. Females (0 to <1000 cm, mean 285 cm, n=26) while males (0 to 1500 cm, mean 192 cm, n=19) (Figure 3a).

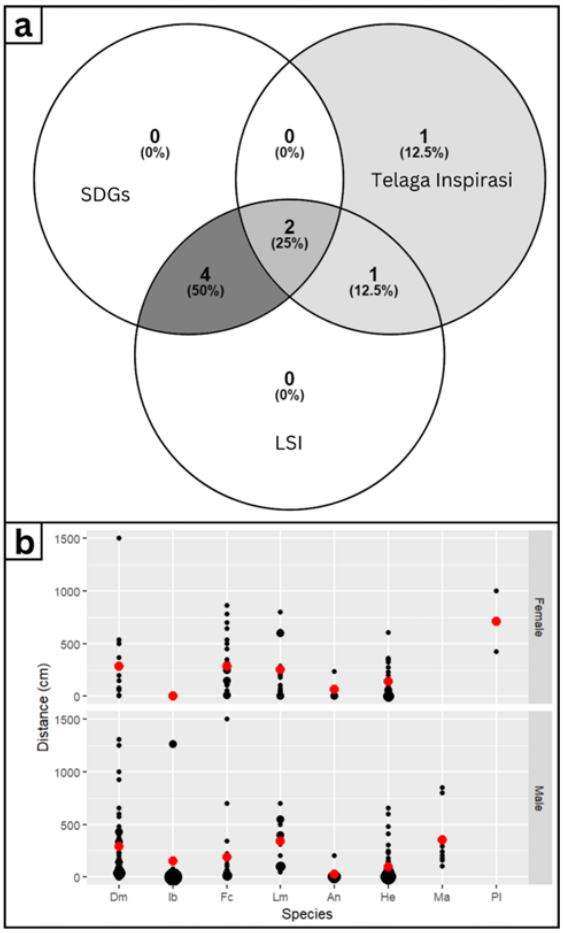

Figure 3. a. Distribution of eight species of the Frogs in the Lake Ecosystem of IPB Dramaga. b. Horizontal distribution of water bodies of the frogs in the lake ecosystem at IPB Dramaga (An: *A. nicobariensis*, Dm: *D. melanostictus*, Fc: *F. cancrivora*, He: *H. erythraea*, Ib: *I. biporcatus*, Lm: *L. macrodon*, Ma: *M. achatina*, and Pl: *P. leucomystax*). Notes: Red dots = mean.

There are four species distributed in SDGs, and LSIs, including *H. erythraea*, *I. biporcatus*, *L. macrodon,* and *P. leucomystax* (Figure 3a). *H. erythraea* species were female (0 to 607 cm, 143 cm, n=27) and male (0 to 653 cm, mean 93 cm, n=51). Most individuals were found in this species (Figure 3b). *H. erythraea* was found on almost all sides of the SDGs lake and only a few points in the LSI.

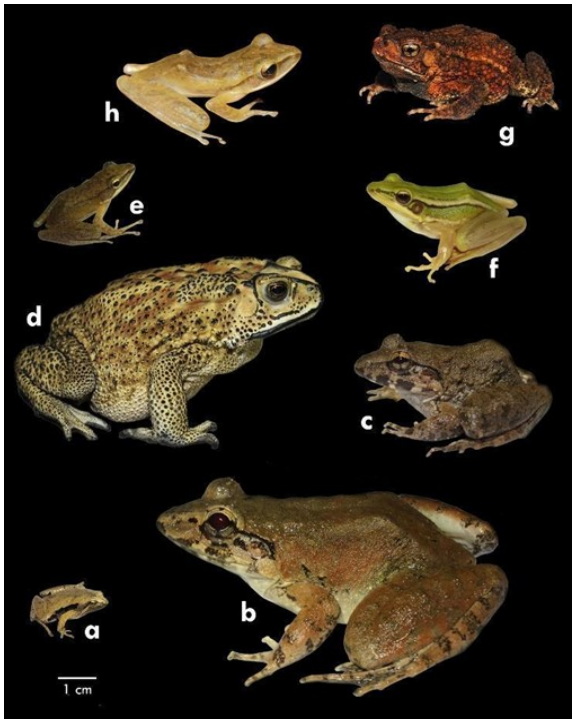

Figure 4. Frogs in lake ecosystem at IPB Dramaga *(*a. *M. achatina,* b. *L. macrodon,* c. *F. cancrivora, d. D. melanostictus,* e. *A. nicobariensis,* f. *H. erythraea,* g. *I. biporcatus,* h. *P. leucomystax).*

Rifanjani *et al.* (2023) also found *H. erythraea* with the highest species abundance in stagnant water habitats.

Horizontal distribution on *I. biporcatus* female (0 cm, n=1) and male (0 n=3 and 1260 cm, n=2) (Figure 3b). These species were distributed in clusters found in water bodies; some were far from water bodies. Sites located in water bodies had grass vegetation. Two males were far from the main water body but were found in standing water under rubber trees with calling activity. Habitats with such characteristics are not found in Telaga Inspirasi. According to Yuliana *et al.* (2005) and Yudha *et al*. (2017) *I. biporcatus* has a habitat preference for inundated areas with sparse to dense grass vegetation.

Limnonectes macrodon species were found with female (0 to 800 cm, mean 256 cm, n=16) and male (0 to 700 cm, mean 339 cm, n=18) individuals (Figure 3b). Most individuals of *L. macrodon* were found on predominantly ungrazed ground. This species was not distributed around the lake. It was always found close to the inlet streams of SDGs and LSI. According to Yuliana *et al*. (2005) stated that *L. macrodon* requires rivers and environments that have clear water as their habitat. This species can be found up to 1000 cm away from the water body.

Polypedates leucomystax species only found female individuals and found far from water bodies in terrestrial habitats (distance 420 and 1000 cm, mean 710 cm, n=2) (Figure 3b). According to Sitorus *et al*. (2014), this species is commonly found above the crown or vegetation, such as on tree leaves or grass in humid or even wet conditions. These results align with the research of Jusmaldi *et al*. (2019), who found two individuals of this species at 1.5 - 2.0 m from the ground and a distance of 200 to >500 cm from water bodies.

Amnirana nicobariensis species was found in Telaga Inspirasi and LSI (Figure 3a). The horizontal distribution of females is wider than males. Female individuals (0 to 232 cm, mean 66 cm, n=5) and males (0 to 200 cm, mean 25 cm, n=9) (Figure 3b). The results of this study indicate that *A. nicobariensis* is found very close to or on grasses in water bodies. According to Yuliana (2000), this species can be found at the edge of water bodies up to 200 cm away. Mardinata (2017) and Miftakhurrohmah *et al*. (2019), this species is commonly found in disturbed habitats. However, based on the study's results, it was not found in SDGs. Based on Google Earth spatial, SDGs Lake is an artificial lake formed in 2022. We assume that this species has not been distributed in this location.

One species is only present in Telaga Inspirasi, namely *M. achatina* (Figure 3a). In this study, individuals were clustered in one point area. The microhabitat has less dense grass vegetation with a waterier soil substrate. According to Firdaus *et al.* (2016) and Dharma *et al.* (2021), this species likes water bodies in clean ponds or puddles with slow currents to reproduce. The habitat has grass vegetation in secondary forests. *M. achatina* species only found male individuals (n=3) 200 cm and 800 cm away from the water body (Figure 3b). According to research by Yuliana (2000), *M. achatina* was found at a distance of 2000 cm from the water body. These species have high adaptability in disturbed habitats (Fathoni *et al.* 2022; Febriyono *et al.* 2023), and adult individuals of *M. achatina* can be found in terrestrial habitats close to water bodies with high humidity characteristics accompanied by litter and grasses of forest ecosystems, rivers to rice fields (Kurniati 2013; Kurniawan *et al.* 2018; Septiadi *et al.* 2018; Baihaqi *et al.* 2022; Febriyono *et al.* 2023).

Environmental Parameter

Based on the data obtained, the environmental conditions in the three lake ecosystems of IPB Dramaga showed slight variations in environmental conditions, such as air temperature, air humidity, water temperature, and water pH. The three lake ecosystems have an average air temperature of 27.1– 27.5°C, with 89–90% air humidity, water temperature of 27.59–28.04°C, and water pH of 5.89–6.27 (Table 2). Overall, the frog is a poikilothermic animal, which means that the frog's body temperature depends on the environment's temperature (Maulana *et al.* 2023). Frogs generally have an optimum range of air temperature between 19–31°C with humidity ranging from 70–90% and water pH ranging from 4.3–7.5 (Kurniati 2011). These conditions are very influential for the frogs because they affect the body's physiological functions (Setiawan *et al.* 2019; Sunar *et al.* 2023). Environmental moisture in frogs prevents their skin from drying out (Izza & Kurniawan 2014). Water temperature and pH affect the reproduction and growth cycle (Yulianti 2023). According to Hanifa *et al.* (2016), the difference between one or two numbers in environmental parameters and optimum parameters for each frog species is natural because environmental conditions change following the weather and the environment around them. In addition, vegetation also plays a role in helping some frog species maintain moisture and body temperature.

Table 2. Environmental Parameters at IPB Dramaga Sampling Site.

Parameters	SDGs	Telaga Inspirasi	LSI
Air Temperature (°C)	27.4±0.28	27.53±1.72	27.1±1.27
Humidity (%)	90.6±0.27	90.4±1.77	89.6±4.32
Water Temperature (°C)	27.98±0.85	27.59±1.76	28.04±0.33
pH Water	6.27±0.55	5.89±0,254	6.12±0.36

In addition, weather and environmental or ecosystem characteristics can also affect the presence or variation of frog species in a location (Inger & Voris 1993). The lake ecosystem at IPB Dramaga has different characteristics and environmental conditions. These conditions include differences in water sources, vegetation, and human activities.

SDGs Lake has a water source (stream water inlet, groundwater, rainwater, and irrigation water) that flows fast with vegetation around the water body in the form of dense grass, some rubber trees, bamboo, and shrubs. As a blue open space, Lake SDGs has a fairly high level of human activity compared to the other two locations. This is because students have direct access to the lake and it is located in the middle of the campus.

Telaga Inspirasi has a water source (rainwater, and raw water runoff) that flows slowly, has vegetation in the form of short grass, and is surrounded by trees around the lake. Telaga Inspirasi, as one of the visiting objects at IPB, has a high level of human activity and noise from the highway.

LSI Lake has a water source (stream water inlet and rainwater) that flows quite fast with vegetation in dense grass and trees near the water body. The location of the LSI lake between the LSI library and the Postgraduate building has quite low human activity compared to SDGs, this is thought to be because students and the general public cannot directly access this lake, but its location between the two buildings is a location that students often pass during the day.

We assume that the different conditions in each lake affect the presence of the frogs. Based on Table 1, *L. macrodon* and *P. leucomystax* species were found in SDGs and LSI lakes. Both locations have dense vegetation conditions in the form of shrubs, plant roots, and muddy soil at the edge of the water source. According to Kaprawi *et al.* (2022), some frogs, such as *L. macrodon*, are found in dense vegetation such as shrubs, plant roots, and muddy soil on the banks of water sources. SDGs Lake is suspected to be disturbed by human activities, which may affect the composition of species found there. Then, at Telaga Inspirasi, which has a slow-flowing water source, vegetation cover in the form of short grass and not dense, and also high human activity at this location shows less species presence. According to Rostikawati *et al.* (2022) and Devi *et al.* (2019), water sources serve to keep the frog's skin moist and as a place for the breeding and growth of tadpoles. In addition, vegetation also plays an important role in regulating the environment for the frogs. Dense vegetation can help maintain frogs' body temperature and skin moisture; environmental conditions related to human activities also need to be considered. These three lakes may experience different levels of pollution, which may affect the diversity of species found within them.

CONCLUSION

This study concludes that the value of the Shannon-Wiener Diversity index in the IPB Dramaga Lake ecosystem (SDGs, Telaga Inspirasi, LSI) is included in the moderate category. Brillouin Diversity Index is included in the high category. Evenness index was close to even. Simpson's Dominance Index and Margalef's Species Richness are in a low category. In the eight species found, there is a tendency for seven species from the Bufonidae, Dicroglossidae, Ranidae, and Microhylidae families to approach the water body. While the Rhacophoridae family is far from the water body.

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