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Environmental research of land snail diversity at a selected rice field in lower Katingawan

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Abstract

This study examined the variety and abundance of land snails in a specific rice field located in Lower Katingawan, Midsayap, Cotabato. Land snails are mollusks that dwell on land and possess spiral shells on their backs. Notably, no published research is available on land snails in the municipality of Midsayap, North Cotabato. The study identified three noteworthy species of land snails in the selected rice field, namely Paropeas achatinaceum, Achatina fulica, and Pomacea canaliculata, totaling 1048. The study utilized the quantitative-descriptive method and computed the diversity indices. Simpson's index was calculated, indicating a low probability of two randomly chosen individuals belonging to the same taxon. Shannon's index yielded a value indicating relatively low species richness and uneven distribution of individuals among taxa. These findings offer valuable insights into the community's structure and ecological significance, emphasizing the need for further research to comprehensively understand its diversity and dynamics.

Keywords: Biology; diversity indices; shells; snails; taxonomy; terrestrial ecosystem

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1. Introduction

A land snail is a type of mollusk that lives on land and has a spiral shell on its back (Haase & Misof, 2009; Coppolino, 2010). In rice fields, land snails play an important role in the ecosystem by helping to break down organic matter and recycle nutrients (Agida et al., 2022). The biodiversity of land snails in rice fields has been studied in various regions around the world, including Asia, Africa, and South America and they need to be conserved for various purposes (Halwart, 1994; Snyder & Chesson, 2003; Sosa, Batomalaque & Fontanilla, 2014; Van Dooren, 2022). For example, a study in Vietnam found that rice fields support a high diversity of land snails, with 29 species identified across six provinces (Nguyen et al., 2018). Another study in Nigeria identified 21 species of land snails in rice fields (Olaniyi et al., 2019).

Understanding the biodiversity of land snails in rice fields is important for several reasons. First, land snails are important components of the rice field ecosystem (Dewi, Sato & Yasuda, 2017; Horgan, 2017; Vijayan, Mahendhiran & Suganthasakthivel, 2021), playing important roles in nutrient cycling and soil structure (Wang, Lu, Zhang, Wei & Xiong, 2020). Second, land snails are sensitive to environmental changes and can serve as indicators of ecosystem health (Auclerc et al., 2022). Finally, land snails are also economically important as a source of food and medicine in many cultures (Kobayashi et al., 2019; Broto et al., 2020; Rabelo et al., 2022; Panda et al., 2021; Ouafi et al., 2021). In the Philippines, due to their capacity to decompose and recycle rotting plant components, their existence in the environment is a key sign of ecosystem health (Dapar et al., 2014; Song et al., 2020; Nandy et al., 2022; Chinenye & Bamidele, 2023). Another ecological function that land snails perform is the calcium uptake from the earth and organic materials, which transfers calcium to higher trophic levels (Salih et al., 2021). Moreover, they provide small mammals, amphibians, reptiles, birds, arthropods, and humans with vital food sources. Land snails perform a variety of ecological tasks that support habitat integrity (Rosales et al., 2020).

According to Auffenberg and Páll-Gergely (2020), with almost 2,000 species and subspecies known, the land snail fauna of the Republic of the Philippines is vast. Only a few studies have concentrated on the Visayas, especially Leyte, despite the diversity of the malacofauna in the Philippines, particularly in Luzon, having received considerable attention. On Leyte Island, a previous study on land snails revealed that there are roughly 60 species of macro (38) and micro (21) land snails, spread across the island's northern and southern sections (Pogado et al., 2022). However, there is a lack of published studies on the identification and description of land snails in rice fields in the localities of the Philippines. In line with this, this study would like to provide baseline information on the identity of the land snail species in the area. Moreover, data on the current diversity and the description of land snail species in the rice fields are lacking. At present, there is no published literature in the municipality of Midsayap, North Cotabato about land snails.

1.1. Purpose of study

This study sought to address the following:

a. identify the composition of snail species found in a selected rice field in Lower Katingawan, Midsayap, Cotabato; and
b. determine diversity indices of the snail species such as the Shannon diversity index, Pielou index, and Margalef diversity index.

2. Method

2.1. Study Site

The researcher utilized the quantitative-descriptive method and conducted this study in the Lower Katingawan rice field area of Midsayap, Cotabato because the area is convenient and there were no related studies made regarding the land snails. Lower Katingawan is situated at approximately 7.1980, 124.5251, on the island of Mindanao. Elevation at these coordinates is estimated at 20.5 meters or 67.3 feet above mean sea level. It is physically situated in the southwest corner of the province of

Cotabato, where rice is the primary crop grown across the majority of the land (Cabasan et al., 2019). Altitude, coordinates, and environmental parameters such as air temperature, and humidity were measured on-site. The rice field was sampled by creating four quadrants out of a 1 x 1 m string and placing it in each corner (Suartini & Sudatri, 2021).

2.2. Ethical consideration

The researcher sought informed consent from the owner of the rice field before the conduct of the study.

2.3. Collection and Identification of Samples

The snails that were detected were directly collected during the sampling by wearing hand gloves for protection, which took place from 6 am to 10 am. Three days were spent sampling. Quadrate snails of all sizes, whether they were submerged, floating, or connected to aquatic vegetation, were collected (Suartini & Sudatri, 2021). Some of the empty shells were collected while live specimens were photographed and returned to their original habitat after taking their pictures (Parcon et al., 2020). The collected samples were placed in a plastic container and repeatedly submerged in a spring water basin to wash away macro-debris and muddy material that had stuck to the snail's surface. Using standardized taxonomic keys as described by Burch (1980), Kerney and Cameron (1979), and Godan (1983), as well as photo-referencing of images from various journal articles, preliminary snail identification based on morphological features of the shell was carried out. By looking at the morphology of the shell, including the shell's shape, color pattern, and other shell ornaments, morphological character data were collected (Martin & Cabrere, 2018; Ali & Ramdane, 2020). Furthermore, confirmation of species was sought from experts and the University of the Philippines – Diliman, Institute of Biology.

2.4. Data analysis

Data Computation covered diversity and abundance**.** Data were analyzed using different quantitative measures for ecology. Shannon diversity index (H) was used to get the apportionment or diversity in a community ∑_(i=1) ^S⁡〖-p_i 〗 ln p_i. Where H is the Shannon diversity index; Pi= fraction of the entire population made up of species I; S= number of species encountered. Evenness or Pielou index (J) is the Shannon diversity divided by the logarithm of several taxa J=H/ (ln S). Richness will be measured using the Margalef diversity index d=(S-1)/ (ln N).

3. Results

3.1. Identification of Snail Composition

The study was conducted from 6 to 10 morning with an average air temperature of 27 degrees Celsius and a humidity value of 94% which means wet. There were three recorded snails in the rice field. First was the *Paropeas achatinaceum* (Figure 1) which belongs to the Family Achatinidae, class Gastropoda. In actuality, it has an oblong-shaped shell that measures 3.5 cm with eight whorls. According to Naggs (1994), it is a synanthropic species ubiquitous in disturbed habitats throughout the tropical Indo-Pacific, but it has never made it inland on any significant landmass. *Paropeas achatinaceum* has a shell morphology similar to that of robust *Allopeas* species.

Figure 1

Paropeas achatinaceum (Air-breathing land snail)

a. Shell length

b. (Reference photo: Poppe, 2015)

Paropeas achatinaceum has been mistaken for *Allopeas clavulinum* on several occasions, although it differs in having a semi-globose apex and flatter succeeding whorls. The periostracum is practically opaque pale brown to semi-transparent pale yellow, with a matt to silky sheen in new material. The shell of *Allopeas clavulinum* is much shinier and translucent when young. Following whorls include fine spiral striae and dense, fine, and conspicuous transverse striations inclined laminae with flaking margins. The lack of shell shine is most likely due to these laminae. The striations can be vertical or retracted towards the sutures, but they aren't usually arched forward above and retracted below like *Prosopea*s. The columellar border is straight and faintly reflexed, and the aperture height is about a third of the shell height. Large shells have a closed umbilicus, while smaller but reproductively mature individuals and youngsters have a minute umbilicus. Convex whorls with relatively deep sutures can be seen in shells with up to 9.7 convex whorls (Naggs, 1994).

The second shell found was from the *Achatina fulica*. Figure 2 shows a giant African land snail member that belongs to the Family Achatinidae, class Gastropoda (Olusi et al., 2021). The collected sample featured a narrow, conical shell with four whorls that are twice as long as it is wide. The shell is reddish-brown with faint yellowish vertical patterns that resemble light coffee. It was 6.5 cm long. Sobrepeña and Demayo (2014) reported that in the Philippines, *Achatina fulica* has a wide range of shell variants, including banding pattern, color, size, and form. Land snail shell shape and color have been linked to various environmental factors. Geometric morphometric research revealed significant morphological diversity in the shell form of geographically distant snails in the Philippines and an important link between shell shape and banding pattern categorization of *Achatina fulica*.

Figure 2

Achatina fulica (Giant African snail)

a. Shell length

b. (Reference photo: Aquino, 2011)

Figure 3 below shows the Golden apple snail or the channeled apple snail. In actuality, the obtained sample measured around 30 mm of shell length with 4 whorls. It also has yellowish-brown with darker spiral bands. It is commonly known as the golden apple snail or the channeled apple snail, a freshwater snail species that belongs to the family Ampullariidae. They are also regarded as amphibious because they can endure the changing seasons in both terrestrial and aquatic environments. It is native to South America but has been introduced to various regions worldwide, including Asia, North America, and Europe. *P. canaliculata* is known for its significant impact on rice crops and wetland ecosystems due to its voracious feeding habits and high reproductive capacity.

Figure 3

Pomacea canaliculata (Channeled Applesnail)

a. Shell length

b. Reference Photo: gbif.org

Estebenet and Martin (2013) investigated the population dynamics of *P. canaliculata* in rice fields in Argentina. The authors assess snail abundance, reproduction, growth, and mortality rates to understand the factors influencing population dynamics. The study provides insights into the life history traits of *P. canaliculata* and its potential to thrive in agricultural habitats.

3.2. Diversity indices and relative abundance

Table 1 below reveals that the community consisted of three taxa and a total of 1048 individuals. Dominance, calculated as the proportion of the most abundant taxon, was found to be 0.9495. This indicates that one taxon dominated the community, with a high relative abundance compared to the other taxa.

Table 1

Diversity Indices of Land Snails in Selected Rice Fields in Lower Katingawan, Midsayap, Cotabato

Diversity Indices	Result
Taxa_S	3
Individuals	1048
Dominance	0.9495
Simpson	0.05045
Shannon	0.1344
Evenness	0.3813
Margalef	0.2976

Simpson's index, a commonly used measure of diversity, was calculated to be 0.05045. The low value of Simpson's index suggests a high level of diversity within the community, as it measures the probability that two randomly selected individuals belong to the same taxon. In this case, the low value indicates that individuals are more likely to belong to different taxa, highlighting the heterogeneity of the community.

Shannon's index, which incorporates both richness and evenness, was determined to be 0.1344. This index takes into account both the number of taxa and their relative abundances. The low value of Shannon's index indicates relatively low species richness and uneven distribution of individuals among taxa in the community.

Evenness, a measure of the equitability of species abundances, was calculated to be 0.3813. This index describes how evenly individuals are distributed among the taxa in the community. A value of 0.3813 suggests a moderate level of evenness, indicating that the abundance of individuals across the taxa is not highly skewed towards one or a few taxa.

Margalef's index, which measures species richness and takes into account the total number of individuals, was found to be 0.2976. This index considers the presence of rare species and provides a measure of the richness of the community. The relatively low value of Margalef's index suggests a moderate level of species richness within the community.

4. Discussion

In summary, the diversity indices analyzed in this study provide a comprehensive assessment of the community. While the community exhibits a high dominance by one taxon, it also demonstrates relatively high diversity, as indicated by the low Simpson index. However, the Shannon index suggests lower species richness and uneven distribution of individuals among taxa. The moderate evenness and Margalef's index value further support the notion of a moderately diverse community.

It is important to note that the interpretation of diversity indices should be considered in the context of the specific ecosystem being studied. Factors such as habitat type, disturbance, and sampling effort can influence the values obtained. Future research and additional sampling efforts could provide a more detailed understanding of the community's diversity and its ecological implications.

The analysis of diversity indices in the community highlights its mixed characteristics, with high dominance but also high diversity. The community exhibits a relatively low species richness, uneven distribution of individuals, and moderate evenness. Margalef's index suggests a moderate level of species richness. These findings provide valuable insights into the structure and ecological significance of the community and underscore the importance of further research to fully understand its diversity and dynamics.

5. Conclusion

The study identified three land snail species in the rice field: *Paropeas achatinaceum, Achatina fulica*, and *Pomacea canaliculata*. These species exhibit distinct morphological characteristics and ecological preferences. The community of land snails in the rice field is characterized by high dominance, with one taxon significantly outnumbering the others. Further, the diversity indices indicate a mixed pattern in the community. Simpson's index suggests a high level of diversity, with individuals more likely to belong to different taxa. However, Shannon's index reveals relatively low species richness and uneven distribution among taxa.

Moreover, evenness analysis indicates a moderate level of equitability in species abundances, while Margalef's index suggests a moderate level of species richness. The community's structure and ecological significance emphasize the need for further research to gain a comprehensive understanding of its diversity and dynamics.

Relative to this, this study suggests conducting additional research to explore the land snail diversity in the municipality of Midsayap, North Cotabato, as there is a lack of published research in this area. Also, expand the study to include more sampling sites within the rice field and surrounding habitats to obtain a broader understanding of land snail populations.

6. Recommendations/Future Directions

It is recommended to investigate the ecological interactions between land snails and other organisms in the rice field ecosystem to assess their roles and impacts. Future studies should also consider factors such as habitat type, disturbance levels, and seasonal variations in future studies to better contextualize the diversity indices and their implications.

To the local authorities and stakeholders, it is recommended to implement long-term monitoring programs to track changes in land snail populations over time and assess the effects of potential anthropogenic disturbances on their abundance and diversity. Through this, raising awareness about the ecological importance of land snails and promoting conservation efforts to preserve their habitats might be feasible.

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