

# Species composition, relative abundance, and distribution of land snail species in Mt. Lantoy Key Biodiversity Area, Cebu, Philippines

RAAMAH ROSALES<sup>1\*</sup>, EDGARDO LILLO<sup>2</sup>, STEVE MICHAEL ALCAZAR<sup>2</sup>, LEA COLITA<sup>1</sup>,  
JOED CABALLERO<sup>1</sup>, ARCHIEBALD BALTAZAR MALAKI<sup>2</sup>

<sup>1</sup>College of Arts and Sciences, Cebu Technological University. Main Campus, Cebu City 6000, Philippines

\*email: raamah.rosales@ctu.edu.ph

<sup>2</sup>Department of Forestry, Cebu Technological University. Argao Campus, Argao, Cebu 6021, Philippines

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**Abstract.** Rosales R, Lillo E, Alcazar SM, Colita L, Caballero J, Malaki AB. 2020. Species composition, relative abundance, and distribution of land snail species in Mt. Lantoy Key Biodiversity Area, Cebu, Philippines. *Biodiversitas* 21: 5438-5447. This study aimed to establish an inventory of land snails in Mt. Lantoy, Cebu Island, Philippines. A two-person team conducted sampling on eight permanent plots with an elevation range of 182 m-691 m. The study has listed a total of 872 individuals represented by 25 species belonging to 15 genera and nine families. Seven families belong to the air-breathing pulmonate group, Order Stylommatophora: Bradybaenidae, Camaenidae, Trochomorphidae, Achatinidae, Ariophantidae, Helicarionidae, Helicinidae. Two families were under the prosobranch group, Order Caenogastropoda: Cyclophoridae, and Pupinidae. The Cyclophoridae was the richest family with five species, followed by Bradybaenidae, Camaenidae, Helicinidae, having four species. The Trochomorphidae and Helicarionidae have three species. The Pupinidae has two species, while the Achatinidae and Ariophantidae has one species each. There were three (3) endemic and ten (10) new island record species collected and identified with four (4) species that were classified as rare. *Rysotta otaheitana* Ferussac 1821 was the most abundant, representing 25.22% of the total number of individuals. The *Leptoma nitidum ancilis* Bartsch 1918 has the widest geographical distribution with a constancy rate of 100%. Widespread species appear to be more abundant, while other species were geographically restricted in few study areas.

**Keywords:** Gastropod, leaf litter, malacology, mollusk, terrestrial

## INTRODUCTION

Determining the species composition and structure of biotic assemblages, including patterns of variation in spatial distribution, is fundamental in the field of community ecology (Jackson and Blois 2015). Its focus is to understand how communities of different species are organized by identifying, describing, and explaining patterns that affect the structure of communities (Morin 2011; Verberk 2011). This task is somewhat easier in terrestrial gastropods because most species are readily identifiable by their shells, including empty shells, and highly contained within the habitat (Cernohorsky et al. 2010). The inclusion of empty shells is essential because its presence can provide evidence of occupation, a record of environmental change, and represent species no longer found in the area (Rundell and Cowie 2003; Cameron and Pokryszko 2005).

Worldwide, gastropods represent the most diverse invertebrate group after arthropods with estimated species richness of 80,000 to 135,000 (Abbott 1989; van Bruggen 1995). The Philippines alone reportedly possess around 31% (22,000 of 70,000 species) of all described mollusks worldwide with 2-4% endemism (Vallejo 2002). Land snails were estimated to number about more than 35,000 extant species with the tropics serve as a haven for most of the species (Solem 1984). The geographical barrier between islands effectively enhanced the endemism by

limiting the migration of land snails across forest habitats. In the Philippines, it is highly likely that the majority of the land snails remained undiscovered or undescribed because only a few islands have been surveyed or explored for malacofaunal diversity.

Land snails are regarded as indicators for rainforest biodiversity as they are highly diverse and generally common in areas described as stable, temperate, litter-rich, and moderately moist forests (Solem 1984; Schilthuizen and Rutjes 2001). Their presence in the habitat is a fundamental indicator of ecosystem health due to their ability to break down and recycle decaying plant materials. Another ecosystem service provided by land snails is the transfer of calcium nutrient to higher trophic levels through calcium uptake from the soil and organic matter (Beeby 1991; Adams and Wall 2000). They also serve as an essential food source for small mammals, amphibians, reptiles, birds, arthropods, and humans. These ecological functions assumed by land snails help to maintain habitat integrity necessary to sustain rainforest biodiversity.

Cebu Island has one of the most denuded forest areas in the Philippines, with an estimated remaining forest cover of less than 1% of the total land area (Mallari et al. 2001). Deforestation has led to the extinction of some endemic birds, native trees, and other wildlife (Brooks et al. 1995). In a move to save the remaining flora and fauna, a total of 117 terrestrial areas classified as Key Biodiversity Areas (KBA) were established based on vulnerability and

irreplaceability, and among them was Mt. Lantoy. The impact of deforestation on the malacofauna is still unclear as data on the land snail population composition and structure are sparse in zoological literature. Among the Philippine land snail species, the *Helicostyla smargadina* Reeve 1842 is the only critically endangered endemic species listed under the International Union of Nature (IUCN) in 2008 (de Chavez and de Lara 2011). The list could be an underestimation as other species have been extensively exploited as food and shell trades like the *Rysotta otaheitana* Ferussac 1821.

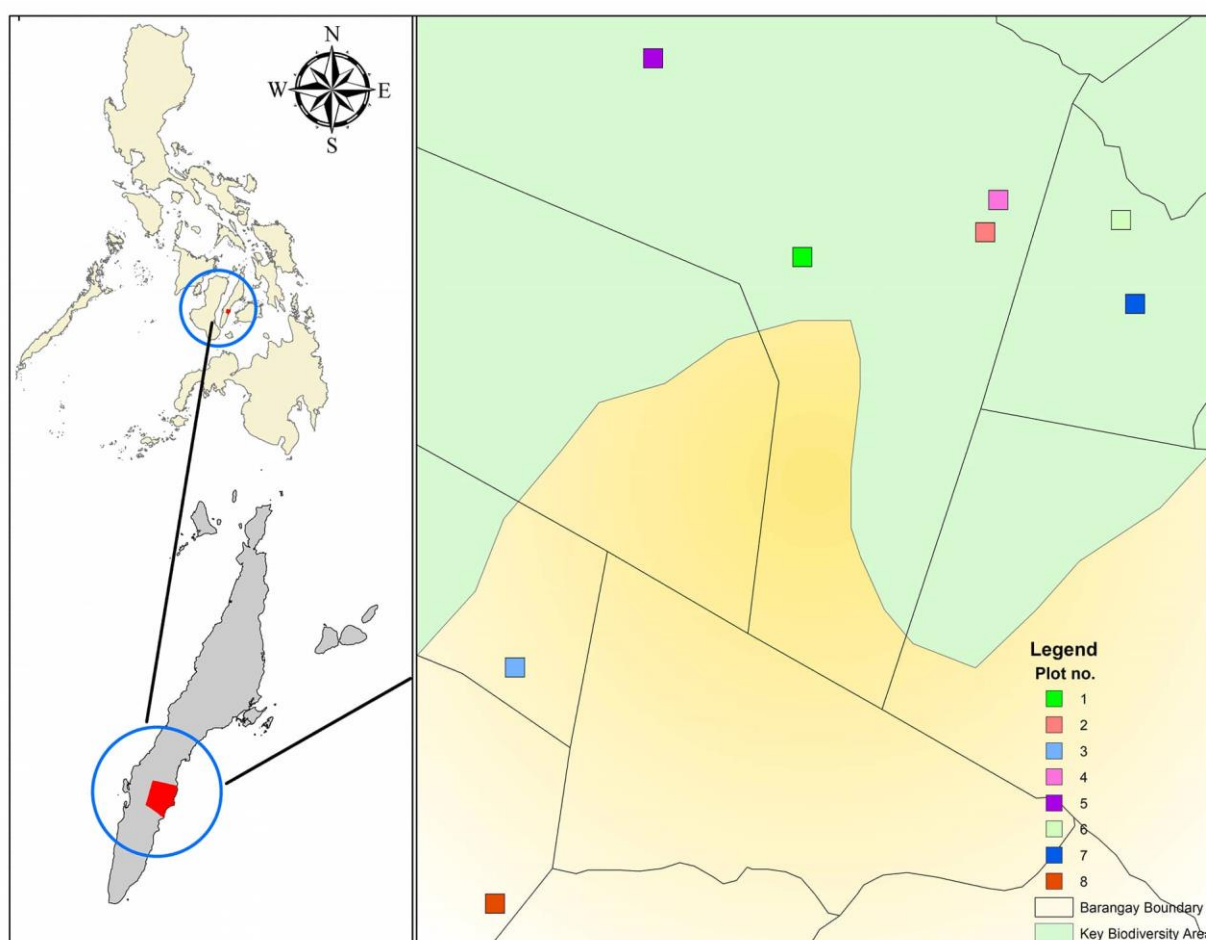
This study aimed to establish an inventory of land snails in Mt. Lantoy, Cebu Island, Philippines. Information on species composition, relative abundance, and distribution on land snails in any of the KBA of Cebu Island is inadequate and scarce in any published literature in a scientific journal. Given the importance of land snails to the whole ecosystem health on the island, data established for land snails can help policymakers in developing conservation measures to protect the species from becoming threatened or extinct. Understanding the

biological requirements may allow the possibility of breeding and culture of species with ecological and economic importance (Giokas et al. 2005).

## MATERIALS AND METHODS

### Study areas

The Mount Lantoy Key Biodiversity Area (KBA) (9°549 N, 123°329 E) is located in the Municipality of Argao southern part of Cebu Island, Philippines (Figure 1). It is part of a protected landscape of the Argao-Dalaguete Watershed Forest Reserve under Presidential Proclamation No. 414 promulgated on 29 June 1994. Coconut plantations, cultivations, plantations of non-indigenous trees and scrubland surround the study site, which was also used for grazing livestock by local communities. Cultivation of seasonal crops like corn, cabbage, carrot, and onion was common in the surrounding areas of the forests (Paguntalan and Jakosalem 2008).



**Figure 1.** Location map of MT. Lantoy KBA in Cebu Island, Philippines with the established sampling plots

**Table 1.** Locations and environmental conditions of the sampling sites

Plot no.	Locations	Coordinates	Relative humidity (%)	Ambient temp. (°C)	Elevation (meters)
1	Mt. Lantoy	09°54'09" N 123°31'42.9" E	75	28.4	525
2	Mt. Lantoy	09°54'17.7" N 09°54'17.7" E	77	26.0	583
3	Canbantug	09°52'58"N 09°52'58" E	78	26.8	575
4	Cansuje	09°54'50.8" N 123°30'41.8" E	89	25.0	608
5	Cansuje	09°64'15" N 109°59'09" E	92	23.0	695
6	Cunalum	09°90'37.3 N 123°54'35.7 E	69	29.0	226
7	Catang	09°89'86.1" N 123°54'44.4" E	57	29.6	182
8	Bulak	09°86'20.9" N 09°86'20.9" E	90	23.5	691

### Establishment of permanent plots

A Permanent Biodiversity Monitoring System (PBMS) was established in Mt. Lantoy KBA for the Flora and Fauna biodiversity assessment, including the terrestrial gastropods. The monitoring system utilized permanent plots based in the lower elevation (less than 200 m) and upper elevation (above 500 m) across five barangays within the KBA, namely: Mt. Lantoy, Canbantug, Cansuje, Cunalum, Catang, and Bulak (Table 1).

The size of the permanent plots was 20 m x 100m, with a total of eight plots established in highly stratified vegetation (Lillo et al. 2019). Each plot was divided into five subplots with a size of 20 m x 20 m to maintain consistency with the sampling protocol used by de Winter and Gittenberger (1998) and Schilthuizen and Rutjes (2001) for land snail diversity assessment in Cameroon and Danum, Sabah-respectively.

### Sampling

A two-person team conducted all sampling for about two hours for six months. Collection efforts were directed on specific habitats highly favored by land snails such as leaf litters, rotting logs, barks, and undersides of plant leaves. Samples collected include one live specimen for each species, empty shells, and shell fragments. Litter samples were sieved at a decreasing mesh-width (de Winter and Gittenberger 1998). The collected samples from the subplots were recorded and tallied as one plot based on the permanent monitoring system used in this study.

### Species identification

All collected samples were sorted into groups with similar morphological characteristics and identified using published keys and reference guides (Hidalgo 1901; Springsteen and Leobrera 1986; Abbott 1989). All collections were kept in the biodiversity laboratory, Cebu Technological University, Cebu, Philippines.

### Data analysis

After collection and identification of the species, the harvested individuals were counted and analyzed for relative abundance and rarity, and constancy using the following equations;

#### Species abundance and rarity

Species abundance is the number of individuals in a given area (Brower et al. 1989). Relative abundance is computed as:

#### Species abundance

$$\text{Relative abundance} = \frac{\text{Species abundance}}{\text{Total number of individuals}} \times 100 \quad (1)$$

Species with less than 0.5% of the total individual counts are considered rare (Emberton et al. 1997).

#### Constancy index

The constancy index (C) for each species is calculated according to Dajoz (1985) and calculated using the following equation:

$$(C) = \frac{p \times 100}{P} \quad (2)$$

Where;  $p$  is the number of samples in which a given species occurs and  $P$  is the total number of samples analyzed. Species can be classified into three different constancy categories: constant ( $C \geq 50\%$ ), accessory ( $C > 25\% - C < 50\%$ ) and accidental ( $C < 25\%$ ) (Dajoz 1985).

## RESULTS AND DISCUSSION

### Sampling results

The study has listed a total of 872 individuals represented by 25 species belonging to 15 genera and nine (9) families (Tables 2 and 3). Seven (7) families belong to the air-breathing pulmonate group, Order Stylommatophora: Bradybaenidae, Camaenidae, Trochomorphidae, Achatinidae, Ariophantidae, Helicarionidae, Helicinidae. Two families were under the prosobranch group, Order Caenogastropoda: Cyclophoridae, and Pupinidae. The Cyclophoridae was the richest family with five species, followed by Bradybaenidae, Camaenidae, Helicinidae, having four species each. The Trochomorphidae and Helicarionidae have three species. The Pupinidae has two species, while the Ariophantidae and Achatinidae has one species each. However, *Achatina fulica* (Achatinidae) can be excluded in species count since it is an introduced species. *A. fulica*, also known as Giant African Snail, is described as an invasive species that was brought to the Philippines by the Japanese Military during WWII as a source for food to their soldiers (Pangga 1949). The summary of all identified land snails was presented systematically in Table 2. Figures 2 and 3 show the profile photos of the representative specimen of all land snails collected throughout the study.

*Stylommatophora (pulmonate)*



A



B



C



D



E



F



G



H



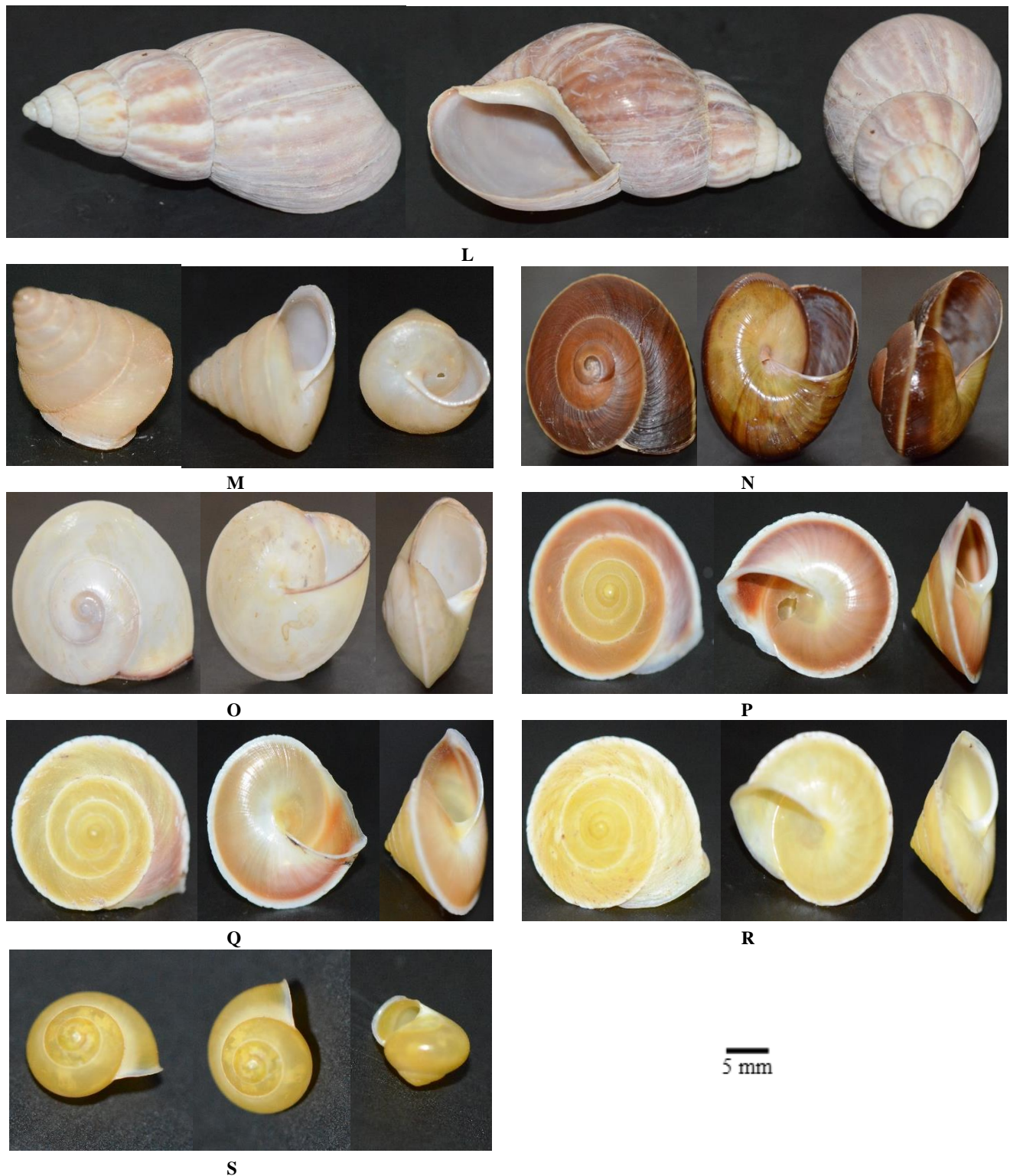
I



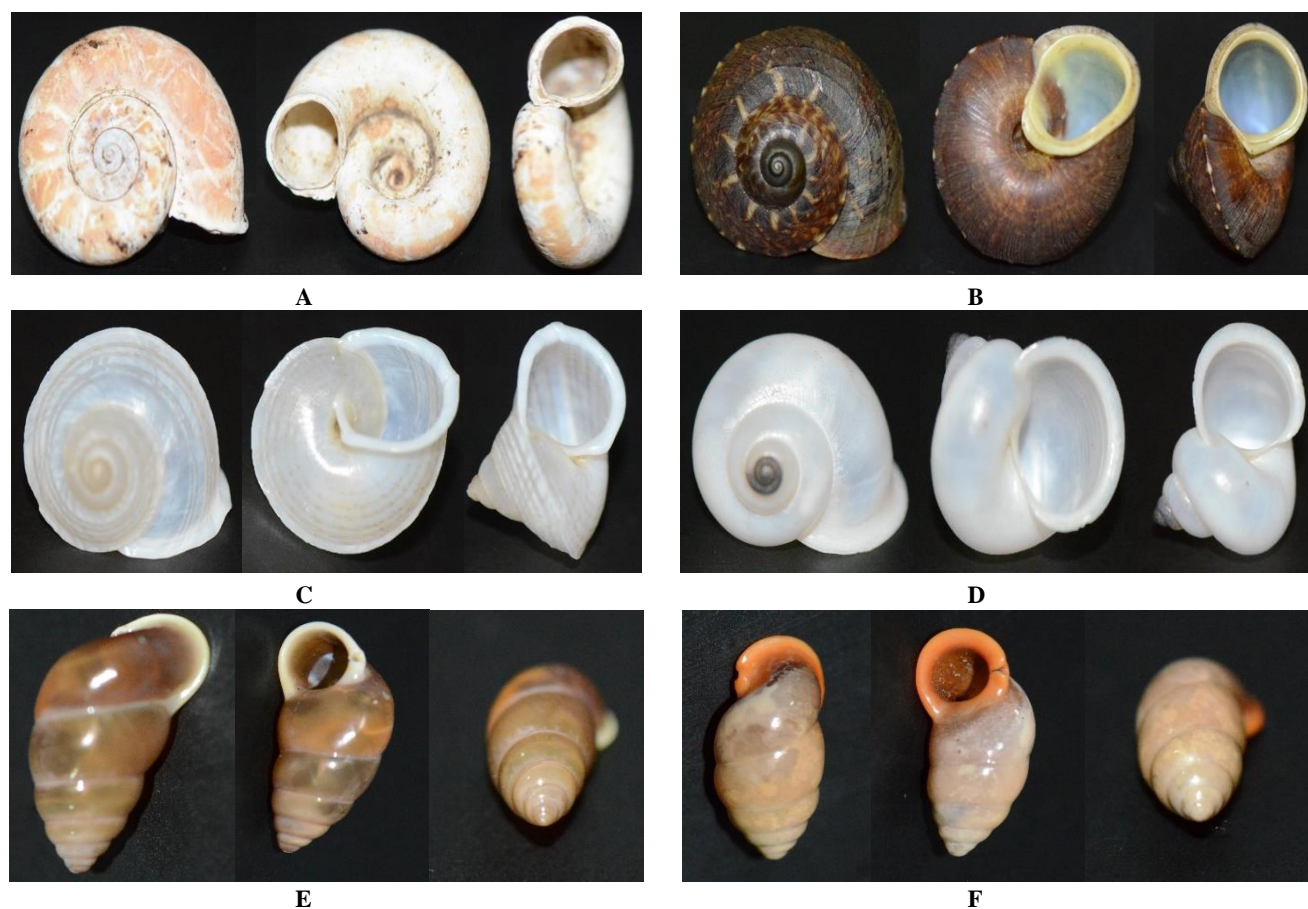
J



K



**Figure 2.** Profile photos in three (3) dimensions of empty shells for land snail species under pulmonate group, Stylommatophora: A. *Chloraea fibula* (Reeve, 1842); B. *Helicostyla amagaensis* (de Chavez, 2015); C. *Helicostyla phitogaster* (Férussac, 1821); D. *Helicostyla daphnis* (Broderip, 1841); E. *Obba marginata parmula* (Broderip, 1841); F. *Obba horizontalis* (Pfeiffer, 1845); G. *Conchlostyla camelopardalis* (Broderip, 1841); H. *Anixa zebuensis* (Broderip, 1841); I. *Trochomorpha repanda* (Möllendorf, 1890); J. *Trochomorpha schmarkerii* (Möllendorf, 1894); K. *Trochomorpha metcalfei* (Pfeiffer, 1845); L. *Achatina fulica* (Férussac, 1821); M. *Sitala acuta* (Salvat, 1966); N. *Ryssota oweniana* (Lea, 1852); O. *Euplecta apicata* (Blanford, 1870); P. *Geophorus acutus* (Pfeiffer, 1847); Q. *Geophorus acutus acutus* (Pfeiffer, 1847); R. *Geophorus acutus siquijorensis* (Bartsch, 1918); *Helicina clappi* (Pilsbry, 1909).

*Caenogastropoda (prosobranh)*

**Figure 3.** Profile photos in three (3) dimensions of empty shells for land snail species under prosobranh group, Caenogastropoda: A. *Cyclophorus daraganicus* (Hidalgo, 1888); B. *Cyclophorus fulguratus* (Pfeiffer, 1847); C. *Leptopoma woodfordi* (Sowerby, 1889); D. *Leptopoma nitidum ancilis* (Bartsch, 1918); E. *Moulinsia fusca* (Gray, 1841); F. *Moulinsia fusca erythrostoma* (Möllendorf, 1890).

### Species composition and community structure

Table 3 summarizes the relative abundance and rarity of all the species collected. The population of *Ryssota oweniana* has the largest number, with 197 individuals representing 25.22% of the total number of individuals. It is relatively the most abundant species. It is followed by *Geophorus acutus acutus* (13.99%) with 122 individuals, and *Geophorus acutus* (11.93%) with 104 individuals. The remaining 22 species have less than 10% relative abundance. Based on the rarity of species by Emberton et al. (1997), species with less than 0.5% abundance are considered rare. Four species fall under this category: *Sitala acuta*, *Cyclophorus fulguratus*, *Moulinsia fusca*, and *Moulinsia fusca erythrostoma*.

Table 4 summarizes the population density of the different land snail communities in the study areas. Plot 1 has the largest number of species, followed by plot 8 with 15 and 13 species-respectively. Plot 2 and 4 have the lowest with seven species each, while plot 1 has the highest number of individuals collected with 389, but Plot 2 has the lowest with 52 individuals (Table 4). As for abundance per plot based on percent frequencies of species, *R. oweniana* was most abundant in Plot 1 (41.14%) and 2 (55.77%), while *G. acutus acutus* was abundant in Plots 3 (30.43%)

and 4 (34.48%). The *H. clappi* was the most abundant in Plot 5 (28.57%). The population of *G. acutus* was most abundant in Plots 6 (32.58%), 7 (49), and 8 (20.43%). This variability indicates the suitability of the Mt. Lantoy forest habitat for terrestrial gastropod.

### Occurrence and distribution of land snails

Table 5 summarizes the occurrence and geographic distribution, through constancy, of land snails in study areas. Based on the interpretation of Dajoz (1985), ten out of 25 land snails are constant species having a constancy of  $\geq 50\%$ . Among the constant species, only *Leptopoma nitidum ancilis* has the broadest geographic distribution with a constancy of 100%. Eight land snails are considered accessory species with a constancy range of 25%-37.5%. The rest are accidental species with a constancy of 12.5%. Some species occurred only in one specific plot: *C. daraganicus* and *C. fulguratus* (Plot 1); *S. acuta* (Plot 3), *T. schmarkerii* (Plot 6); and *A. zebuensis*, *M. fusca*, and *M. fusca erythrostoma* (Plot 8). Most of the accidental species were classified as rare species as well. The species with higher constancy are also widely distributed, which means they occur in higher densities than species restricted in their geographic distribution.

**Table 2.** Systematic list of collected land snails in Mt. Lantoy KBA, Cebu Island, Philippines

Kingdom	Phylum	Class	Order	Family	Genus	Species
Animalia	Mollusca	Gastropoda	Stylommatophora (pulmonate)	Bradybaenidae (Pilsbry, 1934)	<i>Chloraea</i> (Reeve, 1842) <i>Helicostyla</i> (Férussac, 1821)	<i>Chloraea fibula</i> (Reeve, 1842) <i>Helicostyla amagaensis</i> (de Chavez, 2015) <i>Helicostyla phitogaster</i> (Férussac, 1821) <i>Helicostyla daphnis</i> (Broderip, 1841)
				Camaenidae (Pilsbry, 1895)	<i>Obba</i> (Broderip, 1841)	<i>Obba marginata parvula</i> (Broderip, 1841) <i>Obba horizontalis</i> (Pfeiffer, 1845)
					<i>Conchlostyla</i> (Férussac, 1821)	<i>Conchlostyla camelopardalis</i> (Broderip, 1841)
					<i>Anixa</i> ((Pilsbry, 1895)	<i>Anixa zebuensis</i> (Broderip, 1841)
				Trochomorphidae (Möllerndorff, 1890)	<i>Trochomorpha</i> (Albers, 1850)	<i>Trochomorpha repanda</i> (Möllerndorff, 1890) <i>Trochomorpha schmarkerii</i> (Möllerndorff, 1894) <i>Trochomorpha metcalfei</i> (Pfeiffer, 1845)
				Achatinidae (Swainson, 1840)	<i>Achatina</i> (Lamarck, 1799)	<i>Achatina fulica</i> (Férussac, 1821)
				Ariophantidae (Godwin-Austen, 1888)	<i>Sitala</i> (Adams, 1865)	<i>Sitala acuta</i> (Salvat, 1966)
				Helicarionidae (Bourguignat, 1877)	<i>Ryssota</i> (Albers, 1850) <i>Euplecta</i> (Semper, 1870)	<i>Ryssota oweniana</i> (Lea, 1852) <i>Euplecta apicata</i> (Blanford, 1870)
				Helicinidae (Férussac, 1822)	<i>Geophorus</i> (Fischer, 1885)  <i>Helicina</i> (Lamarck, 1799)	<i>Geophorus acutus</i> (Pfeiffer, 1847) <i>Geophorus acutus acutus</i> (Pfeiffer, 1847) <i>Geophorus acutus siquijorensis</i> (Bartsch, 1918) <i>Helicina clappi</i> (Pilsbry, 1909)
			Caenogastropoda (prosobranch)	Cyclophoridae (Gray, 1847)	<i>Cyclophorus</i> (Montfort, 1810)  <i>Leptopoma</i> (Pfeiffer, 1847)	<i>Cyclophorus daraganicus</i> (Hidalgo, 1888) <i>Cyclophorus fulguratus</i> (Pfeiffer, 1847) <i>Leptopoma woodfordi</i> (Sowerby, 1889) <i>Leptopoma nitidum ancilis</i> (Bartsch, 1918) <i>Moulinsia fusca</i> (Gray, 1841)
				Pupinidae (Pfeiffer, 1853)	<i>Moulinsia</i> (Grateloup, 1840)	<i>Moulinsia fusca erythrostoma</i> (Möllerndorff, 1890)

**Table 3.** Relative abundance and rarity of land snails in Mt. Lantoy forest, Philippines (n = 872)

Species	No. of individuals	Relative abundance / Rarity (%)
<i>Chloraea fibula</i>	28	3.21
<i>Helicostyla amagaensis</i>	4	0.46
<i>Helicostyla phitogaster</i>	13	1.5
<i>Helicostyla daphnis</i>	79	9.05
<i>Obba marginata parvula</i>	3	0.34
<i>Obba horizontalis</i>	9	1.03
<i>Conchlostyla camelopardalis</i>	31	3.56
<i>Anixa zebuensis</i>	7	0.8
<i>Trochomorpha repanda</i>	7	0.8
<i>Trochomorpha schmarkerii</i>	4	0.46
<i>Trochomorpha metcalfei</i>	11	1.26
<i>Achatina fulica</i>	63	7.22
<i>Sitala acuta</i>	3	0.34
<i>Ryssota oweniana</i>	220	25.22
<i>Euplecta apicata</i>	8	0.92
<i>Geophorus acutus</i>	104	11.93
<i>Geophorus acutus acutus</i>	122	13.99
<i>Geophorus acutus siquijorensis</i>	15	1.72
<i>Helicina clappi</i>	80	9.17
<i>Cyclophorus daraganicus</i>	9	1.03
<i>Cyclophorus fulguratus</i>	1	0.11
<i>Leptopoma woodfordi</i>	12	1.38
<i>Leptopoma nitidum ancilis</i>	37	4.24
<i>Moulinsia fusca</i>	1	0.11
<i>Moulinsia fusca erythrostoma</i>	1	0.11

## Discussion

This study provides the first extensive records of land snails in Mt. Lantoy Key Biodiversity Area, Cebu Island, Philippines. The forest area of Mt. Lantoy exhibits the characteristics of a suitable environment for terrestrial gastropod to flourish as described by Solem (1984), these are: (i) litter-rich forest; (ii) moderately moist; (iii) temperate and stable; and (iv) dissected topography. Native trees cover most of the plots dominated by *Parishia malabog* Mer belonging to the family Anacardiaceae. The sizes of the trees are comparable to species belonging to Dipterocarpaceae. The limestone hills in the forest is an excellent source of calcium essential for shell development.

The land snail population structure and geographic distribution vary from one plot to another. The *Ryssota oweniana* is relatively the most abundant species representing 25.22% of the total number of individuals collected. It is followed by *Geophorus acutus acutus* (13.99%) with 122 individuals, and *Geophorus acutus* (11.93%) with 104 individuals. There were three endemic land snails collected: *H. daphnis*, *Anixa zebuensis*, and *Leptopoma nitidum ancilis*. The *Helicostyla daphnis* was previously believed as threatened species but found thriving on Cebu island by Flores (2014). The *Anixa zebuensis* was first recorded in the proceedings of the zoological society of London in 1833 (Molluscabase 2019).

**Table 4.** Percent (%) frequencies of collected land snails in the study areas

Species	Plot number							
	1	2	3	4	5	6	7	8
<i>C. fibula</i>	5.14	0	2.17	0	0	1.12	4	1.08
<i>H. amagaensis</i>	0	0	0	0	3.57	0	0	3.23
<i>H. phitogaster</i>	2.83	0	0	6.90	0	0	0	0
<i>H. daphnis</i>	13.62	1.92	19.57	17.24	0	0	0	2.15
<i>O. marginata parmula</i>	0.51	0	0	0	0	0	1	0
<i>O. horizontalis</i>	1.54	0	0	0	0	0	3	0
<i>C. camelopardalis</i>	5.66	5.77	0	13.79	0	0	2	0
<i>A. zebuensis</i>	0	0	0	0	0	7.87	0	0
<i>T. repanda</i>	0	1.92	0	0	0	1.12	0	5.38
<i>T. schmarkerii</i>	0	0	0	0	0	4.49	0	0
<i>T. metcalfei</i>	0	5.77	4.35	0	0	4.49	0	0
<i>A. fulica</i>	14.65	0	3.26	0	10.71	0	0	0
<i>S. acuta</i>	0	0	3.26	0	0	0	0	0
<i>R. oweniana</i>	41.14	55.77	25.00	6.90	7.14	0	0	4.30
<i>E. apicata</i>	0	0	0	0	10.71	0	1	4.30
<i>G. acutus</i>	0.51	0	0	0	17.86	32.58	49	20.43
<i>G. acutus acutus</i>	10.80	26.92	30.43	34.48	3.57	10.11	0	19.35
<i>G. acutus siquijorensis</i>	0	0	0	0	0	3.37	0	12.90
<i>H. clappi</i>	0	0	0	0	28.57	29.21	35	11.83
<i>C. daraganicus</i>	2.31	0	0	0	0	0	0	0
<i>C. fulguratus</i>	0.26	0	0	0	0	0	0	0
<i>L. woodfordi</i>	0.26	0	6.52	6.90	10.71	0	0	0
<i>L. nitidum ancilis</i>	0.78	1.92	5.43	13.79	3.57	5.61	5	12.90
<i>M. fusca</i>	0	0	0	0	0	0	0	1.08
<i>M. fusca erythrostoma</i>	0	0	0	0	0	0	0	1.08
<i>S</i> = 25	15	7	10	7	10	10	8	13
Totals	389	52	92	29	28	89	100	93

**Table 5.** Constancy of land snails in the different plots (n = 872)

[illegible]

Initially assigned under genus *Helix* but later reclassified under genus *Anixa*. The rediscovery of the *A. Zebuensis* validated the previous recording of the species after more than a hundred years. The *Leptopoma nitidum ancilis* was first reported in synopses published by Bartsch in 1918. Bartsch described the shell's incised spiral sculpture of *Leptopoma* complex as the delineating morphological characteristic among the different subspecies.

The study has listed ten (10) new island record species: *Helicostyla amagaensis*, *Helicostyla phitogaster*, *Obba horizontalis*, *Conchlostyla camelopardalis*, *Trochomorpha schmarkerii*, *Sitala acuta*, *Euplecta apicata*, *Helicina clappi*, *Cyclophorus daraganicus*, and *Cyclophorus fulguratus*. *H. amagaensis* was first described by de Chavez et al. (2015) from a dipterocarp forest in Patnanungan Island, Philippines. The presence of this species in Cebu Island may indicate that this land snail may not be strictly endemic in Patnanungan Island but may inhabit other islands as well.

The result also showed that abundant species are well distributed in the study areas, as demonstrated by its constancy. In contrast, the ones described as rare are collected only in one specific plot. Its small size may have contributed to a fewer number of collections, or merely the species are undergoing some ecological pressure that affects their population abundance and distribution. The abundance and rarity of land snails have a significant implication on the survival of species (McGill et al. 2005). The relatively abundant species will have the capacity to sustain its population. The rarity of species may indicate local extinction occurring in the forest habitat due to ecological phenomena such as competition when one species excludes the other, or through predation or species are highly habitat specific (Verberk 2011).

Verberk (2011) proposed that their interactions and environmental conditions drive population dynamics of species co-occurring in the same area, which can be exemplified by the presence of *A. fulica*. The World Conservation Union (IUCN) listed *A. fulica* as one of the world's 100 most invasive species (Lowe et al. 2000). The snail has a high reproductive capacity producing as many as 1800 eggs per year and becomes sexually mature between 5 and 8 months (Raut and Barker 2002). It is a voracious herbivore that feeds on a wide range of cultivated plants, including weeds and indigenous plants. It also scavenges from decaying and detritus plant material (Raut & Barker 2002). This behavior is highly likely will isolate the other land snail species in the forest habitat.

The Mt. Lantoy species count of 24, excluding the *A. fulica*, could be compared with Marinduque, another Island in the Philippines extensively surveyed for land snails, with a species count of 23 (Sosa et al. 2014). These two islands have an uneven topographic landscape with mountain ranges composed of limestone karst. Both Islands have the same climatic patterns, mainly of wet and dry seasons. However, there were species common to both islands and species that were recorded only in one of them indicative of endemism. The differences in species composition could be due to geographic isolation and the varying elevation used

in the survey. The Marinduque land snail survey utilized the highest elevation of 125 m compared to the stratified elevation used in this study (182 m-691m). De Chavez and De Lara (2011) observed a positive correlation between elevation and abundance of land snails, particularly in the undisturbed rainforest in Mt. Makiling, Laguna, Philippines.

Land conversion and other agricultural activities were some of the ecological disturbances occurring around the peripheries of the Mt. Lantoy forest (Malaki et al. 2013). Disturbances in the forest habitat have an adverse effect on the distribution and abundance of land snails being highly sensitive to climatic and other environmental changes (Bloch 2012). Belhiouani et al. (2018) showed that areas with less to no anthropogenic disturbances in Northeast Algeria recorded high land snail abundance and diversity with ten species than to areas with anthropogenic disturbances that obtained only four species. Bloch (2012) suggested that regular cyclic disturbances such as typhoons or extreme dry season can cause a decline in land snail abundance but can recover over five or ten years. However, human-induced alteration of habitat may have longer-lasting effects on population structure due to prolonged ecological pressure.

In conclusion, the inventory of land snails has recorded 24 species, excluding the *A. fulica* being an introduced species, from eight plots across the different locations. There were three endemic and ten new Island record species recorded in the study. Four species were classified as rare, which should be given special attention for conservation purposes. This study provides the baseline information on the population structure and species composition of land snails in the Mt. Lantoy KBA. Future studies on the abundance and diversity of gastropod populations are highly recommended in the same permanent plots to monitor its responses against the long-term effect of environmental change.

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