A PRELIMINARY LAND SNAIL SURVEY OF SEAHORSE POINT NATURE RESERVE ISLA BASTIMENTOS PANAMA, CENTRAL AMERICA

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ABSTRACT

Land snails are a highly diverse but understudied component of tropical ecosystems, particularly in regions such as Panama where much of the fauna remains undocumented. In addition to their taxonomic significance, land snails play critical ecological roles, contributing to nutrient cycling, soil formation, and the transfer of energy through terrestrial food webs. By breaking down organic matter and serving as a key food and calcium source for a wide range of organisms, they are integral to ecosystem functioning and interconnectedness.

This survey was conducted to establish a baseline understanding of the land snail fauna at Seahorse Point Nature Reserve on Isla Bastimentos, Panama. Over a five-day period, a total of 12 families, 16 genera, and 19 species were documented within a 4-hectare plot, including two species that are potentially new to science. The diversity recorded within a limited timeframe underscores both the richness of the region and the need for further investigation.

This study provides foundational data to support ongoing research, conservation planning, and biodiversity monitoring efforts within the reserve and the broader region.

INTRODUCTION

In general, our understanding of land snail diversity, ecology, and distribution is vastly incomplete, particularly in tropical regions of the world. The number of recorded land snail species from Panama is estimated to be around 35% of the actual fauna with a predicted 65% still yet to be discovered (Thompson, 2011). Sporadic surveys in Panama and the broader region of Central America may explain the high number of estimated undescribed species of land snails, especially micro-species less than 5 mm in diameter. Little is known about anatomical features of most species or life histories of the fauna. Land snails are critical support species for a wide range of organisms as sources of food, calcium, and shelter. This survey was conducted to establish a baseline of information for further investigation of the land snail fauna of Seahorse Point Nature Reserve and provide managers of the private nature preserve information about the biodiversity in order to manage the property in a sustainable manner.

Land snails play a foundational role in terrestrial ecosystems, contributing to nutrient cycling, soil formation, and the transfer of energy through food webs. By breaking down leaf litter, fungi, and detritus, they accelerate decomposition processes and help release essential nutrients back into the soil. In turn, they serve as a key food source for a wide range of organisms, linking lower trophic levels to higher ones. Their presence and diversity reflect the health and stability of microhabitats, making them important indicators of ecosystem integrity. Understanding their diversity at Seahorse Point Nature Reserve therefore provides insight not only into species richness, but also into the broader ecological functioning and resilience of the system.

HISTORIC LAND SNAIL RESEARCH IN CENTRAL AMERICA

Most of what is known about the land snail fauna from Central America is based on early 18th century works, sound taxonomic studies and reviews dating back to Shuttleworth, Menke, and Pfeiffer (Thompson 2011). Specimen locations are rarely straightforward. Many collections have been separated and sent to different museums while others have proven to be impossible to locate. Fischer and Crosse material is in Paris; Von Martens' collection is in Berlin but most of his early Central American material can be found in London. Much of the Pfeiffer collections were lost during WWII. The material that remains including many types described by him on the basis of Cuming's 1851 material are located in London. Morelet's collections partly reside in London and partly in Geneva. The largest collection of Central American land snails currently is found at the Florida Museum of Natural History. Since the majority of early shell collections of Cen-

tral America reside in museums outside of the area, accessibility to researchers of Central America is limited. Recent technology and the digitization of museum databases along with imaging of type specimens has increased the accessibility for researchers in the region.

While literature records are important contributions to the overall knowledge, specimens upon which the records are based are even more valuable as they can be studied to verify reports or make new taxonomic, ecological or biogeographical discoveries. Historic collections are indeed an important source of fundamental reference, but caution must be used. Many institutionalized specimens have been incorrectly identified by well-meaning researchers without further verification. For this study, every attempt was made to compare material collected with the original Holotype, Paratype or Syntype specimens and, in some cases, first known illustrations.

Land snail collecting in Panama prior to this study has been sporadic with most surveys occurring near and around the Panama Canal or allied close to main thoroughfares. In 1926 Pilsbry, reported 77 species and subspecies of land snails from the Republic of Panama and the Canal Zone. The following is an excerpt from his classic 1926 paper on Panama's land snail fauna.

> *It will be seen from this list that 34 species, or 44 per cent of the whole, have been found only in the Republic of Panama and the Canal Zone. Twenty-four species, or 32 per cent, also northward. Thirteen species, or 16 per cent, both north and south, and 6 species, 8 per cent, only southward. Of the 31 genera, 20, or about two-thirds, occur both north and south of the Isthmus; 3, or about one-tenth, southward only; 8, or about one-fourth only northward. These figures have no great significance, since the Costa Rican fauna is the best known in Central America, while that of north-western Colombia, adjacent to the Isthmus, is almost unknown. Moreover, the land snails of the Republic of Panama east of the Canal Zone are far less known than those westward, and many more remain to be found, especially minute species. Of 30 species from Chiriqui and Bocas del Toro, 6 are widely spread both north and south, 16 only northward, and 8 found only in these Provinces; of these 8 the affinities of 7 are with the Central American, and of 1 (Labyrinthus) with the South American fauna. The fauna is thus overwhelmingly Central American. In the Canal Zone (plus Panama City and the adjacent islands) some 38 species have been found, of which 11 are widely distributed forms, 10 northern, 4 South American, and 13 special to the Zone. Of the latter, 6 are about equally related north and south, and of the rest, three are South American and 4 northern in their affinities. Thus, excluding the generally spread tropical forms and those of about equally northern and southern affinities, 14 of the Canal Zone forms are distinctively northern in their affinities, and 7 are as clearly South American. Of the 8 species reported from eastern Panama, 2 occur also in Colombia, and the others are all distinctly Colombian in their affinities. It appears therefore that while the transition between the South American and tropical North American faunas is gradual, some genera of each region penetrating far into the other, the change is most rapid in a comparatively short section of the isthmus at and immediately east of the Canal Zone.*

Thompson later reported in 2011 around 80 land snail species from Panama. Research conducted since 2023 of all available records including published works and global museum databases as well as field surveys now brings the total of land snail species in Panama to a staggering 300+ species now known to occur within the arbitrary boundaries of Panama, with as many as 140 species undetermined and possibly new to science.

Every expedition into this vastly under-collected area has yielded spectacular finds and has advanced our understanding of land snails in ecosystems and Seahorse Point is no exception. As a result, Panama is considered to be one of the most important molluscan regions in Central America (pers. comm. Thompson 2010) and might exceed other regions of comparable size in terms of numbers of species and endemism. This, however, remains to be more thoroughly investigated.

Early isolation from North and South America, geophysical (soils) and ecological influences such as diverse vegetation are thought to be the driving forces for such a rich fauna. As the isthmus or land bridge of Central America closed, the once-isolated areas of North America allied to the greater continent of South America resulting in a rich tapestry of both temperate and tropical land snails. These gastropods continue to diverge, creating new and unique locally endemic species. The inaccessibility of the densely forested and precipitous topography has also been a major deterrent to past collectors leaving the interior mountain ranges entirely unsampled.

Important and largely unsampled habitats within Panama await further investigation include the volcanic highlands, epiphytic plants found high in the jungle canopies, cloud forests, and rare elfin forests at the uppermost elevations (>2500 meters). Although these areas generally yield far less snail diversity and numbers of shells than the limestone sites, greater land snail endemism is expected. In the past, land snail endemism in Panama was reported to be low, the country containing few endemic species. Our research suggests otherwise, demonstrating that there are a number of endemic land snail species concentrated in high elevation mountains ranges, islands, and hydrologically isolated cave systems found

in Panama. Deep cave systems are expected to add rare, endemic, and troglobitic forms of land snails not previously documented.

IMPORTANCE OF LAND SNAILS IN ECOSYSTEMS

Land snails and slugs are widely distributed, and they are an essential food source for many terrestrial animals. Furthermore, land snails contribute to micronutrient cycling (Dallinger et al. 2000), seed and fungal spore dispersal (Richter 1980). Live snails and their vacant shells provide food and calcium carbonate sources to many systematic groups. Interspecies relationships with a variety of organisms including ants, firefly larva, snail-killing flies, *Cychrine* beetles, which feed chiefly on land snails (Symondson 2004), arachnids, carnivorous snails, salamanders, turtles and frogs, shrews, mice, moles, snakes, a variety of passerine birds (Graveland et al. 1994; Graveland 1996), thrushes, ruffed grouse and wild turkey (Martin et al. 1951), bats (Bonato et al. 2004; Thabah et al. 2007) support further study of land snails as critical components of a healthy ecosystem.

In addition to their role in food webs, land snails are key contributors to soil processes. Through their feeding activity on decaying plant material, fungi, and microorganisms, they fragment organic matter and enhance microbial decomposition. This activity improves soil structure, increases nutrient availability, and contributes to the formation of fertile topsoil. Their fecal matter further enriches the soil with bioavailable nutrients. In calcium-limited environments, snail shells represent an important reservoir of calcium carbonate, which becomes available to other organisms after decomposition. These processes highlight the integral role of land snails in maintaining soil health and supporting plant productivity.

Land snails have been shown to predict vertebrate conservation priorities (Moritz et al. 2001). With annual movement limited of around 20 meters a year (Bauer and Bauer, 1993; Aubry et al., 2006), land snails are confined to a specific habitat which makes them excellent sources of information about the health of an ecosystem. Additionally, snail shells may be present long after the animal is deceased. Definitive species richness and abundance can be easily determined as opposed to relying on other taxa as bioindicators. Additionally, land snails are easy to document and fairly easy to identify when compared to field work for vertebrates. Yet, despite these valuable and cost effective characteristics, land snails are rarely used as indicators. (Gerlach et al., 2013). Because land snails are sensitive to microclimatic conditions such as moisture, temperature, and soil chemistry, changes in their diversity and abundance can signal broader environmental changes, reinforcing their value as bioindicators in conservation and land management.

Due to the interference of metals with calcium metabolism and their need to prevent water loss, snails have developed strategies for metal immobilization, both at the cellular and molecular level (Dallinger, 1994; Oehlmann and Schulte-Oehlmann, 2003). This characteristic make land snails good bioindicators of heavy metal environmental pollution.

Mollusks support a number of contributions to human health. Marine mollusks may help fight liver cancer through the development of a drug that uses Kahalalide F, a protein extracted from a species of mollusks that eat sea slugs in the Pacific Ocean. Lethal toxins produced by cone snails, are used to develop a non-addictive drug called Ziconitide for patients with cancer and AIDS who suffer from chronic pain that cannot be relieved by opiates. Slime from the land snail, *Helix aspersa* (one of the commonly eaten snails referred to as escargot) is now used to treat many different types of skin disorders. Snail slime is reported to reduce scarring, repair skin damage from overexposure to the sun and reduce scarring caused by severe acne. The mucus of snails is known to contain antibacterial properties but remains largely unstudied. In Belize, the Maya use gastropods to treat a number of ailments including skin disorders, warts, glaucoma and whooping cough.

STUDY AREA

The study was conducted within a 4 ha plot located at Seahorse Point Nature Reserve (SPNR) on Isla Bastimentos, Bocas del Toro Province, Panama. Isla Bastimentos is part of the Bocas del Toro Archipelago in the Caribbean region of northwestern Panama and is characterized by a humid tropical climate and heterogeneous coastal landscapes, including lowland rainforest, mangroves, and coral reef systems .

SPNR occupies a coastal promontory overlooking Bahía Honda on the southern side of the island. The reserve encompasses a mosaic of secondary tropical forest, landscaped areas, and remnant vegetation associated with a resort property. The site now functions as a small-scale nature reserve and environmental learning center, integrating conservation, ecological restoration, and low-impact ecotourism .

The surrounding region falls within the broader influence of the Isla Bastimentos National Marine Park (13,226 ha), which protects diverse Caribbean ecosystems including evergreen tropical forest, mangroves, seagrass beds, and coral reefs . Vegetation on the island is typically characterized by dense lowland rainforest with high plant diversity, a complex understory, and frequent occurrence of palms and large canopy trees. Mangrove systems and coastal wetlands are also prominent in sheltered areas of the island, contributing to high habitat heterogeneity at local scales .

Within SPNR, the habitat includes forested slopes, coastal edge vegetation, and anthropogenically modified areas associated with trails and infrastructure. Elevated walkways and maintained paths provide access through forest canopy and mangrove-associated habitats, while portions of the site remain relatively undisturbed. The combination of regenerating forest, coastal proximity, and microhabitat diversity (e.g., leaf litter, woody debris, and understory vegetation) provides suitable conditions for terrestrial gastropod communities.

METHODS AND MATERIALS

Sites were selected based on previous knowledge of suitable habitat for tropical snail surveys in other Central American countries (Dourson et al., 2019) where land snails would be expected to occur. Habitats surveyed included the examination of the undersides of vegetation, under rotting logs in advanced stages of decay, under sloughing bark of tropical palm species, under rocks, along rock walls and old foundations of buildings, rock steps and walkways, and along creeks and streams. Visual survey techniques for macro snails utilized a hand rake to scrape leaf litter and detritus from the forest floor. Care was given to return the scraped litter to its original location. Each site was documented with GPS coordinates, habitat, time, and date. Macro snails found were placed in Ziploc bags labeled with site name and number along with GPS coordinates. At least 5 quart-size bags of leaf litter were collected from each site to be processed in the lab.

Soil/leaf litter samples were dried and sifted for micro-snails (<5 mm). Head loupes and a digital stereoscope were utilized in the field lab to aid in identification.

Specimens were identified using a variety of sources including GBIF (a global database of specimens housed in museums around the world), and literature searches for any relevant research or snail identifications from the 1700's to present day. All specimens were compared to type specimen images and descriptions. Nomenclature followed Molluscabase.org, the leading authority on current nomenclature.

RESULTS

A total of 12 distinct families, 16 genera, and 19 species were identified. Of the 19 species recorded, 2 are currently undetermined and possibly new to science. Micro-snails of <5 mm were most abundant comprising 52% of the total number of species recorded. The family with the greatest number of genera was ACHATINIDAE with 5 genera identified. The genera with the greatest number of species documented during the survey were *Miradiscops* in the SCOLODONTIDAE family including *Miradiscops balboa, Miradiscops panamensis, Miradiscops maya,* and *Miradiscops puncticipitis.* The SCOLODONTIDAE family is undergoing an extensive review and appears to be far more numerous than originally thought with species that occur in Panama being documented as far as Ecuador. Two species of slugs were documented in two different families including one undescribed species in the family VERONICELLIDAE, *Diplosolenodes species undetermined* and one slug in the family PHILOMYCIDAE, *Pallifera costaricensis.*

DISCUSSION

The primary goal of this study was to conduct a cursory inventory of the land snail fauna of the Seahorse Point Nature Reserve (SPNR) to provide a framework for future study within this biologically diverse region. Of particular interest are the islands that comprise the archipelago of Bocas del Toro like Isla Bastimentos as these islands were once connected to the mainland. A secondary goal of the study was to provide context for the importance of land snails within healthy functioning ecosystems. The documentation of two potentially new species to science as well as the documentation of 19 diverse species in such a small area supports the urgency to continue further study on Seahorse Point Nature Preserve and the remaining forest on Isla Bastimentos.

Perhaps the most interesting discovery was the slug, *Diplosolenodes species* (common name: Painted Slug) one of the most decorated slugs in the Veroncillidae family whose species tend to be drab. Native slugs are uncommon in most of Central America while exotic slugs are the ones considered to be agricultural pests and often found in abundance. It is also notable that both slug species found on Seahorse Point were native and therefore not considered pests.

The other noteworthy species was another species likely new to science, *Glyphyalinia* species undetermined. This minute snail has now been documented at sites across Panama which begs the question of how it made its way onto Isla Bastimentos. One hypothesis may be that it traveled there on the wings of a bird. Studies of the woodcock, a native to the USA, documented anywhere from 1-10 snails on 11% of the birds surveyed. Land snails are known to survive inside the gut of birds as well, to be dispersed through defecation (van Dooren, 2023). These dispersal methods could explain the higher number of other micro snails documented at Seahorse Point Nature Preserve.

This study also highlights the accessibility of land snail research as a tool for public engagement. Land snails are relatively easy to observe and document, making them ideal organisms for citizen science initiatives. Platforms such as iNaturalist allow participants to upload observations that contribute to global biodiversity databases, supporting species distribution mapping and conservation efforts. Encouraging visitors, students, and local community members to search for and document land snails at Seahorse Point Nature Reserve could greatly expand the knowledge base for the region

while fostering a deeper connection to local biodiversity. Such efforts can play an important role in building long-term conservation awareness and stewardship.

RECOMMENDATIONS FOR FUTURE RESEARCH

The diversity of species documented in such a small area during this brief cursory land snail survey warrants future study. Invertebrate surveys are much more likely to continue to produce new species discoveries when compared to vertebrate surveys which further supports the critical nature of protecting this biodiversity hotspot. When compared to surveys for other taxa, land snails are inexpensive and easy to find. Furthermore, impacts to live populations are minimal as most surveys collect only shells not live animals.

Given the stated mission of Seahorse Point Nature Reserve, we propose future studies that include Parque National Bastimentos and community outreach workshops that coincide with the SPNR's stated mission to provide environmental education to the local population.

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LAND SNAIL SPECIES OF SEAHORSE POINT, ISLA BASTIMENTOS BOCAS DEL TORO PROVINCE, PANAMA January 2026

Key: (sp. nov.)= new species to science NPR=New Province Record NCR=New Country Record

Family	Genus/Species	<5 mm	Notes
HELICINIDAE	*Lucidella lirata*		
VERONICELLIDAE	*Diplosolenodes species undetermined*		(sp.nov.)
SUCCINEIDAE	*Succinea recisa*		
ACHATINIDAE	*Allopeas micra micra*	X	
	Lamellaxis filicostatus		
	Leptinaria unilamellata unilamellata		
	Opeas hannense		
	Subulina octona		
FERUSSACIIDAE	*Karolus consobrinus primus*	X	
SAGDIDAE	*Xenodiscula taintori*	X	
EUCONULIDAE	*Gupyya gundlachi*	X	
SCOLOTONTIDAE	*Miradiscops balboa*	X	
	Miradiscops maya	X	
	Miradiscops puncticipitis	X	
	Miradiscops panamensis	X	
GASTRODONTIDAE	*Glyphyalinia species undetermined*	X	(sp. nov.)
SPIRAXIDAE	*Pittieria brocktontomlini*		
PHILOMYCIDAE	*Pallifera costaricensis*		
THYSANOPHORIDAE	*Lyroconus caecoides*	X	

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