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Diversity and conservation of the land snail fauna of the western Pacific islands of Belau (Republic of Palau, Oceania)*

Rebecca J. Rundell[1,2,†]

[1] Committee on Evolutionary Biology, University of Chicago, 1025 East 57th Street, Chicago, Illinois 60637, U.S.A.

[2] Division of Invertebrates, Department of Zoology, Field Museum of Natural History,

1400 South Lake Shore Drive, Chicago, Illinois 60605, U.S.A.

Corresponding author: rrundell@interchange.ubc.ca

Abstract: Pacific land snails are among the most threatened animals on Earth, and basic information on the number of extant species is lacking for many island groups. The isolated western Pacific archipelago of Belau comprises 586 islands, most of which have suitable land snail habitat; yet little has been published on the land snail fauna. I undertook surveys throughout Belau, searching trees and emergent vegetation, leaf litter, and limestone rock. Survey results from selected, geographically representative islands are presented here. The total number of species found in these areas (117) indicates that there may be ca. 200 extant Belau land snail species. This number far exceeds previous estimates. Most species are endemic to Belau (95% in this survey), and species endemic to one or a few islands are not uncommon. Leaf litter and rock dwelling diplommatinid land snails are a large component of the snail biota: only 26 Belau diplommatinids have been described, and 81 species were collected in this survey. Although caenogastropod land snails comprise the most obvious portion of the fauna, notable pulmonates include the partulids and endodontoids, two land snail groups that have suffered extinction throughout the Pacific region. Belau has one of the most spectacularly diverse extant land snail faunas in the Pacific region, and the restricted ranges of many species highlight the need for conservation attention, particularly on the island of Babeldaob, which is undergoing increased deforestation.

Key words: biodiversity, distribution, management, biogeography, Micronesia

Pacific oceanic islands have drawn European explorers' vessels for hundreds of years, including the *Beagle* and the ships of Captain Cook although many islands remained virtually unknown to the rest of the world until a little over a century ago. Major inroads have been made in understanding diversification patterns in some of the larger island groups, such as the Hawaiian islands (Wagner and Funk 1995), Galápagos (Grant 1986), and French Polynesia (Clarke and Murray 1969), yet the fact that we are still uncovering many undescribed species (particularly of lesser-studied taxa) in these areas suggests that not only does much work remain in understanding the evolution of species on these islands, but there is a seemingly endless need for natural history information on species, including species distributions. The need for species surveys and natural history data for all Pacific island species is particularly urgent because of the high extinction rate for Pacific island biotas (Quammen 1996).

The high levels of species richness found among oceanic island land snails was noted by Darwin (1859), and since then, Pacific island land snail extinction has accelerated to the point where almost 90% of the 763 described Hawaiian land snail species are now extinct (Cowie 2001a), and the snail faunas of other archipelagos have suffered a similar fate (*e.g.*, Samoa [Cowie 2001b, Cowie and Cook 2001]; French Polynesia [Cowie 1992]). Habitat destruction, introduction of rats and mice, introduction of snail predators, invasive species, and in a few cases, over-collecting, have all contributed to the disaster that is land snail extinction in the Pacific (Hadfield 1986, Hadfield *et al.* 1993, Lydeard *et al.* 2004).

Early land snail specialists such as C. Montague Cooke and Yoshio Kondo of the Bishop Museum (Honolulu, Hawai'i) were likely aware of these threats and fortunately collected some of the few remaining examples of many land snail species whose populations were later decimated. These collections, in addition to those of Alan Solem (Field Museum of Natural History, Chicago, Illinois) are an invaluable resource for future research; however, we still frequently lack basic information such as the number of recorded or extant endemic

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† Present address: Department of Botany, University of British Columbia, #3529-6270 University Blvd., Vancouver, British Columbia V6T 1Z4, Canada.

species currently on an island. Such information is necessary for developing and implementing conservation management strategies (*e.g.*, alien species prevention and eradication efforts) that are sorely needed on many islands (Lydeard *et al.* 2004). Given the rate at which extinction is occurring on Pacific islands (Solem 1990, Cowie 1992, Lydeard *et al.* 2004), we do not have the luxury of time in documenting faunas at such great risk of complete decimation.

The land snail fauna of the western Pacific islands of Belau (Fig. 1, and described in Materials and Methods) is not well documented, and there is urgent need for baseline data on species distributions. Smith (1993) lists 69 described species (including both indigenous/endemic and introduced species). Cowie *et al.* (1996) suggest that there may be 40-50 indigenous/endemic species in Belau, based on a survey of the literature and a scan of the Bishop Museum (Honolulu, Hawai'i) collections.

I present the first results of an intensive survey effort on the islands of Belau, which began in 2003. Documentation of the rock and leaf litter dwelling diplommatinid land snails was the priority of this work (Rundell 2008), and this paper represents the first of several detailing surveys of Belau's diverse land snail fauna. Many species are undescribed and some, particularly those <5 mm, are cryptic. Results indicate that endemism is high (at least 95% for the present survey of 26 areas), and many species, particularly the rock and leaf litter dwelling diplommatinids, are single or few-island endemics. Based on my surveys, Belau land snail species richness has been seriously underestimated, particularly for the tiny diplommatinids. Few invasive species were collected, a rarity for Pacific islands, and representatives of two of the most endangered land snail groups in the Pacific, namely the endodontoids and the partulids, were found. Belau's land snail fauna ranks among the most diverse in the Pacific relative to island area and is worthy of conservation protection.

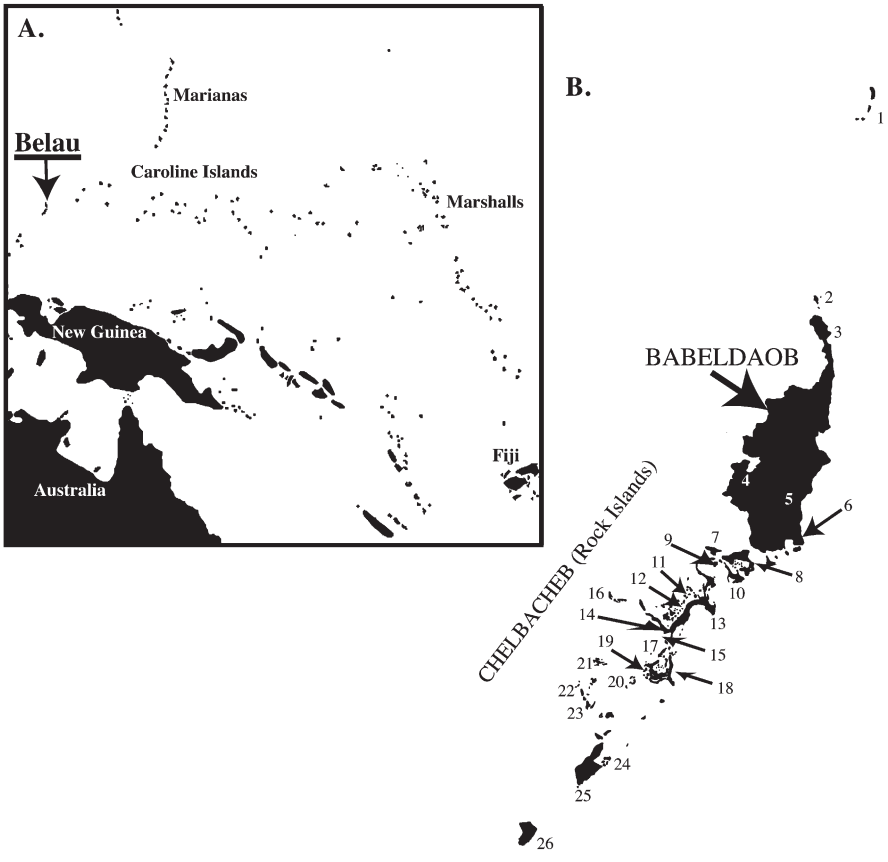

Figure 1. A, (Inset) Western Pacific region, showing the location of Belau. The Belau archipelago is centered at 7°20′N and 134°E. B, The islands of Belau (Republic of Palau, Oceania). The archipelago is 160 km in length. Island names follow Motteler (2006). Numbers represent the following islands and localities: (1) island of Ngcheangel, (2) island of Ngerechur, (3) Ngerchelong State, island of Babeldaob, (4) near waterfall, Ngatpang State, island of Babeldaob (5) near Ngardok Lake, island of Babeldaob, (6) Oikull and Ngerduais, Airai State, island of Babeldaob, (7) island of Ngerekebesang, (8) Ngermid, island of Oreor, (9) island of Malakal, (10) island of Ulebsechel, (11) an unnamed northern Rock island, Koror State, (12) an unnamed Rock island, south of 11, Koror State, (13) island of Ngeruktabel, (14) Medukriikuul, island of Ngeruktabel, (15) island of Ngchus, (16) island of Ulong, (17) island of Eudelchol, (18) near Jellyfish Lake, island of Mecherchar, (19) western Mecherchar, (20) island of Omekang, (21) near island of Kmekumer, (22) one island of Ngemelis, (23) large island of Ngemelis, (24) Techakl, island of Beliliou, (25) island of Beliliou, and (26) island of Ngeaur.

MATERIALS AND METHODS

Survey area

The islands of Belau (comprising the independent Republic of Palau; Fig. 1), spanning 160 km, are centered at 7°20′N and 134°E in the western Pacific region known as Micronesia. Belau is a crest of an arc ridge (Kobayashi 2004) and has never been in contact with a continental landmass. The closest large islands to Belau are: Mindanao in the Philippines, the Moluccas and New Guinea (800 km), and Borneo (1500 km) (Crombie and Pregill 1999). The oldest emergent rocks in Belau are ca. 30 Ma, and its 586 islands (415 km^2

total land area) are composed of volcanic rock and limestone. There are several different island types: volcanic (highest elevation is 242 m), high limestone, low limestone, reef or atoll, and a combination of volcanic rock and limestone (Crombie and Pregill 1999). Although most of the land area (333 km^2) is the volcanic island of Babeldaob, the Miocene (23 to 5 Ma) to Pleistocene limestone islands to the south, many of which are <1 km^2, also harbor great diversity. The karst mushroom-shaped Rock Islands in particular (Kelletat 1991) were suspected to harbor many calciphilic species; land snail species richness has been shown to increase with increasing pH and calcium (Emberton *et al.* 1997), and similar tropical limestone rock outcrops are known to harbor diverse land snail faunas (Vermeulen 1993, 1994, Schilthuizen *et al.* 2005, 2006).

The Belau islands are humid tropical (350-400 cm annual precipitation; rainfall can be heavy year-round), and forested with mostly native species, even at low elevations (Crombie and Pregill 1999). The island of Babeldoab has the largest tract of pristine rainforest in Micronesia.

Field methods and specimens

Land snail collections occurred in 2003, 2005, and 2007. I selected 26 localities throughout Belau to represent a diversity of island and habitat types as well as geographical spread, and collected land snail specimens using timed searches. Island localities are numbered and shown in Fig. 1. I undertook separate searches in the trees/emergent vegetation, leaf litter, and rocks (both live and dead shells were collected in the different habitats). Where there were no limestone outcrops (*e.g.*, on volcanic substrates), searches included only the first two habitats.

Snail sampling involved thorough search of each habitat, locating snails by eye, and using forceps or hands to place snails in separate vials, each labeled according to habitat. Sorting several collections of bulk leaf litter in 2003 and 2005 revealed that this procedure could be abandoned in favor of the field-based hand capture method since bulk leaf litter collections did not result in additional species diversity.

I killed snails in 95% ethanol on the day of capture and replaced ethanol in each vial two times post-killing to ensure proper preservation. Following shipment to the Field Museum of Natural History (FMNH), I sorted adult specimens to species using a dissecting microscope, shell characters (*e.g.*, shape, presence/absence of keel, spines, number of ribs), species descriptions (and additional species accounts, *i.e.*, Kobelt 1902, Wagner 1905, Thiele 1927, Cooke and Kondo 1960, Thompson and Huck 1985), and comparative and type material from the Bishop Museum (BPBM) and FMNH. For Diplommatinidae, species identifications based on shell morphological differences were corroborated by molecular data (Rundell 2008). Undescribed diplommatinid species were listed by letter code, reflecting the order in which they were collected. To impose order on the enormous diversity of diplommatinids, each undescribed species was assigned a temporary genus name, reflecting its habitat and morphology. *Palaina* Crosse, 1866 species are generally leaf litter dwelling, ovate conical, brown, and with different rib patterns. *Diplommatina* Benson, 1849 species are rock dwelling, pointed, heavily calcified, and whitish or yellowish. *Hungerfordia* Beddome, 1889 species are rock dwelling with dramatic shell spines or lamellae and are whitish and heavily calcified. I deposited land snail specimens at the FMNH, which holds one of the world's largest collections of Pacific island land snails.

RESULTS

Faunal composition

Described species in the current survey are listed in Table 1. Species localities are listed by island and locality (as indicated by number: see Fig. 1) in Table 2. Table 2 is most representative of species presence on an island, rather than absence (particularly for some widespread species); in other words, some common species such as the assimineid *Omphalotropis cheynei* Dohrn and Semper, 1862 and the helicinid *Palaeohelicina heterochroa* A. J. Wagner, 1906 occur on most islands and I expect, as additional data come to light, species matrices will include additional taxa. A large number of species have been recorded in the current study: *i.e.*, the island of Beliliou has 36 species and the Medukriikuul site on the island of Ngeruktabel has 20 species, 18 of which are diplommatinids (Tables 1-2).

The total number of species documented in this survey was 117. These species represent 14 families (Tables 1-2). Approximately 95% of the species found were Belau endemics, and many species occur on only one or a few islands (Table 2).

The amount of undescribed diversity in Belau is great. Out of the 117 total species found in this survey, only 36 species are described. The families with the most undescribed species were: Diplommatinidae (only 10 of the 81 species recorded here were described), Hydrocenidae (none of the four species recorded were described), and Helicarionidae (two of the 10 species recorded were undescribed).

Some species are relatively widespread, while others are endemic to single islands. The Diplommatinidae in particular are composed of some species that occur on only a single island (*e.g.*, the leaf litter dweller *Palaina* AU), and others that occur on multiple islands (*e.g.*, the rock dweller *Hungerfordia* A; Table 2).

DISCUSSION

The total number of species recorded in this survey (117) exceeds previous estimates by Smith (1993), who listed 69 described species (including both native and introduced

Table 1. Described species included in survey, authors, and habitat (Ground and Gr. = leaf litter, Veg. = trees and emergent vegetation, Rock = limestone rock). Some endodontoids occur under rocks as well as in leaf litter. Under the category of "status," endemic refers to species that are native to only the Belau islands, indigenous refers to species that are native to Belau, but also found elsewhere, and introduced refers to all species that are non-indigenous to Belau, having been introduced either accidentally or deliberately. Species marked with an asterisk are listed in the *1994 Red List of Threatened Animals* (Groombridge 1993, IUCN 2004).

Family	Species	Habitat	Status
Caenogastropoda			
ASSIMINEIDAE	*Kubaryia pilikia* Clench, 1948	Ground	Endemic
	Omphalotropis cheynei (Dohrn and Semper, 1862)	Ground/Veg.	Endemic
DIPLOMMATINIDAE	*Diplommatina lutea* Beddome, 1889*	Rock	Endemic
	Palaina albata (Beddome, 1889)*	Ground	Endemic
	Palaina dimorpha (Crosse, 1866)*	Ground	Endemic
	Diplommatina inflatula (Crosse, 1866)*	Rock	Endemic
	Palaina moussoni Crosse, 1866*	Ground	Endemic
	Palaina patula (Crosse, 1866)*	Ground	Endemic
	Diplommatina polymorpha (Crosse, 1866)*	Rock	Endemic
	Diplommatina ringens (Crosse, 1866)*	Rock	Endemic
	Palaina striolata Crosse, 1866*	Ground	Endemic
	Hungerfordia pelewensis Beddome, 1889*	Rock	Endemic
HELICINIDAE	*Palaeohelicina heterochroa* (Ancey?)	Ground/Veg.	Endemic
	Pleuropoma pelewensis (Sykes, 1901)	Gr./Rock/Veg.	Endemic
PUPINIDAE	*Pupina difficilis* Semper, 1864*	Ground	Indigenous
TRUNCATELLIDAE	*Truncatella guerinii* A. and J. B. Villa, 1841	Ground	Indigenous
Pulmonata			
ACHATINELLIDAE	*Elasmias ovulatum* (Möllendorff, 1900)	Vegetation	Indigenous
ACHATINIDAE	*Achatina fulica* Bowdich, 1822	Ground	Introduced
CHAROPIDAE	*Semperdon kororensis* (Beddome, 1889)*	Ground	Endemic
	Semperdon uncatus Solem, 1982*	Ground	Endemic
	Semperdon xyleborus Solem, 1982*	Ground/Rock	Endemic
ELLOBIIDAE	*Pythia scarabaeus* (Linnaeus, 1758)	Ground	Indigenous
ENDODONTIDAE	*Aadonta constricta* (Semper, 1874)*	Ground	Endemic
	Aadonta fuscozonata depressa Solem, 1976*	Ground	Endemic
	Aadonta irregularis (Semper, 1874)*	Ground	Endemic
	Aadonta kinlochi Solem, 1976*	Ground	Endemic
HELICARIONIDAE	*Coneuplecta turrita Belauensis* Baker, 1941	Ground	Endemic
	Kororia palaensis (Semper, 1870)	Ground/Rock	Endemic
	Liravidena lacerata (Semper, 1974)	Ground/Rock	Endemic
	Palaua minor (Semper, 1873)*	Ground/Rock	Endemic
	Videna electra (Semper, 1873)*	Gr./Rock/Veg.	Endemic
	Videna oleacina (Semper, 1873)*	Ground/Rock	Endemic
	Videna pagodula (Semper, 1873)*	Ground/Rock	Endemic
	Videna pumila (Semper, 1873)*	Ground	Endemic
PARTULIDAE	*Partula calypso* Semper, 1865*	Veg.	Endemic
	Partula thetis Semper, 1865*	Veg.	Endemic
SUBULINIDAE	*Subulina octona* (Bruguière, 1789)	Ground	Introduced

species), and Cowie *et al.* (1996), who suggested that there may be 40-50 indigenous/endemic species in Belau. Given the fact that only 26 areas were included in the present study, and that many of the species are very small and morphologically cryptic (*e.g.*, diplommatinids, hydrocenids, and helicarionids), an overall estimate of ca. 200 species for the Belau fauna is reasonable.

Perhaps the most significant result of this survey was the discovery of the extraordinary species richness among the diplommatinid land snails of Belau. Previously, only 26 species were described, and yet 81 species were recorded in this study. Most of these species are undescribed. Several of the described diplommatinid species were not collected in this

survey, and it is unknown whether these species are extinct or merely await collection as more islands are added to the results. Given that most habitat destruction has occurred on the islands of Babeldaob and Oreor, species from these islands may be most likely to have suffered extinction.

A surprising result was the high species diversity on the island of Beliliou, despite the island's notoriety as the site of one of the bloodiest battles of World War II (Crombie and Pregill 1999). Although much of the island was burned during this conflict, apparently enough habitat survived to maintain high endemic species richness there, since Beliliou is home to 36 Belau endemics (Table 2). Much of this diversity is concentrated along the limestone spine of the island, popularly known as "Bloody Nose Ridge."

This study also uncovered at least seven endodontoid species, which is noteworthy since endodontid and charopid species are generally rare or extinct throughout most Pacific islands where they were once known to occur (Cowie 1996). Another Pacific endemic family, the Partulidae, was represented by at least one species, which is likely *Partula calypso*. However, there could be an additional extant endemic *Partula* species present among some of my records (D. Ó Foighil, pers. comm.). Partulids were recorded from two of the islands presented in this paper. Given the extinction of Partulidae throughout the Pacific (Cowie 1992), all Belau partulid localities warrant conservation attention.

Threats and conservation recommendations

Although the impacts of rats and introduced predatory land snails (*e.g.*, the rosy wolf snail *Euglandina rosea* Férussac, 1821) have, rightly, been emphasized for their role in the decimation of land snail faunas throughout the Pacific (*e.g.*, Cowie 1992, Lydeard *et al.* 2004), habitat destruction is the most significant looming threat to Belau's endemic land snails. For example, deforestation caused by the construction of subsidiary roads to Babeldaob's Compact Road (also mentioned by Cowie *et al.* 1996, in the early stages of its construction), development near the new capital building in the state of Melekeok on Babeldoab as well as planned tourist-centered areas on Babeldoab and low limestone islands could have rapid and far-reaching consequences for Belau's snail species. Once forests are cut, a cascade of effects ensues, including erosion, soil and microclimate changes, and the subsequent invasion of non-indigenous species suited to disturbed areas. This inevitably leads (and likely has led, prior to species records) to the extinction of endemic snails, most of which have very small geographic ranges and can survive only under a narrow set of ecological conditions under which their specific fungal and detrital food accumulates.

Mining of limestone outcrops is another important threat to Belau's land snails since many species, particularly diplommatinids, but also some of the *Videna* Semper, 1873 species and endodontoids, are endemic to limestone karst and limestone karst forests. Although to date most of Belau's Rock Islands are protected by a management plan (*e.g.*, Koror State) and are considered one of Belau's most important natural resources—not just for tourism, but for future generations of Belauans—the limestone excavation pressure that exists in similar tropical areas, such as Malaysian Borneo (Schilthuizen *et al.* 2005) indicates that diligence should be exercised in maintaining Belau Rock Island protection, both in Koror and Airai States. The environs of Oikull and Ngerduais in southeastern Babeldoab are especially important since they are home to one of the few remaining populations of endemic partulid tree snails.

Predation by rats may be an issue for some Belau land snails, such as the slow-reproducing partulids (Cowie 1992). Broken shells of some indigenous land snail species (though not partulids), indicative of rat predation, were found on Ulong (Rundell, unpubl. data, 2003, 2005, and 2007). Given the decimation by rats of achatinelline and partulid land snails elsewhere in the Pacific (Hadfield 1986, Cowie 1992, Hadfield *et al.* 1993), this threat should not be ignored though further study of Belau partulid populations is needed to understand whether current populations are healthy or in decline. While partulids may have co-occurred with rats on Ulong for many years (*e.g.*, since the shipwreck of the English vessel the *Antelope* centuries ago), it is unknown whether the current pockets of partulids are fragments of more widespread populations that are now in decline. Comparisons with past collections and generation of more complete current baseline data are vital in this regard. It is also unknown whether rats on other partulid islands, such as Ngeruktabel, could have a negative effect on partulids, particularly if combined with other pressures, such as other invasive plant and animal species. Evidence from other Pacific islands suggests that the answer is "yes."

Summary and future directions

Future work on Belau land snail faunal diversity should include species descriptions and enumeration of geographic distributions with the eventual aim of producing a species catalogue and thorough conservation management plan for Belau land snails. Given the decimation of endodontoids and partulids throughout the Pacific region, these two groups should be paid particular attention. In addition, undescribed diversity in groups such as the helicarionids and hydrocenids indicates that these families warrant taxonomic effort.

Belau's land snails are incredibly species rich (ca. 200 extant species) relative to the small island area they inhabit, and the people of the Republic of Palau are in a unique position to conserve the many species that still remain. The presence of endemic and indigenous species throughout the Belau archipelago and the rarity of invasive land snail species, relative to many other Pacific island groups, indicate that if native forests

Table 2. Species occurrences on each surveyed island. Taxa are indicated on vertical axis. Undescribed or unassignable species were given letter codes, which simply reflect the order of identification. Localities (individual islands in most cases) are represented by numbers. Key to island numbers is shown in Figure 1. Species presence at a locality is indicated with a "+".

	Island												
Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13
Assimineidae													
Omphalotropis cheynei	+					+	+	+					
Diplommatinidae													
Palaina patula								+					
Palaina dimorpha								+	+				
Palaina striolata							+						
Palaina K									+				
Palaina L						+							
Palaina albata						+							+
Palaina O										+			+
Palaina T				+									
Palaina V				+									
Palaina moussoni	+												
Palaina AI							+						
Palaina AJ							+						
Palaina AM						+							
Palaina AN						+							
Palaina AS										+			
Palaina AU										+			
Palaina AW										+			
Palaina BJ				+									
Palaina BK				+									
Palaina BM		+											
Palaina BN		+											
Palaina BO		+											
Palaina BP		+											
Palaina BQ			+		+								
Palaina BR			+		+								
Palaina BS					+								
Palaina CE													+
Palaina CL											+		
Palaina sp.												+	
Diplommatina lutea						+				+	+	+	
Diplommatina AF								+					
Diplommatina AG										+			
Diplommatina AH								+					
Diplommatina AK						+		+					
Diplommatina AL												+	+
Diplommatina AV										+		+	
Diplommatina BA													+
Hungerfordia A						+		+		+			+
Hungerfordia C								+				+	
Hungerfordia D										+			
Hungerfordia K												+	
Hungerfordia pelewensis						+					+		
Hungerfordia T						+							
Hungerfordia P												+	

(continued)

Table 2. (Continued)

	Island												
Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13
Helicinidae													
Palaeohelicina heterochroa						+	+	+					
Pleuropoma pelewensis	+												
Hydrocenidae													
Georissa sp. 1						+		+					
Georissa sp. 2	+												
Georissa sp. 5								+					
Pupinidae													
Pupina difficilis	+						+		+				
Truncatellidae													
Truncatella guerinii	+												
Achatinellidae													
Elasmias ovulatum	+												
Achatinidae													
Achatina fulica						+		+					
Charopidae													
Semperdon uncatus											+		
Semperdon sp.						+							
Endodontoid				+									
Ellobiidae													
Pythia scarabaeus	+					+		+					
Endodontidae													
Aadonta fuscozonata depressa						+						+	
Aadonta irregularis												+	
Helicarionidae													
Kororia palaensis	+					+	+	+					
Liravidena lacerata						+							
Palaua minor						+			+				
Palaua sp. 1	+												
Videna electra								+					
Videna oleacina						+							
Partulidae													
Partula sp.						+							+
Subulinidae													
Subulina octona	+					+	+	+					

	Island												
Taxon	14	15	16	17	18	19	20	21	22	23	24	25	26
Assimineidae													
Kubaryia pilikia												+	
Omphalotropis cheynei			+				+				+	+	
Unidentified sp. 1			+										
Diplommatinidae													
Palaina dimorpha							+						
Palaina K												+	
Palaina albata		+	+	+	+	+	+		+	+		+	+
Palaina N			+		+			+	+	+		+	+
Palaina O	+	+	+	+	+	+	+					+	+
Palaina Q			+									+	

(continued)

Table 2. (Continued)

	Island												
Taxon	14	15	16	17	18	19	20	21	22	23	24	25	26
Palaina AJ					+								
Palaina AP												+	
Palaina AR									+			+	
Palaina AS	+			+	+	+			+	+		+	
Palaina AY	+				+	+							
Palaina AZ	+		+	+	+	+	+			+			
Palaina BB	+												
Palaina BC	+												
Palaina BD	+			+									
Palaina BE						+							
Palaina BF	+		+		+								
Palaina BI	+												
Palaina CE													+
Palaina CG					+								
Palaina CH													+
Palaina sp.											+		
Diplommatina inflatula			+									+	
Diplommatina polymorpha												+	
Diplommatina ringens												+	
Diplommatina AG	+			+	+				+	+		+	
Diplommatina AL							+					+	
Diplommatina AO	+	+										+	
Diplommatina AQ												+	
Diplommatina AT												+	
Diplommatina AX	+	+	+	+	+	+	+	+	+	+			
Diplommatina BA	+												
Diplommatina BG					+	+							
Diplommatina BH			+									+	
Diplommatina BL								+					
Diplommatina CD													+
Diplommatina CM							+						
Diplommatina CR							+				+		
Diplommatina CS						+	+						
Hungerfordia A	+	+		+	+	+	+		+	+		+	+
Hungerfordia C			+									+	
Hungerfordia D			+									+	
Hungerfordia E			+										
Hungerfordia J	+	+											
Hungerfordia K	+	+											
Hungerfordia L	+												
Hungerfordia M	+												
Hungerfordia N		+											
Hungerfordia S							+						
Hungerfordia U								+					
Helicinidae													
Palaeohelicina heterochroa			+									+	
Pleuropoma pelewensis			+									+	

(continued)

Table 2. (Continued)

	Island												
Taxon	14	15	16	17	18	19	20	21	22	23	24	25	26
Hydrocenidae													
Georissa sp. 1												+	
Georissa sp. 2			+										
hydrocenids	+												
Pupinidae													
Pupina difficilis			+										
Truncatellidae													
Truncatella guerinii											+		
Achatinellidae													
Elasmias ovulatum			+									+	
Elasmias sp. 1			+										
Charopidae													
Semperdon xyleborus	+		+	+			+					+	
Semperdon kororensis			+										
Endodontoids		+								+			+
Ellobiidae													
Pythia scarabaeus			+								+	+	
Endodontidae													
Aadonta constricta			+				+						
Aadonta irregularis							+						
Aadonta kinlochi			+				+					+	
Helicarionidae													
Coneuplecta turrita												+	
Kororia palaensis			+				+				+	+	
Palaua minor			+								+	+	
Palaua sp. 3			+										
Videna electra			+								+	+	
Videna oleacina			+									+	
Videna pagodula												+	
Videna pumila			+										
Subulinidae													
Subulina octona			+								+	+	

can be preserved in Belau and non-indigenous species can be kept out of the country, Belau has every hope of conserving this fauna for future generations. Land snails will be not only of interest to evolutionary biologists and ecologists (though this interest should be substantial), but land snails' presence coincides with healthy indigenous forests, which support watersheds, plants, and animals critical for human survival, and that make the islands of Belau one of the most beautiful, unique, and instantly recognizable places on the planet.

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