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October 18, 1996.

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AN ABSTRACT OF THE THESIS presented by Scott Bauman for the Degree of Master of Science in Biology, October 18, 1996.

Title: Diversity and decline of land snails on Rota: Mariana Islands

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This study reviews the land snail fauna of Rota to assess the diversity of the fauna (based on recent field collections and the literature) and the status of each species encountered (currently extant vs. apparently extinct but known from historically collected live specimens vs. known only from dead material). This information can be used to determine the conservation needs of land snails on Rota and to provide insights into the origin and evolutionary history of the fauna. Two known land snail predators have been introduced to Rota since World War II: the predatory flatworm *Platydemus manokwari* and the predatory gastropod *Gonaxis kibweziensis*. Of the 43 species encountered on Rota, 9% are considered to survive well, 23% have questionable survival status, 56% are in decline and 12% are potentially extirpated. Land snails tend to be more widespread among the islands of the Marianas than among the Hawaiian Islands. Thus while 87% of Oahu's land snails are restricted to that island only 31% of Rota's land snails are such single island endemics. The greater range of land snails in the Marianas than in Hawaii could be related to the frequent typhoons that track across the former island group. In situ diversification in the Mariana Islands has occurred at least in the families

Assimineidae, Charopidae, and Partulidae. An annotated checklist of land snails recorded from the southern Mariana islands is given as an appendix.

DIVERSITY AND DECLINE OF LAND SNAILS ON ROTA: MARIANA ISLANDS

BY

SCOTT BAUMAN

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INTRODUCTION

Terrestrial gastropods are possibly the most extinction prone organisms on oceanic islands (Hadfield et al. 1993, Paulay 1994). Many insular land snails have restricted ranges and small population sizes, making them especially sensitive to introduced competitors, predators, and habitat destruction (Hadfield et al. 1993). Also, certain species have been over-collected by shell enthusiasts in the past (Hadfield 1986, Solem 1990). Since many species of land snails on oceanic islands evolved *in-situ*, under limited predation pressures, they tend also to possess few adaptations protecting them from introduced predators (Cowie 1992).

Two known land snail predators have been introduced to Rota since World War II: the predatory flatworm *Platydemus manokwari* De Beauchamp, 1962, and the predatory gastropod *Gonaxis kibweziensis* (Smith, 1894) (Eldredge and Smith 1994). The predatory gastropod *Euglandina rosea* Férussac has been introduced onto Guam, however, *E. rosea* was not found on Rota during 1994, 1995 and 1996. There is also no indication in the literature of the occurrence of this species on the island. These three predators, especially *P. manokwari* and *E. rosea,* have been implicated in declines of land snails on several Mariana Islands, as well as on other islands around the Pacific (Hadfield and Mountain 1980, Clarke et at. 1984, Murry et al, 1988, Hopper and Smith 1992).

To fully understand the evolution and biogeography of insular faunas, it is important to examine the diversity and distribution of the organisms prior to the onset of anthropogenic activity (Balouet and Olson 1989). The only way to do this is to sample past faunas through the fossil record. On islands the best preserved fossil faunas typically

are of land snails and vertebrates. Erroneous biogeographical and evolutionary theories can be drawn from data collected only from recent faunal and floral surveys (Steadman 1993).

In the Mariana Islands, the Partulidae have been extensively studied (Crampton 1925, Kondo 1970, Hopper and Smith 1992, Smith unpubl.) while other land snails have received little attention aside from taxonomic studies (Quadras and Möllendorf 1894a, 1894b, Baker 1938, Abbott 1949, Cooke and Kondo 1961, Solem 1983, Kurozumi 1994). While Guam was extensively surveyed for land snails in the late nineteenth century by J. F. Quadras (Quadras and Möllendorff 1894a, 1894b), the other islands in the archipelago were little studied before the 1920's. Crampton and Kondo made notable land snail collections on Rota in 1925, 1949, and 1952. While numerous species have been described and recorded from Guam, few records have been published from other islands in the archipelago.

The objectives of this study are to review the land snail fauna of Rota, specifically to determine 1) the diversity of the fauna, based on recent field collections and the literature, 2) the current status of each species (extant, apparently extinct but known from historically collected live specimens, or known only from dead material). On the basis of these data I will evaluate the conservation status of the fauna, as well as its origin and evolutionary history.

MATERIALS AND METHODS

Rota is the second southernmost island in the Mariana Islands, just north of Guam (Fig. 1). During July 1994, March 1995 and April 1996, I searched for and collected subfossil and living land snails at 26 sites on Rota (Fig. 2). Land snails other than partulids were collected at 14 of the 26 sites surveyed. The July 1994 collections were from paleontological excavations at Payapai Cave and As Matmos Cliffside Cave (sites 20 and 12 respectively). These sites along with a preliminary list of vertebrate remains from them, are described in Steadman (1992 and unpubl.). Land snails at these sites were picked from sediments sieved through *ca.* 1.6-mm mesh screens. The March 1995 survey focused on living land snails and associated land snail death assemblages (i.e. subfossils). This was part of a joint University of Guam and U.S. Fish and Wildlife Service survey of partulid tree snails on Rota; I was invited to survey other terrestrial snails. During April 1996 two days were spent searching for snails at two sites already studied during March 1995. At each site I searched microhabitats for live snails and also collected dead shells accumulated on the forest floor. Searching of less accessible microhabitats, such as under bark and deep in rock cracks, was limited at some sites because of time constraints.

Voucher specimens of all species have been deposited in the University of Guam Invertebrate Collection, and where available in sufficient numbers, in the Bernice P. Bishop Museum (BPBM). Catalog numbers used are from the Bishop Museum's Malacological Collection catalogs.

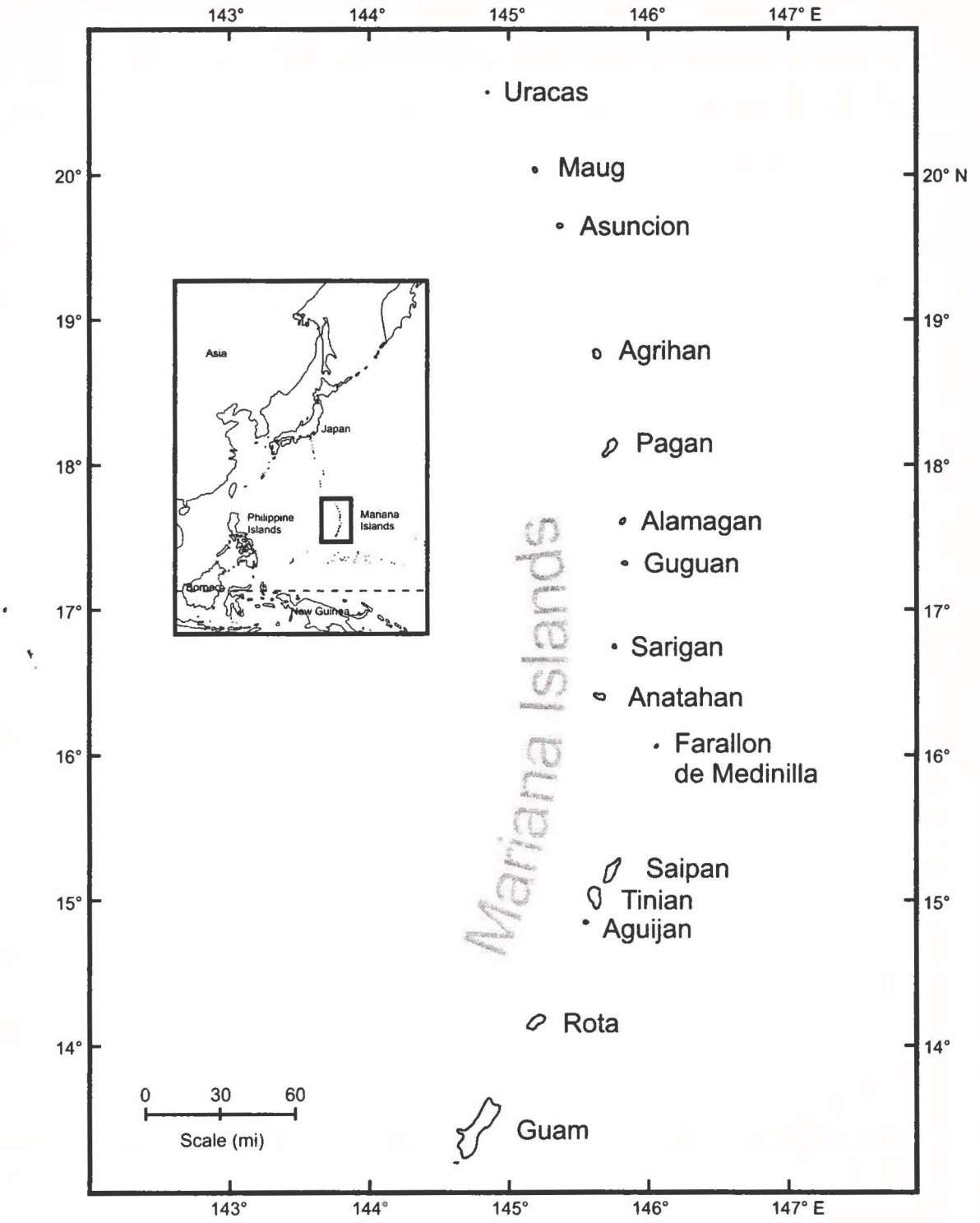

Figure 1. Map of the Mariana Islands. Inset depicts the location of the Mariana Archipelago in the western Pacific region.

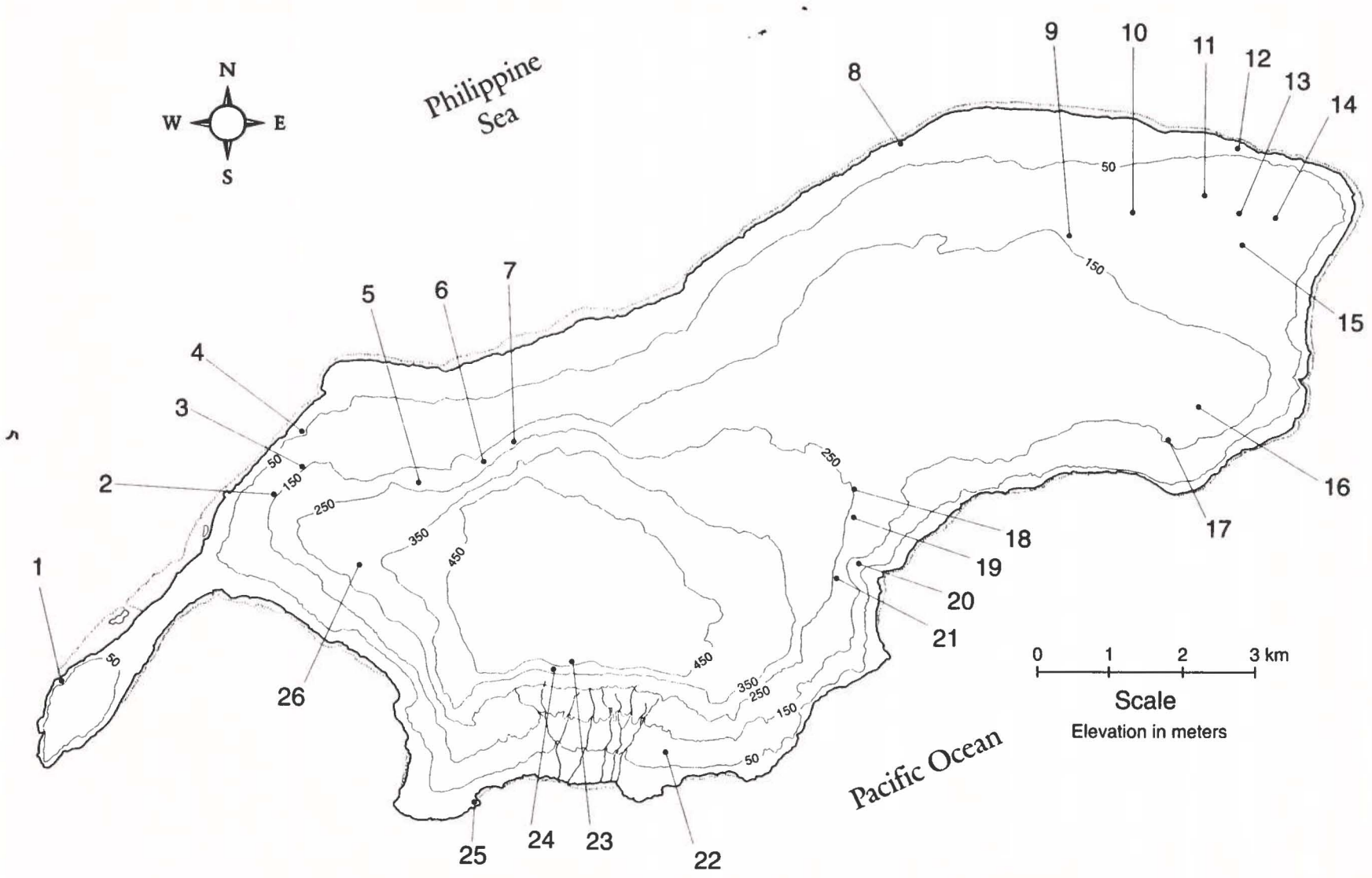

Figure 2. Map of Rota indicating the locations of sites surveyed.

The status of each species was coded as follows. A species is considered "declined" if it was collected at <5 sites as dead shells only or collected at >5 sites with ≤20% of the sites having live animals. A species is considered "possibly extirpated" on Rota if it was collected at ≥5 sites with no living animals found. A species is considered to be surviving well on Rota if it was collected at >5 sites, with ≥50% of the sites having living populations. Species collected at <5 sites with some sites supporting living populations and those collected at >5 sites with 20-50% of the sites supporting living populations are considered as surviving with uncertain status.

I have used three designations to refer to species which are not definitely identified. Species names preceded by "cf." are represented by specimens that are close to the nominal form, but differ slightly from it. Species names preceded by "aff." are represented by specimens that differ sufficiently from the nominal taxon to be considered specifically distinct. Species names preceded by a "?" refer to specimens that were either too poorly preserved for definitive identification, or whose identity with a respective nominal taxon could not be fully ascertained.

RESULTS

Tables 1 and 2 summarize the status and collection information for each species on Rota. Additional details are treated in the systematic section below.

Table 1. Land snail ranges among the southern Mariana Islands and status of species found on Rota. Island occurrences: numbers refer to references, 1=Baker 1938; 2=Cooke and Kondo 1961; 3=Zilch 1973a; 4=Zilch 1953; 5=Zilch 1973b; 6= Solem 1983; 7=Kondo 1970; 8=Abbott 1949; 9=Smith 1993; 10=Solem 1988; 11=Eldredge 1969; 12=Muniappan 1983; 13=Lange 1950; 14=Davis 1954; +=new record; cf.=new record of cf. nominal species. Range: M=Mariana Islands; R=Rota endemic; I=Introduced; +=New record; W=Wide ranging; ?=Range not known at this time, D=declined; S=surviving; S?=surviving with questionable status; E=potentially extirpated.

	Island Occurence					
Species	Guam	Rota	Tinian	Saipan	Range	Status on Rota
Family Assimineidae						
?*Quadrasiella* sp. 1	-	+	+	-	M	D
Omphalotropis cookei	8	+	+	8	M	D
O. elongatula	9	+	-	+	M	E
O. granum	9	+?	-	13	M	D
O. laevigata	9	+/cf.	-	-	M	D
O. octhogyra	9	+	-	-	M	D
O. quadrasi	8	+	-	-	M	D
O. semicostulata	9	+	-	-	M	D
O. suturalis	9	+	-	-	M	S?
O. sp. 1	-	+	-	-	R	D
O. sp. 2	-	+	-	-	R	D
O. sp. 3	-	+	-	-	R	D
O. sp. 4	-	+	-	-	R	D
O. sp. 5	-	+	-	-	R	D
O. sp. 6	+	+	-	-	M	D
O. sp. 7	-	+	-	-	R	S?
Paludinella conica	8	+	-	8	M	S
Allepithema quadrasi	9	+?	+?	-	M	D
A. sp. 1	+	+	-	-	M	S?
Family Diplommatinidae						
Palaina taeniolata	4	+	+	13	M	S?
Family Hydrocenidae						
Georissa elegans	3	+	+	13	M	D
G. laevigata	3	+	-	-	M	S

Table 1. (*Continued*)

Species	Island Occurence				Range	Status on Rota
	Guam	Rota	Tinian	Saipan		
Family Truncatellidae						
Taheita mariannarum	5	+	-	13	-	S?
Family Achatinellidae						
Pacificella ?variabilis	+	+	-	-	W,I?	S?
Lamellidea microstoma	2	2	2	2	M	-
L. subcylindrica	2	2	-	-	M	D
Elasmias quadrasi	2	2	2	2	M	S
Family Achatinidae						
Achatina fulica	12	12	12	12	I	E
Family Charopidae						
Himeroconcha sp. 1	-	+	-	-	R	D
H. sp. 2	-	+	-	-	R	D
Semperdon heptaptychius	6	+	-	-	M	D
S. rotanus	6	6	-	-	M	-
S. sp. 1	-	+	-	-	R	D
Family Ellobiidae						
Pythia scarabaeus	9	+	-	13	W	E
Family Helicarionidae						
Liardetia doliolum	1	1	1	-	W	-
L. tenuisculpta	-	1	-	1	W	-
L. sp(p).	-	+	-	-	?	S
Lamprocystis denticulata	1	1	-	1	M	-
L. fastigata	1	1	1	-	M	-
L. sp(p).	-	+	-	13	?	S?
Family Partulidae						
Partula gibba	7	7	7	7	M	D
Partula cf./aff. *gibba*	-	+	-	-	R	S?
Samoana fragilis	7	7	-	-	M	S?
Family Pupillidae						
Gastrocopta sp.	10	+	+	13	I,?	E
Nesopupa sp.	9	+	+	13	I,?	D
Family Streptaxidae						
Gonaxis kibweziensis	-	11	14	-	I	D
Family Subulinidae						
Subulina octona	9	+?	-	13	I	S?
Family Succineidae						
Succinea sp(p).	9	+	+	13	?	E
Family Undetermined						
Gen. sp. 1	-	+	-	-	I,?	D

Table 2. Distribution and collection status of each species found on Rota. F=subfossil collection; FL=collected both subfossil and live; L=collected live.

Species Sites	1	2	4	6	7	8	10	11	12	17	20	21	24	25
Family Assimineidae														
?Quadrasiella sp. 1	-	-		-	-	-	-	-	-	-	F	-	-	-
Omphalotropis cookei	F	F	L	-	-	F	-	F	-	F	F	-	-	-
O. elongatula	F	F	-	-	-	F	F	-	-	F	F	-	-	-
O. granum	-	F	-	-	-	-	-	-	-	-	-	-	-	-
O. laevigata	-	-	-	-	-	-	-	-	F	-	-	-	-	-
O. octhogyra	-	F	-	-	-	-	-	-	-	-	-	-	-	-
O. quadrasi	-	-	-	-	-	-	-	-	-	-	-	F	-	-
O. semicostulata	-	-	-	-	-	F	-	-	-	-	F	-	-	-
O. suturalis	-	-	-	-	-	FL	-	-	F	-	F	-	-	L
O. sp. 1	-	-	-	-	-	-	-	-	F	-	F	-	-	-
O. sp. 2	-	-	-	-	-	-	-	-	F	-	F	-	-	-
O. sp. 3	-	-	-	-	-	-	-	-	-	-	F	-	-	-
O. sp. 4	-	-	-	-	-	-	-	-	-	-	F	-	-	-
O. sp. 5	-	-	-	-	-	-	-	-	-	-	F	-	-	-
O. sp. 6	F	F	-	L	-	-	F	-	-	F	F	-	-	-
O. sp. 7	-	-	-	-	-	-	-	-	-	-	-	-	-	L
Paludinella conica	FL	F	L	L	L	F	F		F	F	F	F	L	
Allepithema quadrasi	-	-	-	-	-	-	-	-	-	-	F	-	-	-
A. sp. 1	-	-	-	L	-	-	-	-	-	-	F	-	L	-
Family Diplommatinidae														
Palaina taeniolata	F	F	L	L	-	F	F	F	F	F	FL	-	L	-
Family Hydrocenidae														
Georissa elegans	F	-	-	-	-	F	F	-	-	-	F	-	-	-
G. laevigata	F	FL	L	L	L	FL	F	F	-	FL	FL	-	L	-
Family Truncatellidae														
Taheitia mariannarum	-	-	-	-	-	F	-	-	F	-	F	-	-	L
Family Achatinellidae														
Pacificella ?variabilis	FL	-	-	-	-	-	-	-	F	-	F	-	-	-
Lamellidea subcylindrica	F	F	-	-	-	F	-	-	F	F	F	-	L	-
Elasmias quadrasi	FL	F	-	-	-	-	F	FL	F	F	FL	-	L	-
Family Achatinidae														
Achatina fulica	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Family Charopidae														
Himeroconcha sp. 1	-	-	-	-	-	-	-	F	-	F	-	-	-	-
H. sp. 2	-	-	-	-	-	-	-	-	F	-	-	-	-	-
Semperdon heptaptychius	-	-	-	-	-	F	-	-	-	F	-	-	-	-
S. sp. 1	-	-	-	-	-	-	-	-	-	F	-	-	-	-
Charopid sp(p).	-	F	-	F	-	-	-	F	-	-	-	-	-	-

Table 2. (*Continued*)

Species / Sites	1	2	4	6	7	8	10	11	12	17	20	21	24	25
Family Ellobiidae														
Pythia scarabaeus	F	F	-	-	-	F	-	-	F	F	F	F	F	-
Family Helicarionidae														
Liardetia sp(p).	FL	-	L	-	-	FL	F	FL	-	F	FL	FL	L	-
Lamprocystis sp(p).	FL	F	-	L	-	F	F	-	F	F	F	-	L	-
Family Partulidae														
Partula gibba	F	F	L	L	F	FL	F	F	F	F	FL	-	FL	-
Partula cf./aff. *gibba*	-	-	-	-	-	-	-	-	F	-	F	-	-	-
Samoana fragilis	-	-	-	-	-	-	-	-	-	-	-	-	L	-
Family Pupillidae														
Gastrocopta sp.	F	-	-	-	-	F	F	-	F	F	F	F	-	-
Nesopupa sp.	F	-	-	-	-	-	-	-	-	-	F	-	-	-
Family Streptaxidae														
Gonaxis kibweziensis	-	-	F	-	-	-	-	-	-	-	-	-	-	-
Family Subulinidae														
Subulina octona	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Family Succineidae														
Succinea sp.	F	F	-	-	-	-	-	F	F	-	F	F	F	-
Family Undetermined														
Gen. sp. 1	-	-	-	-	-	-	-	-	F	-	-	-	-	-

SYSTEMATIC REVIEW

Class GASTROPODA

Subclass PROSOBRANCHIA

Family ASSIMINEIDAE

The Assimineidae is the most diverse family of land snails in the Mariana Islands, with 25 species recorded from Guam (Smith 1993). Types of 22 species described by Quadras and Möllendorff (1894a, 1894b) are illustrated by Zilch (1967). While only six species were collected alive on Rota, an additional 13 were encountered as subfossils.

Tribe GARRETTIEAE

Quadrasiella Möllendorff, 1894

Quadrasiella was erected by Möllendorff in Quadras and Möllendorff (1894b) for two species of land snails on Guam; Möllendorff (1900) described a third species from Pohnpei (Caroline Islands). *Quadrasiella* is differentiated from other assimineids by its operculum, which has an "inner calcareous lamella which overlaps the peristome" (Möllendorff 1900).

?*Quadrasiella* sp. 1

Fig. 3

?*Quadrasiella* sp. 1 is conchologically similar to *Quadrasiella clathrata* from Guam. It differs from *Q. clathrata* in that the body whorl does not expand as fast, the spire is higher, and the sculpturing is more prominent. No opercula were found preserved in association with the new specimens, thus their generic status is uncertain. This species is known only from Rota and Tinian.

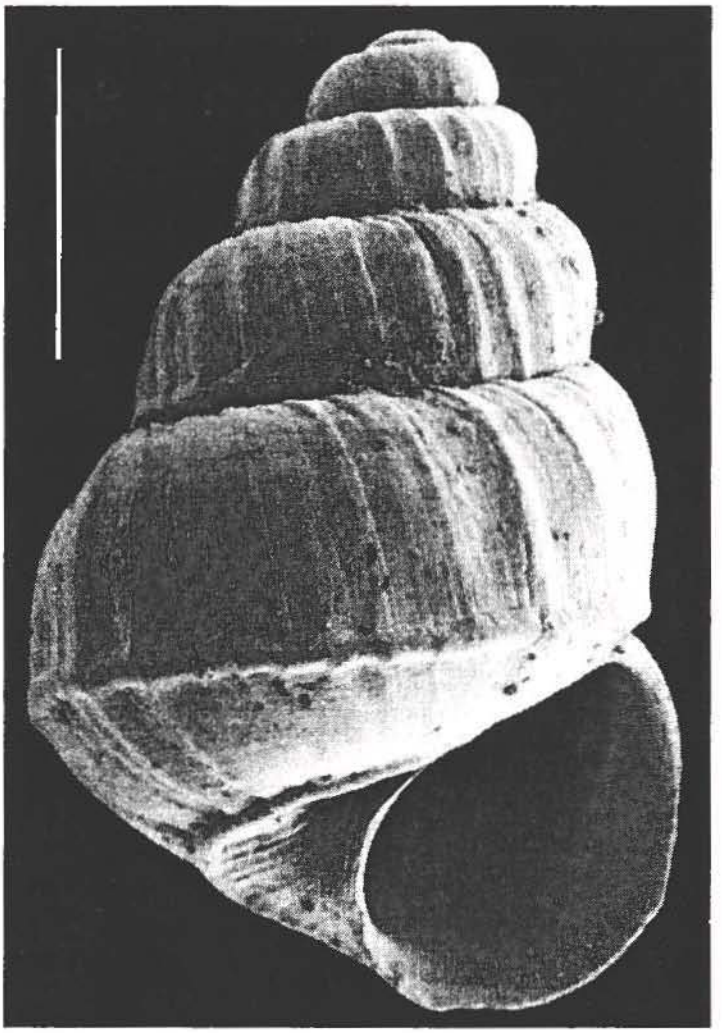

Figure 3. ?*Quadrasiella* sp.1 Scale bar = 1 mm.

Tribe OMPHALOTROPIDEAE

Omphalotropis Pfeiffer, 1841

This is the most diverse genus of land snails on Rota and Guam. Smith (1993) listed 16 species from Guam; 15 species are recorded from Rota.

Omphalotropis cookei Abbott, 1949

Fig. 4

Omphalotropis cookei is distinguishable from other Rota *Omphalotropis* by the presence of "pronounced spiral threads" (Abbott 1949). Abbott (1949) states, "*O. cookei* is closest in morphological characters to *Omphalotropis erosa* (Quoy & Gaimard) from Guam," but that species was not found on Rota. *Omphalotropis cookei* is closest morphologically to *Omphalotropis elongatula* on Rota.

Omphalotropis cookei was previously known from Guam and Saipan (Abbott 1949). Although this species was found dead at 7 sites, only a single living population was encountered on Rota. Live animals were collected from the undersides of decaying leaves. *Omphalotropis cookei* appears to have declined on Rota.

Omphalotropis elongatula Quadras & Möllendorff, 1894

Fig. 5

Previously known only from Guam, *Omphalotropis elongatula* is closest to *Omphalotropis cookei* on Rota (see above). No live animals of *O. elongatula* were found on Rota during 1994 or 1995.

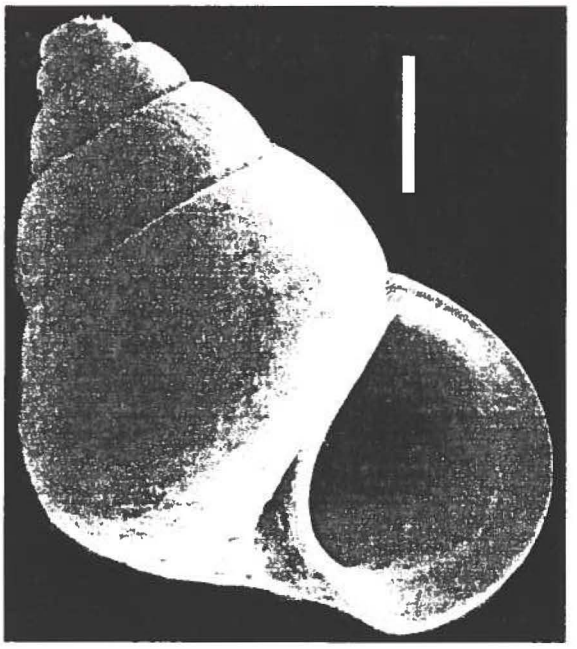

Figure 4. *Omphalotropis cookei*. Scale bar = 1 mm.

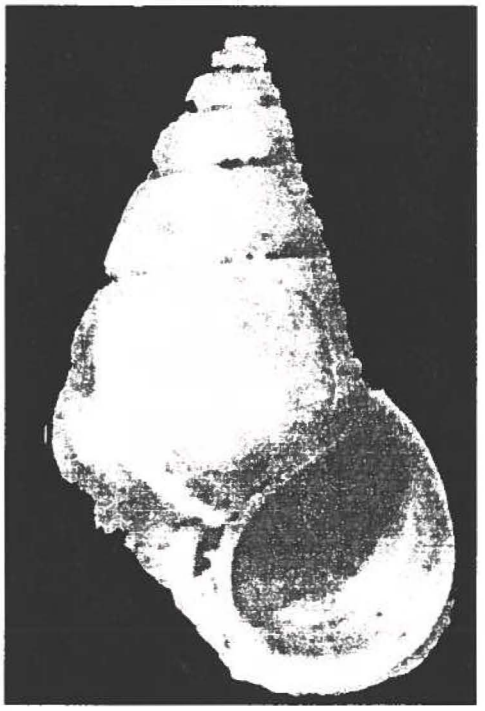

Figure 5. *Omphalotropis elongatula*. Scale bar = 1 mm.

Omphalotropis granum (Pfeiffer, 1854)

Fig. 6

Omphalotropis granum can be distinguished from the similar *Omphalotropis suturalis* by its larger size and more rounded sutural ramps. Dead shells of *Omphaloropis granum* were found at one site on Rota. Previously this species was only known from Guam and Saipan.

Omphalotropis laevigata Quadras & Möllendorff, 1894

Fig. 7

Omphalotropis laevigata was described from Guam. Shells nearly matching, but differing by not having a mottled color pattern as in figured specimens from Guam. They were found at As Matmos Cliffside Cave on Rota.

Omphalotropis octhogyra Quadras & Möllendorff, 1894

Fig. 8

Previously known only from Guam, *Omphalotropis octhogyra* was abundant as subfossils at one site on Rota. Many *O. octhogyra* shells collected at this site appeared to be fresh (still covered with periostracum). At this site only one land snail species was found alive (*Georissa elegans*), although 14 other land snail species were found as subfossils in leaf litter and soil samples. Traces of the predatory flatworm, *Platydemus manokwari* were noted at this site.

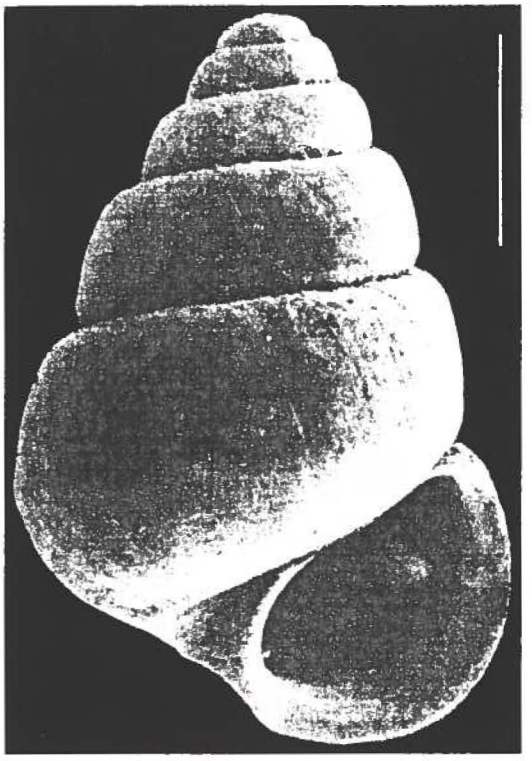

Figure 6. *Omphalotropis granum*. Scale bar = 1 mm.

Figure 7. *Omphalotropis laevigata*. Scale bar = 1 mm.

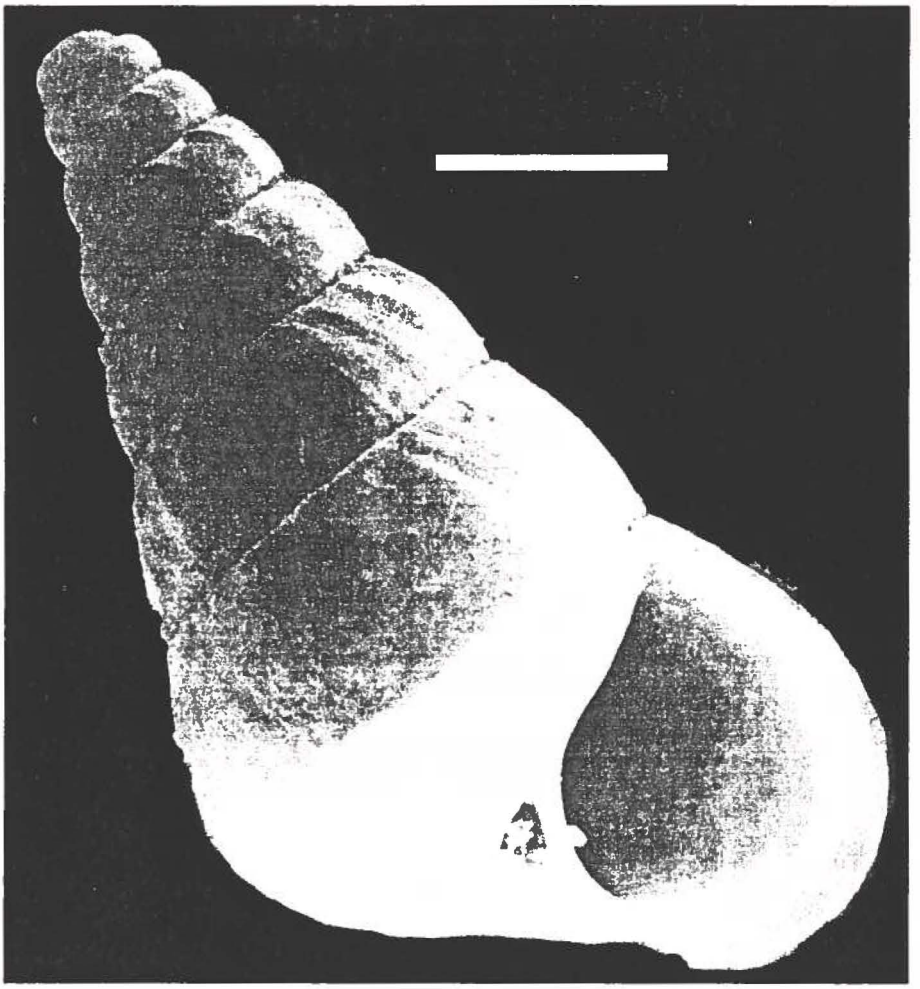

Figure 8. *Omphalotropis ochthogyra*. Scale bar = 1 mm.

Omphalotropis quadrasi Möllendorff, 1894

Fig. 9

Abbott (1949) redescribed and figured *Omphalotropis quadrasi*, then considered a Guam endemic. Only one *Omphalotropis quadrasi* shell was found at one site on Rota's east coast.

Omphalotropis semicostulata Quadras and Möllendorff, 1894

Fig. 10

This species was previously known only from Guam. No living animals were found.

Omphalotropis suturalis Quadras and Möllendorff, 1894

Fig. 11

Omphalotropis suturalis was described from Guam and is only known from two populations on Rota. This species appears to be restricted to coastal margins of forests; both on Guam (pers. obs.) and Rota.

Omphalotropis "carinate" species complex (species 1-5)

Seventeen specimens collected as subfossils at two locations on Rota appear to represent a previously unrecognized species complex characterized by turriculate shells ornamented by a well developed carina. All of the species appear to be undescribed and no species like them have been collected on Guam to date. They may represent an endemic radiation of assimineids on Rota. They are tentatively included in *Omphalotropis* on the basis of Thiele's (1929) definition of the genus: "Shell oval to turriculate, with perforated umbilicus surrounded by a more or less distinct ring, aperture

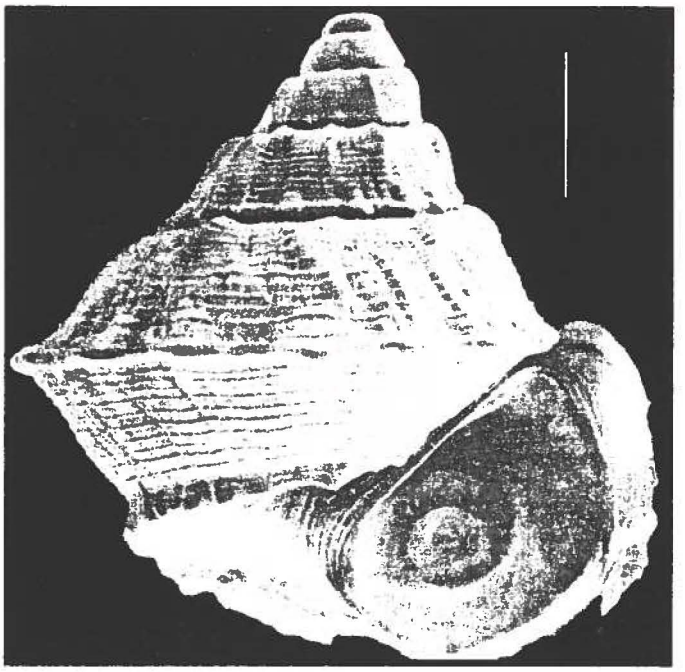

Figure 9. *Omphalotropis quadrasi*. Scale bar = 1mm.

Figure 10. *Omphalotropis semicostulata*. Scale bar = 1 mm.

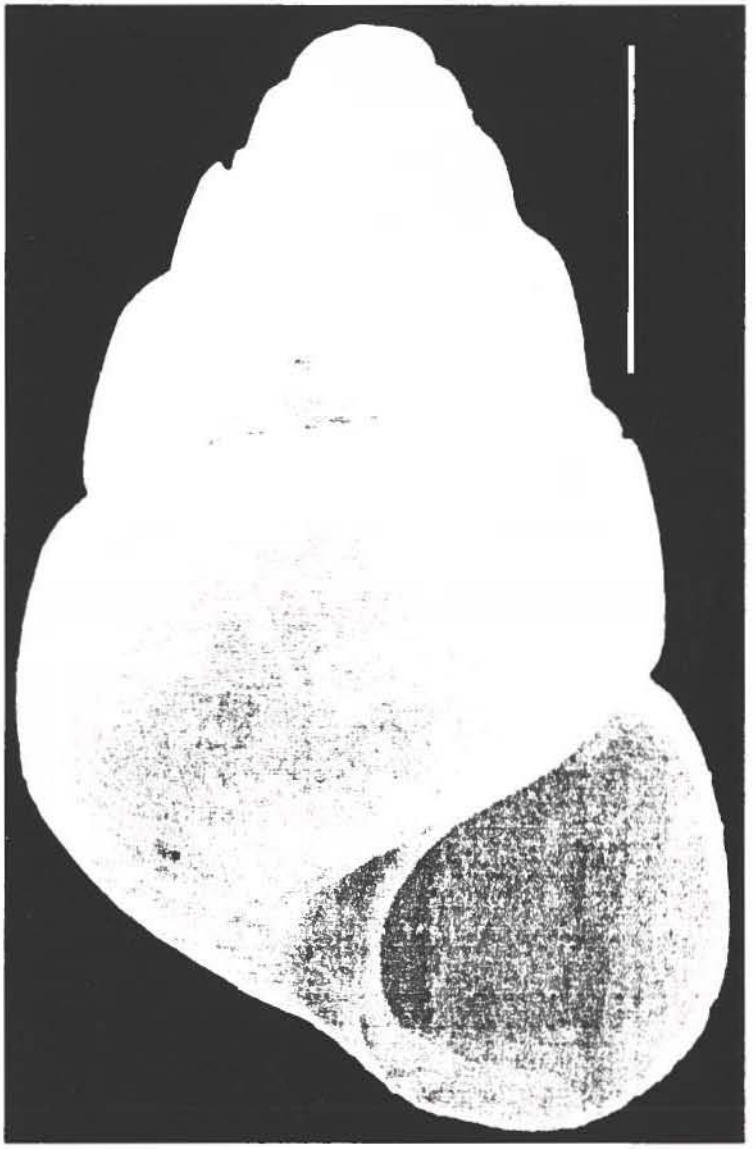

Figure 11. *Omphalotropis suturalis*. Scale bar = 1 mm.

oval, apertural margin in most cases interrupted, occasionally somewhat broadened." At present five species are recognized, but as material to evaluate variation is limited, this number may have to be revised in the future. All five putative species possess the generic characters mentioned by Thiele except apertural characters cannot be resolved in all specimens due to their poor preservation.

Omphalotropis sp. 1

Fig. 12

Shell small, globose and carina does not reach apex. Known from 11 specimens from excavation at site 12 and 20.

Omphalotropis sp. 2

Fig. 13

Shell similar to *Omphalotropis* sp. 1 but slightly larger with a higher, thinner spire. Known from one specimen each from excavations at sites 12 and 20.

Omphalotropis sp. 3

Fig. 14

Shell high spired, cyrtoconoid (with convex sides), suture channeled with a somewhat prominent carina. Site 20 yielded two specimens from excavation.

Omphalotropis sp. 4

Fig. 15

Shell slightly smaller and similar to *Omphalotropis* sp. 3, high spired, cyrtoconoid, carina not as prominent. One specimen was collected from excavation at site 20.

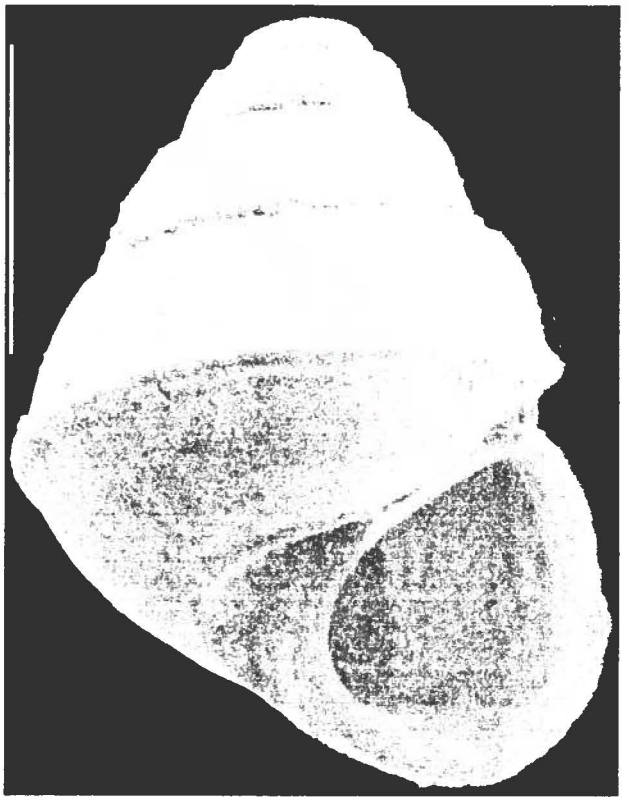

Figure 12. *Omphalotropis* sp. 1. Scale bar = 1mm.

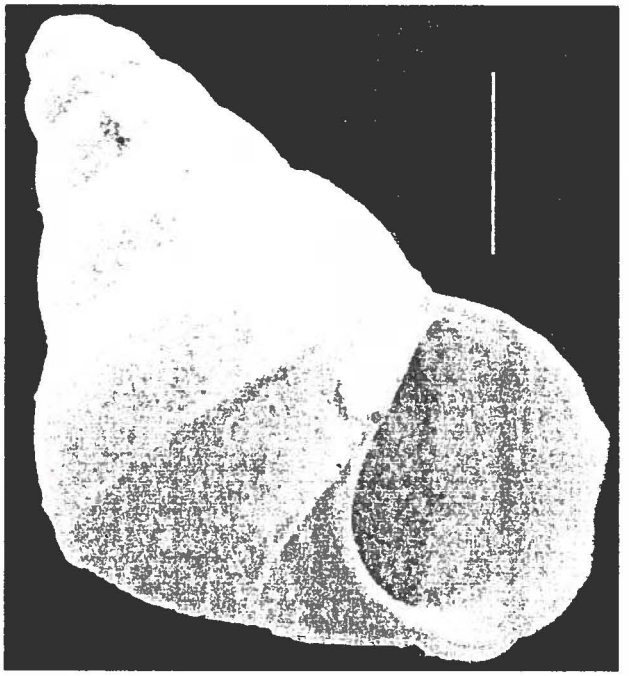

Figure 13. *Omphalotropis* sp. 2. Scale bar = 1 mm.

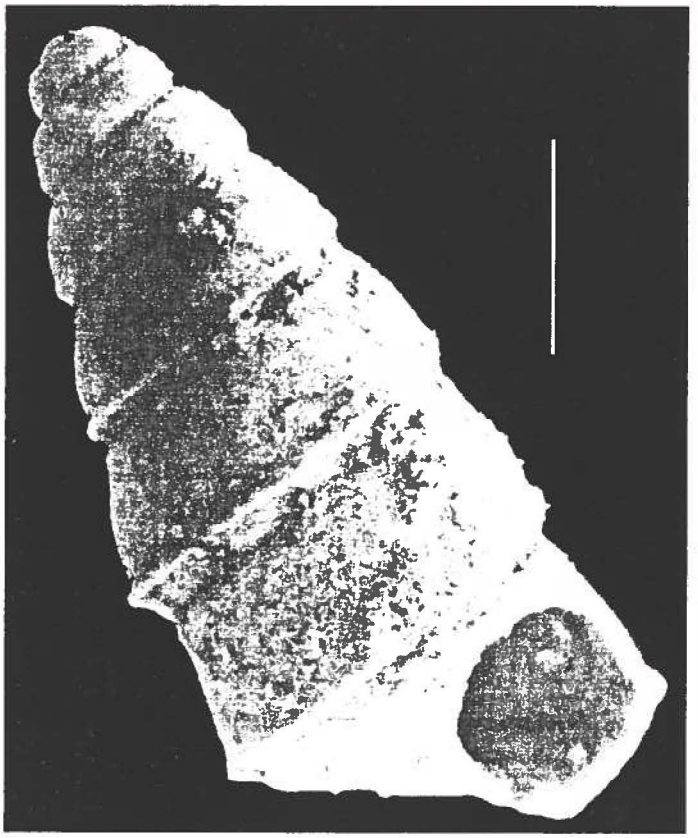

Figure 14. *Omphalotropis* sp. 3. Scale bar = 1mm.

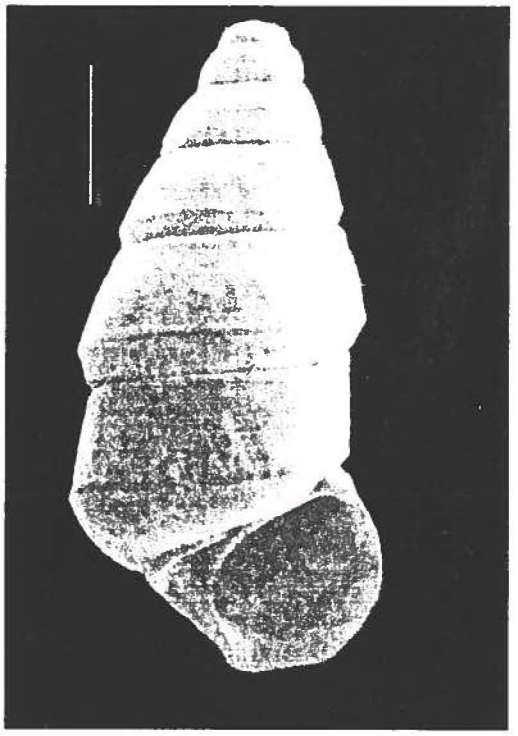

Figure 15. *Omphalotropis* sp. 4. Scale bar = 1 mm.

Omphalotropis sp. 5

Fig. 16

Shell close to *Omphalotropis* sp. 4 but carina is near the middle of a whorl. Known from one specimen from excavation at site 20.

Omphalotropis sp. 6

Fig. 17

Omphalotropis sp. 6 is conchologically close to *Omphalotropis elongatula* and *Omphalotropis cookei* on Rota and to *Omphalotropis erosa* from Guam. *Omphalotropis* sp. 6 was found living under limestone rubble in forest, but not on the undersides of decaying leaves. They were moderately abundant.

Omphalotropis sp. 7

Fig. 18

This species was only found at Poña Point living sympatrically with *Omphalotropis suturalis* and a truncatellid. It is similar in shell shape to *O. suturalis* but differs by being finely ribbed. Of the three species found at Poña Point *O.* sp. 7 is the rarest in my collections.

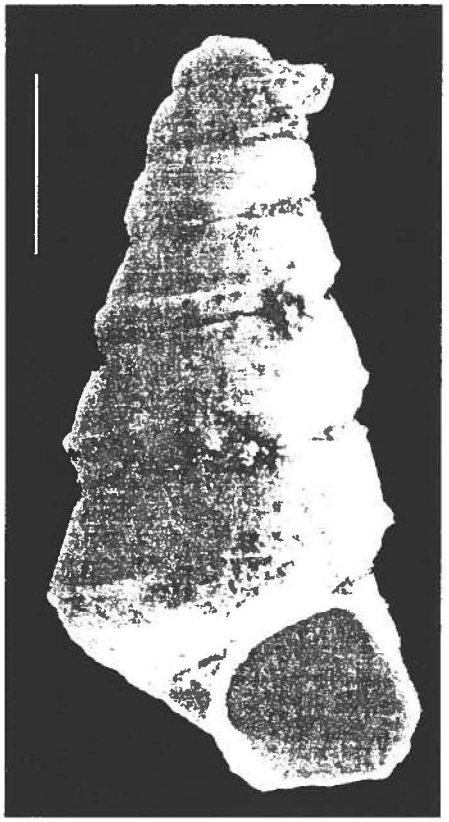

Figure 16. *Omphalotropis* sp. 5. Scale bar = 1mm.

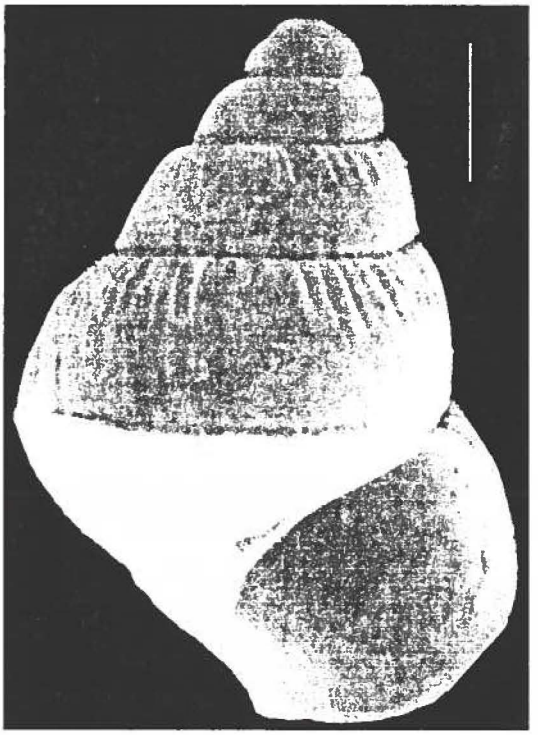

Figure 17. *Omphalotropis* sp. 6. Scale bar = 1 mm.

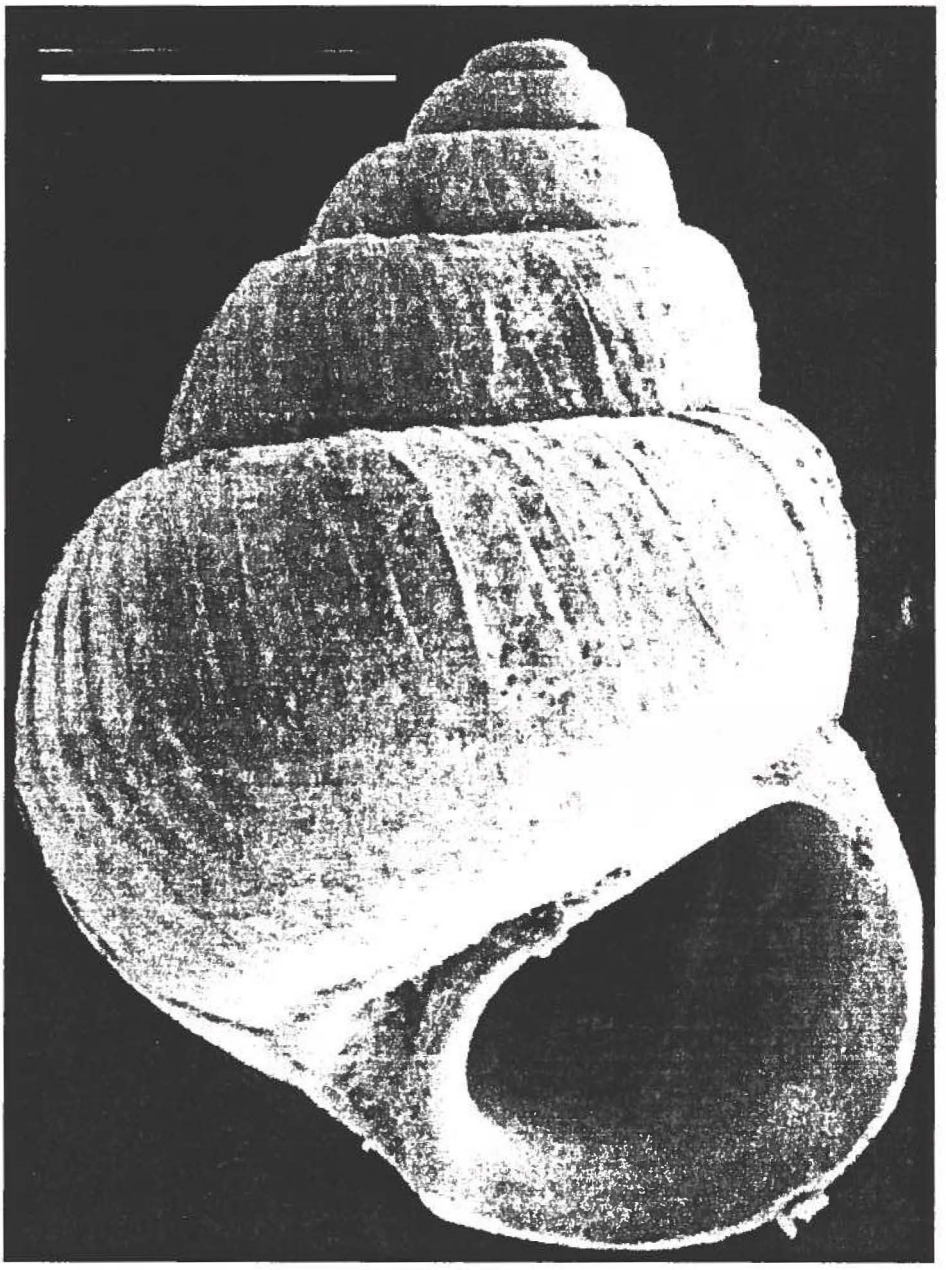

Figure 18. *Omphalotropis* sp. 7. Scale bar = 1mm.

Paludinella Pfeiffer, 1841

Paludinella conica (Quadras & Möllendorff, 1894)

Fig. 19

Paludinella may be separated from the similar genus *Assiminea* Fleming, 1828 by the absence of a fine spiral thread just below the suture (Abbott 1949). It is the most abundant and widespread assimineid on Rota. Living specimens occurred at five sites and were noted as common at many locations by Fish and Wildlife Officers on Rota. They were also found as subfossil at seven other sites.

Tribe PSEUDOCYCLOTEAE

Allepithema Tomlin, 1931

Allepithema quadrasi Möllendorff, 1894

Fig. 20

This species, previously known only from Guam, is figured by Zilch (1967). On Rota it was found in excavations at site 20 and erronously identified as *Quadrasiella clathrata* in Bauman (1996).

Allepithema sp. 1

Fig. 21

This species is tentatively placed in *Allepithema*. It is distinct from the six species of *Allepithema* described from Guam by Quadras and Möllendorff (1894b), and is only known from Guam and Rota. A single living animal was found at each of two sites.

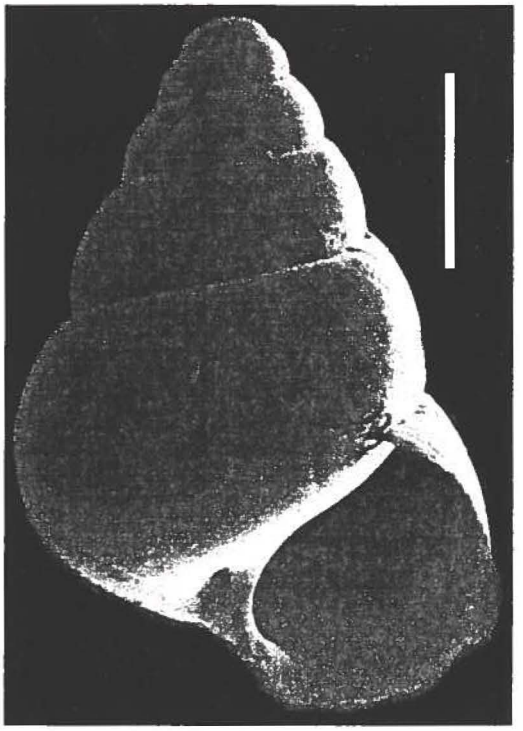

Figure 19. *Paludinella conica*. Scale bar = 1 mm.

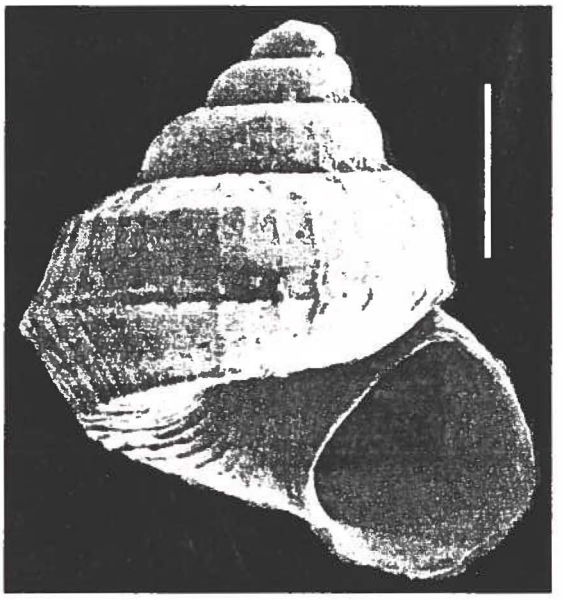

Figure 20. *Allepithema quadrasi*. Scale bar = 1 mm.

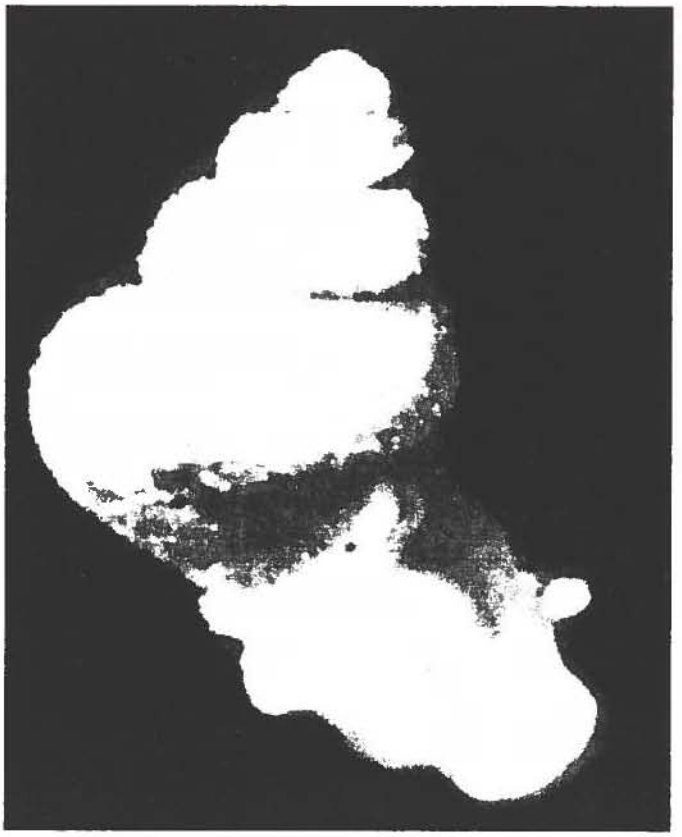

Figure 21. *Allepithema* sp. 1. Scale bar = 1 mm.

Family DIPLOMMATINIDAE

Genus *Palaina* Semper, 1865

Palaina taeniolata Quadras & Möllendorff, 1894

Fig. 22

This species was described from Guam; Zilch (1953) figured the lectotype. Live animals are abundant and widespread on Rota. Animals are common on the undersides of rotting leaves and on limestone rubble in forests.

Family HYDROCENIDAE

Solem (1988), Thompson and Dance (1983) and Thompson and Huck (1985) provide useful recent reviews of Pacific Hydrocenidae. Three species of hydrocenids have been described from the Mariana Islands; two of these are here recorded from Rota. These are the first published records of *Georissa* from Rota.

Georissa Blanford, 1864

Georissa elegans Quadras & Möllendorff, 1894

Fig. 23

Shells of *Georissa elegans* have a sculpted and angled body whorl compared to the more rounded and weakly sculptured shell of *Georissa laevigata*. *Georissa elegans* was not found alive on Rota. *Georissa elegans* was described from Guam and figured by Zilch (1973a).

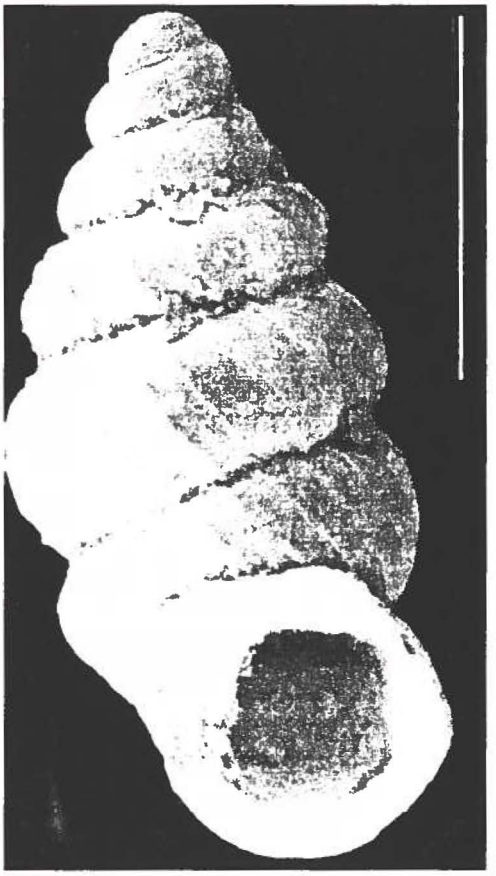

Figure 22. *Palaina taeniolata*. Scale bar = 1mm.

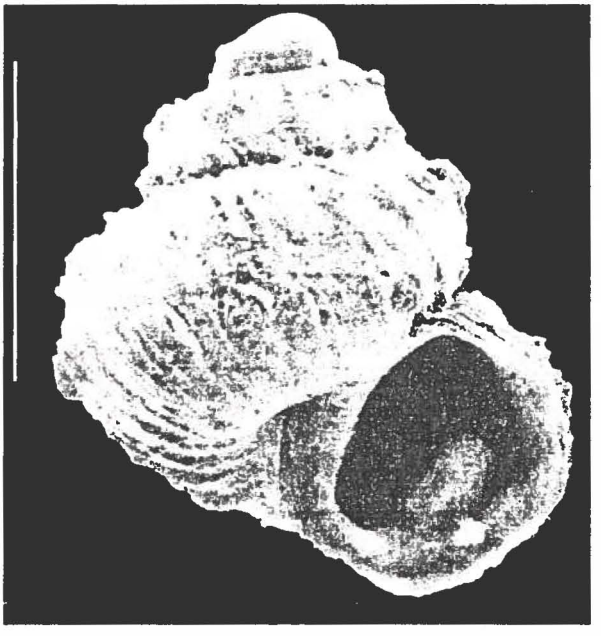

Figure 23. *Georissa elegans*. Scale bar = 1mm.

Georissa laevigata Quadras & Möllendorff, 1894

Fig. 24

Georissa laevigata was described from Guam and figured in (Zilch 1973a). *Georissa laevigata* is widespread and abundant on Rota. It was found among limestone rubble and on the undersides of rotting leaves.

Family TRUNCATELLIDAE

Truncatellids tend to occur in marginal marine habitats. This habitat type was not thoroughly searched on Rota in 1995.

Taheitia H. Adams & A. Adams, 1863

Taheitia mariannarum (Quadras & Möllendorff, 1894)

Fig. 25

One colony of the truncatellid *Taheitia mariannarum* (Quadras & Möllendorff, 1894) was discovered on Rota in 1988 at Poña Point (Barry Smith pers. comm.). Live snails were still present at this site in 1995. No other truncatellids were found alive though numerous fragments were discovered at three other sites. Poña Point is a limestone plateau raised ca. 7-10 m above sea level, and is covered with short grasses growing on limestone, which has very little soil or sand and is in the spray zone of large waves. The assimineids *Omphalotropis suturalis* and *Omphalotropis* sp. 7 are microsympatric with this truncatellid species on Rota. The same truncatellid species and *O. suturalis* cooccur in similar habitats on Guam.

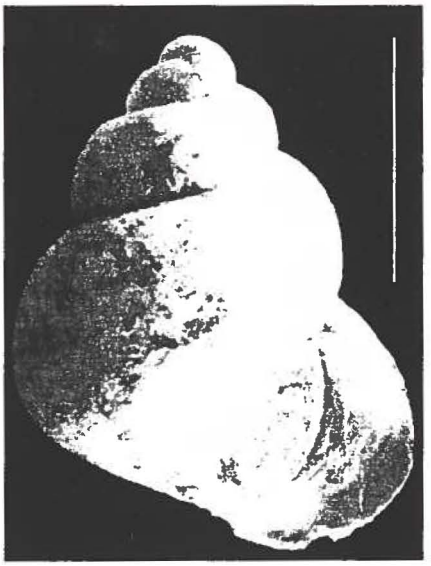

Figure 24. *Georissa laevigata.* Scale bar = 1mm.

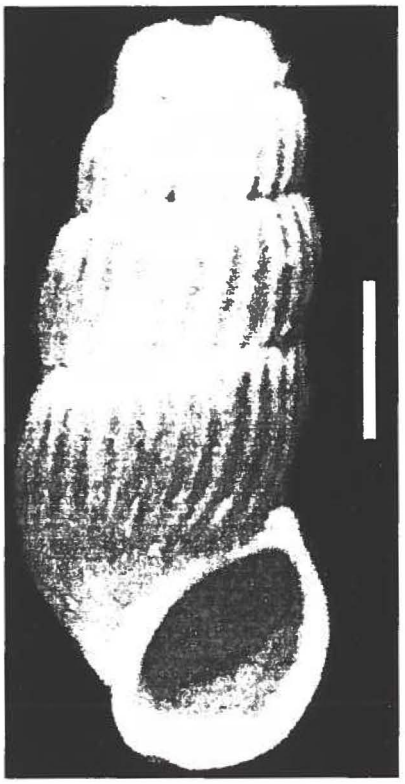

Figure 25. *Taheitia mariannarum.* Scale bar = 1 mm.

Subclass PULMONATA

Family ACHATINELLIDAE

Pacificella Odhner, 1922

Pacificella ?variabilis Odhner, 1922

Fig. 26

Species of *Pacificella* are widely distributed on Pacific islands and are recorded from the Mariana Islands without specific locality data (Cooke and Kondo 1961, Preece 1995). The species' wide range indicates it could have been introduced prehistorically onto the Mariana Islands. Live animals were found at one site, on the undersides of tree leaves.

Lamellidea Pilsbry, 1910

Lamellidea microstoma (Quadras and Möllendorff, 1894)

Cooke and Kondo (1961) reviewed and recorded this species from Rota. It was not encountered during the present surveys. It is figured in Zilch (1962).

Lamellidea subcylindrica (Quadras & Möllendorff, 1894)

Fig. 27

L. subcylindrica only known from Guam and Rota (Cooke and Kondo 1961). Cooke and Kondo (1961) noted this to be a less abundant species than *Lamellidea microstoma* on both islands. Animals were collected from the undersides of leaves.

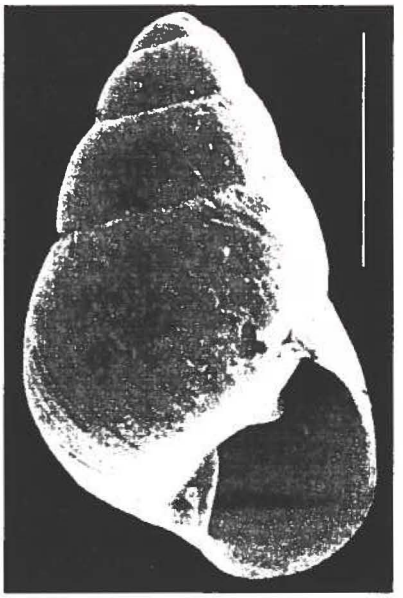

Figure 26. *Pacificella ?variabilis.* Scale bar = 1mm.

Figure 27. *Lamellidea subcylindrica.* Scale bar = 1 mm.

Elasmias Pilsbry, 1910

Elasmias quadrasi (Möllendorff, 1894)

Fig. 28

This species is distinguished from other achatinellids on Rota by its small size (≈2.5 mm length) and distinct apertural barriers. *Elasmias quadrasi* is known from Guam, Rota, Tinian, Saipan and extends onto the Northern Mariana Islands (Cooke and Kondo 1961). Live animals were found aestivating on the undersides of leaves and twigs on trees.

Family ACHATINIDAE

Achatina Lamarck, 1799

Achatina fulica Bowdich, 1822

Achatina fulica, an introduced agricultural pest, was once extremely common on Rota, demonstrated by the large numbers of shells seen at many sites (Muniappan 1983). Several surveys were conducted during the late 1940's and early 1950's by Bishop Museum staff and associates to ascertain the status of *A. fulica* in the Mariana Islands (Lange 1950, Mead and Kondo 1950, Chamberlin 1952, Kondo 1952). The occurrence of this species was not tracked during 1994 and 1995 because its previous distribution on the island is known. No living animals or fresh shells were seen during surveys in 1994 or 1995. However, residual populations may still exist on Rota in agricultural areas, which were not surveyed during 1994 or 1995.

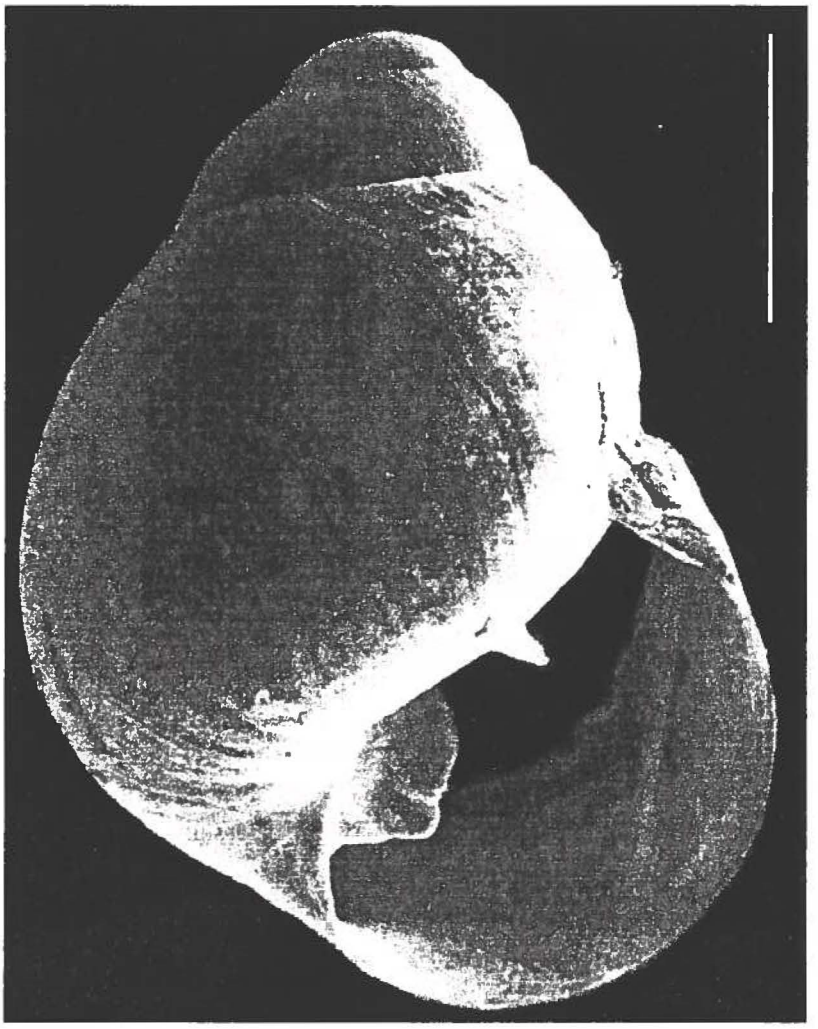

Figure 28. *Elasmias quadrasi.* Scale bar = 1 mm.

Family CHAROPIDAE

Solems's (1976, 1983) monographs provide the systematic framework for the Mariana Island charopids. No living specimens of any charopid were found during 1995 or 1996 surveys, although Bishop Museum records and records in Solem (1983) indicate they were once common. All Rota charopids could be extirpated. Many of the specimens collected were either fragmentary or too obscured by soil to make species identification possible (indicated on Table 2 as charopid sp(p). indet.).

Himeroconcha Solem, 1983

Himeroconcha sp. 1

Fig. 29

This apparently undescribed species appears to fit within *Himeroconcha* generic limits set by Solem (1983). It differs from *Himeroconcha rotula* (Quadras and Möllendorff, 1894) by its rapidly descending body whorl. A single shell of this species was collected at each of two sites.

Himeroconcha sp. 2

Fig. 30

Eight subfossil specimens of another apparently undescribed *Himeroconcha* were found at site 12. Three complete specimens show this species to fall within the generic limits set for *Himeroconcha* by Solem (1983). The apertural periphery of *Himeroconcha* sp. 2 is expanded compared to *Himeroconcha rotula*. The body whorl of *Himeroconcha* sp. 2 does not descend as rapidly as in *Himerochoncha* sp. 1.

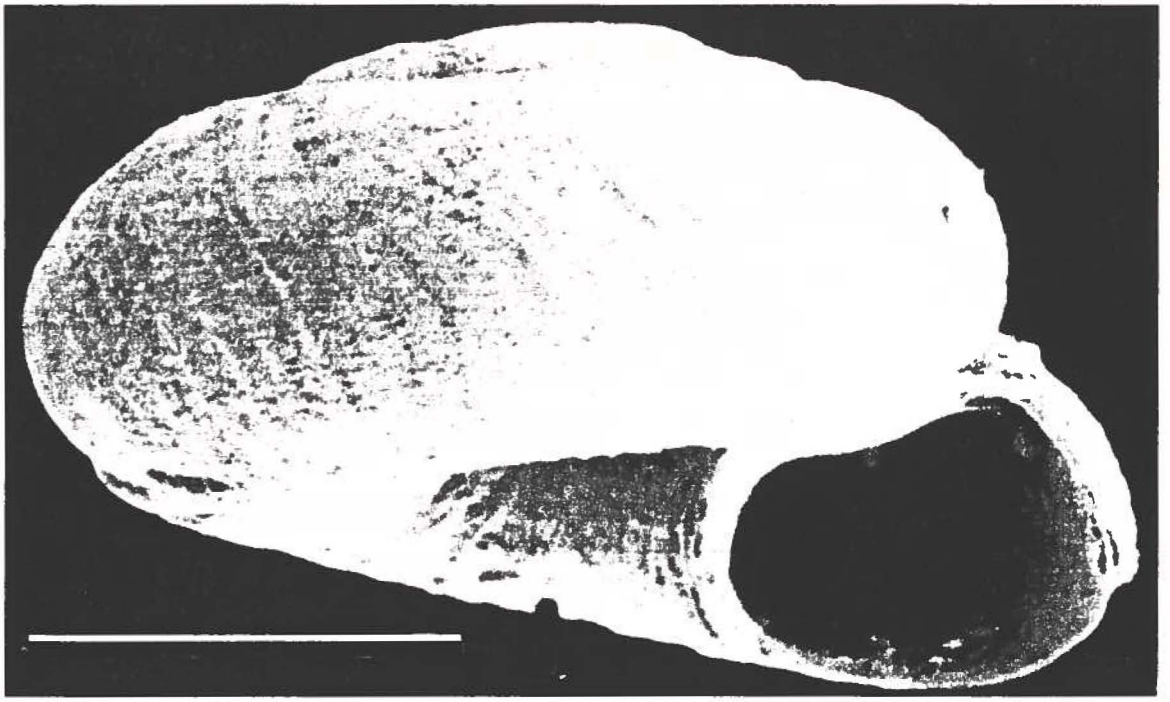

Figure 29. *Himeroconcha* sp. 1. Scale bar = 1 mm.

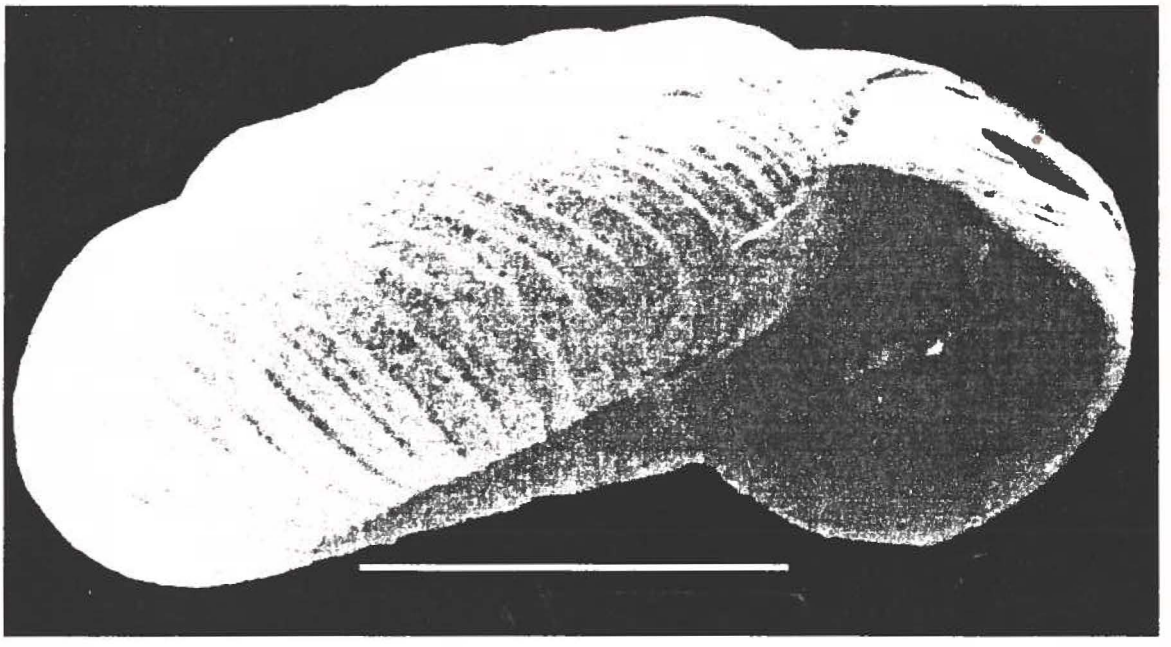

Figure 30. *Himeroconcha* sp. 2. Scale bar = 1mm.

Semperdon Solem, 1983

Semperdon heptaptychius (Quadras and Möllendorff, 1894)

Fig. 31

Shells of this species were found at two sites on Rota. Previously the species was known only from Guam (Solem 1983).

Semperdon rotanus Solem, 1983

Semperdon rotanus was described and thoroughly reviewed in Solem (1983). It was not encountered during the present survey.

Semperdon sp. 1

Fig. 32

Semperdon sp. 1 is easily distinguished from other Rota *Semperdon* species by its extremely high spire. It was found at one site as rare subfossils.

Family ELLOBIIDAE

Pythia Roding, 1798

Pythia scarabaeus (Linnaeus, 1758)

Pythia scarabaeus ranges widely on islands in the Western Pacific. Shells of this species are a highly visible component of the ground shell paleofauna in many forested areas on Rota. No living animals were found. Bishop Museum records indicate that the species was common alive on Rota in 1925 and 1949 (BPBM 213232, 213261 and 82427). Subsequently *P. scarabaeus* has declined and may be extirpated on Rota.

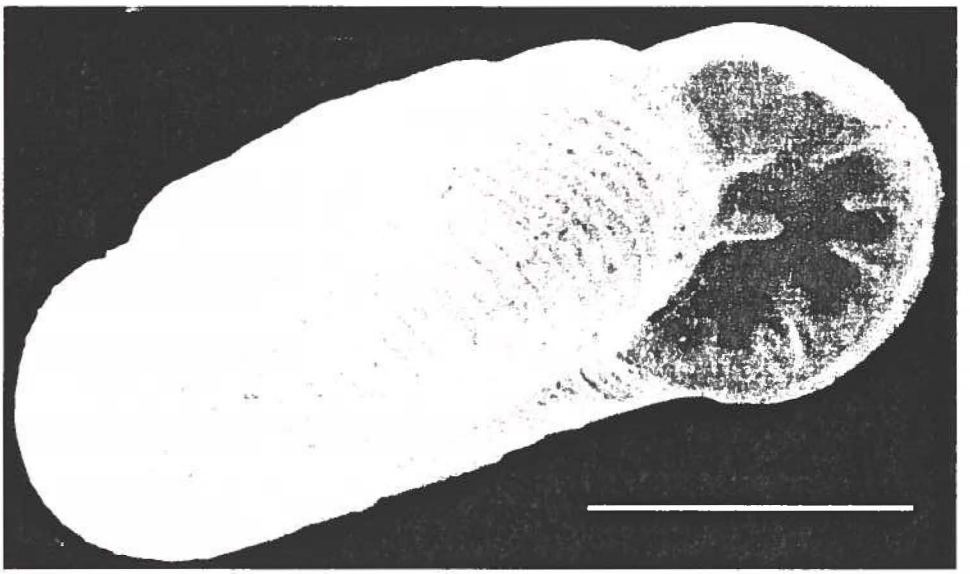

Figure 31. *Semperdon heptaptychius*. Scale bar = 1mm.

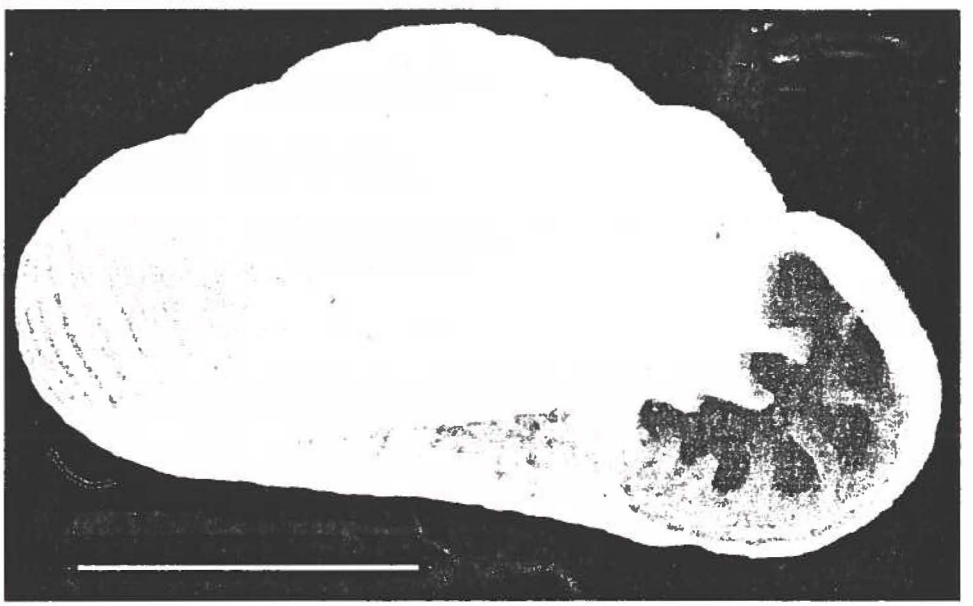

Figure 32. *Semperdon* sp. 1. Scale bar = 1 mm.

Family HELICARIONIDAE

Liardetia Gude, 1913

Liardetia sp(p).

Fig. 33

Two species of *Liardetia* were recorded from Rota by Baker (1938): *L. doliolum* (Pfeiffer, 1846) and *L. tenuisculpta* (Möllendorff, 1893). The identification of new material from my collections is uncertain at this stage. *Liardetia* specimens were collected from screw pine leaves and other vegetation by using a beating sheet. *Liardetia* seems to be surviving well and not declining on Rota.

Lamprocystis Pfeffer, 1883

Lamprocystis sp(p).

Fig. 34

Two species of *Lamprocystis* were recorded from Rota by (Baker 1938): *L. fastigata* (Gude, 1917) and *L. denticulata* (Quadras & Möllendorff, 1894). The identification of new material in my collections is uncertain at this stage. Living specimens were found on the underside of decaying leaves on the forest floor. At site 1, *Platydemus manokwari* was noted on the underside of a rotting leaf alongside four adults of *Lamprocystis* sp(p). Very few living specimens of *Lamprocystis* sp(p). were found on Rota, although, at site 24 they were fairly abundant.

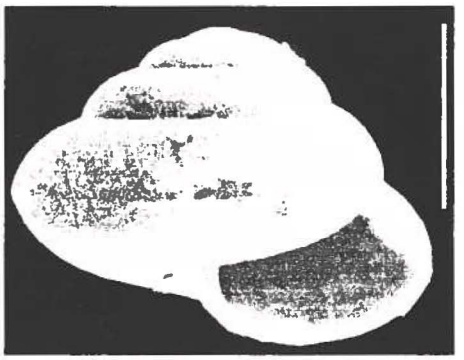

Figure 33. *Liardetia sp.* Scale bar = 1mm.

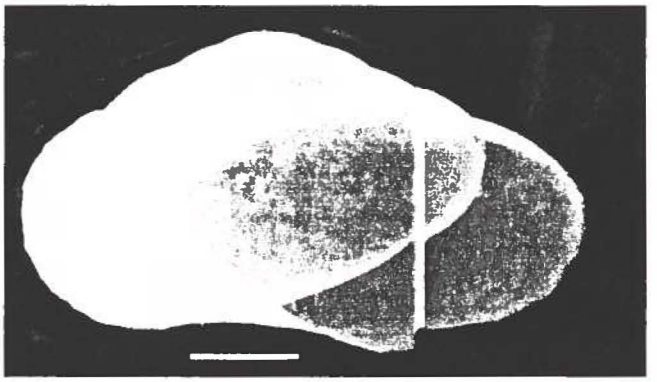

Figure 34. *Lamprocystis sp.* Scale bar = 1 mm.

Family PARTULIDAE

Partula Férussac, 1821

Partula gibba Férussac, 1821

Fig. 35

Partula gibba is endemic to the Mariana Islands, ranging from Guam through the Northern Mariana Islands (Kondo 1970). This was a widespread species on Rota at one time attested to by the large number of subfossils found at almost all sites visited and the large number of live collected specimens housed at the Bishop Museum. Only five of the sites surveyed now support living populations of *P. gibba*, indicating this species has declined greatly in recent years.

Partula cf./aff. *gibba*

Fig. 36

Four shells of a distinctive *Partula* were collected from paleontologic test pits at Payapai and As Matmos caves. They are close in general shell shape to *Partula gibba*, but differ in having an extremely thickened and heavy shell. Similar shells are not mentioned in Crampton's (1925) monograph on variation in Partulidae of the Mariana Islands. Limited material leaves the status of these shells uncertain; they could represent an extinct undescribed (sub)species or local race of *P. gibba*.

Samoana Pilsbry, 1909

Samoana fragilis (Férussac, 1821)

No shells of this species were found in 1995. Bishop Museum records indicate *Samoana fragilis* once occurred on Rota, on the Sabana in 1959 (BPBM 213164).

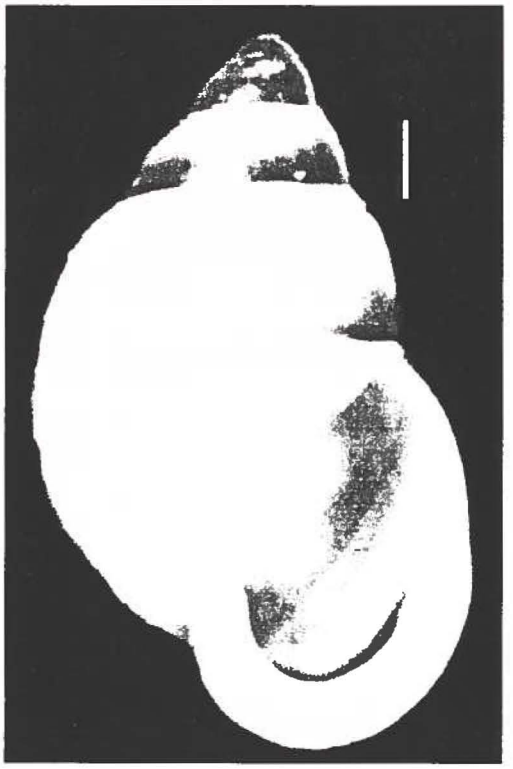

Figure 35. *Partula gibba*. Scale bar = 2mm.

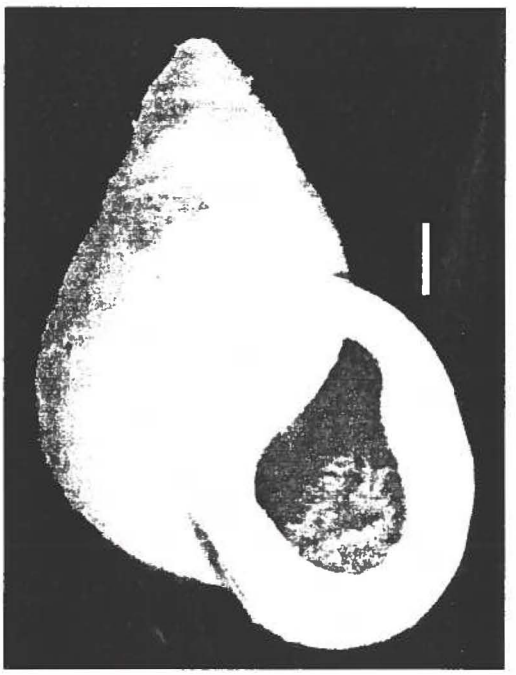

Figure 36. *Partula* cf./aff. *gibba*. Scale bar = 2 mm.

Today the Sabana area has been mostly converted into agricultural fields and no living partulids were found there in 1995. During a short field trip in 1996 to Rota a colony of *Samoana fragilis* was found at site 24.

Family PUPILLIDAE

Gastrocopta Wollaston, 1878

Gastrocopta sp.

Fig. 37

Gastrocopta is a wide-ranging genus apparently in part distributed by humans (Solem 1959, 1988). No live *Gastrocopta* were found on Rota. Records at BPBM indicate a species of *Gastrocopta* was alive on Rota in 1949 (BPBM 213220 and 213221).

Nesopupa Pilsbry, 1900

Nesopupa sp.

Fig. 38

Australian *Nesopupa* are reviewed by Solem (1988). No live *Nesopupa* were found on Rota in 1995. *Nesopupa (Nesopupa) quadrasi quadrasi* (Möllendorff, 1894) was described from Guam. A few records of live *Nesopupa* on Rota were found at the Bishop Museum (e.g. BPBM 82202, 82429), indicating that live specimens were collected in 1925 by H. G. Hornbostel. The wide range of many *Nesopupa* species are indicative of human transport. Specific identification of material was not made.

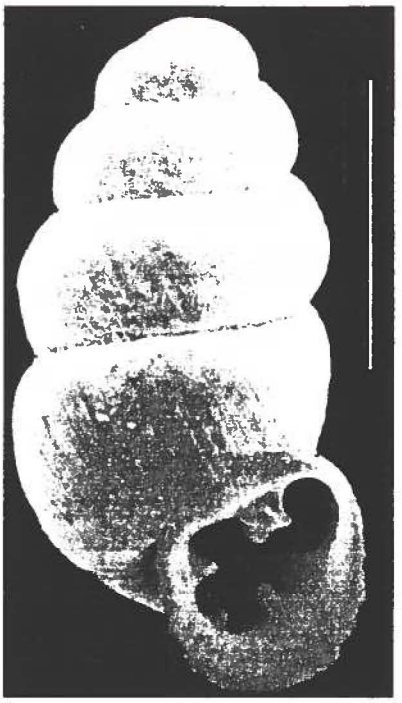

Figure 37. *Gastrocopta sp.* Scale bar = 1mm.

Figure 38. *Nesopupa sp.* Scale bar = 1 mm.

Family STREPTAXIDAE

Genus *Gonaxis* Taylor, 1877

Gonaxis kibweziensis (Smith, 1894)

This species was introduced to Rota probably from Aguiguan where it was released as a possible control agent for *Achatina fulica* Bowdich, 1822. Shells of this species were found at site 2. I know of no further information about this species on Rota other than that it was alive in 1969 (Eldredge in Tsuda ed. 1969: 27).

Family SUBULINIDAE

Subulina octona (Bruguière, 1789)

Subulina octona, a human transported species, is reviewed and figured in Solem (1988). On Rota it was noted alive at several sites, although I did not collect this species. It apparently is surviving well on the island. On many islands it is noted for inhabiting cultivated gardens. In the Mariana Islands it was probably introduced prehistorically.

Family SUCCINEIDAE

Succinea Draparnaud, 1801

Succinea sp(p).

Fig. 39

The number of species of *Succinea* on Rota could not be determined because animals cannot be identified by shell characters alone (Cowie et al. 1995). Four species of *Succinea* are recorded from Guam (Smith 1993), two are figured by Zilch (1978). Bishop Museum records indicate *Succinea* was widespread and living on the island in 1925 and 1949 (e.g. BPBM 213287-213289). *Succinea* may be extirpated from Rota.

Figure 39. *Succinea* sp. Scale bar = 2 mm.

Family UNDETERMINED

Genus species 1

Fig. 40

The taxonomic affinity of this species is uncertain at present. It resembles the many Achatinellidae in that it has an unsculptured shell, with a strong and large parietal barrier present. It was found only at the paleontological excavation at Payapai Cave.

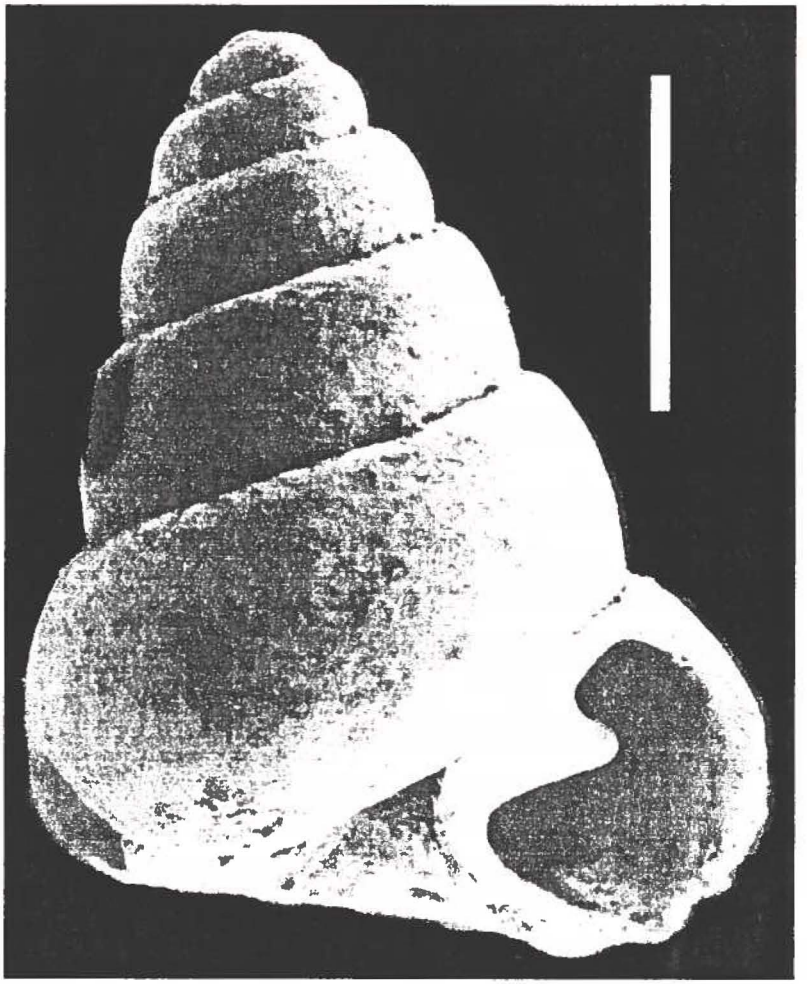

Figure 40. Genus species 1. Scale bar = 1 mm.

DISCUSSION

This is the first review of the land snail fauna of Rota. I have recorded a total of at least 43 species during the 1994, 1995 and 1996 surveys. Several taxa, however, were identified only to genus and may contain multiple species. Thus among helicarionids, I identified specimens only to the genera *Liardetia* and *Lamprocystis*; Baker (1938) records four helicarionid species from Rota: (*Liardetia tenuisculpta, Liardetia doliolum, Lamprocystis denticulata* and *Lamprocystis fastigata*). The pupillids (*Gastrocopta* sp(p). and *Nesopupa* sp(p). are not identified at the species level in my collections. Two additional land snail species have been recorded in the literature from Rota which were not encountered in the present survey: *Lamellidea microstoma* (Achatinellidae) and *Semperdon rotanus* (Charopidae) (Cooke and Kondo 1961, Solem 1983).

This brings the total native and introduced fauna of Rota to at least 47 taxa, noticeably fewer than the ca. 86 species known from Guam. This difference possibly reflects in part the much lower intensity of sampling that Rota has received compared with Guam, but may also be due to the island's smaller size and greater habitat homogeneity.

Three species (*Subulina octona, Achatina fulica* and *Gonaxis kibweziensis*) are certainly introductions while three others (*Nesopupa* sp(p)., *Gastrocopta* sp(p). and *Pacificella ?variabilis*) are potential introductions (Cook and Kondo 1961, Solem 1988). One additional species remains unidentified even to family and is not considered further below. This leaves at least 40 taxa as indigenous to Rota.

Eighty five percent of the indigenous species appear to be endemic to the Mariana Islands. Of the three indigenous species that are known to be more widespread, *Liardetia doliolum* and *Liardetia tenuisculpta* are recorded from the Philippines and the Caroline Islands while *Pythia scarabaeus* is widespread throughout western Pacific islands (Baker 1938).

Thirty six percent of the Mariana endemic taxa are known from Rota only. These are possible Rota endemics. Guam is the closest island to Rota and also has the best known modern land snail fauna of any Mariana Island. However, Guam's fossil fauna is still poorly known, and some of the species recorded as Rota endemics may have existed on Guam in the past.

Restriction of species ranges to single islands is characteristic of land snails and many insect groups (e.g. weevils) on central Pacific islands (Crampton 1925, Baker 1938, Cooke and Kondo 1961, Paulay 1994). As noted above, most of the Rota land snails occur on neighboring islands also (i.e. Guam and anecdotally from Tinian and Saipan). Within the Mariana Islands, wide multi-island species ranges have been found to be the rule among the systematically revised families Achatinellidae, Partulidae and Helicarionidae (Baker 1940, Cooke and Kondo 1961, Kondo 1970). The other taxonomically well known family, the Charopidae, has not been extensively collected for on the Mariana Islands outside of Guam. For other historically recorded non-introduced families (Hydrocenidae, Diplommatinidae, Truncatellidae, Assimineidae, Ellobiidae, and Succineidae) little is known about the ranges of component species among the southern

Mariana Islands. Observing that many land snail species are widely distributed among the Mariana Islands implies the existence of an effective dispersal mechanism.

To evaluate whether the proportion of single island endemics is indeed relatively low in the Mariana Islands compared with other Pacific islands, I compared the proportion of single island endemics on Rota and on Oahu (Hawaiian Islands). The fauna of the Hawaiian Islands was chosen for comparison, because it is taxonomically well known at the whole faunal level (Cowie et al. 1995, Cowie 1996). Oahu was chosen as a representative island from that archipelago.

A much larger proportion of Oahu's (87%, N=283) than of Rota's (31%, N=39) indigenous land snail fauna is constituted by single island endemics ($G=54.5$; $p<<0.001$). The greater proportion of widespread species in the Marianas than in the Hawaiian Islands could be the result of several factors. A larger proportion of Rota's fauna is comprised of prosobranchs, which may be better dispersers by virtue of the protection provided by their operculum. Thus while 59% of the indigenous land snails of Rota are prosobranchs, only 2% of the Oahu land snails are. However, the remaining pulmonates are still significantly ($G=30.5$; $p<<0.001$) more often single island endemics on Oahu (87%, N=278) than on Rota (25%, N=16). Further, most (all but 3) of the Rota pulmonates belong to groups that are well represented on Oahu: Achatinellidae, Succineidae, Endodontoidea and Helicarionidae. Thus it appears that phylogenetic bias is not the cause of the differences. Intra-island speciation, which generates large numbers of endemics *in situ* has progressed to large radiations in several lineages on Oahu, but less so on Rota (but see below), and this process is expected to increase endemicity on Oahu (R. Cowie, pers. comm.).

Finally the Mariana Islands lie in the western Pacific typhoon trough and are frequently battered by these catastrophic storms. Wind dispersal and transport by birds and bats are believed to be perhaps the most important agents of dispersal among Pacific island land snails (Rees 1965, Kondo 1970, Vagvolgyi 1975). The much greater availability of wind transport provides a site specific explanation, and also matches observations in the marine environment, where storms have been shown to exert a major control on the distribution of marine organisms in the area (Kerr et al. 1993, Kerr 1994).

Assimineids are the most diverse family of land snails on both Guam and Rota. The Mariana Islands are the only oceanic Pacific island group with a diverse assemblage of assimineids. The Philippine Islands also support a diverse assemblage of assimineids but are continental islands. Of the 19 assimineid species recognized on Rota at this time; nine may be endemic, although six of the possible endemics are known from fewer than 20 specimens at three sites, making their identification and range among the islands tentative.

It appears that speciation within the Mariana Islands has occurred at least in the families Assimineidae, Charopidae, and Partulidae. There is clear evidence for both inter and intra-island speciation within the Assimineidae and Charopidae. The *Omphalotropis* "carinate" species group forms a well defined portion of the Rota assimineid fauna, with no apparent close relatives known from any of the other Mariana Islands. A single ancestral colonist is hypothesized for the radiation of the five nominal species in this complex. The frequent multi-island ranges of species in the families Assimineidae and Partulidae indicate that inter-island speciation may have been the main form of diversification in their evolutionary history. This is true as well for the Charopidae among

the Mariana Islands, even though endodontoid land snails are renowned for their almost strict single island endemicity (Solem 1983).

Habitat destruction and introduced predators appear to have caused the decline and even possible extirpation of all species in three families of pulmonate land snails (Charopidae, Succineidae and Pupillidae) on Rota since 1949. *Pythia scarabaeus* a member of the Ellobiidae may also be extirpated. In addition to the invertebrate predators, introduced feral mammals (pigs, rats) may have contributed to the decline of some species. The species in two other pulmonate families (Partulidae, Achatinellidae) have drastically declined since 1949. Partulids were abundant enough on Rota in 1969 for Eldredge (in Tsuda 1969) to state "these [partulids] are common enough to be collected for ornamentation and jewelry." In contrast, only five *Partula* populations are known to remain on Rota today.

Thirty five of the 47 taxa known from Rota were encountered in the material from paleontological excavations at As Matmos and Payapai caves. These fossil assemblages thus represent a remarkably complete record of the island's malacofauna. The absence of many species in the material collected from the caves is readily explained: *Subulina octona, Achatina fulica* and *Gonaxis kibwziensis* were introduced to the island in historic times; *Samoana fragilis* was only known from a single site on the island and has a thin fragile shell; the other four species are assimineids of which some seem to have naturally small ranges on Rota (*Omphalotropis octhogyra, Omphalotropis quadrasi*) or are restricted to certain habitats (*Omphalotropis granum, Omphalotropis* sp. 7). The number of land snail species recorded from these cave sites is high compared to other studies on

land snail remains in archaeological settings (Chambers and Steadman 1986, Christensen and Kirch 1981). Paleontological excavations at As Matmos and Payapai caves reveal 13 taxa which no longer occur on the island, 11 of which cannot be matched to any species recorded previously from Guam or Rota. An abundance of *Lamellidea* shells in the paleontological excavations indicates they were much more common in the past at these two sites than they are today.

Of the 43 taxa found on Rota during 1994, 1995 and 1996 only 9% are considered surviving well while, 23% are surviving with questionable status. All families of land snails except Diplommatinidae have component species which are declining. Twelve percent of the species are potentially extirpated, while 56% of the fauna is considered to have declined. In conclusion, all evidence gathered to date suggests declines in populations, ranges and species numbers of many land snails on Rota.

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APPENDIX A

ANNOTATED SPECIES LIST OF SOUTHERN MARIANA ISLAND LAND SNAILS

In this appendix I summarize current knowledge of the southern Mariana Islands' land snail fauna based on the literature and my collecting efforts. Notes on the identification and taxonomy of each species is given in the text. The distribution among the islands of Guam, Rota, Aguiguan, Tinian and Saipan is summarized in Table 3. This information is compiled to facilitate further research on the land snails of the Mariana Islands.

Class GASTROPODA

Subclass PROSOBRANCHIA

Family ASSIMINEIDAE

At present the genera *Allepithema*, *Assiminea*, *Omphalotropis*, *Paludinella* and *Quadrasiella* are known from the Mariana Islands. I recognize 37 named and unnamed morphospecies on the five islands studied. Thiele (1929) divided the Assimineidae into the Assimineinae=Syncerinae (*Assiminea, Paludinella*) and Omphalotropinae (*Allepithema, Omphalotropis*, *Quadrasiella*). Later Abbott (1949) transfered *Paludinella* from the Assimineinae to the Omphalotropinae. The latter subfamily is the most important in the Marianas in terms of genera and number of species.

Subfamily ASSIMINEINAE

Assiminea Fleming, 1821

=*Syncera* Gray, 1821

Abbott (1958) reviews the Philippine species of *Assiminea* and provides useful information on the genus.

Table 3. Distribution of the land snails on the southern Mariana Islands. Island occurrences: numbers refer to references, 1=Quadras & Möllendorff 1894a, 1894b; 2=Abbott 1949; 3=Pfeiffer 1857; 4=Quoy & Gaimard 1832; 5=Cooke & Kondo 1961; 6=Solem 1983; 7=Baker 1938; 8=Crampton 1925; 9=Kondo 1970; 10=Solem 1988; 11=Eldredge in Tsuda 1969; 12=Muniappan 1983; 13=Lange 1950; 14=Harry 1966; 15=Davis 1954; 16=Clench & Turner 1948; 17=Smith 1993: +=collected during this study; cf.=specimen similar to nominal species but distinct; Range: M=Mariana Islands endemic; G=Guam endemic; R=Rota endemic; I=Introduced; W=Wide ranging; ?=Range not known.

	Island Occurence					
Species	Guam	Rota	Aguiguan	Tinian	Saipan	Range
Family Assimineidae						
Quadrasiella clathrata	1+	-	-	-	-	G
Q. mucronata	1+	-	-	-	-	G
?Q. sp. 1	-	+	-	+	-	M
Assiminea nitida guamensis	2	+	-	-	-	G
Omphalotropis cookei	2+	+	+	+	2+	M
O. elegans	1+	-	-	-	-	G
O. elongatula	1+	+	-	+	-	M
O. erosa	4	-	-	-	13	G
O. granum	1+	+?	-	-	13	M
O. guamensis	3	-	-	-	-	G
O. laevigata	1	cf.	-	-	-	M
O. laticosta	1+	-	-	-	-	G
O. latilabris	1+	-	-	-	-	G
O. ochthogyra	1+	+	-	-	-	M
O. picta	1+	-	-	-	-	G
O. pilosa/gracilis	1+	-	-	-	-	G
O. quadrasi	1+	+	-	-	-	M
O. semicostulata	1+	+	-	-	-	M
O. suturalis	1+	+	-	-	-	M
O. sp. 1	-	+	-	-	-	R
O. sp. 2	-	+	-	-	-	R
O. sp. 3	-	+	-	-	-	R
O. sp. 4	-	+	-	-	-	R
O. sp. 5	-	+	-	-	-	R
O. sp. 6	+	+	-	-	-	M
O. sp. 7	-	+	-	-	-	R
O. sp. 8	+	-	-	-	-	G
O. sp. 9	+	-	-	-	-	G
Paludinella conica	1+	+	-	-	-	M
P. conica saipanensis	-	-	-	-	2	S
Allepithema fulvum	1+	-	-	-	-	G
A. glabratum	1	-	-	-	-	G
A. pyramis	1	-	-	-	-	G
A. quadrasi	1+	+?	-	+?	-	M

Table 3. (*Continued*)

Species	Island Occurence					Range
	Guam	Rota	Aguiguan	Tinian	Saipan	
A. tuberculatum	1+	-	-	-	-	G
A. turritum	1+	-	-	-	-	G
A. sp. 1	+	+	-	-	-	M
A. sp. 2	+	-	-	-	-	G
Family Cyclophoridae						
Lagochilus? sp. 1	+	-	-	-	-	?
Family Diplommatinidae						
Palaina taeniolata	1+	+	+	+	13	M
Family Hydrocenidae						
Georissa elegans	1+	+	-	+	13	M
G. laevigata	1+	+	-	-	-	M
G. sp. 1	+	-	-	-	-	G
G. sp. 2	+	-	-	-	-	G
Family Truncatellidae						
Taheitia alata	1+	-	-	-	-	G
T. lamellicosta	1	-	-	-	-	G
T. mariannarum	1+	+	-	-	14	M
T. parvula	1	-	-	-	-	G
T. subauriculata	1+	-	-	-	-	G
Truncatella expansibilabris	1	-	-	-	-	G
T. guerinii	16	-	-	-	13	W
Family Achatinellidae						
Pacificella ?variabilis	+	+	-	-	-	W,I?
Lamellidea. microstoma	1+	5	-	5+	5	M
L. m. moellendorffiana	5	5	-	5	5	M
L. subcylindrica	1+	5+	-	-	-	M
Elasmias quadrasi	1+	5+	+	5	5	M
Family Achatinidae						
Achatina fulica	12+	12+	15+	12	12	I
Family Bulimulidae						
Drymaeus multilineatus	+	-	-	-	-	I
Family Camaenidae						
Gen. sp. 1	17+	-	-	-	-	I
Family Charopidae						
Himeroconcha fusca	1	-	-	-	-	G
H. lamlanensis	6	-	-	-	-	G
H. quadrasi	6	-	-	-	-	G
H. rotula	1+	-	-	-	-	G
H. sp. 1	-	+	-	-	-	R
H. sp. 2	-	+	-	-	-	R
H. sp. 3	-	-	-	+	-	T
Ladronellum mariannarum	1+	-	-	-	-	G
Semperdon heptaptychius	1+	+	-	-	-	M
S. rotanus	6+	6	-	-	-	M
?*S.* sp. 1	-	-	-	+	-	T
?*S.* sp. 2	-	-	-	+	-	T
S. sp. 5	-	-	+	+	-	M
S. sp. 6	-	+	-	-	-	R
?*S.* sp. 7	+	-	-	-	-	G

Table 3. (*Continued*)

Species	Island Occurence					
	Guam	Rota	Aguiguan	Tinian	Saipan	
?*S.* sp. 8	+	-	-	-	-	G
Sinployea sp.	-	-	-	-	6	I?
Family Ellobiidae						
Pythia scarabaeus	17+	+	-	-	13	W
Family Helicarionidae						
Liardetia doliolum	7	7	-	7	-	W
L. sculpta	7	-	-	-	-	W
L. tenuisculpta	-	7	-	-	7	W
L. sp(p).	+	+	+	+	+	?
Lamprocystis denticulata	7+	7	-	-	7	M
L. fastigata	7	7	-	7	-	M
L. hornbosteli	-	-	-	7	-	T
L. misella	7	-	-	7	13	M
L.? sp. 1	-	-	-	+	-	T
L. sp(p).	+	+	-	-	-	?
Family Partulidae						
Partula gibba	8+	9+	9	9	8	M
P. cf/aff. gibba	-	+	-	-	-	R
P. langfordi	-	-	9	-	-	A
P. radiolata	8+	-	-	-	-	G
P. salifana	8	-	-	-	-	G
Samoana fragilis	8+	9+	-	-	-	M
Family Pupillidae						
Gastrocopta lyonsiana	-	-	-	-	13	S
G. pediculus	10+	-	-	-	-	I
G. sp. 1	+	-	-	-	-	?
Gastrocopta sp(p).	+	+	+	+	13	I,?
Nesopupa quadrasi	1	-	-	-	13	I,?
N. sp. 1 = *quadrasi*?	?	?	?	?	?	?
N. sp. 2	?	?	?	?	?	?
pupillid(?) gen. sp. 1	+	-	-	-	-	?
Family Spiraxidae						
Euglandina rosea	17+	-	-	-	-	I
Family Streptaxidae						
Gonaxis kibweziensis	-	11+	15+	-	-	I
Gulella bicolor	+	-	-	-	14	I
Family Subulinidae						
Lamellaxis gracilis	17+	-	?	+	13	I
Opeas pumilum	17+	-	?	+	-	I
Prosopeas achatinaceum	17+	-	-	-	-	I
Subulina octona	17+	?	+	+	13	I
Family Succineidae						
S. guamensis	3	-	-	-	-	G
S. piratarum	1	-	-	-	13?	M
S. quadrasi	1	-	-	-	-	-
Succinea sp(p).	+	+	+	+	13	M
Family Undetermined						
Gen. sp. 1	-	+	-	-	-	I,?

Assiminea nitida guamensis Abbott, 1949

Identification based on: Abbott (1949: Fig. 8)

This single species of *Assiminea* known in the Marianas can be readily distinguished from *Paludinella conica* by the presence of a thin raised thread just below the suture.

Subfamily OMPHALOTROPINAE

Quadrasiella Möllendorff, 1894

Quadrasiella species are distinguishable from other genera using the following characters: "Shell small, disk-or sphere-shaped. Operculum more or less projecting, formed of 2 plates" Thiele (1929:255).

The genus is comprised of two described species from the Marianas and one (*Quadrasiella ammonitella* Möllendorff, 1900) from Pohnpei. A fourth species in the Marianas is tentatively assigned here.

Quadrasiella clathrata Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 85)

Quadrasiella clathrata differs from *Quadrasiella mucronata* in having a taller spire and lacks the flared apical end of the operculum found in the latter. It is slightly variable in the degree of spiral carination and is similar to *Allepithema quadrasi*. Previously (Bauman 1996) identified specimens from Rota as *Q. clathrata*, however, they are now reinterpreted as *A. quadrasi*. On the basis of dead shells *Quadrasiella clathrata* was once distributed along the eastern coast of Guam, up to an elevation of ≈300m on the top of Mt. Santa Rosa in northern Guam. Only one living colony was found on Guam.

Quadrasiella mucronata Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 84)

For notes distinguishing *Quadrasiella mucronata* from *Quadrasiella clathrata*, see under that species. Many colonies and shell have been located on Guam, with size variation apparent between sites.

Quadrasiella? sp. 1

These shells are similar to other *Quadrasiella* in general shell shape, having well developed axial ribs and carination. However as no opercula have been found the generic assignment is tentative. Alternatively, it could belong to another assimineid genus. I have collected several lots from Rota and Tinian.

Omphalotropis Pfeiffer, 1841

"Operculum as a rule simple, horny, thin in most cases." Thiele (1929:252). *Omphalotropis* is the most species rich genus in the southern Marianas with 16 named and nine unnamed forms known.

Omphalotropis cookei Abbott, 1949

Identification based on: Abbott (1949: Fig. 1)

Recognized by having faint to pronounced spiral threads on all whorls. The abundance of this species appears to increase from South (Guam) to North (Saipan) in the Marianas.

Omphalotropis elegans Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 53)

Shell small (4.25 mm high x 3 mm wide: from Thiele (1929)), with well defined, abundant fine axial ribs, faint spiral striae and an umbilical carina . I have no specimens referable to this name.

Omphalotropis elongatula Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Figs. 54-57)

Distinct smooth shell, slightly higher spired than *O. cookei* and *O.* sp. 6. Color varies from a light tan to yellow to reddish brown. Quadras & Möllendorff (1894a) also describe three *O. elongatula* varieties, Var. *brunnescens*, Var. *chrysostoma* and Var. *contracta*. I have not split my specimens into these varieties. They are commonly found live on Guam near the ocean living on rock faces and in leaf litter.

Omphalotropis erosa (Quoy & Gaimard, 1832)

=*Cyclostoma erosa* Quoy & Gaimard, 1832

Identification based on: The original Quoy & Gaimard figure was unavailable for study.

Abbott (1949) discusses *O. erosa* in reference to *O. cookei* remarking on their similarities. *Omphalotropis erosa* is close to and possibly the same species as *O.* sp. 6 from Rota (see discussion under that species). On Guam specimens assignable to the *O. erosa* / *O.* sp. 6 complex exhibit considerable conchological variation. The number of taxa involved in this complex and how they relate to *O. erosa* remains to be determined.

Omphalotropis gracilis Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 29)

Omhalotropis pilosa and *O. gracilis* are very similar and these two nomina may be synonymous. *Omphalotropis gracilis* shells approach *O.* sp. 9 in form and may be related. I have only collected one series of shells on Guam assignable to *O. pilosa* or *O. gracilis*. Without examining the type series I cannot distinguish between the two binomens and I am therefore designating my single lot as *O. pilosa* / *O. gracilis* indicating a possible synonymy.

Omphalotropis granum (Pfeiffer, 1854)

=*Hydrocena granum* Pfeiffer 1854

=*Omphalotropis submaritima* Quadras & Möllendorff, 1894

Identification based on: Harry (1966: Fig. 14); Zilch (1967: Fig. 28)

This is a small, low spired, generally unsculpted species with a peripheral and umbilical carina variably expressed from absent to moderately developed.

The synonymy of *O. submaritima*, described from Guam, with the widespread *O. granum* was made by Harry (1966) and Solem (1959:200). Harry (1966) provides a redescription of the species and lists its known known occurrences in Lifu (Loyalty Islands), New Caledonia, New Hebrides, Ulithi and Guam. I have many lots collected from coastal habitats on Guam and questionably from Rota.

Omphalotropis guamensis Pfeiffer, 1857

Identification based on: Abbott (1949: Fig. 4)

Only the headfoot and operculum is figured by Abbott (1949). Pfeiffer (1857) did not include a figure with his description. I know of no figure accompaning this name other than Abbott (1949). Three lots at the United States National Museum (USNM catalog #'s 591315, 201176 and 589979) are cited by Abbott (1949). The species is known from Mt. Alifan, Agana and Pago Bay and I have no specimens assigned to this name.

Omphalotropis laevigata Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 44)

Two similarly shaped small assimineids *O. laevigata* and *O. picta* were named from Guam. I have tentatively identified two morphospecies in the Marianas that are close to the types figured for *O. laevigata* and *O. picta*. The larger thinner shelled one is tentatively placed under *O. picta* (see under that species below), while the smaller thicker shelled form is tentatively identified as *O. laevigata*. However, one illustrated type is clearly mottled while my single specimen from Rota tentatively assigned to this binomen is not. No live animals have been taken on any of the islands.

Omphalotropis laticosta Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 58)

Very distinctive only *O. ochthogyra* approaches it in form. *Omphalotropis laticosta* is distinct based on its high spire, slight mid-whorl keel forming an umbilical

carina and irregular thickened axial ribbing. I have several live collected lots from Guam where it cooccurs commonly with *O. quadrasi* in leaf litter.

Omphalotropis latilabris Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 59)

Similar in shape to *O. quadrasi*, but has less prominent spiral and axial sculpture. Only four dead specimens have been taken of this species, all on Guam.

Omphalotropis octhogyra Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Figs. 60-61)

Similar to *O. laticosta* in being high spired with a slight body whorl keel, umbilical carina and irregular, slightly-raised axial ribs. Axial ribbing is much less developed and largely lacking on the newly collected *O. octhogyra* specimens. *Omphalotropis octhogyra* types illustrated by Zilch appear to have slightly raised axial ribbing, thus assignment of my collections to this binomen is tentative. The illustrated types as well as my live collected specimens have a mottled color pattern.

Omphalotropis picta Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 62)

Moderate in size, degree of spire protrusion, with a brown mottled color pattern and with a slight to moderate umbilical carina. *Omphalotropis picta* resembles *O. ochthogyra* in shape, but lacks its characteristic sculpture. Three dead specimens from Guam are tentatively assigned to this binomen; however, the distinction from *O. laevigata* is unclear based on Zilch's type photographs (see comments under that species).

Omphalotropis pilosa Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig 30)

Omphalotropis pilosa and *O. gracilis* are possibly synonymous; see discussion under the latter.

Omphalotropis quadrasi Quadras & Möllendorff, 1894

Identification based on: Abbott (1949: Figs. 2-3); Zilch (1967: Figs. 63-64)

A very distinctive species with well developed keel, pronounced sculpture, triangular shape and an umbilical carina with an uneven margin. See under *O. latilabris* for a comparison with that species. This species was taken at many locations around Guam; a single lot taken on Rota extends its range northward.

Omphalotropis semicostulata Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig 45)

Only a few worn specimens from Rota are assigned to this binomen. They are small, with slight umbilical carination. One specimen appears to retain some mottled color pattern as is evident in Zilch's (1967) type photographs. I have not collected specimens from Guam, the type locality.

Omphalotropis suturalis Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig 43)

A small, smooth species which I have collected on Guam and Rota. Zilch's (1967) photograph of a type *O. suturalis* specimen is of a shell very similar to *O. granum* and approaches the latter in having similarly parallel sided whorls. The color pattern illustrated in Zilch's *O. suturalis* photograph is, however, light with a darker apex, while *O. granum*

is darker overall. Specimens are somewhat abundant in coastal forest and habitats inhabited by truncatellids near the ocean.

Omphalotropis "carinate" species complex

The following five forms are from two paleontological sites on Rota (Bauman 1996). They form a distinct species group, all having well developed peripheral and umbilical carinae. Three are turriculate while two are lower spired. Only 20 shells were collected; this limited material makes an evaluation of variability difficult, and the group may consist of as few as two or as many as five species.

Omphalotropis sp. 1

This is the smallest form in the group, with a shell height of ≈2.5mm, and well developed peripheral and umbilical carina. The apex has distinct spiral cording visible and later whorls have fine ribs, otherwise the shell is smooth.

Omphalotropis sp. 2

Spire much higher than in *O.* sp. 1, peripheral and umbilical carina not as well developed and only occurs on the body whorl distinctly keeled. Axial and radial sculpturing is absent.

Omphalotropis sp. 3

Shell much larger than the preceding two species with a well developed umbilical carina. The peripheral carina is not as strong and is developed as a thin raised thread continuing up the spire becoming indistinct nearing the apex. Axial ribbing or growth wrinkles are visible on all whorls except the embryonic whorls which are smooth.

Omphalotropis sp. 4

This species is closest in general shell morphology to *O.* sp. 3, but *O.* sp. 4 has the peripheral carina developed as a distinct raised cord running around the shell. The body and penultimate whorl has spiral threads visible.

Omphalotropis sp. 5

Omphalotropis sp. 5 resembles *O.* sp. 4 but differs in several characters. Unlike *O.* sp. 4, *O.* sp. 5 lacks spiral cording. As in *O.* sp. 4 the carina is well developed as a distinct raised cord, continuing up the shell becoming indistinct on the third whorl from the apex. The umbilical carina is well developed, and the columellar margin of the aperture is reflected.

Omphalotropis sp. 6

Shell thick, brown, large with a lightly developed keel, strongly developed umbilical carina, axial fold-like ribs from the apex to the body whorl. I am only applying this name to a single lot collected on Rota, which is quite distinct. However, many specimens of a similar form were collected on Guam, these, however, exhibit a wide range of variation in carination, axial sculpture, whorl shape and color pattern development. These specimens from Guam may include more than one species and some are close to *O.* sp. 6 on Rota others to *O. erosa.* The species complex represented by *O. erosa*, *O.* sp. 6 and the Guam specimens mentioned is left unresolved.

Omphalotropis sp. 7

A small (≈3mm height), low spired, thick shell, with light peripheral and umbilical carina. First whorl with fine spiral striae, all other whorls with thin raised axial ribbing

which only descends halfway down on the body whorl. The single collection from Rota of this species was microsympatric with *O. granum* and *Taheitia. mariannarum.*

Omphalotropis sp. 8

Shell very small with a slightly developed peripheral and umbilical carina, brownish with lighter brown peripheral carina. It is smooth except the apical whorl has fine spiral striae. This species was found sympatrically with *Q. clathrata* on damp moss covered limestone faces, at one location on Guam. It resembles the other small non-descript assimineids, *O. granum*, *O. suturalis* and *O. semicostulata.*

Omphalotropis sp. 9

The generic assignment of this species is tentative, based on its general similarity to *O. pilosa* / *O. gracilis*. *Allepithema* is the alternative generic placement, but without opercula generic assignment is tentative. This species is the highest spired assimineid found in the Marianas. The shell is thin, lacks an umbilical carina and has closely spaced, fine, axial ribs running from suture to suture. These characters are shared by *O. pilosa* and *O. gracilis*. It was collected dead at one site on Guam.

Paludinella Pfeiffer, 1897

Paludinella conica (Quadras & Möllendorff, 1894)

=*Omphalotropis* (*Solenomphala*) *conica* Quadras & Möllendorff, 1894

Identification based on: Abbott (1949: Figs. 5-6); Zilch (1967: Fig. 19)

Abbott (1949) distinguished *P. conica* from the similarly shelled *A. guamensis* by the absence of a thin, raised thread just below the suture. The shell is also characterized by having no or only a slightly developed umbilical carina which is a lighter brown color in

P. conica saipanensis than in the nominal subspecies (Abbott 1949). The columellar lip is reflected, aperture does not form a distinct ring with a heavy parietal callous or detached aperture as in many *Allepithema*, *Omphalotropis* and *Quadrasiella* species. I have collected many live specimens on Guam and Rota.

Paludinella conica saipanensis Abbott, 1949

Identification based on: Abbott (1949; description)

No specimens of this subspecies have been collected during my study.

Allepithema Tomlin, 1930[1931?]

=*Heteropoma* Möllendorff, 1894 non Benson, 1856

Species of *Allepithema* may be recognized by characters described by Thiele (1929:254) "Shell top-shaped or depressed. Operculum consisting of an inner horny and an outer calcareous, in most cases indistinctly spiral plate without marginal furrow".

Quadras & Möllendorff (1894a) described six *Allepithema* species from Guam.

Allepithema fulvum (Quadras & Möllendorff, 1894)

=*Heteropoma fulvum* Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 78)

Allepithema fulvum is very similar to *A. tuberculatum* based on Zilch's (1967) type figures. One of two similar morphospecies that appears to belong in this complex are tentatively assigned to *A. fulvum* and to *A. tuberculatum*, both are based on single collections from Guam.

Allepithema glabratum (Quadras & Möllendorff, 1894)

=*Heteropoma glabratum* Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 77)

Among the known Mariana *Allepithema* this shell is very distinct. I have not collected it during my study.

Allepithema pyramis (Möllendorff, 1894)

=*Heteropoma pyramis* Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 79)

This shell has a high spire but not as high as that of *A. turritum*. I have not collected it during my study.

Allepithema quadrasi (Möllendorff, 1894)

=*Heteropoma quadrasi* Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 80)

This shell is similar to *A. fulvum* and *A. tuberculatum* but is somewhat larger, and wider, perhaps with stronger sculpture and angulation of whorls while being slightly larger. A series of specimens from Rota and Tinian are tentatively assigned here based on their similarity to Zilch's (1967) type photograph. *Allepithema quadrasi* approaches *Quadrasiella clathrata* in general form, but, *A. quadrasi* is more strongly carinated. *Allepithema quadrasi* was erroneously identified as *Q. clathrata* in Bauman (1996). Opercula are unknown among the new Rota and Tinian material, therefore, generic placement is tentative pending an examination of Quadras & Möllendorff's type series.

Allepithema tuberculatum (Quadras & Möllendorff, 1894)

=*Heteropoma tuberculatum* Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 81)

See comments under *A. fulvum.*

Allepithema turritum Quadras & Möllendorff, 1894

=*Heteropoma turritum* Quadras & Möllendorff, 1894

Identification based on: Zilch (1967: Fig. 82)

This species has the highest spire among the known Mariana *Allepithema.* I have only collected one lot which has a slightly lower spire than the specimen depicted in Zilch's figure.

Allepithema sp. 1

The shell is smoother and higher spired than *A. glabratum.* Generic assignment is certain based on evidence from overall similarity with Guam *Allepithema* species and operculum structure which agrees closely with Thiele's (1929) description. Several specimens from Guam and Rota are assigned here. They differ slightly between the two islands, but probably represent the same species.

Allepithema sp. 2

Similar to *A. pyramis*, but lacking the distinct carina of that species. Collected on Mt. Santa Rosa, Guam where they are common in damp, closed-canopy limestone forest.

Family CYCLOPHORIDAE

Lagochilus Blanford, 1864

Lagochilus? sp. 1

Identification based on: van Benthem Jutting (1963: Fig. 6)

Shells of this species are similar to *Lagochilus* sp(p). illustrated by van Benthem Jutting (1963) from Papua New Guinea. Fewer than 20 shells collected from Pagat Cave on Guam. This is the first record of the family in the Marianas.

Family DIPLOMMATINIDAE

Palaina Semper, 1865

Palaina taeniolata Quadras & Möllendorff, 1894

=*Ralaina hyalina* (Quadras &Möllendorff, 1894)

Identification based on: Zilch (1953: Figs. 66-67)

Zilch (1953) split *Palaina taeniolata* into two subspecies (*P. taeniolata taeniolata* and *P. taeniolata apapaensis*). However, the distinction between Zilch's photographs of the two subspecies and *Palaina hyalina* are vague and I tentatively consider *P. taeniolata* and *P. hyalina* synonymous pending detailed work with the type specimens. I have provided a translation of Zilch's (1953:14) diagnosis of *Palaina* (*Palaina*) *taeniolata apapaensis*; "The series from Apapa, Guam show constantly smaller and more rounded shells. The fluting on the last whorl is tighter than *taeniolata*. The aperture is more rounded." This may just be variation between sites as shown above for *Quadrasiella mucronata*. Diplommatinid colonies are known from many sites on Guam, Rota and Saipan.

Palaina sp.

A third diplommatinid, *Palaina* sp. (BPBM 152813) is listed by Smith (1993) as occurring on Guam. I have not seen the specimens.

Family HYDROCENIDAE

Georissa Blanford, 1864

Georissa elegans Quadras & Möllendorff, 1894

=*Georissa biangulata* Quadras & Möllendorff, 1894

Identification based on: Zilch (1973a: Figs. 23-24)

Georissa elegans with its distinct prominent raised axial striae is the most recognizable hydrocenid in the Marianas. *Georissa elegans* and *Georissa biangulata* appear to differ only in size based on Zilch's type photographs, therefore, I tentatively consider them synonymous. I have collected many lots of this species from Guam, Rota and Tinian. It is common alive on Guam and Rota.

Georissa laevigata Quadras & Möllendorff, 1894

Identification based on: Harry (1966: Figs. 1-3); Zilch (1973a: Fig. 25)

Apical sculpture is of fine spiral threads, post nuclear whorls with faint axial striae. Many colonies known on Guam and Rota.

Georissa sp. 1

Shells are recognizable by their well developed spiral threads.

Georissa. sp. 2

Georissa sp. 2 is close to *G. laevigata* but has better developed axial striae on the nuclear and post nuclear whorls and has faint spiral threads continuing down from the

apex through to the body whorl. It also appears to have a slightly lower spire height than *G. laevigata.*

Family TRUNCATELLIDAE

Clench & Turner (1948) have partially reviewed the family listing all species recorded from Guam. I have only partially worked through the material collected during my studies. Of the seven species recorded by Clench and Turner (1948) only three have been identified to species in my collections.

Truncatella Risso, 1826

Truncatella expansilabris Quadras & Möllendorff, 1894

Identification based on: Zilch (1973b: Fig. 10)

I know of no other information on this species except Zilch (1973b) and its original description in Quadras & Möllendorff (1894b).

Truncatella (*Truncatella*) *guerinii* A. Villa & J.B. Villa, 1841

Identification based on: Clench & Turner (1948: Plate 23, Figs. 12-13)

Known from many locations around the Indo-Pacific. Clench & Turner (1948) describe a large amount of variation for this species and present a long list of synonyms.

Taheitia H. Adams & A. Adams, 1863

Taheitia alata (Quadras & Möllendorff, 1894)

=*Truncatella* (*Taheitia*) *alata* Quadras & Möllendorff, 1894

Identification based on: Zilch (1973b: Fig. 16)

Easy to identify due to its large, flaring palatal lip which no other Mariana island truncatellid species has. I have only collected this species dead, inside coastal forest (≈30-

100m inland) but never far inland. Clench & Turner (1948) claim that this species lives inland.

Taheitia lamellicosta (Quadras & Möllendorff, 1894)

=*Truncatella* (*Taheitia*) *lamellicosta* Quadras & Möllendorff, 1894

Identification based on: Zilch (1973b: Fig. 17)

No further information available on this.

Taheitia mariannarum (Quadras & Möllendorff, 1894)

=*Truncatella mariannarum* Quadras & Möllendorff, 1894

Identification based on: Zilch (1973b: Fig. 18-19)

This is the most common truncatellid in the southern Marianas, with many populations around Guam and Rota, on low-lying limestone habitats very close to the ocean, sometimes in the spray zone. This is a robust, thick-shelled species, with a brown base color and lighter colored sutures, matching Zilch's (1973b) type photographs well. Clench & Turner (1948) considered *T. mariannarum* and *Taheitia subauriculata* synonymous. Based on Zilch's type illustrations of both species, however, the two are distinct morphologically and I also found them to occupy different habitats.

Taheitia subauriculata (Quadras & Möllendorff, 1894)

=*Truncatella subauriculata* Quadras & Möllendorff, 1894

Identification based on: Zilch (1973b: Fig. 21-22).

Shells of *T. subauriculata* differ from *T. mariannarum* in being light color, almost white, and somewhat translucent. I have collected live *T. subauriculata* on Guam ≈25m above sealevel in limestone forest alongside endemic forest-dwelling assimineid species,

clearly a different environment from that occupied by *T. mariannarum*. These observations make Clench & Turner's (1948) synonymy of *T. mariannarum* and *T. subauriculata* untenable.

Taheitia parvula (Quadras & Möllendorff, 1894)

=*Truncatella* (*Taheitia*) *parvula* Quadras & Möllendorff, 1894

Identification based on: Zilch (1973b: Fig. 20)

I did not encounter this species.

Subclass PULMONATA

Family ACHATINELLIDAE

Pacificella Odhner, 1922

Pacificella ?variabilis Odhner, 1922

Identification based on: Cooke & Kondo (1961: Fig. 76)

Identification of *P. variabilis* is difficult and should be based on a comparison with a range of specimens particularly subadult shells of both *Pacificella* and *Lamellidea*. Cooke & Kondo (1961:164) provide a comparison between *Pacificella* and *Lamellidea* stating: "...*Pacificella* is most readily separated by its slightly shorter length, proportionately wider diameter, fewer whorls, blunter apex, larger aperture, and weaker parietal lamella." Juvenile shells of *Pacificella* do not have palatal ribbing which is found in *Lamellidea*. *P. ?variabilis* was only identified from Guam and Rota.

Subfamily LAMELLIDEINAE

Lamellidea Pilsbry, 1910

Palatal ribbing characterizes juvenile *Lamellidea* (*Lamellidea*) shells and is evident in most of my achatinellid specimens. Cooke & Kondo (1961:178) describe juvenile *Lamellidea* shells as having the, "...palatal wall with one to three vertical ribs or without ribs; ribs serrate or plain", they continue and point out palatal ribs are only absent in some *Lamellidea* (*Atea*) specimens. A direct comparison between *Pacificella* and *Lamellidea* shows *Pacificella* to have a shorter blunter shell with sutures not impressed compared to the more elongate shells of *Lamellidea* which have slightly impressed sutures.

Lamellidea (*Lamellidea*) *microstoma* (Quadras and Möllendorff, 1894)

=*Tornatellina* (*Lamellina*) *microstoma* Quadras & Möllendorff, 1894

Identification based on: Zilch (1962: Fig. 10)

Adult shells recognizable by being higher spired, without a concave palatal wall as found in *Lamellidea subcylindrica*, and having more impressed sutures than in *P.* ?*variabilis*.

Lamellidea (*Lamellidea*) *microstoma* form *moellendorffiana* (Pilsbry, 1915)

=*Tornatellina* (*Lamellina*) *moellendorffiana* Pilsbry and Cooke, 1915

Identification based on: Cooke & Kondo (1961: description)

Cooke & Kondo (1961) say this form cooccurs with *L. microstoma* in museum lots they examined. Which may make this just a distinct morph of *L. microstoma* and not a "subspecies." The use of "form" is not clear and interpreting it as a subspecies of *L. microstoma* is probably not warranted.

Lamellidea (*Lamellidea*) *subcylindrica* (Quadras & Möllendorff, 1894)

=*Tornatellina* (*Lamellina*) *subcylindrica* Quadras & Möllendorff, 1894

Identification based on: Zilch (1962: Fig. 11)

Palatal wall with a slightly concave shape extending back around the shell for about one entire whorl (Cooke & Kondo 1961).

Subfamily TORNATELLININAE

Elasmias Pilsbry, 1910

Shells of *Elasmias* have one characteristically flat columellar barrier, one parietal barrier, a low spire and rapid whorl expansion. Only one species is recorded from the Mariana Islands. The genus ranges widely throughout Micronesia and Polynesia.

Elasmias quadrasi (Möllendorff, 1894)

=*Tornatellina quadrasi* Möllendorff, 1894

Identification based on: Cooke & Kondo (1961: Fig. 98); Zilch (1962: Fig. 8)

Small size, characteristically flat columellar barrier and one small parietal barrier distinguishes this species from other Mariana land snails. I found *E. quadrasi* surviving well in arboreal habitats around Guam and Rota.

Family BULIMULIDAE

Drymaeus Albers, 1850

Drymaeus multilineatus (Say, 1825)

Identification based on: Barry Smith (pers. comm.).

This species is a recent introduction from Florida. Large, off white shell with conspicuous black to brownish bands. Two specimens were originally found on

ornamental plants at the Hyatt Hotel on Tumon Bay, Guam in 1994. The species was then found to be thriving on tangan tangan (*Leucaena leucocephala* (Lamarck)) in Mangilao, Guam in 1995. The Mangilao population has been loosely monitored and appears to be spreading from behind George Washington High School toward University of Guam. This species is not considered a threat to native land snail species due to its non-predatory life history and preference for dry arboreal habitats where native land snails do not occur.

Family CAMAENIDAE

Genus sp. 1

A large ground and tree trunk dwelling camaenid was first found on Guam by Barry Smith in 1984. Since that time the snail has spread considerably and is now common at many sites around Guam. The species is unidentified at present.

Family CHAROPIDAE

Subfamily SEMPERDONINAE

Except for three *Semperdon* species in Palau, the Semperdoninae is endemic to the Mariana Islands (Solem 1983).

Himeroconcha Solem, 1983

Himeroconcha fusca (Quadras & Möllendorff, 1894)

=*Patula fusca* Quadras & Möllendorff, 1894

Identification based on: Solem (1983: Fig. 105d-f)

I have not collected this Guam endemic, however, see *H. quadrasi* below.

Himeroconcha lamlanensis Solem, 1983

Identification based on: Solem (1983: Fig. 104d-f)

I have not collected this Guam endemic, which is known only from Mt. Lamlam (Solem 1983). The name is based on a misspelling of the type locality.

Himeroconcha quadrasi (Möllendorff, 1894)

=*Patula quadrasi* Möllendorff, 1894

Identification based on: Solem (1983: Fig. 105a-c)

H. quadrasi and *H. fusca* are very similar in appearance, both having a distinctly keeled shell and differing mainly in size and degree of umbilical constriction. Previous collections of these two species all have very general locality labels ("Guam", "Marianas" or "Mariana Islands") and their exact distribution is unknown (Solem 1983). Specimens I collected from Mt. Santa Rosa, Guam are similar in size to *H. quadrasi*, however, they differ in having a narrowed umbilicus, as in *H. fusca*. Thus they are identified as *H.* cf. *quadrasi*, until further collections resolve their specific status

Himeroconcha rotula (Quadras & Möllendorff, 1894)

=*Patula rotula* Quadras & Möllendorff, 1894

Identification based on: Solem (1983: Fig. 104a-c)

H. rotula is distinguishable from its closest relative *H. lamlanensis* by being smaller with a rounded, not expanded, palatal wall, protruding spire and well developed secondary spiral cording (Solem 1983). I have only collected one dead lot of this species on Guam.

Himeroconcha sp. 1

This Rota endemic species, found in paleontological digs, is readily recognized because its aperture is practically under the body whorl.

Himeroconcha sp. 2

Similar to *H.* sp. 1 but with the aperture not under the body whorl, giving the shell a more planispiral shape than in *H.* sp. 1. Has only been collected in paleontological digs on Rota.

Himeroconcha sp. 3

Himeroconcha sp. 3 resembles *Himeroconcha lamlanensis* but is distinctive because of its smaller size. It has only been collected from paleontological digs on Tinian.

Ladronellum Solem, 1983

Ladronellum mariannarum (Quadras & Möllendorff, 1894)

=*Endodonta mariannarum* Quadras & Möllendorff, 1894

Identification based on: Solem (1983: Fig. 101a-c)

Ladronellum is a monospecific genus, and has a medium-sized shell among the Semperdoninae. The two apertural barrier traces and a high spire distinguish this species from Mariana *Semperdon* species. My specimens clearly fit Solem's (1983) conchological description and diagnosis of this endemic Guam species.

Semperdon Solem, 1983

Semperdon heptaptychius (Quadras & Möllendorff, 1894)

=*Endodonta heptaptychia* Quadras & Möllendorff, 1894

Identification based on: Solem (1983: Fig. 99)

Most *S. heptaptychius* specimens can be seperated from *S. rotanus* by having four palatal barriers and evenly rounded whorls (Solem, 1983). I have specimens from many sites around Guam. Barry Smith collected one live lot at Hilaan Pt. Guam in 1993 and one tiny live juvenile specimen during 1995. On four collecting trips I made to Hilaan Pt. during 1994, 1995 and 1996 I did not see any live specimens, though, dead shells are abundant and unweathered indicating a recent death.

Semperdon rotanus Solem, 1983

Identification based on: Solem (1983: Fig. 99)

Idendification of shells is made by examining apertural barrier number and placement. Solem (1983) provides good descriptions and diagnosis of the species. I only collected this species on Guam, though it is also recorded from Rota.

Semperdon sp. 1

Found on Rota in Paleontological digs. This species has the highest spire of all known Mariana Island *Semperdon* species. Very few shells were found making variation in apertural barrier positioning and number impossible to analyze.

?*Semperdon* sp. 2

This species is known from one site and very few specimens. It is distingishable from other *Semperdon* by having a large triangular shaped palatal barrier and only one

parietal barrier. Shells only were found on Guam in the Naval Magazine by Adam Asquith and Steve Miller.

?*Semperdon* sp. 3

?*Semperdon* sp. 3 is similar to ?*Semperdon* sp. 2 in having one parietal barrier, but differs in that it has fewer apertural barriers and lacks that species' large triangular apertural barrier. It is probably allied to ?*Semperdon* sp. 2. It is found on Guam, in the southern mountains on the first big peak South of Mt. Alifan.

?*Semperdon* sp. 4

This species has three apertural barriers, and is quite different from known species of *Semperdon*. The palatal barrier is developed perpendicular to the plane of coiling as a large plate, while the collumelar and parietal barriers are again large and developed parallel to coiling. *Semperdon* is the only genus in Marianas with significant apertural barriers, hence tentative generic assignment there. However this species could represent an undescribed genus together with ?*Semperdon* sp. 5 from Tinian. ?*Semperdon* sp. 5 is close to but distinct from ?*Semperdon* sp. 4, on the basis of two specimens examined for each species. Shell sculpturing of these two species is somewhat different: the shell of ?*Semperdon* sp. 4 is dominated by fine spiral cords between each major rib, while ?*Semperdon* sp. 5 has axial riblets dominating between each major rib. However, both species seem to have both characters (riblets and spiral cording) present. The preservation of the shells is such that the sculpturing questions cannot be fully resolved.

?*Semperdon* sp. 5

See comments under ?*Semperdon* sp. 4. Apertural barriers and shape is distinctive for this species. Apertural barriers of ?*Semperdon* sp. 5 differ from ?*Semperdon* sp. 4 in not having the palatal barrier developed perpendicular to the plane of coiling. Only know from paleontologic excavations on Tinian.

?*Semperdon* sp. 6

This species has three prominent parietal barriers unlike other Mariana *Semperdon* species which have two prominent and one reduced parietal barriers. ?*Semperdon* sp. 6 is known only from paleontologic excavations on Tinian.

Family ELLOBIIDAE

Pythia Röding, 1798

Pythia scarabaeus (Linnaeus, 1758)

Distinctive large flattened shell with apertural barriers. Shells are abundant, at most locations, from the beach to≈300m elevation. Several colonies have been reported on Guam, living among limestone rubble on the coast.

Family HELICARIONIDAE

Liardetia Gude, 1913

Liardetia shells are similar to the smooth shelled *Lamprocystis* but differ in being smaller and having well defined axial ribbing. *Liardetia* has two subgenera in the Marianas with three species, all of which occur outside the Marianas. Growth thread density (i.e. spacing) is a well-defined character among the three species and seems to be

species specific. I have not yet identified the specimens to species. *Liardetia* appears to be surviving quite well on Guam and Rota, where they live arboreally.

Liardetia (*Liardetia*) *sculpta* (Möllendorff, 1893)

=*Microcystis sculpta* Möllendorff, 1893

Identification based on: Baker (1938: Plate 14, Fig. 6; Plate 9, Fig. 8)

Liardetia (*Liardetia*) *tenuisculpta* (Möllendorff, 1893)

=(?) *Kaliella tenuisculpta* Möllendorff, 1893

Identification based on: Baker (1938: Plate 9, Fig. 7)

Liardetia (*Belopygmeus*) *doliolum* (Pfeiffer, 1846)

=*Helix doliolum* Pfeiffer, 1846

Identification based on: Baker (1938: Plate 14, fig. 9; Plate 9, Fig. 9)

Lamprocystis Pfeffer, 1883

Two subgenera and four species of *Lamprocystis*, three belonging in *Guamia* an endemic subgenus, one in *Lamprocystis* a widespread subgenus, are known in the Mariana Islands. The species of *Guamia* are difficult to tell apart on the basis of shell characters, especially *L. hornbosteli* and *L. misella*, the former being essentially a smaller version of the latter (Baker 1938). Specimens have been found living both arboreally and on the ground among rotting leaves. I found only a few live specimens referable to this genus although dead shells are common.

Lamprocystis (*Lamprocystis*) *denticulata* Quadras & Möllendorff, 1894

Identification based on: Baker (1938: Plate 13, fig. 9-10)

This species can be readily identified by its prominent lamella on the columella pointing into the aperture. I have only collected two dead lots of shells.

Lamprocystis (*Guamia*) *hornbosteli* Baker, 1938

Identification based on: Baker (1938: Plate 11, fig. 12-13)

Lamprocystis (*Guamia*) *fastigata* (Gude, 1917)

=*Pseudhelicarion fastigata* Gude, 1917

Identification based on: Baker (1938: Plate 11, fig. 10-11)

Lamprocystis (Guamia) misella (Férussac, 1821)

=*Helix misella* Férussac, 1821

Identification based on: Baker (1938: Plate 11, fig. 9)

?*Lamprocystis* sp. 1

Generic assignment tentative as the shells are encrusted and their sculpture obscured. I found two specimens in Tinian paleontological excavations, which appear to have a columellar lamella similar to that found in *L. denticulata*.

Family PARTULIDAE

Hopper & Smith (1992) provide a status review of the Partulidae on Guam, detailing their declines and extinctions. Smith (Ph.D. dissertation in prep.) also chronicles the plight of partulids in the Marianas. The five southern Mariana partulids are thoroughly studied, therefore, I am only going to high light new discoveries (Crampton 1925, Kondo 1970, Smith 1992).

Partula Férussac, 1821

Partula gibba Férussac, 1821

Identification based on: (Crampton 1925: Plate 12, Figs. 1-56; Plate 13, Figs. 1-59)

Partula cf/aff. *gibba*

Partula cf./aff. *gibba* is very similar to *P. gibba* but has an enlarged and thickened peristome along with a thickened shell. Three shells of this form were discovered at two widely separated sites on Rota, which suggests they are at least a subspecifically distinct form of *P. gibba.*

Partula langfordi Kondo, 1970

Idendification based on: (Kondo 1970: Fig. 2)

Partula radiolata (Pfeiffer, 1846)

=*Bulimus radiolatus* Pfeiffer, 1846

Identification based on: (Crampton 1925: Plate 11, Figs. 20-64)

Partula salifana Crampton, 1925

Identification based on: (Crampton 1925: Plate 11, Figs. 1-11)

Samoana Pilsbry, 1909

Samoana fragilis (Férussac, 1821)

=*Partula fragilis* Férussac, 1821

Identification based on: Crampton (1925: Plate 11, Figs. 12-19)

Identifiable by having a thin, partially translucent shell, a yellow background and darker anastomosing bands. *Samoana fragilis* was described originally from Guam and discovered on Rota during 1959 at one site on the Sabana living sympatrically with *P.*

gibba (Kondo 1970). We discovered a second *S. fragilis* colony in 1996, again coocuring with *P. gibba* living on *Piper guamensis*, down slope from the Water Cave next to its stream course.

Family PUPILLIDAE

Specimens collected during my study are not completely sorted to morphological species at this time. The large amount of intraspecific variation relative to interspecific varitation makes specific identification in this group difficult. Solem (1988) reviewed the australian pupillids, shell characters distinguishing between several species.

Subfamily GASTROCOPTINAE

Gastrocopta Wollaston, 1878

Gastrocopta may be distinguished from the similar *Nesopupa* by having the parietal and angular barriers fused and lacking a malleated (dimpled) surface sculpture.

Gastrocopta pediculus (Shuttleworth, 1852)

=*Pupa pediculus* Shuttleworth, 1852

Identification based on: Solem (1988: Figs. 46-47)

Solem (1988) figures a specimen *G. pediculus* from Guam and provides a detailed account of the characters of this species. *Gastrocopta pediculus* is recognized in my collections from Guam.

Gastrocopta sp. 1

Gastrocopta sp. 1 was only found at Ritidan Point, Guam. It can be seperated from *G. pediculus* having the angular and parietal barrier on the parietal wall fused tightly

forming a long narrow barrier. The aperture also has one columellar and one palatal barrier, both thin and elongate.

Subfamily NESOPUPINAE

Nesopupa Pilsbry, 1900

At least two morphological *Nesopupa* species are recognizable in my collections. As illustrations are not available for the one recorded *Nesopupa* species from Guam, I am unable to ascertain which of the two morpho-species corresponds to *Nesopupa quadrasi quadrasi*. Both *Nesopupa* morphological species seen have a malleated surface sculpture and promenant ribbing. *Neopupa* specimens have been found on Guam, Rota, Aguiguan and Tinian. They are common in soil deposits and especially in paleontologic excavations on Aguiguan and Tinian.

Nesopupa sp. 1

Recognized by having a tall body whorl with slightly impressed sutures. Aperture with an angular, parietal, columellar, basal and an upper and lower palatal barriers. A smaller thin barrier is present, between the upper and lower palatal, as is a small trace barrier above the upper palatal. This form is differentiated from Nesopupa sp. 2 by not having an infraparietal barrier.

Nesopupa sp. 2

See comments under *Nesopupa* sp. 1.

Nesopupa (*Nesopupa*) *quadrasi quadrasi* (Möllendorff, 1894)

=*Vertigo* (*Ptychochilus*) *quadrasi* Möllendorff, 1894

Described from Guam but its description did not include an illustration making identification difficult. I have not seen an illustration of this species.

Pupillid (?) gen. sp. 1

The absence of apertural barriers distinguishes this species from other Mariana pupillids. Characters distinguishing it from other pupillids include its reflected and thin-edged peristome, non callused parietal wall and fine growth lines. Live specimens have only been collected on Guam during 1995, under ornamental plants, making it a possible recent introduction.

Family SPIRAXIDAE

Euglandina Fischer & Crosse, 1870

Euglandina rosea Férussac, 1818

Identification based on: Barry Smith (pers comm.)

Introduced as a predator to control populations of *Achatina fulica*. Very few shells were found over the course of the study on Guam. One live specimen is recorded from Talofofo, Guam during 1996.

Family STREPTAXIDAE

Gonaxis Taylor, 1877

Gonaxis kibweziensis (Smith, 1894)

Identification based on: Robert Cowie (pers comm.)

Originally introduced to Aguiguan during *Achatina fulica* biological control experiments.

Gulella Pfeiffer, 1856

Gulella (*Huttonella*) *bicolor* (Hutton, 1834)

=*Pupa bicolor* Hutton, 1834

Identification based on: Solem (1988: Figs. 126, 135-136)

A distinctive small species found on Guam, separable from other Guam land snails in being the only small, high spired species with several apertural barriers. It is unlike the undetermined Rota species which has only one enlarged columellar/parietal barrier.

Family SUBULINIDAE

Lamellaxis Strebel & Pfeiffer, 1882

Lamellaxis ?gracilis (Hutton, 1834)

=*Bulimus gracile* Hutton, 1834

Identification based on: Solem (1988: Figs. 117-120)

Difficult to identify in my collections (see Solem (1988)) due to poor preservation and the large amount of intraspecific variation. On Guam *Lamellaxis* shells are easiest to identify by elimination of the other three possible subulinids. *Lamellaxis* shells are small, smoother and tend toward having low whorl expansion thus making the shell appear

straighter than in *Prosopeas*. I have only collected dead specimens of *Lamellaxis* on Guam, Tinian and Saipan, also questionably from Aguiguan.

Opeas Albers, 1850

Opeas pumilum (Pfeiffer, 1840)

=*Bulimus pumilus* Pfeiffer, 1840

Identification based on: Solem (1988: Figs. 125, 132-134)

Unworn specimens with intact apertures are relatively easy to identify by their small size (5-7mm); sinuous palatal wall (Solem 1988:fig. 133) and corresponding sinuous axial sculpture. This species is originally from tropical America, now widespread on Pacific islands; see Solem (1988) for list of locality records.

Prosopeas Mörch, 1876

Prosopeas achatinaceum (Pfeiffer, 1846)

=*Bulimus achatinaceus* Pfeiffer, 1846

Identification based on: Naggs (1994: Figs. 1, 2-7); Solem (1988: Figs. 123-124, 130-131)

Distinguished by a slightly offset spire and large size, although it is smaller than *Subulina octona*. Solem (1988) notes slight differences in protoconch form from the other three species listed from the Marianas. *P. achatinaceum* also has better developed axial ribbing than *Lamellaxis* and *Opeas*. Juveniles are difficult to identify because they tend toward *Opeas* and *Lamellaxis* in form.

Subulina Beck, 1837

Subulina octona (Bruguière, 1792)

=*Bulimus octonus* Bruguière, 1792

Identification based on: Solem (1988: Figs. 115-116)

Easily seperated from all other Mariana subulinids by having a truncated columella Solem (1988). This character is constant for all age classes.

Family SUCCINEIDAE

Four species are recorded in the literature from Guam. I did not try to separate my specimens into species or morphospecies. A fourth unfigured *Succinea* is recorded from Guam as *Succinea* sp. (BPBM 75279) by Smith (1993). Many specimens are only fragmentary. None were found alive on any island, though one live specimen was found Hilaan Pt., Guam by Barry Smith during 1993.

Succinea Draparnaud, 1801

Succinea guamensis Pfeiffer, 1857

Identification based on: No figure available for this species.

Succinea piratarum Quadras & Möllendorff, 1894

Identification based on: (Zilch 1978: Fig.3)

Succinea quadrasi Möllendorff, 1894

Identification based on: (Zilch 1978: Fig. 4)

Family Undetermined

Genus sp. 1

Two specimens of an odd, assimineid-like shell with a single, large, thickened parietal-columellar barrier were collected from Payapai cave on Rota.