REPORT ON A PRELIMINARY SURVEY OF THE LAND SNAIL FAUNA OF ROTUMA

by

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Cover Photographs:

Mount Solroroa, in the district of Itumuta, one of the higher elevated hills on the main island of Rotuma. Inset: two living specimens of the introduced land snail *Quantula striata* (Gray 1834).

Abstract

In May 2012 a survey of the land snails of Rotuma was undertaken. The last previous survey that included land snails collections on Rotuma was conducted over seventy years ago but no dedicated report of that survey seems to exist. The current survey was carried out to; record the number and type of introduced "snails" present and provide information on the potential risk to human, crop and livestock health of any introductions found, and investigate if any previously recorded native and endemic land snail fauna was still alive. Provision of land snail sampling and identification training to targeted community members was also undertaken. We found 70% of the living snail species identified during the survey were introduced and that 91 % of the native snail fauna found was recorded only as dead shells. Unexpectedly we also found the notorious land snail predator, *Platydemus manokwari*, a well-documented invasive flatworm native to Papua New Guinea. To our knowledge this introduced invasive species is not yet found in other parts of Fiji. These results mean that; an evaluation of existing quarantine measures is required to address the potential spread of the flatworm *Platydemus manokwari* to other parts of Fiji, that relatively simple education programs on non-cooked food preparation would be beneficial to the community in respect to the potential for introduced snails to act as disease vectors, and that sampling to further search for living endemic snail fauna, in less accessible areas, is urgently needed.

This report contributes to several different objectives of Fiji's National Biodiversity Strategy Action Plan (DoE 2007) particularly Objective 2.6 – the establishment of specific research programmes on Rotuma.

Introduction

Eighteen introduced (alien) species of land snail were listed from the Fiji Islands by Brodie & Barker (2011). An additional species, *Semperula wallacei* (Issel 1874) has since been added to that list. Seven of these 19 species have known associated risks to human health, agricultural production and biodiversity loss (Brodie & Barker 2011). Fortuitously two of the world's worst invasive land snail species [*Achatina fulica* Bowdich 1822 & *Euglandina rosea* Férussac 1821)] are currently absent from Fiji and strict quarantine regulations are required to keep them out as their introduction would have major health, trade and other economic implications.

Until the current survey it was unknown how many introduced land snail species were currently found in Rotuma and a baseline survey was much needed to provide information to the Rotuman community and Fiji's biosecurity, agriculture and health management agencies.

Globally land snails have the highest number of documented extinctions of any major taxonomic group (Lydeard *et al*. 2004). Pacific Island land snails, and in particular the diverse and famous partulid tree snails have a history of extremely high levels of species extinction (Hadfield *et al*. 1993, Cowie 1992 & 2004).

Islands are of vital importance to the study of biodiversity loss, species extinction and evolution processes at a global and regional level. Small very isolated islands, such as Rotuma, are of particular importance because of the very fragile nature of their ecosystems and possession of

very unique (endemic) fauna. This endemic fauna forms a valuable natural resource for the island communities that own them.

As acknowledged by the Fiji Government (DoE 2007) "Rotuma's terrestrial biodiversity has elements which distinguish it from being merely a Fijian outlier as they are Central Pacific or Samoan in character". Consequently, Rotuma requires special consideration in biodiversity conservation.

Rotuma is well known for several of its unique endemic species of birds (e.g. red & black Rotuman honeyeater) and other vertebrates (e.g. Rotuman gecko) that are not found anywhere else in the world. What is not well known is that Rotuma has at least four endemic land snail species (Table 1) including one member of the famous, critically-endangered, patulid tree snails.

To the best of our knowledge none of these four endemic snail species have been sighted or studied since at least 1938 when scientists from the Bishop Museum (Hawaii) made a research visit to Rotuma (St John 1938, Barker & Bouchet 2010). In the case of the Rotuman endemic snail *Delos gardineri* the species has not be seen since its original collection by J. Stanley Gardiner, and subsequent description by Smith in 1897. A relatively brief land snail survey of the off-shore islet of Uea was undertaken during a marine resource survey for the Fiji government in mid-1986 but did not discover a single native land snail (Parkinson 1988).

Because of strong concerns for global and Pacific Island non-marine mollusc extinction rates (Lydeard *et al*. 2004) the majority of Fiji's native land snails (> 200 species) have recently been IUCN Red-List assessed for their conservation status. These assessments are not yet published (IUCN in press), however the expected outcomes for the four Rotuman endemics are; two critically endangered, one endangered and one data deficient (Table 1). A survey of the presence or absence of these unique snails in Rotuma was needed to determine if they have become extinct, or if they may be present in small numbers and in need of conservation assistance. Documentation of any other native land snails species present would also be beneficial to assist in Rotuma's terrestrial natural resource management (see DoE 2007).

The objectives of our field trip were therefore as follows:

a) To undertake a survey of current introduced land snail species present on Rotuma.
b) To identify any snail "pest" species present and provide access to information on their crop production, quarantine and human health risks.
c) To undertake a preliminary survey of native and endemic snail fauna including a search for known endemic and historic snail fauna considered unique to Rotuma.
d) To provide recommendations for any future associated native snail conservation actions if deemed necessary.
e) To conduct snail survey and identification training to local community members and government officials to enable continued monitoring of Rotuma's land snail fauna.

This survey also contributes to Objective 2.6 in Fiji's National Biodiversity Strategy Action Plan (DoE 2007) which states the need to establish specific research programs on Rotuma.

Materials and Methods

The isolated archipelago of Rotuma (12º 50' E, 177º 07' W) with a total land area of 43 km² lies 646 km north of Fiji's capital city Suva and approximately 550 km west of its closest neighbour Futuna Island in the French overseas collectivity of Wallis & Futuna.

The Rotuman archipelago consists of one large island (Rotuma) and eight rocky islets that lie offshore (Fatiaki *et al*. 1977). These islets include the highly distinctive Hafliua (Split Island) which is bisected by a massive fissure and the largest islet of Uea which is approximately one kilometre wide and rises steeply to over 200 metres in elevation. The land is covered with vegetation and surrounded by coral reefs. The large main island of Rotuma is elongate measuring approximately 15 kilometres in length and 4.5 kilometres in width at its widest point.

Geologically Rotuma is of volcanic origin, with a number of craters rising to heights of 200–260 meters above sea level. The resident population of a little over 2,100 people (2007 census) is spread along the coastline of the large island. Much of the main island is comprised of gardens and human-disturbed "bushland", with coconut trees in abundance. Undisturbed indigenous forest is not considered to remain on Rotuma (Smith 1897) except as inaccessible remnants (Zimmerman 1943).

"Land snail" is used in this report when referring to both 'snails' and 'slugs'. The word 'snail' refers to a gastropod mollusc possessing a fully developed shell that is capable of housing the retracted animal. The word 'slug' refers to the gastropod body form where the shell is reduced to the extent that it is no longer capable of housing the animal. Slugs are simply snails with a reduced or absent shell (Brodie *et al*. 2010).

Land Snail Surveys

Snail surveys were undertaken in nine locations (Table 2) within four of the seven districts of Rotuma (Figure 1). Surveys were conducted during daylight hours when the normally nocturnal snails were located in their day-time refuges.

Snail samples were obtained using the following collection methods; visual line transects, leaf litter samples, rock crevice soil samples plus directed visual sampling of vegetation, beneath large stones, logs and rotting organic debris.

The photographs used in this report were all taken by G. Brodie and show only species found on Rotuma during the survey period. All photographs of living animals were taken directly in Rotuma and no non-preserved material was returned to Suva.

All preserved material collected during this survey will be lodged in the reference collections of the University of the South Pacific; samples have also been given informal "Brodie Lab" identification codes. All species identifications are considered tentative and molecular confirmation is required particularly for the family Subulinidae which are notoriously difficult to identify to species level morphologically even for specialists. Identification of the veronicellid

slugs was based on information provided by S. Gomes which is comparatively summarized in Brodie & Barker (2012a & in progress).

Collection records from this survey will be added to the overall Fiji land snail database (maintained by Barker) which is regularly uploaded to the Fiji National Trust in Suva.

Snail Identification Capacity Building

Snail identification training occurred at two levels:

a) at an informal non-scientific level with community members
b) at a scientific level with formal training to targeted individuals

In addition to the above, general awareness raising, about local land snails, occurred within the community because of the survey visit in itself, particularly in Itumuta where the reasons for the survey were presented directly to the community (in Rotuman) via our inclusion in an evening information session run by our partner organization LäjeRotuma[*].

Therefore

a) The involvement of local people in field sampling survey work, both children and adults, was encouraged at all locations. Local guides from the community accompanied researchers and volunteers on all surveys undertaken.

b) The opportunity for scientific level identification training was extended to targeted individuals, both island residents and professional people operating within the community on a regular basis. The selection of individuals was made by our respective collaborative stakeholder organizations.

Training involved field observation of associated collecting techniques, use of simple collecting equipment, provision of background context documents, formal identification materials prepared by USP, plus use of a dissecting microscope that was also supplied by USP.

Results

Land Snail Surveys

The total number of land snail species found in this survey was twenty-one (Table 3). Two additional species, found as dead shells on land are recorded here (Figure 2a & b) but removed from the land snail analyses because of their marine and freshwater locations when alive.

The twenty-one land snail species found cover eleven different gastropod families (Table 3). Of these twenty-one species, eight are introduced; *Parmarion martensi* Simroth, 1893, *Quantula striata* (Gray, 1834), *Bradybaena similaris* (Rang, 1831), *Allopeas gracile* (Hutton, 1834),

[*] LäjeRotuma Initiative (LRI) is a community-based environmental education and awareness development programme for Rotuma. For more information see http://www.rotuma.net/os/lajerotuma.htm

Paropeas achatinaceum Pfeiffer, 1846, *Subulina octona* (Bruguière, 1789), *Sarasinula plebeia* (Fischer, 1868) and *Semperula wallacei* (Issel, 1874) (Figures 2c-f & 3a-d respectively) and thirteen are native *Elasmias apertum* (Pease, 1865), *Fijianella* sp., *Omphalotrophis zelirolata* Mousson, 1865, *Omphalotrophis* sp., *Melampus flava* (Gmelin, 1791), *Pythia scarabaeus* (Linnaeus, 1758), *Pleuropoma fulgora* (Gould, 1847), *Pleuropoma* sp., *Sturanga modesta* (Pfeiffer, 1854), *Partula leefi* Smith, 1897, *Delos gardineri* (Smith, 1897), *Truncatella granum* Garrett, 1872 and *Truncatella* sp. (Figures 3e&f, 4a-f & 5a-d respectively). No evidence of the Rotuman endemics *Succinea rotumana* or *Sinpolyea rotmana* was found.

Overall the majority of living snail species found (70%) were introduced and the majority of species represented only by dead shells were native (91%) (Table 4). *Partula leefi*, *Delos gardineri* and *Fijianella* sp., and possibly *Omphalotrophis* sp., and *Pleuropoma* sp. are endemic to Rotuma however no endemic or "possibly" endemic snails were found alive during this survey (Table 4). Of the introduced snail species *Parmarion martensi* and *Subulina octona* were the most numerous and widespread. Only dead shells of the relatively hardy introduced snail species *Bradybaena similaris* were found.

Additional Observations

The native land snail *Melampus flava* (Figure 4c) was found to be common along the high tide mark in two locations (Palagneasta, Noa'tau and Oinafa wharf area) during this study. This obviously abundant species was also observed to be used by humans for decorative purposes (Figure 5e). However, it is possible that these decorative items are not made directly on Rotuma but given as gifts from neighboring islands such as Tuvalu where the widespread species *M. flava* is also found.

In snail surveys of other islands the coastal snail *Melampus flava* is recorded as a marine species (e.g. Cernohorsky 1977) however this snail's ability to remain actively crawling during the day while exposed to the air (well out of the water) for relatively long periods marks it as behaviorally and anatomically different to most common marine shells.

During the course of snail sampling the well-known invasive flatworm *Platydemus manokwari* was found (Figure 5f). This worm was observed at two locations (6 & 7) within the districts of Itu'ti'u and Itumuta on the far western end of the island. Thus *P. manokwari* was seen to be relatively abundant under lava stones in one village subsistence garden and also at higher elevation within well-shaded leaf litter directly beneath vegetation on which living populations of small native snails were located.

Snail Identification Capacity Building

a) Informal

Community members with a particular interest and aptitude for snail survey and collection were identified.

b) Formal

Rotuma-based training in sample acquisition and snail identification was provided for four individuals (three of which are Rotuman) from the following three organizations: University of the South Pacific (1), LäjeRotuma (2) and Koronivia Research Station (1). An additional island-based individual from the Fiji Biosecurity Authority (BAF) was unable to attend because of other work commitments, so this person was provided with a set of the identification teaching materials, a poster about introduced land snail species (for education purposes) and two briefings, the first informally via Dr Brodie and the second via the staff member from Koronivia Research Station that attended the training session.

Discussion

The discovery of three species of living native land snails, one in coastal and two in "forested" areas of Rotuma is encouraging. However, the unexpected discovery of the notorious snail predator *Platydemus manokwari* at both lowland and elevated sites means that the local populations of these snails, and other native species that may still persist on the island, should be considered highly threatened. It is well documented that small-island ecosystems (like Rotuma) are fragile making their ecosystems very vulnerable to the impacts of such introduced alien species (see Veitch *et al*. 2011).

Finding evidence (dead shells) of the endemic species *Partula leefi*, a member of the legendary Pacific Island tree snails, makes the results of this survey of international, as well as local interest. This finding will now allow an adequate assessment of the conservation status of *P. leefi* and substantially remove the potential for a "data deficient" IUCN Red-list status. Based on specimens lodged in the Bishop Museum (Hawaii) it appears *Partula leefi* was alive and relatively common in 1938 when the Museum last undertook a survey of Rotuma. Many members of the diverse land-snail family Partulidae, which were used by Polynesians for ceremonial human decoration, are now extinct from all or part of their native range (Cowie 1992; Hopper & Smith 1992). Some remaining members from French Polynesia, critically endangered on the IUCN Red-List because of threats by alien predators and habitat loss, are currently being bred in captivity for conservation purposes.

Only dead shells of nine other native land snail species were found, including a single specimen tentatively identified as the Rotuman endemic species *Delos gardineri*. No evidence of the Rotuman endemics *Succinea rotumana* or *Sinpolyea rotmana* was found in this preliminary survey.

A more extensive survey of Rotuma and its less accessible separated islets is therefore urgently required to ascertain if any living individuals of the Rotuman endemic species *Partula leefi, Delos gardineri, Succinea rotumana* and *Sinpolyea rotmana* still exist.

Of the nineteen introduced land snail species recorded from other parts of Fiji, eight are found in Rotuma. Only two of these, *Parmarion martensi* (Figure 2c) and *Sarasinula plebeia* (Figure 3c) are considered to have medium to high risk "pest" status resulting from their links to human, crop and livestock health (Brodie & Barker 2011). The highest risk species *Parmarion martensi* was found in Rotuma at all inland locations surveyed. This result answers the quarantine related

questions highlighted by Brodie & Barker (2011: 33) and Brodie *et al*. (2010) about the presence or absence of this introduced species on Rotuma. There is therefore no need for specific quarantine restrictions to address the potential spread of this species, which is common in Viti Levu, to Rotuma because it is sadly already present. However, awareness raising activities are needed to inform community members, particularly women and children, of the human health risks associated with this invasive species and the need to thoroughly wash all non-cooked fruits and vegetables to be consumed by humans. This risk exists primarily because *P. martensi* is a known vector for the nematode parasite rat lung worm *Angiostrongylus cantonensis* which may lead to human illness (Brodie & Barker 2011).

The identification of the invasive flatworm *Platydemus manokwari* was unexpected as this serious pest species, to our knowledge, is not yet recorded from other parts of Fiji. As such we therefore consider it a significant quarantine related finding as *P. manokwari* is well documented as one of the world's top 100 invasive species (GISD 2010). The introduction of *P. manokwari* is a serious concern for the conservation of unique land snail fauna not just on Rotuma but on many tropical islands (Sugiura *et al*. 2006). This flatworm is considered a cause of the extinction of native land snails on several Pacific and Pacific Rim islands (Sugiura & Yamaura 2009). Predation is a known important cause of the rapid decline or extinction of native arboreal snails on Pacific islands (Hadfield *et al*. 1993).

P. manokwari is an active and voracious predator of snails both native and introduced (Winsor *et al*. 2004) and is therefore not suitable for use as a biological control agent against introduced crop pests. The presence of *P. manokwari* on Rotuma is one likely reason that only dead shells of the introduced snail *Bradybaena similaris* were found as the flatworm is documented to feed readily on this species as well as on partulids (Winsor *et al*. 2004). The high proportion of native species recorded as dead-shells only (77%) may also result from either the influence of *P. manokwari* predation or other forms of native habitat degradation.

Conclusions and Recommendations

As a result of human development the world's biodiversity is declining at an unprecedented rate (Singh 2002, Gaston 2005). This is affecting the functioning of our environment and is beginning to impact on human livelihoods in many parts of the world. Biodiversity loss and the impact of introduced species are known to be ecologically more significant on inherently fragile small-island ecosystems than they are on larger continental systems (Veitch *et al*. 2011).

The results of this survey will allow a formal IUCN Red List assessment of Rotuma's endemic partulid snail *Partula leefi* to be made. Based on similar assessments already in progress (IUCN in press) for other endemic Rotuman snails (e.g. *Succinea rotumana* Smith 1897), and the discovery of the introduced partulid eating snail-predator *P. manokwari*, it is highly likely that *P. leefi* will be classified as either Critically Endangered or Critically Endangered - possibly Extinct. The discovery of significant numbers of introduced snail species is likely to be representative of similar change in other terrestrial invertebrate groups.

The following recommendations are therefore made: organizations given in brackets indicate recommended lead agencies.

1. That appropriate education materials be designed, and awareness programs be undertaken in cooperation with community health officers and local schools to emphasize:

    a) the potential risks to human and livestock health associated with several of the introduced snails currently found on Rotuma because they may carry parasites.
    b) the strong need for adequate washing of non-cooked fruit and vegetables during their preparation for human consumption
    c) the need for timely reporting by the community to island quarantine services any snails found that do not match those already documented in this current survey. (LäjeRotuma/USP).

2. That the presence of the invasive predatory flatworm *Platydemus manokwari* on Rotuma be discussed (with the aim of determining the appropriate course of action needed) via Fiji's Invasive Species Taskforce (FIST) committee in the presence of representative(s) of LäjeRotuma and other Rotuman and/or government delegates as maybe determined appropriate by the Biosecurity Authority of Fiji (BAF) FIST Chair. (BAF/ LäjeRotuma)

3. That continued and strengthened support is provided by all report stakeholders to existing biosecurity measures on Rotuma and that government departments engage collaboratively with the local NGO LäjeRotuma to help address community education of the strong benefits of biosecurity measures to the health and economic well-being of the island communities (BAF/ Koronivia/LäjeRotuma/).

4. That funding is sought for postgraduate scholarships for Rotuman or Pacific Island research students to undertake molecular confirmation of (i) the species level taxonomy of introduced snails found and (ii) the presence of nematode parasites, with potential human and livestock health risks, within the individual species found on Rotuma (USP).

5. That appropriate information flyers be prepared for communities and a reward (to be determined by LäjeRotuma) be offered (upon confirmation of ID in the field; collection not recommended) for locating a living population of the Rotuman endemic tree snail *Partula leefei* (LäjeRotuma/USP).

6. That further collaboration with existing overseas specialist snail researchers (e.g. Landcare Research, Paris & Stuttgart Museums) occurs to assist with the confirmation of native snail species of uncertain identification (USP).

7. That funding be sought to undertake a 2nd land snail survey of Rotuma particularly to search the remaining hill areas of all districts and the vegetated islets for living native and endemic species (USP/ LäjeRotuma).

Acknowledgements

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Table 1. The four endemic Rotuman land snails, with their proposed IUCN Red-List status (IUCN in press). Brackets in column three indicate change in genus-species combination since original publication of the species description.

Family	**Species Name**	**Author of Species Name**	**Proposed IUCN Red-List Status**	**Date Last Seen**
Rhytididae	*Delos gardineri*	(E.A. Smith, 1897)	Critically Endangered	< 1897
Succineidae	*Succinea rotumana*	E. A. Smith, 1897	Critically Endangered	1938
Partulidae	*Partula leefei*	E. A. Smith, 1897	Not assessed but Data Deficient	1938
Charopidae	*Sinployea rotumana*	(E.A. Smith, 1897)	Endangered	1938

Table 2. Details of snail sampling locations surveyed in Rotuma during May 2012.

Location No.	**Location Name**	**District**
1	Palagneasta (near Methodist Church)	Noa'tau
2	Palagneasta (sal uaf ta)	Noa'tau
3	Palagneasta (taro garden & surrounds)	Noa'tau
4	Oinafa Bay near wharf	Oinafa
5	Upu east side of Mount Kugai	Itu'ti'u
6	Savaea, O'oag ruru	Itumuta
7	Mount Solroroa (Faniua side)	Itumuta
8	Faniua near cemetery	Itumuta
9	Maftoa near cemetery	Itumuta

Table 3. Details of the snail species found on Rotuma during the May 2012 survey.

Family	Species	Habitat Found	Status for Rotuma	Locations Found
Achatinellidae	*Elasmias apertum* (Pease, 1865)	on vegetation	native	5
Ariophantidae	*Parmarion martensi* Simroth, 1893	leaf litter & on vegetation	introduced	2, 3, 5, 6 & 7
Ariophantidae	*Quantula striata* (Gray, 1834)	under rocks and logs in gardens	introduced	2, 3 & 6
Assimineidae	*Fijianella* sp. (dead shells only)	leaf litter, damp soil	endemic	7
Assimineidae	*Omphalotrophis zelirolata* Mousson, 1865 [= *Omphalotrophis rotumana* Smith, 1897] (dead shells only)	damp sand	native	8
Assimineidae	*Omphalotrophis* sp. (dead shells only)	soil	native/?endemic	3
Bradybaenidae	*Bradybaena similaris* (Rang, 1831) (dead shells only)	rock walls & village gardens	introduced	2, 6,7
Ellobiidae	*Melampus flava* (Gmelin, 1791) (3 colour forms)	coastal debris	native	1 & 4
Ellobiidae	*Pythia scarabaeus* (Linnaeus, 1758) (dead shells only)	coastal sands	native	8
Helicinidae	*Pleuropoma fulgora* (Gould, 1847) (dead shells only)	soil	native	3, 7
Helicinidae	*Pleuropoma* sp.	on vegetation	native/?endemic	5
Helicinidae	? *Sturanga modesta* (Pfeiffer, 1854) (dead shells only)	soil and leaf litter	native	7
Naticidae	*Natica* sp. (dead shells only - marine sub-fossil)	lowland “soil”	not applicable	5
Partulidae	*Partula leefei* Smith, 1897 (dead shells only)	rock crevices	endemic	7
Rhytididae	*?Delos gardineri* (Smith, 1897) (dead shells only)	soil	endemic	3
Subulinidae	*Allopeas gracile* (Hutton, 1834)	sand and soil	introduced	9
Subulinidae	*Paropeas achatinaceum* Pfeifer, 1846	soil, under rocks & logs	introduced	5

Subulinidae	*Subulina octona* (Bruguière, 1789)	soil and leaf litter	introduced	2, 5, 6, 7 & 9
Thiaridae	*Melanoides tuberculata* (Muller, 1774) [dead shells only, freshwater species]	lowland soil	not applicable	7
Truncatellidae	*Truncatella granum* Garrett, 1872 (dead shells only)	coastal sands	native	9
Truncatellidae	*Truncatella* sp. (dead shells only)	coastal sands	native	9
Veronicellidae	*Sarasinula plebeia* (Fischer, 1868)	under rocks & old coconut husks	introduced	2, 6
Veronicellidae	*Semperula wallacei* (Issel,1874)	old coconuts husks	introduced	3, 5, 6, 7

Table 4. A comparison of the introduced, native and endemic land snail species proportions.

	Introduced	**Native (includes last two columns)**	**Total**	**Endemic to Rotuma**	**Possibly Endemic to Rotuma**
Found Alive	7	3	10	0	0
Shell Only	1	10	11	2	4
Total	8	13	21	2	4

Figure 1. Map showing the seven districts of Rotuma and the nine locations sampled during this survey.

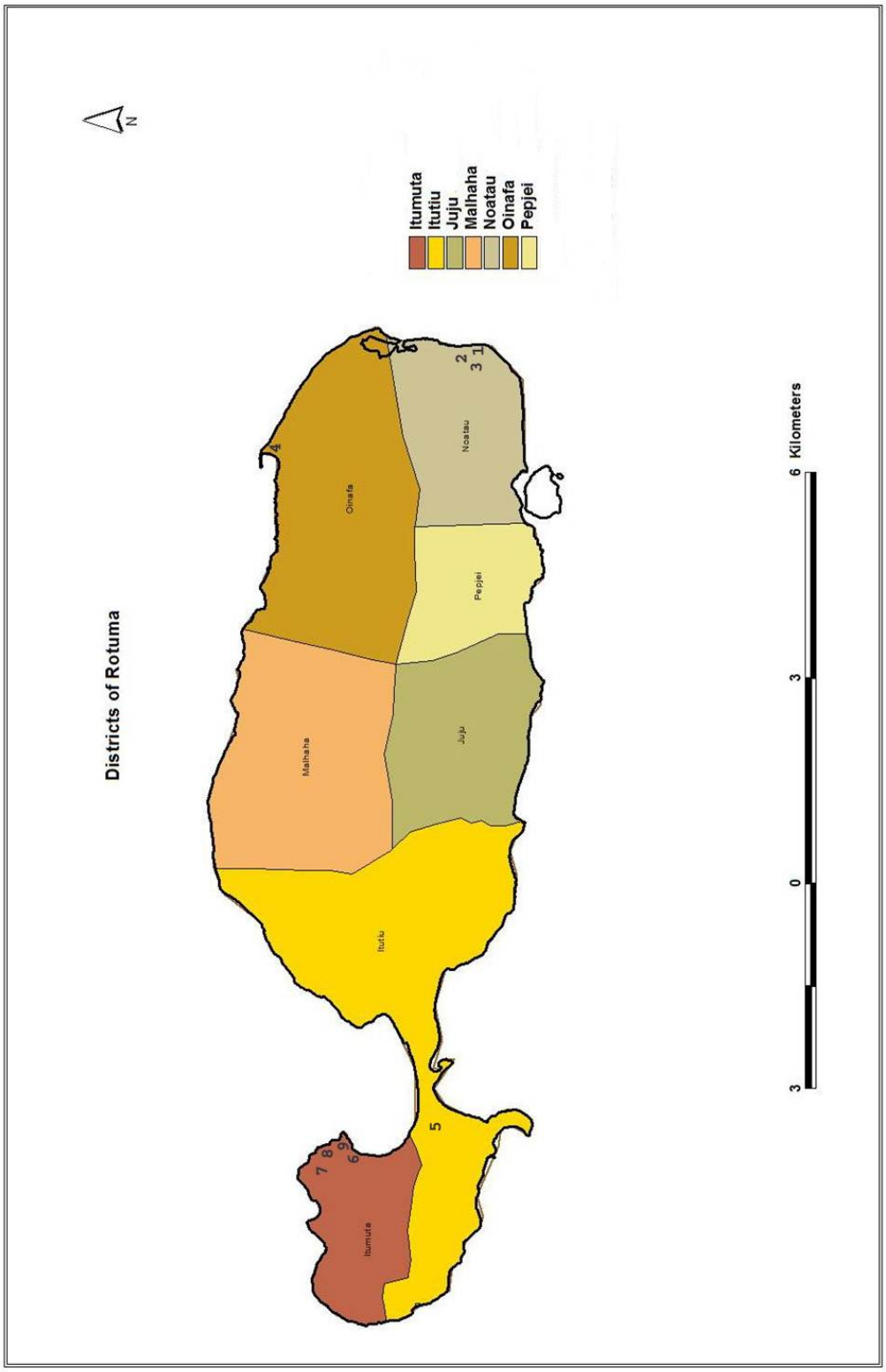


Figure 2 a - f. Photographs of (a) marine sub-fossil *Natica* sp. (b) dead freshwater shell of *Melanoides tuberculata* Muller, 1774. (c) the introduced semi-slug *Parmarion martensi* Simroth, 1893; note the reduced shell "plate" partially hidden by the fleshy mantle. (d) a living specimen of the relatively large introduced snail *Quantula striata* (Gray, 1834). (e) a ventral view of the adult shell of the introduced snail *Bradybaena similaris* (Rang, 1831). (f) a shell of the introduced snail *Allopeas gracile* (Hutton, 1834).

(a)

(b)

(c)

(d)

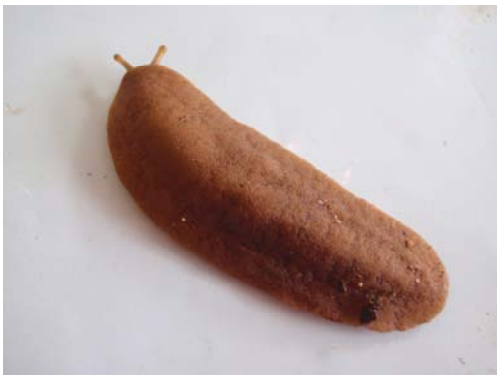
(e)

(f)

Figure 3 a - f. Photographs of (a) a living *Paropeas achatinaceum* Pfeiffer, 1846. (b) a dead shell of *Subulina octona* (Bruguière, 1789). (c) a living shell-less slug *Sarasinula plebeia* (Fischer, 1868). (d) a living shell-less slug *Semperula wallacei* (Issel, 1874). (e) a living native snail *Elasmias apertum* (Pease, 1865) on vegetation. (f) a dead shell of endemic *Fijianella* sp.

(a) 

(b) 

(c) 

(d) 

(e) 

(f) 

Figure 4 a - f. Photographs of (a) the shell of *Omphalotrophis zelirolata* Mousson, 1865. (b) two dead shells of *Omphalotrophis* sp. (c) living banded-colour form of the snail *Melampus flava* (Gmelin, 1791). (d) the shell of an adult *Pythia scarabaeus* (Linnaeus, 1758). (e) two adult shells of the native snail *Pleuropoma fulgora* (Gould, 1847). (f) a living native snail *Pleuropoma* sp. which may be endemic to Rotuma.

(a)

(b)

(c)

(d)

(e)

(f)

Figure 5 a - f. Photographs of (a) a snail shell likely to be *Sturanga modesta* (Pfeiffer, 1854). (b) the shell of an adult *Parula leefi* E.A. Smith, 1897. (c) the shell of a juvenile snail very likely to be *Delos gardineri* (Smith, 1897). (d) the shells of *Truncatella granum* Garrett, 1872 plus an other possible *Truncatella* sp. (e) Two colour forms of dead shells of the snail *Melampus flava* (Gmelin, 1791) as seen in a necklace. (f) the invasive flatworm and snail predator *Platydemus manokwari*.

(a) 

(b) 

(c) 

(d) 

(e) 

(f) 

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