

***Partula* surveys and releases April 2023**

Justin Gerlach, Kayla Garcia, Paulina Chmara, Craig Close



Partula taeniata emerging from a release pot



Release teams on Moorea (left) and Tahiti (right)

Summary:

Planned release sites were surveyed on Tahiti prior to releases of *P. affinis*, *P. hyalina* and *P. nodosa*, and possible sites surveyed on Huahine and Raiatea. Releases were undertaken on Moorea (*P. mirabilis*, *P. mooreana*, *P. suturalis strigosa*, *P. suturalis vexillum*, *P. taeniata nucleola*, *P. taeniata simulans*, *P. tohiveana*) and Tahiti (*P. affinis*, *P. hyaline*, *P. nodosa*). Release sites on Tahiti were found to be generally suitable but dry at Faarapa; this site may only be suitable in wet-season releases. Conditions at the established release sites on Moorea are suitable in all seasons although additional release sites should be considered. Good sites were found on Huahine, but previously used sites are too dry. The suitability of Hamoa valley on Raiatea was confirmed, and a potential future site at Puohine identified.

5704 snails of 7 species were released. These showed good survival, with low levels of predation by *Platydemus manokwari*, except for *P. affinis* where mortality was very high. This is probably due to the behaviour of this species: slow dispersing and grouping gregariously. Night observations showed that different species have different behaviours on release; this needs to be taken into account during releases.

Demonstrating release success remains a problem; finding shells of marked snails indicates at least some survival to maturity and some breeding. However, where the released snails have gone remains unknown. UV reflective paint was found to be greatly increase the ease of locating snails. Combining this with the use of the drone should make it possible to locate marked snails in the canopy.

Snails released:

Partula affinis 99 adults, 57 juveniles, 23 newborn

Partula hyalina 30 adults, 4 newborn

Partula mirabilis 37 adults, 16 juveniles

Partula nodosa 1715 adults, 698 juveniles, 50 newborn

Partula suturalis vexillum 39 adults and 10 juveniles

Partula suturalis 'vexillum' (strigosa?) 62 juveniles

Partula taeniata 'nucleola' (simulans?) 587 adults, 823 juveniles

Partula taeniata 'simulans' (nucleola?) 203 adults, 170 juveniles, 81 newborn

Partula tohiveana 495 adults, 481 juveniles, 14 newborn

68 adult and 30 juveniles *Partula tohiveana* were left at Fare Natura.

Discussion:

In all areas *Platydemus manokwari* were present but at low densities in most places; the population explosions on Huahine and Raiatea have passed. High densities were found on Tahiti in Papehue and flatworms were extremely abundant at night on Moorea. Only one live *Euglandina* was found. Thus predator pressure remains, but may be relatively low except in Papehue.

Previously used sites on Tahiti seem to be suitable, with surviving populations of *Partula clara* and other species of tree snail (especially at Papehue). Faarapa valley was very dry and should probably only be used for wet-season releases. Dry-season releases should use the dampest sites available. The discovery of significant populations of tree snails in some valleys, associated with abundant epiphytic flora of mosses, liverworts and algae provides what should be a good indicator of habitat suitability. Identification of future sites should look for leaves with good epiphyte growth and the presence of arboreal micro-snails. It is worth noting that these were all absent during the invasion by *Euglandina*, and so have recovered since the decline of this predator.

Some previously used release sites have large *Inocarpus* trees with limited understorey; this was based on the assumption that snails moving rapidly into the canopy would be most likely to avoid predators. However, the canopy probably has the greatest climatic fluctuations and will dry rapidly due to air movement and sun exposure. This limits the epiphytic growth on the leaves. Release sites with more understorey may be better options. In the past some experimental release of *P. nodosa* used isolated *Inocarpus* saplings that might have constrained the released snails in a limited area. Snails have not remained on these plants and it would be preferable to use trees with connecting canopies.



Good epiphyte growth on *Inocarpus*

Night-time observations showed that different species exhibit different behaviours: *P. affinis* remained near the release pots in groups; *P. mirabilis* dispersed very slowly; *P. suturalis* dispersed upwards slowly; *P. taeniata* disperse upwards fastest, but small numbers also descend to the ground; *P. tohiviana* disperse slowly but continuously, with small numbers reaching the ground.

Released snails appeared to adjust well to the field conditions and feeding was recorded in a few cases, including on algae, the surface of a *Freycinetia* leaf and on a dead *Freycinetia* leaf. In Papehue drone use showed that the epiphytic moss and algal growth on *Inocarpus* leaves that appear to be the best *Partula* food sources are restricted to approximately the lower 4 m. If (as assumed) *P. nodosa* are ascending to the canopy, there would appear to be little food there other than on the tree trunks. Future releases should consider using other trees in the vicinity, with a more complex structure (e.g. patches of mixed



Partula taeniata feeding on dead *Freycinetia* leaf

Inocarpus and *Hibiscus*). Pure *Inocarpus* stands may provide a relatively predator-free environment (under the 'mape-hypothesis') but with a trade-off in reduced food availability. In this context it is worth noting that the most successful releases appear to have been on Moorea where the vegetation is very mixed and complex.

During releases leaf litter was removed from the base of release trees, this did not prevent *Platydemus* predation but does mean that there are no flatworms living immediately at the base of the tree; this should reduce the predation risk to some extent. The moss in the pots ought to be removed after 24 hours as this is saturated with snail mucus and may attract predators. In the case of *P. affinis* in particular, slow dispersal and gregarious behaviour results in large accumulation of mucus. For this species releases should probably be carried out with only small numbers per tree, to reduce the attraction to flatworms.

Observations of flatworms at night showed that *Platydemus manokwari* will forage in leaf litter, across bare ground and on trees. Although some flatworm-killed shells were seen on bushes and saplings most arboreal foraging seemed to be in the moss on large trees. Therefore it is possible that smaller diameter trees may be safer for release than large ones. The flatworms were observed feeding on millipedes which were highly abundant on Moorea; with this abundance of food it is unlikely that flatworm numbers will ever reduce below current levels. Several other species were found: one earthworm predator of little significance (*Bipalium kewense*), two general invertebrate predators like *Platydemus* but less common (*Endeavouria septemlineata* and *Anisorhynchodemus* sp.), and one currently unidentified. Both *Endeavouria* and *Anisorhynchodemus* have expanded their range and population since 2017, but are probably unlikely to be more problematic than *Platydemus*. The abundance of *Platydemus* will probably prevent a resurgence of *Euglandina* ever occurring. This may be regarded as positive as *Euglandina* is a specialist mollusc predator of high efficiency and with a high consumption rate. *Platydemus* has a mollusc preference but is not a specialist, and is very slow to consume its prey (restricting consumption to about one snail per night). Reintroduction success may be more likely with *Platydemus* present than with *Euglandina* as long as the *Partula* can become established. Further consideration needs to be given to reducing *Platydemus* abundance on and around release trees through the development of traps and barriers. We proposed experimental sand barriers around release trees as a first option.

No live snails from previous releases were found. However, some evidence of survival is shown by the shells of adult snails that had been marked for release as juveniles: *P. affinis* (one), *P. nodosa* (one) and *P. tohiviana* (five). Unmarked shells were found in *P. affinis* (one in 2021), *P. nodosa* (three in 2023) *P. taeniata nucleola* (four from 2021 and 2023) and *P. tohiviana* (four in 2021). In the case of *P. nodosa*, paint has not stuck well to the shell surface and some shells retain only minute flakes of paint, consequently we cannot be certain that these apparently unmarked shells are wild born. The marks on the other species seem to be much more reliable.

Tahiti

Faarapa valley (31 March)

Justin Gerlach, Rava Taputuarai and Eric Lenoble.

Habitat: dominated by invasives (especially *Miconia* and *Spathodea*), but *Inocarpus* and *Barringtonia* present.

Partula snails: *Partula clara* shells very common and live snails easy to find. One *P. hyalina* found on valley slope. Two old *P. affinis* shells found at the base of a release tree, marked white (2018 release); they probably died shortly after release.



Other snails: Other species uncommon but present: *Lissachatina fulica*, *Subulina octona*, *Paropeas achatinaceum*, *Leptinaria unilamellata* (shell only), *Ovachlamys fulgens*, *Elasmias apertum*, *Georissa striata*.

Survey plot (one 5x5 m plot of vegetation to 2 m above ground)

	adult	subadult	juvenile	Total
<i>Partula clara</i>	2	1	1	4
<i>Elasmia apertum</i>	1			1
<i>Lissachatina fulica</i>	1			1
<i>Diastole conula</i>	1			1

Partula clara



P. affinis shells from within the last 5 years



Leaf litter surveys (10 quadrats of 1x1 m)

Numbers per m ²	mean	variance
<i>Georissa striata</i>	0.1	0.10
<i>Subulina octona</i>	0.2	0.40
<i>Paropeas achatinaceum</i>	0.1	0.10
<i>Ovachlamys fulgens</i>	0.9	1.66

P. hyalina



Flatworms: *Platydemus manokwari* was locally common, but not the most abundant species. Two *Bipalium kewensis* were seen and many *Endeavouria septemlineata*. The latter was found in 2017 as a single specimen on Mt Marau and seems to be an expanding recent introduction.

Numbers per m ²	mean	variance
<i>Platydemus manokwari</i>	0.3	0.46
<i>Bipalium kewensis</i>	0.2	0.40
<i>Endeavouria septemlineata</i>	0.3	0.46

Platydemus manokwari



Bipalium kewensis



Endeavouria septemlineata



Although flatworms are common the site is probably suitable for release as *P. clara* are abundant. The number of shells on the ground may indicate high predation rates or abundance. The absence of many *P. affinis* shells may indicate low mortality but flood waters may have washed away most shells from the release sites closest to the river.

Papehue valley (1 April)

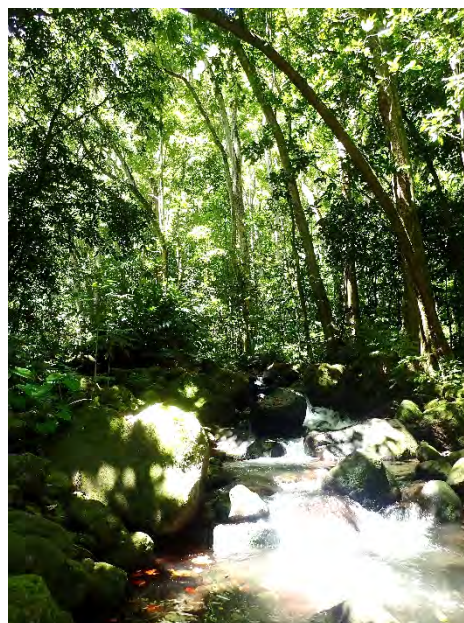
Justin Gerlach, Rava Taputuarai and Eric Lenoble.

Habitat: *Inocarpus* by the river, *Spathodea* abundant, valley sides diverse.

Partula snails: Some *Partula clara* shells, one was probably predated by *Platydemus manokwari* as the shell was very thin and *Platydemus* extracts calcium while feeding. Two *P. nodosa* shells found about 20 m from the nearest release point. One bleached white (no paint mark identifiable) and one fragmentary. On and in the soil on the valley side old shells of *P. nodosa*, *P. otaheitana* and *Trochomorpha pallens* were found; these were probably buried in the 1980s.

One live juvenile *Partula clara* found.

Other snails: A small number of old *Lissachatina fulica* shells found near river, three old *Euglandina* shells found on the side of the valley. Several shells of *Ovachlamys fulgens* and one unidentified Subulindidae were found, but none live. On the south side of the river *Diastole conula*, *Elasmias peaseanum* and *Tornatellides oblongus* were very common on *Inocarpus* leaves. Some *Georissa striata* seen on the ground.



Survey plot (one 5x5 m plot of vegetation to 2 m above ground)

North side	adult	subadult	juvenile	Total
<i>Elasmias peaseanum</i>	4	5	1	10
<i>Diastole conula</i>	2	2		4
South side				
<i>Elasmias peaseanum</i>	2	2	8	12
<i>Diastole conula</i>			1	1
<i>Tornatellides oblongus</i>	7	2	1	10
<i>Partula clara</i>			1	1

Partula clara



Thin-shelled *P. clara*, probably killed by *Platydemus*



Partula nodosa shells



Old *Partula nodosa*, *P. otaheitana* & *Trochomorpha*



Elasmias paeseanum



Tornatellides oblongus



Leaf litter surveys (10 quadrats of 1x1 m): no live snails found in leaf litter

Flatworms: *Platydemus manokwari* was present in low numbers.

Numbers per m ²	mean	variance
<i>Platydemus manokwari</i>	0.2	0.4

Tahiti tour (2 April)

Justin Gerlach tour of Tahiti with Eric Lenoble; useful visit and discussion with Eric Loeve.

Huahine (3 April)

Survey by Justin Gerlach, Rava Taputuarai and Teihoarii Amo. Visit to potential sites with Edwige Lisan and others.

New release sites - Maeva

Two sites in the same area, both groups of *Inocarpus* trees along stream beds. No *Partula* but both are sites where used to be collected.

Site 1 (16° 42' 50.3396" S, 150° 59' 38.3690" W) - *Inocarpus* around stream-bed, agricultural areas nearby. Some large *Inocarpus*, many saplings giving moderately dense understory.

Other snails: Some fairly recent *Lissachatina fulica* shells in the agricultural areas. No recent or old *Euglandina*. Abundant small snails were found on *Inocarpus* leaves: *Elasmias* spp. and *Liardetia samoensis*. In leaf litter live *Ovachlamys fulgens*, *Georissa insularis* and *Assiminea parvula* were present. One shell of *Subulina octona* was present. One *Elasmias apertum* shell found on a leaf 1.5 m above ground, possibly predated by *Platydemus*.



Site 2 (16° 42' 56.7249" S, 150° 59' 42.7577" W) - *Inocarpus* around stream-bed, *Hibiscus tiliaceus* upstream and agricultural areas nearby. Some large *Inocarpus*, many saplings giving moderately dense understory.

Other snails: No *Lissachatina fulica* or *Euglandina*. Abundant small snails were found on *Inocarpus* leaves: *Elasmias apertum* and *Liardetia discordiae*, *Diastole conula* and *Diastole necrodes*. In leaf litter live *Subulina octona*, *Ovachlamys fulgens*, *Georissa insularis* and *Assiminea parvula*, *Atropis vescoi*, *Laeviculis alte* and *Meghimatium* sp. slugs were present.



Survey plot (one 5x5 m plot of vegetation to 2 m above ground)

	adult	subadult	juvenile	Total
Site 1				
<i>Elasmias apertum</i>	2	4		6
<i>Elasmias paesianum</i>	1			1
<i>Liardetia samoensis</i>	2	2		4
Site 2				
<i>Elasmia apertum</i>		4	2	6
<i>Liardetia discordiae</i>	1			1
<i>Diastole conula</i>	2		1	2
<i>Diastole necrodes</i>	1	1		2

Leaf litter surveys (10 quadrats of 1x1 m)

	Site 1		Site 2	
Numbers per m ²	mean	variance	mean	variance
<i>Ovachlamys fulgens</i>	0.2	0.18	0.2	0.18
<i>Georissa insularis</i>	0.4	0.71	0.1	0.10
<i>Assimineia parvula</i>	0.1	0.10	0.5	0.72
<i>Atropis vescoi</i>			0.1	0.10
<i>Meghimatium</i> sp.			0.1	0.10
<i>Subulina octona</i>			0.3	0.23
Veronicellidae			0.2	0.18

Flatworms: *Platydemus manokwari* present in low numbers

	Site 1		Site 2	
Numbers per m ²	mean	variance	mean	variance
<i>Platydemus manokwari</i>	present		0.1	0.10

Diastole conula



Diastole necrodes



Liardetia samoensis



Liardetia discordiae



Elasmias apertum



Elasmias paesianum



Ovachlamys fulgens



Meghimatium sp.



Subulina octona



Leptinaria unilamellata



Georissa insularis



Assimineia parvula and *Atopis vescoi*



Laeviculis alte



Sarasinula plebeia



Platydemus manokwari



Elasmias possibly eaten by *Platydemus*

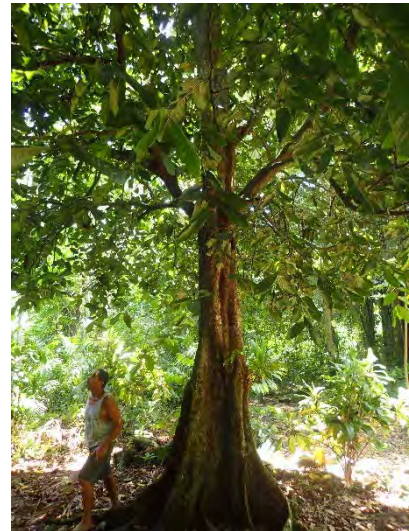


Marae Tefano (Matairea)

2019 release site – an isolated *Inocarpus* next to the Marae.

Partula: One juvenile *P. rosea*. This was pink painted, from the 2019 release. The site is dry and at mid-day was 33.8°C and 69% relative humidity. The absence of a significant snail fauna indicates that it is not suitable for further releases.

Other snails: No live snails on the ground: one *Paropeas javanicum* and two *Subulina octona* shells. The only arboreal snail found was *Elasmias apertum*.



Survey plot (one 5x5 m plot of vegetation to 2 m above ground)

	adult	subadult	juvenile	Total
<i>Elasmias apertum</i>	1	3		4

Flatworms: *Platydemus manokwari* present in low numbers

Numbers per m ²	mean	variance
<i>Platydemus manokwari</i>	0.1	0.1

Partula rosea shell



Huahine (4 April): Faahiti 2019 release site

Justin Gerlach, Rava Taputuarai, Teihoarii Amo, Edwige Lisan and others.

Habitat: *Inocarpus* by in a river-bed; agricultural land on slopes of valley.

Partula snails: 6 adult and 1 juvenile *Partula varia* shells found, all pink painted from the 2019 release. All are bleached white, with the periostracum missing, but the paint marks perfectly intact. All were under release trees.



Other snails: Not a single live snail was found: an old shell of *Euglandina*, a small number of fresh shells of *Ovachlamys fulgens*, a small number of *Paropeas achatinaceum* and one *Omphalotropis huahinensis*. No snails were found on the trees.

The absence of any live snails and the lack of algae etc on the *Inocarpus* leaves indicates that this is not a suitable site for future releases. The temperature at 9 am was recorded at 27.8°C and humidity of 83.3%.

Flatworms: *Platydemus manokwari* was present; 5 were found.

Numbers per m ²	mean	variance
<i>Platydemus manokwari</i>	0.1	0.10

Partula varia shells



Paropeas achatinaceum



Ovachlamys fulgens



Omphalotropis huahinensis



Raiatea (5 April)

Justin Gerlach, Rava Taputuarai, Teihoarii Amo and Kayla Garcia.

Haamoa

Temperature at 9am recorded at 27.4C and 83.6% humidity.

Habitat: *Inocarpus* by the river, with *Freycinetia*; upper parts with abundant invasion of *Ardisia*.

Partula snails: None, this is a previously selected potential release site.

Other snails: No shells of *Lissachatina fulica* or *Euglandina*. Several points were surveyed, recording abundant small snails in most sites. In addition to species in the samples, *Assiminea parvula* was seen. *Subulina octona* was only found as an empty shell. Empty shells of *Ovachlamys fulgens* and *Diastole conula* were locally common, suggesting flatworm predation and an empty shell of *Elasmias apertum* stuck to a leaf also indicates *Platydemus* presence. However, flatworm abundance was very low.

Survey plot (one 5x5 m plot of vegetation to 2 m about ground)

Top site	adult	subadult	juvenile	Total
<i>Elasmias apertum</i>	2	6		8
<i>Elasmias paesianum</i>		1	1	2
<i>Diastole conula</i>	3	5	3	11
Lower site				
<i>Elasmias paesianum</i>	2			2
<i>Diastole conula</i>		3	2	5
<i>Ovachlamys fulgens</i>	2			2



Ovachlamys fulgens



Diastole conula



Leptinaria unilamellata



Elasmias apertum



Georissa striata



Assimineia parvula



Anisorhynchodemus sp.



Platydemus manokwari



Diastole probably eaten by *Platydemus*



Leaf litter surveys (10 quadrats of 1x1 m)

	Top site		Lower site	
	mean	variance	mean	variance
<i>Georissa striata</i>	0.2	0.18	1.9	0.54
<i>Georissa parva</i>	0.1	0.10	0.4	0.49
<i>Leptinaria unilamellata</i>	0.2	0.18		
<i>Ovachlamys fulgens</i>	0.2	0.18	0.5	0.50

Flatworms: *Platydemus manokwari* was present in low numbers (one individual found) and two *Anisorhynchodemus* sp. were recorded; none in survey quadrats.

Pohuine

Habitat: Lower part with *Inocarpus* by river. Upper part with *Inocarpus* and *Hibiscus* by the river, with dense areas of *Freycinetia*; slopes invaded by *Cecropia*.

Partula snails: None.

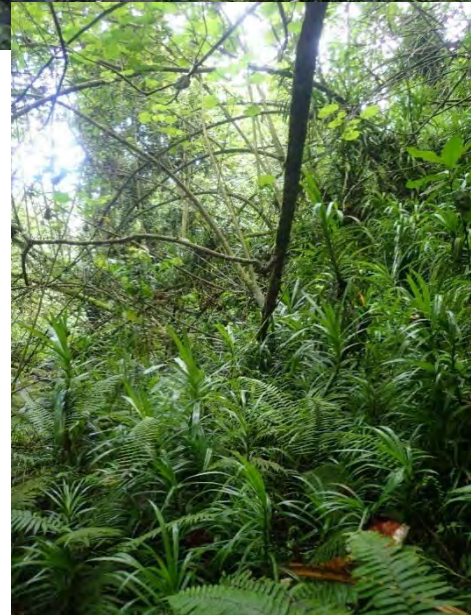
Other snails: No shells of *Lissachatina fulica* or *Euglandina*. Two points were surveyed. The lower part recorded only a single shell of *Subulina octona* and no live snails of any species. In the upper part in the *Freycinetia* thicket snails were found only on fallen *Pandanus* leaves, here diversity and abundance were high. In the *Inocarpus* snails were abundant in the litter but none were seen on vegetation except for a *Diastole cornuta* outside of the sampling quadrat.

Survey plot (one 5x5 m plot of vegetation to 2 m about ground)

Upper site (1m)	adult	subadult	juvenile	Total
<i>Ovachlamys fulgens</i>	2		3	5
<i>Georissa insularis</i>	4			4
<i>Omphalotropis huahinensis</i>	1			1

Leaf litter surveys (a single quadrat of 1x1 m)

Numbers per m ²	
<i>Georissa insularis</i>	8
<i>Omphalotropis huahinensis</i>	2
<i>Ovachlamys fulgens</i>	5



Ovachlamys fulgens



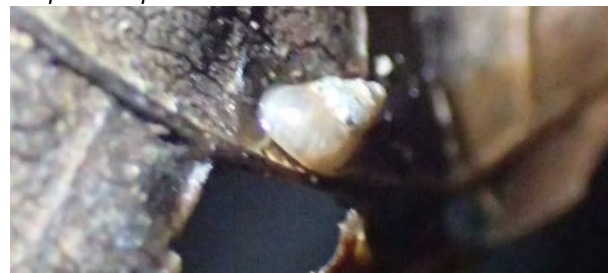
Subulina octona



Georissa insularis



Omphalotropis huahinensis



Flatworms: One *Platydemus manokwari* was found in the lower part but not in a survey quadrat.

The site has a good climate – being relatively cool and permanently damp, predator numbers are low and litter snail abundance is high. The absence of arboreal snails is a puzzle.

Platydemus manokwari



Tahiti (6 April) - Planning meeting with Christophe Brocherieux, Rava Taputuarai, Matai Depierre, Paulina Chmara, Craig Close and Kayla Garcia.

Moorea (7 April)

Visit to Fare Natura Justin Gerlach, Paulina Chmara, Craig Close, Kayla Garcia, Christophe Brocherieux, Rava Taputuarai and Eric Lenoble.

Discussion with Kirahu Howard concerning several points (their proposals followed by our recommendations):

1. keeping of *Partula* at Fare Natura - one box of *P. tohiviana* to be left with them to learn techniques (68 adults, 30 juveniles).
2. modification of the littoral aquarium to replicate the mangrove fern habitat and introduction of *Partula* to the exhibit – future transfer of a small number from the Opunohu population.
3. *Partula* research – Kirahu’s proposal to study *Partula* for her diploma is to be encouraged. It will be timely to review the research needs of the programme. Suitable projects for Kirahu are likely to include dietary range and ease of adjustment from *Partula* food and ease of adjustment of captive snails to field conditions.
4. Creation of an additional mangrove fern population: we visited the coastal site near the Opunohu population on Kellam family land – their plan of planting more mangrove fern and introducing some *P. taeniata* is to be encouraged as a worthwhile experiment. The ground is slightly higher than in the existing population but does flood occasionally and so may be safe from predators.



Fare Natura seems to be a highly suitable venue, with good facilities and very enthusiastic, but also practical, staff.

Visit to Opunohu and potential site Justin Gerlach, Paulina Chmara, Craig Close, Kayla Garcia Christophe Brocherieux, Rava Taputuarai, Eric Lenoble, and Kirahu Howard.

Several *Partula taeniata* found on *Acrostichum*: one adult and numerous juveniles of different sizes. Many individuals of *Elasmias apertum* were also present. There is no apparent food on the *Acrostichum* leaves but *Hibiscus tiliaceus* leaf stalks entangled in them appeared to have been grazed by *Partula*. A data-logger is to be left with Fare Natura to gather climatic data from this site.

Kirahu showing *P. taeniata* to Craig, Paulina and Kayla



Adult *P. taeniata*



Juvenile *P. taeniata* and *Elasmias apertum*



Hibiscus stem showing grazing marks



Potential site for future *P. taeniata* introduction following habitat improvement

Visit to west coast Motu Justin Gerlach, Paulina Chmara, Craig Close, Kayla Garcia, Christophe Brocherieux, Rava Taputuarai, Eric Lenoble and Kirahu Howard.

The Motu was proposed as a possible *Partula* site following creation of suitable vegetation. It is an artificial coral island created around 50 years ago. It supports sparse *Casuarina equisetifolia*, *Cordia subcordata*, *Guettarda speciosa* and *Thespesia populnea*. No snails of any species were present. The most abundant animals were a species of isopod and crazy ants *Anoplolepis longipes*. There is significant coastal erosion on one side.



At present the Motu is not suitable for *Partula*. If extensively vegetated it might be possible that the Opunohu *P. taeniata* that are adapted to extreme heat might be able to survive.

Moorea (8-9 April)

Partula reintroduction: Justin Gerlach, Paulina Chmara, Craig Close, Kayla Garcia, Christophe Brocherieux, Rava Taputuarai, Eric Lenoble and Kirahu Howard.

Habitat: *Inocarpus* and *Hibiscus* woodland, with locally abundant *Freycinetia*.

Releases followed previous protocols in fixing pots 1.5-2 m above ground. Three modifications were used: trees were selected that had a good growth of algae and mosses on the leaves which supported abundant small snail species; they had interconnecting foliage at around head height, providing the opportunity for *Partula* to move between trees without descending to the ground and without having to move to the canopy; leaf litter was removed from the base of the release tree to a radius of 1 m (this was omitted by accident in some cases).

Partula taeniata 'simulans' site

The established release site, however, these snails are phenotypically *nucleola*, not *simulans*. Shells of the previous releases are the same *nucleola* phenotype.

Partula: One old adult shell (white marked - 2018) and one adult marked as juvenile on the apex (pink 2019). Demonstrating some maturation of released snails.

Other snails: Many old and recent *Lissachatina fulica* shells and one of *Subulina octona* found. Other species in survey plots.

Survey results (one 5x5 m plot of vegetation to 2 m about ground and one 1x1 m of leaf litter)

	Vegetation plot			Leaf litter
	adult	Immature	Total	
<i>Elasmias paesianum</i>	1			
<i>Diastole conula</i>	1	5		
<i>Laeviculis alte</i>				1



Release: 203 adults, 170 juveniles, 81 newborn. In 24 hours dispersed to 4 m upwards. No mortality recorded.

Partula sturualis vexillum site

The established release site.

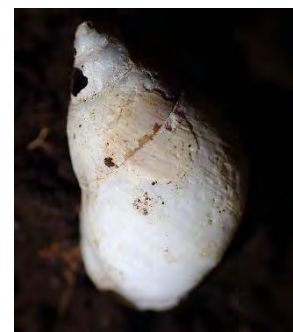
Partula: Two old shells, white marked (2018 release).

Other snails: Many old *Lissachatina fulica* shells found and one fresh juvenile, also one *Paropeas achatinaceum*. All other species in survey plots, except for one *Disastole necrodes*.

Survey results (one 5x5 m plot of vegetation to 2 m about ground and one 1x1 m of leaf litter)



	Vegetation plot			Leaf litter
	adult	Immature	Total	
<i>Elasmias paesianum</i>				
<i>Diastole conula</i>	1	4		
<i>Subulina octona</i>				2



Platydemus: one found in the leaf litter sample.

Release: 39 adults and 10 juveniles released. Two killed by *Platydemus* (1 adult, 1 juvenile), others dispersed up to 6 m upwards. Most dispersed by 17 April.

Partula taeniata 'nucleola' site

The established release site, however these snails are phenotypically *simulans*, not *nucleola*. Shells of the previous releases are the same *simulans* phenotype. Leaf-litter was not cleared from release tree bases.

Partula: 22 old shells found, the presence of an adult marked as juvenile confirms maturation after release and one unmarked adult demonstrates breeding and recruitment. A newborn *Samoana diaphana* found nearby.

P. t. 'nucleola' shells (colour and year)



Stage	Adult		Subadult	Juv.
	adult	Juv.	Juv.	
Pink (2019)	5	1	2	
White (2018)	6			
Blue (2017)	2			
unmarked	1			1
fragments	6			



Other snails: One old *Lissachatina fulica* and one *Subulina octona* shell found. No live leaf-litter species found.

Survey results (one 5x5 m plot of vegetation to 2 m about ground and one 1x1 m of leaf litter)

	Vegetation plot			Leaf litter
	adult	Immature	Total	
<i>Elasmias apertum</i>	3	8		
<i>Elasmias paesianum</i>		3		
<i>Ovachlamys fulgens</i>	1			
<i>Diastole conula</i>		1		
<i>Omphalotropis sp.</i>	1			

Release: 587 adults and 823 juveniles released. Monitored over 24 hours (see below). 5 killed by *Platydemus* (4 adult, 1 juvenile) on the ground apparently, having moved to the ground deliberately. N.b. we omitted to clear the leaf-litter from the base of the trees in this site.

Partula tohiviana site

The main release site at the old enclosure. Leaf litter was not removed from the base of the trees in this site.

Partula: No live individuals found but many old shells from past releases were collected. Two adults marked as juveniles confirms some maturation of released snails.

P. tohiviana shells (colour and year):

Stage	Adult		Subadult	Juv.
	adult	Juv.		
Marked as			Juv.	
Pink (2019)	2			
White (2018)	14	2		
Blue (2017)	2			
Yellow (2016)	3		1	
unmarked	6			
fragments	1			



Other snails: A small number of old *Lissachatina fulica* shells, *Leptinaria unilamellata* and *Subulina octona* found. One dead *Elasmias paesianum* and a *Samoana diaphana* killed by *Platydemus* found on leaves. A single *Laeviculis alte* slug was observed.

Survey results (one 5x5 m plot of vegetation to 2 m about ground and one 1x1 m of leaf litter)

	Vegetation plot			Leaf litter
	adult	Immature	Total	
<i>Elasmias apertum</i>	1	3		
<i>Elasmias paesianum</i>	7	4		
<i>Diastole conula</i>		4		
<i>Ovachlamys fulgens</i>	1			
<i>Omphalotropis sp.</i>	1			
<i>Samoana diaphana</i>		1		



Release: 495 adults, 481 juveniles, 14 newborn released. Monitored over 24 hours (see below). Two moved to the ground deliberately, but no mortality noted. On 17 April low mortality, wide dispersal, some on ground.

Partula mirabilis site (new)

A new release site down-slope from the old enclosure.

Partula: None, but three *Samoana diaphana* and a shell of *S. attenuata* were found, confirming the suitability of the site for partulids.

Other snails: A small number of old *Lissachatina fulica* shells and one of *Samoana attenuata*.

Survey results (one 5x5 m plot of vegetation to 2 m about ground and one 1x1 m of leaf litter)



	Vegetation plot			Leaf litter
	adult	Immature	Total	
<i>Elasmias paesianum</i>	5	1		
<i>Diastole conula</i>	1	6		
<i>Samoana diaphana</i>		4		
<i>Ovachlamys fulgens</i>				3
<i>Meghimatium</i> sp.				1

Release: 37 adults and 16 juveniles released. Monitored over 24 hours, two moved to the ground deliberately. No mortality noted. Dispersal high in the tree by 17 April (7 dead).

Partula suturalis 'vexillum' site (new)

A new site established as these snails are phenotypically *strigosa*, not *vexillum*.

Partula: None.

Other snails: A small number of old and recent *Lissachatina fulica* shells, and one live juvenile *Euglandina* found.

Survey results (one 5x5 m plot of vegetation to 2 m about ground and one 1x1 m of leaf litter)



	Vegetation plot			Leaf litter
	adult	Immature	Total	
<i>Elasmias paesianum</i>	1	3		
<i>Diastole conula</i>		4		
<i>Subulina octona</i>				1
<i>Ovachlamys fulgens</i>	1			
<i>Euglandina</i> sp.		1		

Flatworms: one *Platydemus*-like flatworm found.

Release: 62 juveniles released. Monitored over 24 hours (see below). No descent to the ground, no mortality. Dispersal high in the tree by 17 April.

Samoana diaphana



Samoana attenuata



Diastole conula



Diasole necrodes



Elasmias peaseiana



Elasmias apertum



Ovachlamys fulgens



Leptinaria unilamellata



Subulina octona



Paropeas achatinaceum



Fresh dead juvenile *Lissachatina fulica*



Euglandina



Meghimatium sp.



Laeviculis alte



Atropis obesa



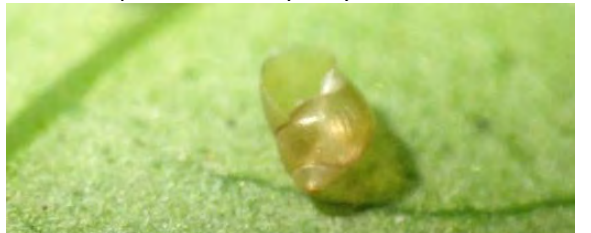
Ompahlotropis huahinensis



Elasmias apertum



Elasmias apertum killed by *Platydemus*



P. taeniata 'nucleola' killed by *Platydemus*



P. suturalis vexillum killed by *Platydemus*



Flatworms: *Platydemus manokwari* was present in low numbers in leaf-litter but was abundant at night. Four were found foraging on tree trunks, 0.5-1.5 m above ground. Three were found eating: one *Elasmias apertum* 1 m above ground and two millipedes on the ground. The '*Platydemus*' sp. was also found eating a millipede.

Anisorhynchodemus sp. having consumed a millipede



Arboreal foraging *P. manokwari*



Unidentified



P. manokwari eating millipedes



Bipalium kewense

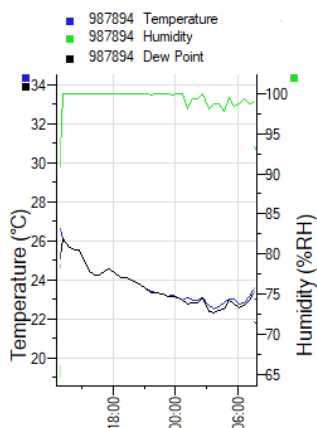


Research

Climate: Two data-loggers were left in situ in the *P. tohiviana* release site of the old enclosure and in the Opunohu *P. taeniata* population. These will be downloaded by Kirahu Howard, providing us with data on the temperature and humidity in a normal site, and in the extreme mangrove fern site. Four data-loggers were used in the enclosure to sample temperature and humidity on the ground, at 1 m above ground, 2 m and 4 m. This covered the period 12:25 9 April – 8:00 10 April.

	0m	1m	2m	4m
Temperature (°C)	23.3-24.3	23.1-24.5	22.6-25.4	22.6-25.7
Humidity (%)	100	100	98.3-100	98.7-100

Climate patterns over the monitored period:



Notes:

Rain at mid-day caused relative humidity to reach 100%.

Temperature declined from mid-day to a minimum at 3:15.

A sensible drop in temperature occurred at 3:00. The recorded temperature range of 23.3-25.7°C is a good match for captive conditions for the Moorean species.

Partula interactions with other species

All interactions with other species were noted. None appeared very significant: ants (*Plagiolepis alluaudi* and *Technomyrmex vitiensis*) passed by or over *Partula* but three millipedes were seen with resting *Partula* for extended periods (over an hour in two cases). One seemed to be using the snail as a shelter or anchor while grazing on algae (see photo).

Partula taeniata with *Plagiolepis alluaudi* ant



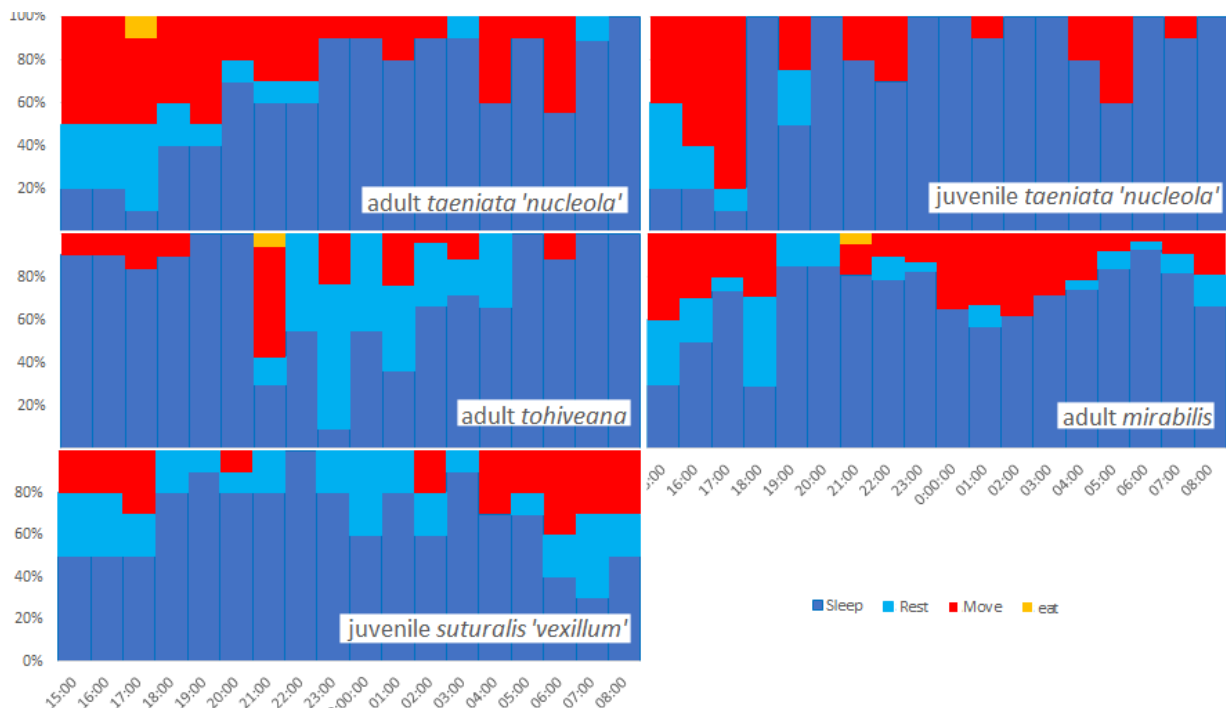
P. taeniata with a grazing *Oxidius gracilis* millipede



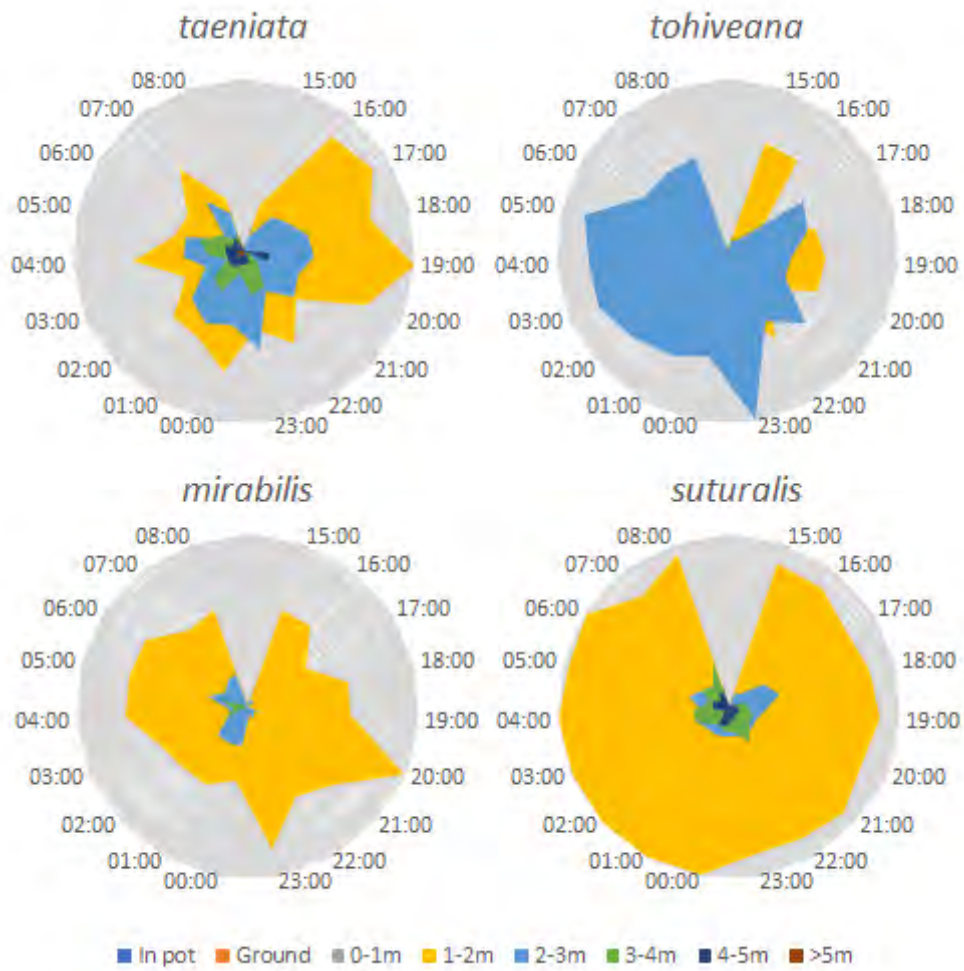
Night surveys

Activity and behaviour of four species was monitored for 18-20 hours after release, providing data on immediate release behaviour and on night-time activity. The species were *P. taeniata* 'nucleola', *P. tohiveana*, *P. mirabilis* and *P. suturalis* 'vexillum'. Behaviour was recorded hourly as 'sleep' (totally inactive), 'rest' (body visible but not moving), 'move' and 'eat'.

Results of the behaviour study are shown below (data in appendix). Activity was greatest in *P. taeniata*, both in total and in distribution. This species was most active at 15:00-19:00, with a resurgence of some activity at 4:00-6:00. *P. tohiveana* had patches of activity throughout the night, with no clear pattern. *P. mirabilis* was most active at 13:00-19:00 and 0:00-4:00. *P. suturalis* only showed significant activity at 15:00-18:00 and 4:00-8:00. Dusk was at 18:00. Dawn started at 5:30, with full daylight at 6:15. The air temperature dropped at 3:00, associated with a breeze, this may have some association with slight increases in activity in *P. taeniata* and *P. suturalis* but there does not seem to be a strong link between activity and air temperature.



The dispersal of released snails is given below with time from release moving clockwise. This shows that *P. taeniata* moved furthest up the trees (most remaining within 2 m, some to 7 m), followed by *P. tohiveana* (most up to 3 m). *P. mirabilis* and *P. suturalis* remained almost exclusively at 1-2 m with a small number of *P. suturalis* reaching 5 m.



Flatworm observations:

Every few hours a stretch of path was walked and all flatworms encountered were recorded. This provided a transect of 1x84 m.

Time	18:00	20:00	21:00	23:00	2:00	5:00
<i>Platydemus manokwari</i>	0	3	5	5*	4*	0
<i>Anisorhynchodemus</i> sp.	0	0	0	0	1	0

*one flatworm observed at 23:00 1m up a tree, same individual at 1.5m at 2:00, a second at 2:00 0.5m off ground

At 23:00 on a circuit of the path Rava counted 26 *Platydemus manokwari*, 2 *Bipalium kewense* and many *Lissachatina fulica* on the upper part.

Tahiti (10-11 April)

Partula hyalina and *P. affinis* release in Papehue valley: Justin Gerlach, Paulina Chmara, Craig Close, Kayla Garcia, Rava Taputuarai, Matai Depierre and Veronique Mu.

Papehue valley was chosen as the usual release site of Faarapa is very dry, and in this season Papehue offers a better chance of success.

P. hyalina

Release in edge habitat near the start of the path, 30 adults, 4 unmarked newborns. 24 hours later – 1 dead, 16 adults and 1 newborn found live, all on the release plant at 1-2m.

Other snails: One old *Euglandina* shell found. Small species abundant on leaves: *Elasmias paesianum*, *Diastole necrodes*, *Tornatellides oblongus* and *Georissa striata*.

Survey plot (one 5x5 m plot of vegetation to 2 m about ground)



	adult	subadult	juvenile	Total
<i>Elasmias paesianum</i>	2	1	2	5
<i>Diastole necrodes</i>	1			1
<i>Tornatellides oblongus</i>	6	2		8
<i>Georissa striata</i> .	1			1

Elasmias paesianum



Diastole necrodes



Tornatellides oblongus



Georissa striata



Leaf litter surveys (1 quadrats of 1x1 m)

Numbers per m ²	
<i>Omphalotropis</i> sp.	5

Flatworms: *Platydemus manokwari* was present nearby.

Release monitoring:

Time	In pot	ground	<1 m	1-2 m	2-3m	dead	alive	unknown
2.5 hours after release	1	0	0	18	4			
24 hours after release	0	0				1	17	22

P. affinis

Released in *P. nodosa* site: 99 adults, 57 juveniles, 23 unmarked newborns.

Release monitoring:

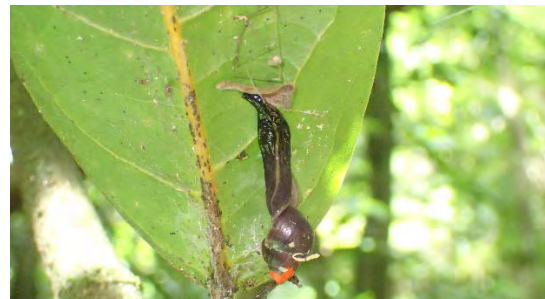
Time	In pot	ground	<1 m	1-2 m	2-3m	dead	alive	unknown
1 hour after release	158	0	20					
24 hours after release		0				29	58	155

Mortality in this species was very high: 22 adults, 7 juveniles. All dead were killed by *Platydemus*, 6 still had flatworms in the shells (2 in one case) and two flatworms were still feeding on the tree, 1.5 and 2 m above ground. All dead were found immediately below the pots and only one live snail had moved around the tree. 15 were still in the pots, 2 had descended below 1m above ground, 8 had moved upwards to no more than 2.5 m above ground. It was notable that many of them were resting in clusters and the tree surface was covered in their mucus.

Platydemus manokwari feeding on ground and in tree



Dead *Partula hyalina*



Dead *P. affinis*



P. affinis clustering



P. affinis mucus on the tree surface



Other partulids:

In addition to the two *P. nodosa* shells found on the previous visit, several more were found. The totals are given below.

	Worn or fragment	2019 (pink)	2018 (white)	Unmarked
North side of river	1 adult			1 adult
South side of river		9 adult, 1 juvenile	1 adult	2 adult

Large numbers of *P. clara* shells were found. Most were extremely fragile and were probably killed by *Platydemus manokwari*, which were highly abundant (6 encountered while looking for shells).

One live juvenile *Samoana attenuata* was found on a small sapling and one on one of the release trees.

Partula clara shells



P. nodosa shells



Samoana attenuata



Tahiti (15 April)

Partula nodosa release in Papehuet valley.

Released: 1715 adults, 52 subadults, 646 juveniles, 50 unmarked newborns.

Research in Papehue

Climate: A data-logger were left in situ to gather a year's worth of climate data. Four data-loggers were used to provide 24 hours of data on temperature and humidity on the ground, at 1 m above ground, 2 m and 4 m.

This covered the period 12:00 10 April – 11:00 11 April.

	0m	1m	2m	4m
Temperature (C)	22-25	22-25.5	22-25.5	22-25.5
Humidity (%)	98-100	94-97	93-97	90-97

Other research

Drone: The drone was tested in the forest. It worked well and does enable a view of the canopy. It is unlikely that most *Partula* would be visible, the large pale *P. tohiviana* should be an exception. However, if a UV light could be attached it seems probable that suitably marked snails would be easily visible. Use of the drone did show that *Inocarpus* leaves in the canopy lack epiphyte growth.

Shell decomposition: Old *Partula* shells are occasionally found but we do not know how old these are. In order to determine the rate of shell decomposition an experiment was set up with 5 pots in the old enclosure on Moorea. Three contained leaf litter, one soil and one covered by a rock. Each contained 1 *Euglandina* and 5 *P. varia* shells (to prevent confusion with shell of local species), except for the soil experiment which contained 1 *Euglandina* and 4 *P. varia*. The shells are to be photographed every 6 months.

Appendix 1: night study data

Notes: dark at 18:00, fully dark at 19:00 (other snail species fully active from 20:00)

P. taeniata 'nucleola'

Number monitored: 90. Release time: 11:42. Monitored from 3 hours after release.

Time	In pot	Ground	0-1m	1-2m	2-3m	3-4m	4-5m	>5m	Note
14:39	7	4	4	13	4				Ground <1m radius
15:50	14	3	4	39	12				Ground 0.3-1m
17:00	5	3	4	41	14				
18:00	8	3	6	35	18		1		
19:00	5	4	5	46	19	4	7		
20:00	4	3	10	36	16	2	7		4 dead*
21:00	7	1	5	19	18	5		1	One at 6m
22:00	6	2	2	28	12	11	3		
23:00	6	2	4	21	27	12	4		
0:00	6	2	2	33	20	6	4	1	One at 6m
1:00	6	2	2	26	22	12	5	1	One at 6m
2:00	6	2	7	26	19	11	5	3	One at 6m, 2 at 7m
3:00	4	2	3	17	11	5	5	1	One at 6m
4:00	6	1	2	30	16	10	5	2	2 at 6m
5:00	4	1	7	19	16	12	5	1	1 at 6m
6:00	2	1	6	18	6	8	3		
6:30	2	4	3	24	11	2	3	?	UV not working
7:00	2	1	2	28	17	4	4	?	
8:00	2	1	1	15	11	4	2	?	

*deaths 3 by *Platydemus* (5cm off ground, 2 on ground), 1 ants

Activity

time	Adults				Juveniles				notes
	Sleep	Rest	Move	eat	sleep	Rest	Move	Eat	
14:39	2	3	5		2	4	4		
15:50	2	3	5		2	2	6		1 j eat algae
17:00	1	4	4	1	1	1	8		
18:00	4	2	4		10				
19:00	4	1	5		4	2	2		
20:00	7	1	2		10				
21:00	6	1	3		8		2		
22:00	6	1	3		7		3		
23:00	9		1		10				
24:00	9		1		10				
1:00	8		2		9		1		
2:00	9		1		10				
3:00	9	1			10				
4:00	6		4		8		2		
5:00	9		1		6		4		
6:00	5		4	1*	10				
6:15	7		2	2*	10				
6:30	4	1	3	2*	10				
6:45	3	1	4	1*	8		2		
7:00	8	1		1*	9		1		

7:15	9	1				10			
7:30	7	2	1			9		1	
7:45	10					10			
8:00	10					10			

* Feeding on dead *Freycinetia* leaves (6:00-7:00) and grazing surface of living *Freycinetia* (6:16-6:45)

P. tohivanga

Number monitored: 249 Release time: 12:13. Monitored from 3 hours after release

Time	In pot	Ground	0-1m	1-2m	2-3m	3-4m	4-5m	>5m	Note
14:57	15	2	5	29	3				
17:00	?	1	3	10	23	18			
18:00	?	1	3	23	21				
19:00	?	1	5	25	16				
20:00	?	1	5	25	16				
21:00	?	1	5	14	27				
22:00	?	1	7	25	20				
23:00	?	1	5	15	43				
24:00	?	1	6	15	27				
1:00	>8	1	4	20	30				c8 on pots
2:00	?	1	4	15	32				
3:00	>4	1	3	10	35				4 on pots
4:00	?	1	2	15	35				
5:00	?	1	1	10	37				
6:00	?	1	1	15	25				
7:00	?	1	1	15	25				
8:00	?	1	1	15	25				

Activity

time	Adults				Juveniles				notes
	Sleep	Rest	Move	eat	sleep	Rest	Move	Eat	
14:57	9		1						
17:00	46		9						
18:00	43		5						
19:00	47								
20:00	31								
21:00	14	6	24	3					dispersing
22:00	40	33							
23:00	6	43	15						
0:00	27	22							
1:00	30	33	20						
2:00	34	15	2						
3:00	35	8	6						
4:00	35	18							
5:00	49								
6:00	37		5						
7:00	42								
8:00	42								

P. mirabilis

Number monitored: 53. Release time: 14:00. Monitored from 2 hours after release.

Time	In pot	Ground	0-1m	1-2m	2-3m	3-4m	4-5m	>5m	Note
15:28	6	0	0	15	1				
17:12	4	0	2	10	1				
18:10	2		2	15					
19:02	2		2	15					
19:58			4	25	3	1			
21:10			2	17	1	1			
22:13			2	15	2				
23:19			2	21	1				
0:26			2	11	6				
1:30			2	13	6				
2:37			2	13	6				
4:00			2	14	3	4			
5:19			2	18	3	2			
6:08			2	18	6	4			
7:11			2	18	4				
7:57		2	2	14	5				

Activity

time	Adults				Juveniles				notes
	Sleep	Rest	Move	eat	sleep	Rest	Move	Eat	
15:28	3	3	4						
17:12	11	1	3						
18:10	5	7	5						
19:02	28	5							
19:58	28	5							
21:10	17	0	3	1					<i>Platydemus</i> removed
22:13	15	2	2						
23:19	19	1	3						
0:26	13	0	7						<i>Platydemus</i> removed
1:30	12	2	7						Possible mating
2:37	13	0	8						
4:00	17	1	5						
5:19	21	2	2						
6:08	25	1	2						
7:11	18	2	2						
7:57	14	3	4						

P. suturalis 'vexillum'

Number monitored: 62. Release time: 14:23. Monitored from 1.5 hours from release.

Time	In pot	Ground	0-1m	1-2m	2-3m	3-4m	4-5m	>5m	Note
15:42	9	0	0	29	3				
17:00	7	0	0	27	8				
18:00	5	0	0	28	10	3	1		
19:00	5	0	0	29	7	4	2		
20:00	4	0	0	28	6	5	2		
21:00	4	0	0	30	6	5	2		
22:00	4	0	0	29	6	8	2		
23:00	4	0	0	29	6	5	3		

24:00	4	0	0	33	6	5	4		
1:00	4	0	0	33	6	4	4		
2:00	4	0	0	33	6	5	1	3?	>4m out of view
3:00	4	0	0	33	7	7	2	?	
4:00	4	0	0	33	6	7	3	?	
5:00	4	0	0	32	8	4	3	?	
6:00	4	0	0	33	6	6	2	?	
7:00	4	0	0	27	5	5	3	?	
8:00	4	0	0	31	3	9	3	?	

Activity

time	Adults				Juveniles				notes
	Sleep	Rest	Move	eat	sleep	Rest	Move	Eat	
15:42					5	3	2		
17:00					5	2	3		
18:00					8	2			
19:00					9	1			
20:00					8	1	1		
21:00					8	2			
22:00					10				
23:00					8	2			1 feeding at 23:20
0:00					6	4			
1:00					8	2			
2:00					6	2	2		
3:00					9	1			
4:00					7		3		
5:00					7	1	2		
6:00					4	2	4		
7:00					3	4	3		
8:00					5	2	3		