Final Report

***Placostylus bivaricosus* Breeding Project**

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Introduction to *Placostylus bivaricosus*

The genus *Placostylus* is a group of large ground dwelling gastropods with a disjunct distribution in the Southwest Pacific from the Solomon Islands, Fiji and New Caledonia, to Lord Howe Island and the northern extremity of New Zealand.

Three recent subspecies of the Lord Howe Island *Placostylus* are recognized. *P. bivaricosus bivaricosus* from the settlement area; *P. bivaricosus cuniculinsulae* from Blackburn Island (now presumed extinct) and P. *bivaricosus etheridgeri* from Little Slope considered likely to be extinct but there is a chance it may survive in isolated populations based on recent identification of hatchling snails from leaf litter collected on Little and Big Slopes in the 1970's.

The extant Lord Howe land snail *Placostylus bivaricosus bivaricosus* (from now on called *Placostylus bivaricosus*) is a large terrestrial snail found only on Lord Howe Island. This snail has a brown, pointed shell up to 7cm long and 2 cm in diameter. It is most closely related to New Zealand *Placostylus* species. Its status has declined from common to endangered.

Historical accounts and fossil evidence indicate that the LHI *Placostylus bivaricosus* was formerly widespread and abundant on parts the island. The decline was first noted in the 1940's and the species is now listed as critically endangered on the *2000 IUCN Red List of Threatened Species.*

The causes for decline of the LHI *Placostylus* are likely to include habitat clearing and modification, predation and habitat disturbance by introduced fauna (rats, Blackbirds and Song thrushes) and possibly herbicide and pesticide use.

The Ship rat *Rattus rattus* (accidentally introduced in 1918) is considered to be the major predator of the LHI *Placostylus,* and likely to be a significant threat to its survival. European Blackbirds and Song Thrushes (introduced around 1950) are also thought to be predators of *Placostylus*.

In October 2001 a Recovery Plan was completed for *Placostylus bivaricosus,* under the provisions of the Threatened species Conservation Act 1995. This plan describes the current understanding of the snail, documents research and management actions to date and identifies actions required to maximize the opportunity for the species ongoing viability in the wild.

The overall objectives of the Recovery Plan are to protect and recover the LHI *Placostylus* in the wild in the long term. Specific objectives include: to identify habitat and populations of the LHI *Placostylus*; to identify and ameliorate current threats to LHI *Placostylus;* to support and coordinate research into LHI *Placostylus* relevant to its recovery; to encourage community awareness of the status of LHI *Placostylus* and threats to its survival and support community involvement in its recovery.

A number of objectives in the Recovery Plan have been initiated by the LHI Board – including additional rat baiting in areas of known *Placostylus*

populations, investigation into the feasibility of eradicating rodents from LHI, commencement of regeneration of an area of Blackburn Island (rat free) for possible translocation of *Placostylus*, prohibiting domestic chickens foraging in forest leaf litter.

Previous experience with breeding Placostylus snails on Lord Howe Island

Several previous attempts at breeding *Placostylus* snails on Lord Howe Island have been carried out.

2004 - An initial breeding pen set up behind the LHI Central School in 2004 did not provide suitable high humidity and shade conditions so adult snails died.

2006 A second attempt in 2006 using a glass aquarium with hessian covering continually wetted by "wicking" was used. This provided ideal microclimate conditions for the adult snails and they did reproduce and lay eggs. However hatchling snails died at about 60 days. From experience in New Caledonia and New Zealand, this 60 days has proved a critical point which is difficult to progress hatchlings past. In New Caledonia this has been achieved by use of artificial food supplements provided to hatchlings.

2009 - An attempt at breeding *Placostylus* snails using plastic boxes with soil and leaf litter was set up in 2009, but was abandoned because the temperature inside plastic containers used to hold adult breeding snails exceeded 28 degrees C and some snails started to die. Remaining snails were repatriated to locations where they were collected. A small number of snails hatched, but did not survive beyond days.

The purpose of this 2010 breeding experiment is to try and improve on holding pens for breeding adults to provide a much more natural setting so as to maintain a temperature and humidity regime similar to the natural forest in which they live. The site chosen was under *Howea forsteriana* palm forest adjacent to Arajilla Resort, where density of *Placostylus* had been found to be amongst the highest on the island (Surveys of *Placostylus bivaricosus* Lord Howe Island December 2006 to May 2007).

However at the point of installation of the breeding pens, the owner of the Arajilla lease had a change of mind, and would not allow the pens to be located on the lease. A search was made for another site that would provide suitable temperature, humidity and soil conditions; plus be accessible to power and water supply. The area behind the Lord Howe Island Museum was chosen and approved by the LHI Historical Society committee to be for this purpose. However this caused a delay in commencement of the project, going past what may be considered the optimum time of breeding of *Placostylus bivaricosus.*

Breeding Pens - external

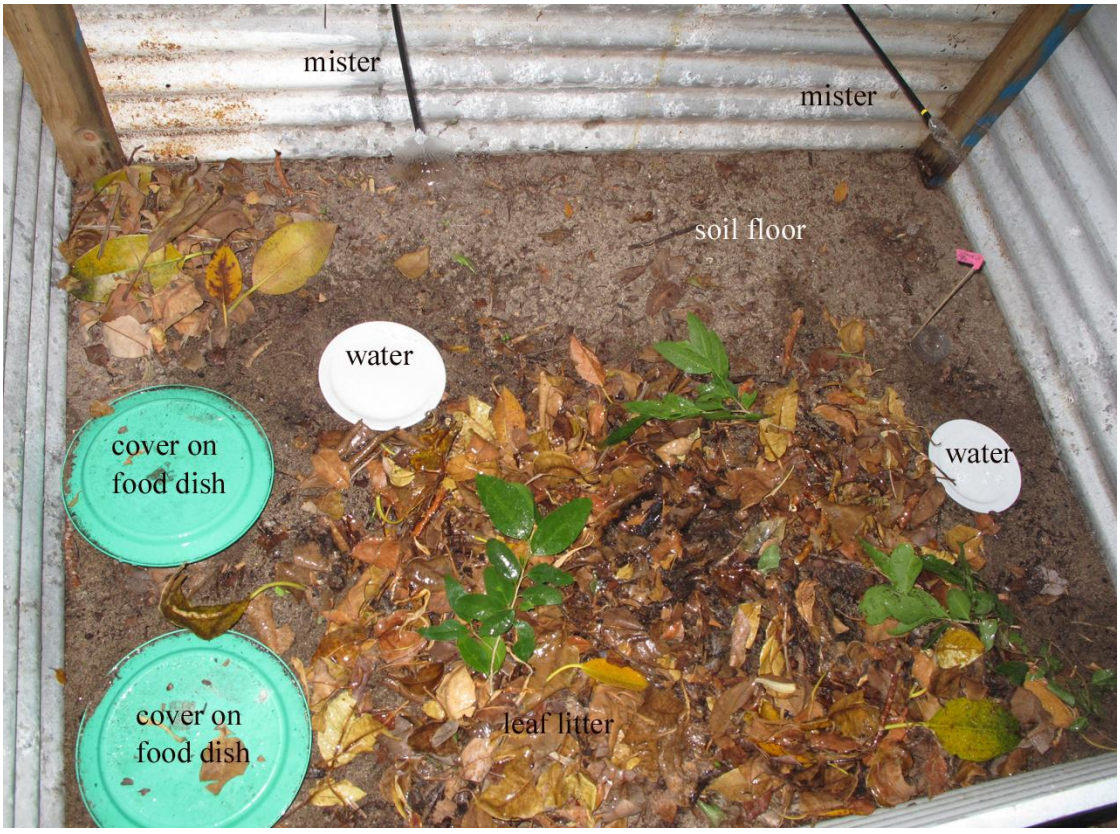
Three breeding pens were completed as per instructions. These consist of a frame of hardwood, with corrugated iron sides attached. Each pen has a removable lid with a double layer of screen mesh to allow adequate ventilation and rainfall into the enclosures, to keep any predators out and retain adult snails within. Sides of pens buried 40cm in the soil, to prevent rodents digging under and gaining entry, and preventing snails from digging out. Location was under on sandy soil which is preferred habitat of *Placostylus bivaricosus*. Shade cover was provided by a dense canopy of *Howea forsteriana, Drypetes affinis* and *Cryptocarya triplinervis* trees. Power and water supply was available to the pens.

Breeding Pens - internal

An automatic spray system was set up for each breeding pen according to the contract plan- with mist sprayers and a timer to turn on 2 minutes, three times daily.

Four saucers were provided in each pen – two with drinking water in, topped up daily; two others have an overhead lid to keep rain and spray off artificial food placed in the saucer beneath – one with crushed chicken pellets and the second with flour/lime powder mix.

Leaf litter from areas under Banyan trees *Ficus macrophylla columnaris* was collected and spread across the floor of the pens. Dead and living leaves of *Celtis conferta* and *Lagunaria patersonius* were also placed in the pens.



Breeding stock
Eight adult Placostylus snails were taken from three different areas:

P Pinetrees - just south of the Pinetrees cemetery. 31 31 26.8S 159 04 08E

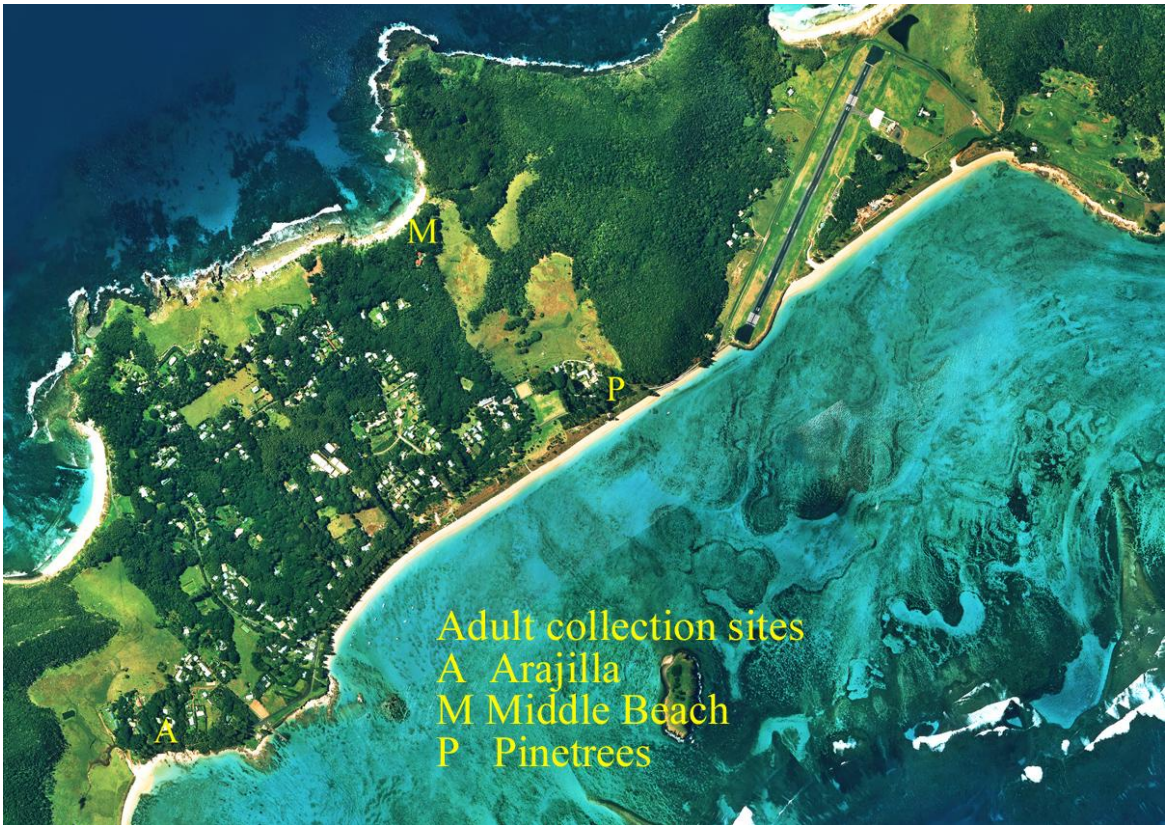
M Middle Beach area - along the walking track to Middle Beach, approximately 80 metres in from the start off the end of Anderson Road. 31 31 40.6S 159 04 26.5E

A Arajilla – on the corner of Lagoon Road and the road leading to John Green house. 31 31 12.2S 159 03 29.2E

These snails were marked individually with identification letters and numbers 1 to 8, using enamel paint.

The snails were collected on 26 July and held in plastic containers, in order to not miss any egg laying, as previous experience had shown eggs are laid July and August.

When the breeding pens were set up by 10 August these snails were then placed in three different pens, marked Pinetrees, Middle Beach and Arajilla.



Observations to be carried out

As per the instructions in the contract, observations were made once each night and once each morning. The observations were to observe and record any copulation activity and any egg laying. Where possible length of copulation was to be recorded, and length of egg laying was also to be recorded. Weather conditions and soil temperature also recorded at observation times.

At times of observations the artificial food and water were to be checked and topped up or changed as necessary. Fresh leaf litter was to be added .

Adult snails were weighed each fortnight to assess condition.

Any eggs laid were to be recorded and treated in one of two ways:

(1) half of the clutches were to be left in breeding pens, with small plastic container placed over the top to avoid disturbance by other snails.

(2) half of the clutches were to be taken into the temperature controlled environment of the museum annex and following treatment with fungicide (Searles Mancozeb, supplied) be placed on wetted tissue in plastic containers.

RESULTS

Observations general

After 20 days into the project, an assessment was made of the prescribed procedures and how they were working in actual field conditions.
It became apparent that the breeding pens are an ideal design to house adult snails. – good size, plenty of leaf litter and spray system to keep humidity up. The snails survive and breed.

However these are not ideal for twice daily observing to search for snails and monitor breeding and egg laying activity.

The main problem is that the constant disturbing of the leaf litter twice a day, or even once a day just turns the leaf litter quickly into a mess of sand and leaf material. The fact that the leaf litter is wet by a) rain and b) mist sprayers means that when moving leaf litter to check snails and find them, the underlying sand sticks to the leaves, this keeps moisture on leaves, which attracts more sand. After a short few days the whole lot is a wet, heavy, sticky mess. The leaf litter/soil interface is very diffuse. This is not easy to search for snails, it is not good habitat for the snails and creates huge disturbance to the snails. This is evidenced by the numbers of one or two eggs found laid on the surface with no snail nearby. Previous egg laying events recorded in past years have indicated 15 eggs per clutch, only one of the 2010 snails have laid 14, the others 10 or less, with a number of 1 or 2 eggs being laid on the surface.

It is not feasible to replace leaf litter daily or even every third day- this would require too much leaf litter removed from the natural environment- where other snails and invertebrates make their home.

After consultation with the project supervisor it was decided to remove most of the leaf litter from the pens and have only about 1/3 of pen soil floor covered with leaf litter, as a way to monitor the snail's activities with less disturbance.

Results of copulation observations

Copulation activity was recorded on the following nights, with time intervals observed. Note that these are minimum copulation periods, as no actual start time was observed.
3rd September P4 and P8 from 2030 to 2130
4th September M1 and M4 from 1930 to 2030
11 October P1 and P2 from 2315 to 2340
6 November M2 and M3 from 2115 to 2300 (105 minutes)
19 November P2 and P7 2115 to 2205 (50 minutes)
20 November M2 and M6 2050 to 2300 (120 minutes)
20 November A1 and A4 2050 to 2240 (110 minutes)
20 November A5 and A8 2050 to 2250 (120 minutes)

the most reliable observations of copulation duration were:
6 November M2 and M3 2115 to 2300 (105 minutes)
20 November M2 and M6 2050 to 2300 (120 minutes)
20 November A1 and A4 2050 to 2240 (110 minutes)
20 November A5 and A8 2050 to 2250 (120 minutes)

But these are minimum period as no start time was recorded.

Results of eggs laid

Because of twice daily searching for adult snails, there was huge disturbance to the adult snails. The egg clutches were not laid as they might have in undisturbed conditions (previous years typical egg number was 14 per clutch). This meant that sometimes just 1 or 2 eggs were laid on the surface, some clutches were not partially buried; sometimes no snail was seen next to eggs that had been laid; sometimes two or more snails were adjacent to eggs laid.
The following dates gives eggs observed as laid.

Eggs laid in Pinetrees pen

P unknown A laid 7 eggs in holding box while pens being built between **26/7 and 10/8**
Sizes: 7.8x7.2; 7.8x7.4; 8.1x7.3; 8.0x7.5; 8.1x7.7; 8.0x7.4; 7.8x7.5
total weight of 7 eggs 1.6 grams
these dipped in fungicide and kept inside

P 5 laid 7 eggs 13 August
Sizes: 7.9x7.2; 7.9x6.9; 7.7x6.7; 8.3x6.9; 8.2x7.3; 7.3x6.6; 7.4x7.2
total weight of 7 eggs 1.6 grams
these dipped in fungicide and kept inside

P8 laid 10 eggs 16 August
Sizes: 7.4x6.9; 7.3x7.0; 7.7x6.8; 7.5x 6.8; 7.2x7.1; 7.6x6.8; 7.7x7.0; 7.4x7.1; 7.6x6.9; 7.6x6.6
total weight 10 eggs 2.3 grams
These eggs left in breeder pen

P1, P3, P4 three adult snails close together, not sure who is laying
started 27 Aug/finished 28 Aug 6 eggs
Sizes: 8.4x6.8; 8.0x6.8; 8.0x7.2; 8.0x7.0; 8.1x7.2; 8.5x6.8
total weight 6 eggs 1.5 grams
these eggs left in breeding pen

Eggs laid in Middle Beach pen

M4 laid 7 eggs 25 August
Sizes: 7.8x7.6; 8.1x7.3; 7.8x7.7; 7.8x6.9; 8.1x7.7; 8.2x7.3; 8.2x7.3
total 7 eggs 2.0 grams
these eggs left in breeding pen

Eggs laid in Arajilla pen

Unknown AA laid 15/08
2 eggs on surface
Sizes: 7.7x7.2; 7.9x7.3
total weight 0.5gms
these eggs left in breeding pen

A6 laid 2 eggs on 17 Aug
Sizes: 7.7x6.9; 7.9x6.9;
total weight 2 eggs 0.4 grams
these dipped in fungicide and kept inside

Unknown AB laid 14 eggs 24 August
Sizes: 8.3x8.0; 8.3x8.1; 7.8x7.4; 8.5x8.1; 8.4x7.9; 8.0x7.6; 7.8x7.6; 8.4x7.9; 8.0x7.8; 8.0x7.6; 8.4x8.1; 8.0x7.8; 8.4x8.1; 8.3x7.6
total weight of 14 eggs 4.4gms
these eggs left in breeding pen

A4 laid 10 eggs 25 August
Sizes: 7.6x6.9; 7.3x6.7; 7.5x7.2; 7.6x6.9; 7.8x7.2; 7.8x6.9; 7.8x7.2; 7.6x6.9; 7.8x7.1; 7.6x7.3
total weight of 10 eggs 2.4grams
these eggs removed, dipped in fungicide and kept inside.

A1 laid 3 eggs with A6 eggs on 28 August
Sizes: 7.9x7.4; 7.9x7.3; 7.8x7.3
total weight of 3 eggs 0.7 grams
these dipped in fungicide and kept inside

Unknown AC 28 August
1 egg on surface
Sizes: 7.5x7.0 weight 0.2gms
left in breeding pen

Range of egg sizes 7.2mm to 8.5mm long x 8.1 to 6.6mm wide
Range of egg weights 0.2 grams to 0.31 grams (clutches of eggs weighed as scales not accurate beyond 0.1gms.)

Eggs hatched

Approximately half of egg groups were left in pens, the other half treated with fungicide and kept inside in humid containers.

For eggs treated with fungicide and kept under controlled temperature environment (17° to 22° C), no eggs hatched during the observation period.

Table Eggs and their fates

Adult ID	Date laid	Number eggs	kept	Date hatch	Days incubtn	Hatch size	Alive 1st DEC
P unknown	10/08	7	inside	none			
P 5	13/08	7	inside	none			
P8	16/08	10	pens	9/11 10/11	85 86	8.10 7.94	no yes
P134	27/08	6	pens	6/11 6/11 9/11 10/11 16/11	71 71 73 74 80	8.53 8.49 8.20 8.45 7.92	Yes Yes Yes No yes
M4	25/08	7	pens	6/11	73	7.88	yes
A unknown	15/08	2	pens	6/11 7/11	83 84	7.86 8.03	Yes yes
A6	17/08	2	inside	none			
A unknown	24/08	14	pens	16/11 17/11 21/11 3/12 3/12 3/12	84 85 89 * * *	7.97 8.07 7.92 7.64 7.53 7.48	Yes Yes Yes Yes Yes Yes
A 4	25/08	10	inside	none			
A1	28/08	3	inside	none			
A unknown	28/08	1	pen	none			

Incubation period ranged from 71 days to 89 days with 83 to 86 days most common.

Hatchling size ranged from 7.48mm long to 8.53mm long (mean 8.0mm long).

* these hatchlings were found climbing on underside of the pen lid - they may have come from a clutch laid but undetected.

Conclusion

While only a small number of hatchlings resulted through this project, due to the difficulties encountered with massive disturbance caused by the observation procedures, detailed on page 7, there has been some valuable information gained.

A These types of enclosures are ideal for holding captive populations of snails for future projects that have the outcome of producing eggs and hatchlings. They are relatively inexpensive, strong, secure against predators and provide an easy way to check snails and change water, leaf litter etc. They are also suitable for holding snails if a rodent eradication program takes place requiring captive populations of these snails to be held safe from baits.

B However any future breeding projects to ascertain, through daily observations, the length of copulation time, the length of egg laying time, and time of hatching will require a different holding enclosure; i.e. one that is smaller allowing less disturbance to adult snails. Ideally it needs to be at a residence where the observer carrying out the project can monitor at many time intervals throughout the night.

C Any eggs laid should not be treated with fungicide chemicals as this appears to have had a detrimental effect on egg hatching – no eggs treated in this way did hatch.

D. The adult snails appear not interested in eating crushed chicken pellets as food, and only very mildly interested in the flour/calcium carbonate mix provided. The fact that this artificial food attracted large numbers of slugs, including introduced Leopard slugs, it is probably best not to include artificial foods while holding *Placostylus.* The leaf litter provided enough suitable food resource.

Further work

The completion date of this contract is 1st December 2010. At this point the snail hatchlings are all 3 weeks old or less. It is proposed to continue to house them in the museum annex and continue feeding them as per methods outlined in the contract until 15mm in length, then place them in outside pens.

To minimize any major loss from any infection, hatchlings are being kept in individual containers. To avoid growth of mould or fungus on leaves or flour/milk powder mix, it is proposed to inspect every second day, and at least every fourth day change all material in the containers. This will be done until the snails are 15mm length and then be placed in outside pens. This will provide an assessment of methods to raise the hatchlings. Growth rates will be recorded through the growing period.

snail ID	length mm AUG 11	wt Aug11	wt Aug 25	wt Sept 8	wt Sept 23	wt Oct 5	wt oct 17	wt Nov 5	wt nov 19	wt Dec 5
P1	54.7	16.3	17.9	17.1	17.9	18.1	18.1	19.3	18.8	18.6
P2	55.9	19.5	19.7	19.3	19.6	20.8	20.3	21.1	20.3	21.3
P3	57.6	14.8	14.7	15.1	15.6	16.1	15.9	15.5	16	16.2
P4	56.6	18.2	17.4	18.2	19.3	19.3	19.4	19.8	19.1	20
P5	53.3	15.5	14.9	14.4	14.9	15	15.3	16.8	16.6	16.6
P6	61	18.2	17.3	17.4	18.7	18.4	17.2	18.5	19.5	19.4
P7	56.3	16.8	15.3	15.8	16.7	16.9	17.3	17.1	17.1	15.9
P8	49.7	14.9	14.4	13.6	14.2	14.7	15.2	15.5	14	14.8
M1	56.6	16.1	15.3	16.2	16.5	16.3	15.2	15.3	14.9	15
M2	58.3	17.2	17	16.8	16.8	16.6	17	17.3	16.3	17.1
M3	63.6	22.1	22	20.9	21.6	20.9	21.8	21.5	21.3	21.8
M4	59.9	19.9	18.3	18.7	19	18.8	19.2	19	18.6	19.4
M5	56.2	18.7	17.8	18.2	19.8	19	19.1	18.5	18.9	18.8
M6	56.6	18.7	18.4	19.4	21.1	19.2	20.6	20.5	19.4	20.9
M7	51	16.3	15.4	15.7	15.9	15.8	15.9	16.2	16	16.7
M8	56.6	17.4	17	16.6	17.3	17	17.2	16.8	16.3	17.8
A1	59.8	25.7	24	24.1	25.2	24.8	25	26.2	25.8	26.6
A2	61	24.6	23.6	21.9	22.9	22.1	24.5	22.4	23.8	22.9
A3	59	20.7	20.5	19.6	18.9	19.5	20.4	20.2	20.6	21.1
A4	59.6	21.6	19.9	21.1	21.8	20.8	21.7	21.9	22	23.3
A5	56.2	16.3	16.4	16.1	16.6	16.7	17.5	18	17.1	21
A6	60	21.2	20.4	19.8	20.7	19.8	20.1	20.8	20.9	17.3
A7	64.7	24.6	22.1	23.4	24.3	22.4	23.8	23.5	24.3	21.2
A8	56.9	20	18.9	18.7	19.4	20.1	19.2	19.7	22.2	23.7

Appendix 1: length (mm) and weights (gms) of adult *Placostylus* breeding snails. P Pinetreees site; M Middle Beach site; A Arajilla site.

Appendix 2: CD with files of still images breeding pens and snails copulating; plus movie files snails copulating.

Acknowledgements

Rod Simpson provided valuable input into the project. Thanks to Dean Hiscox and Hank Bower for assisting with observations and care while I had short absences off the Island. The Lord Howe Island Historical Society allowed the breeding pens to be set up in the LHI Museum grounds, and the use of the annex to hold eggs and hatchlings.

References

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6 Poster prepared by Fabrice Brescia for 2004 Malacology conference in Perth.