The Tahitian Shell Game:

A global effort to save an endangered family of snails

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ABSTRACT

In the 1970's and 1980's a series of misguided introductions to islands of French Polynesia led to the mass extinctions within a diverse family of endemic terrestrial snails. This process of decimation was documented by observers that had the foresight to take several of the more threatened species into safe havens in universities and zoos before they became extinct. This paper will touch upon the history of these snails, summarize the *ex situ* endeavor to maintain these colonies, *in situ* efforts to recover the species, and explore the potential for reintroduction of *Partula nodosa* – a species considered extinct in the wild, but maintained in colonies in several zoos.

LIFE HISTORY

The family Partulidae is comprised of roughly 125 species of arboreal snails spread across three genera -*Eua*, *Samoana* and *Partula*. Endemic to islands in the South Pacific, they have a large geographic range from Belau to the Marquesas Islands over 8,500 km to the east (Coote, Pearce-Kelley, 2013). Another way to look at this family is that they are spread over 40 islands within just over 1 million square kilometers of ocean.

Partula snails get their name from the fact that they are ovoviviparous. The young hatch internally, giving the appearance of a live birth. Parca, also known as Partula, is a Roman goddess of childbirth. This explains both the name of the family and one of the genera with this group. These snails are also hermaphroditic. This and the fact that they are capable of self-fertilization come into play later when discussing colony management and record keeping challenges.

Their diet in the wild is not specific, but it is believed that they rasp on algae as well as fresh and decaying leaf matter, most likely consuming a wide variety of microbial fauna in the process.

Their method of eating is thought to assist with plant respiration and decomposition of leaf matter (Owczarzak, 1999).

RECENT HISTORY

Partulidae species were once very common – especially throughout the islands of French Polynesia. In this part of their range, they were even sustainably collected by Polynesian artisans for the making of traditional *Lei* – in the form of necklaces made from their multi-colored shells.

In 1769 a specimen of *Partula faba* was collected on one of Captain Cook's famous expeditions to the area and was described for the first time to science. About 150 species were then described, and as a result, the *Partula* genus of snails later became an integral part of the then burgeoning study of evolution. Over 100 years later, in 1899, Alfred Meyer began to study them for examples of speciation and species radiation in action. Because, geologically speaking, the more recent formation of the snails' home islands formed strikingly deep valleys with very steep sided walls- natural barriers created by both suitable habitat and altitude – the various and numerous valley populations were essentially isolated from one another. And as a result, there were many different species located on the same island. Snails may have been occasionally moved between valleys, captured in caked mud on a bird's foot, or possibly even surviving passage through a bird or small mammal's digestive system. Each valley, was however, essentially isolated and its own unique ecosystem with distinct vegetation and climate. It was a perfect natural laboratory to study the subject.

This long study, however, began in earnest in thanks to Henry Edward Crampton – who for 50 years (1906 – 1956) studied the Partula snail in literally painstaking detail. Crampton was an American evolutionary biologist that served as professor of zoology at Columbia University and Barnard College from 1904- 1943. He was also the curator of invertebrate zoology at the American Museum of Natural History in New York. In using Partula snails as a subject, Crampton set out to find answers fired by the great debate between Lamarckian inheritance and Darwinian adaptation.

During his 50 year study, Crampton measured a mind-numbing number of snails. In all, he personally measured, by hand, over 80,000 snails just for his Tahiti monograph and over 116,000 for his Moorea monograph. (Gould, 1992). Calculations made from these measurements were carried out to eight decimal places!

THE SHELL GAME

It was this incredible treasure trove of a lifetime's worth of baseline data that inspired others to continue Crampton's work shortly after his death. In the early 1960's Bryan Clarke, Jim Murray

and Mike Johnson picked up the snail mantle (for all of you snail enthusiasts - no pun intended). It was during their watch when the Giant African Land Snail (*Lissachatina fulica*) made its way to the islands via introduction as a food source – escargot. This very large and prolific land snail, infested the islands in a short amount of time and by the mid-1970's, it was threatening the islands' food crops and infesting homes and gardens in spectacular fashion

So, on March 16, 1977, against sage advice, but with official governmental approval, the Rosy Wolf Snail (*Euglandina rosea)*, a predatory snail from tropical North America was introduced to combat the introduced pest. This remarkable snail follows the slime trails of its prey, and, like a slow motion lion on the Serengeti, the fierce predator chases them down and devours them….sometimes shell and all. *E. rosea* preferred Partula snails to the Giant African Land Snails.

The decimation of the Partula snails, however, did not happen at a snail's pace. In fact, it was a remarkably quick and efficient massacre. By the mid 1990's about two thirds (56 of the 72) Partula species in French Polynesia were extinct. Partulidae were placed on the IUCN Red List in 1994. Currently on Tahiti, you can find only three of the original eight species. However, in the midst of the impending and certain extinctions, several species were taken into captivity in the late 1980's. Now 15 species (and two additional subspecies) are looked after in *ex situ* populations in zoos.

REFUGEES

As of this writing, one species, *P. nodosa* is maintained in North American Zoos with the remaining species being held in European zoos. *P. nodosa*, natives to Tahiti, were once common there. In fact, you could find them there in seven valleys on the west coast of the island in decent numbers until 1980's when *E. rosea* found its way to the island. The ancestors of this current *ex situ* population were collected in the Papehue Valley in 1984. And because of the introduction of the carnivorous snail, I can (and often do) literally hold the de facto, "native" habitat of this species in my hands. *P. nodosa* is currently considered Extinct in the Wild by IUCN. And, as far as we know, this species is currently found only in aquaria and small plastic boxes in a few zoos around the world. They are, in a sense, refugees, waiting to return to their homeland when conditions become more favorable.

COLONY CARE

Care for this species is has been relatively unchanged since they were first collected for propagation. The consistency in care across institutions only seems to significantly vary on the size and shape of containers, with a few minor variations in presentation of diet.

For the most part, Partula snails can be maintained in a reasonably small space with once or twice weekly care and feeding. Lighting has been basically normal, overhead lighting on a roughly 12:12 hour - light:dark ratio. They have for the most part been housed within temperatures that have been close to room temperatures (18- 24 C / 65-75 F), with some anecdotal evidence pointing to a preference for the cooler side of that range.

As stated earlier the size of containers can vary between institutions depending of preference of care and past history of care. Some use small "sandwich saver"-style containers to "critter carrier"- style containers of various sizes. Others use large acrylic tanks or glass aquaria. The size of the container, to some extent, determines the number snails held within, with fewer snails being maintained in smaller containers. A substrate of paper towels is placed in the bottom of these containers for moisture retention.

The diet is roughly the same throughout all institutions. It is:

3 tsp. Organic Nettle Powder (Available from Frontier Organics: http://www.frontiercoop.com/)
3 tsp. organic oats (ground to powder)
3 tsp. Cuttlebone (ground to powder) *
1.5 tsp. Trout Chow (crushed and ground to powder)
¼ tsp. Stress (Teklad) powder

*Some institutions substitute calcium carbonate powder for ground cuttlebone.

These ingredients are ground into a fine powder and stored in the dry state prior to feeding.

Feeding coincides with cleaning. Containers are cleaned once or twice a week. This involves carefully removing all of the snails and soiled substrate. Snails are placed in a clean container and misted with distilled or reverse osmosis (R/O) water. The dry powdered diet is reconstituted with some distilled or R/O water to a specific consistency and then thinly spread on either the sides of the container or a plastic "feeding board" that is placed in the habitat. A covering of plastic wrap is stretched across the top and secured. Small pin holes are punched in this plastic wrap to allow air exchange yet keep out potential invertebrate pests. More specific details are contained in the Population Analysis and Breeding and Transfer Plan for the AZA Species Survival Plan updated in 2013 and is available at www.aza.org.

Whereas attention is paid to care and genetic management, traditional recordkeeping methods do not work with this SSP. Since this is a hermaphroditic species that can self fertilize and is housed in colonies, it is impossible to track individual lineage. However, population trends by life stages can be monitored and are tracked by a monthly census.

MORE THAN AN ARK

Worldwide there are 16 zoos that care for this genus of snail. Many of these also zoos contribute financially to consortium called the Partulid Global Species Management Programme (PGSMP), based at the Zoological Society of London, UK. In the field, PGSMP funds extensive surveys for *Partula spp.* by Dr. Trevor Coote. Since 2003 Dr. Coote has conducted widespread surveys for remaining populations of Partulidae, evidence of any recent *E. rosea* activity, and other threats to this snail family's survival. Additionally, in the course of this work, he has documented in his monthly reports, threats from human encroachment, temperature variations and potential unexplored new habitats for these snails.

Other contributions by Dr. Coote to this effort are certainly worth mention. In addition to surveys and reporting, he has also helped to coordinate *in situ* activities, from acquiring permits, and protections for this snail, education efforts, identifying a native biologist to assist with monitoring, and coordinating the construction of predator proof snail preserves to test the viability of reintroduction in a controlled situation that was easy to monitor.

Within North America, the SSP has been busy. Whereas some species are doing better than others, on the whole, Partula snails are doing o.k. in zoos. In fact, *P. nodosa*, the only species currently held in North American zoos are doing extremely well. The six zoos that care for them (Akron Zoological Park, Detroit Zoological Park, Disney's Animal Kingdom, Roger Williams Park Zoo, Saint Louis Zoo, and Woodland Park Zoological Gardens) house over 6,000 total.

THE FUTURE

Plans for reintroduction of this species are underway at this writing. So, in short time, *P. nodosa* could be reintroduced to the very same valley from which their ancestors were collected three decades ago. The carnivorous Rosy Wolf Snail has not been found there in over a decade. Several methods of reintroduction – from protection by snail-proof barriers to a monitored general release - are planned, allowing for comparison. A dry run of the reintroduction by PGSMP partners in 2013, pointed out some of the challenges with health screenings, transport and governmental permissions. Lessons learned will be applied this year and, in the near future, a species that is now extinct in the wild may once again be found in their native habitat.

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