Fig. 1. Aerial view of Aldabra. (Photo: Foto Natura 2005) Aldabra banded snail (*Rhachistia aldabrae*). (Photos: C. Onezia, Seychelles Island Foundation)

Group. "As they are small and well camouflaged, landsnails can survive in small crevices and deep within undergrowth, and hence may be re-found after long periods when they are believed to be extinct."

On searching the area further, the SIF team located several individuals, including juveniles, which was encouraging as these young snails are considered to be particularly vulnerable to desiccation as a result of reduced rainfall and had not been recorded since 1976.

"I thought deep down, surely it can't be the endemic snail!" says Catherina Onezia, SIF Senior Ranger and Assistant Training Officer. "I only dared to believe it once I checked it out back at the office".

The team were exploring infrequently visited parts of Malabar Island, Aldabra's second largest island, when the snails were found. One of the aims of the field expedition was to document all of the invertebrates observed, but the team never dreamed that they would make such a find. The snails are unmistakeable, with beautiful elongated deep purple shells lined with bright pink bands. Identification of the snails has also been confirmed by mollusc experts Dr. Vincent Florens of the University of Mauritius and Seychellois naturalist Pat Matyot.

There is still very little known about the ecology of this rare snail but the re-discovery provides a second chance to protect and study this species in the wild and ensure that it is not lost again. Aldabra is one of the largest raised coral atolls on Earth, with an area of approximately 150 km², most of which lies only 1-2 m above sea level. Climate change impacts such as sea level rise and drought continue to be major threats throughout the snail's range. Aldabra was designated a World Heritage Site by UNESCO in 1982 and is managed and protected by the Seychelles Islands Foundation.

The atoll is a refuge for many other threatened species including the world's largest populations of Aldabra Giant Tortoises (*Geochelone gigantea*) and one of the largest congregations of nesting Green Turtles (*Chelonia mydas*) in the Indian Ocean.

The re-discovery of the Aldabra Banded Snail provides a beacon of hope. "Despite major global environmental threats like climate change, this discovery shows that investments into protecting unique island biodiversity are well-placed," says Dr Frauke Fleischer-Dogley, SIF CEO.

For further information, please contact Ms. Rowana Walton, Communications Officer at the Seychelles Island Foundation: *communications@sif.sc*

ONGOING RESEARCH INTO THE NATURAL HISTORY AND ECOLOGY OF AN ENDEMIC AND LITTLE KNOWN APPLE SNAIL FROM THE ALTO PARANÁ AND IGUAZÚ RIVERS (ARGENTINA)

By Pablo R. Martín, Silvana Burela & Fernanda M. Gurovich

Most of our knowledge of the biology and ecology of Neotropical apple snails (Ampullariidae) relates to only three species of the dozens that inhabit freshwater habitats from the Florida Peninsula (USA) to the Southern Pampas (Argentina). The worldwide interest in two of these species (*Pomacea canaliculata* and *Marisa cornuarietis*) is no doubt motivated by their invasiveness and voracious feeding habits, characteristics that have led to their intentional spread as biological control agents (for aquatic weeds and schistosome-bearing snails) and as promising aquaculture animals. Only one species, the Florida apple snail (*Pomacea paludosa*), has been intensively studied in relation to conservation concerns, but even in this case the interest has been mostly incidental as it constitutes the staple food of a U.S. Federally Endangered raptor, the snail kite, *Rostrhamus sociabilis* (Posch *et al.*, 2012). With the exception of conchological, taxonomic and nomenclatural aspects, most Neotropical apple snails are poorly known or completely unknown, although some recent studies have been gathering information on the natural history of a few species, i.e. *Pomacea bridgesii* (Coelho *et al*., 2012) [probably *P. diffusa* – ed.] and *Asolene platae* (Tiecher *et al*., 2014, in press).

On the basis of this increasing but still very fragmentary knowledge, apple snails are habitually seen as quite tough snails with a high biotic potential and an ability to thrive almost anywhere due to their dual respiration system (branchial and pulmonary), resistance to desiccation, generalist feeding habits and unpalatable and even toxic eggs. However, these generalizations may not apply to all apple snails since most of their diversity remains unexplored (Martín *et al.*, 2013).

There are 11 or 12 species of apple snails that occur within Argentina in the lower Río de la Plata basin but only five have been included in the Red List of Threatened Species (IUCN, 2014). Three of them were considered of "Least Concern" because of their presence in three countries (although they inhabit a single drainage basin or part of it) and one, the invasive *Pomacea canaliculata*, due to its wide distribution

and positive population trends (Martín *et al*., 2013). Only one species was categorized as Data Deficient, because of the lack of reliable information on its distribution, even though this state of affairs also applies to many others. The situation is at the same time better and worse on the eastern shore of the lower Río de la Plata since in República Oriental del Uruguay all ten apple snail species have been evaluated with six considered to be under threat, and therefore subjects of priority conservation (Clavijo & Scarabino, 2013).

Pomacea americanista is one of the least known species of Argentinean apple snails. It is the most recently described Argentinean apple snail species, described in 1919 by von Ihering on the basis of shells from Alto Paraná river (at Encarnación City, Paraguay) and the Iguazú Falls (type locality). Hylton Scott (1957) commented on its very restricted geographical distribution and documented some additional localities. *Pomacea americanista* was originally described in *Ampullaria* by von Ihering (1919) and later placed in the genera or subgenera *Asolene* and *Pomella* (Hylton Scott, 1957; Cowie & Thiengo, 2003). *Pomella* was recently synonymized with *Pomacea* (Hayes *et al*., 2012), based on taxonomic work on *Pomacea megastoma*. *Pomacea americanista* resembles *P. megastoma* in sharing an expanded aperture that is much bigger than the operculum and it is also treated here as a species of *Pomacea*. Anecdotal observations, the type locality, (one of the highest and more complex systems of waterfalls in the world) and the shell shape, all suggest that *P. americanista* dwells in fast-flowing water on hard substrates but little is known definitively about its natural history, distribution and conservation status, which has not yet been addressed by the IUCN.

The southernmost part of the native range of *P. americanista* has been impounded by an Argentinean-Paraguayan hydroelectric project, the Yaciretá complex, which has already been responsible for the extinction in the wild of two species of rapids-dwelling endemic snails and the total extinction of another two (Vogler *et al*., 2014). Other large dams have been or are being built in the Alto Paraná and Iguazú rivers upstream of the known range of *P. americanista*, mostly in Brasil. For instance, Guaíra Falls, located between Paraguay and Brasil, were submersed by Itaipú, the largest hydroelectric project in the world. Deforestation, intensification of land use (Fig. 1) and the consequent siltation are driving changes in organic matter and sediment inputs into aquatic communities. Invasive molluscs with high biotic potential and biofouling habits like the golden mussel *Limnoperna fortunei* are widespread and still spreading in the Rio de la Plata basin and are important threats to apple snails, especially those that dwell on hard substrates (Clavijo & Scarabino, 2013).

Our aims are to study the natural history, demography and environmental tolerance of *P. americanista* with the goal of achieving a better understanding of the factors that limit its distribution and abundance and the environmental changes that may be threatening it to help with categorization according to the IUCN criteria.

Last summer we hand-collected egg masses from a tributary of the Iguazú river (Misiones province, Argentina; Fig. 2) with

Fig. 1. Deforestation and agri-sylviculture activities in the Iguazú river basin (Misiones province, Argentina). (Source: Google Earth)

Fig. 2. Collection site of *Pomacea americanista* egg masses at Misiones province (Argentina). (Photo: Fernanda Gurovich)

the required legal permissions. The egg masses were taken to the laboratory and incubated until hatching. At hatching, 50 individuals were randomly selected as experimental individuals (Fig. 3). The snails were reared individually in 3 L aquaria under controlled conditions (water temperature, light and food; Fig. 4) and all possible aspects of their life history, including life span, copulation and egg-laying behaviour, fecundity, etc. were studied. Total shell length of the snails was measured weekly. At first, the growth rate was similar in both sexes but after some weeks it became faster in females. Once a week, all snails were pooled in a common aquarium to observe sexual activity (Fig. 4). We observed that males reached sexual maturity before females, because they tried to mount them but were rejected. Once the females began to accept males as partners in copulations (Fig. 5) they started to lay egg masses soon afterwards. Currently we are incubating all the laboratory egg masses under controlled conditions to gather data on oviposition behaviour, number of eggs per egg mass, egg size, duration of development, viability and hatchling size. Survivorship was so high that we could not obtain information on mortality (only one snail died); however, our plan is to continue the rearing process until the entire cohort dies to gather more data about this important life history trait.

During our field trips we are gathering information about the present distribution of *P. americanista* along the Paraná and Iguazú rivers. We are also planning to study museum

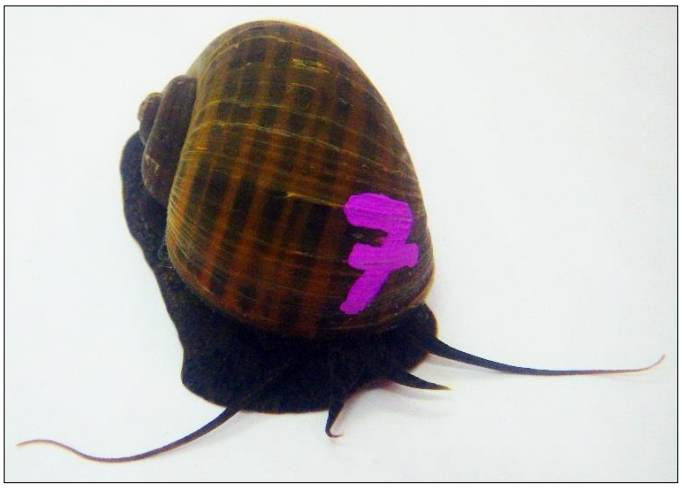

Fig. 3. *Pomacea americanista* reared at Laboratorio de Ecología (INBIOSUR). (Photo: Fernanda Gurovich)

Fig. 4. Rearing facility for *Pomacea americanista* (left) and arena for copulation (right) at the Laboratorio de Ecología (INBIOSUR). (Photos: Fernanda Gurovich)

collections to obtain information about its historical distribution in order to evaluate recent range restrictions. With the same aim we are also gathering information from ecological, archaeological and palaeontological literature to help delineate its natural range, although this task will be hindered by incorrect or dubious original identifications, a common hindrance in a family with a shell-based taxonomy and with much phenotypic plasticity in shell traits (Cowie *et al*., 2006; Estebenet *et al*., 2006).

Recent reviews have emphasized apple snails as invaders and pests (Joshi & Sebastian, 2006; Horgan *et al*., 2014) but also as promising evolutionary and genomic models for scientific research (Hayes *et al*., 2009, in press). However, from a conservation viewpoint apple snails have been seen mostly as trouble-makers (e.g. Burlakova *et al*., 2008; EFSA, 2014). Nevertheless, they also deserve to be studied as vulnerable species (Clavijo & Scarabino, 2013; Martín *et al*., 2013), providers of ecosystem services (Hayes *et al*., in press) and for their potential role in biotic resistance against invasive aquatic weeds (Morrison & Hay, 2011) and snails (Maldonado & Martín, 2014). Hopefully, in the future there will be a change in the way researchers, conservation managers and the general public view these interesting snails and in their attitudes toward them.

Our research on *P. americanista* and other species of apple snails is funded by grants from the Universidad Nacional del Sur (UNS, PGI24/B185) and the Agencia Nacional de Promoción Científica y Tecnológica (ANPCyT, PICT 2012-1956), and through a five-year doctoral scholarship granted by the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) to Fernanda M. Gurovich to study the biology and ecology of *P. americanista*.

Fig. 5. *Pomacea americanista* pair in copulation at Laboratorio de Ecología (INBIOSUR). (Photo: Fernanda Gurovich)

Burlakova, L.E., Karatayev, A.Y., Padilla, D.K., Cartwright, L.D. & Hollas, D.N. 2008. Wetland restoration and invasive species: apple snail (*Pomacea insularum*) feeding on native and invasive aquatic plants. *Restoration Ecology* 17: 1-8.

Clavijo, C. & Scarabino, F. 2013. Moluscos. In: *Especies prioritarias para la conservación en Uruguay. Vertebrados, moluscos continentales y plantas vasculares* (eds. Soutullo, A. Clavijo, C. & Martínez-Lanfranco, J.A.), p. 73-90. SNAP/DINAMA/MVOTMA y DICYT/MEC, Montevideo.

Coelho, A.R.A., Calado, G.J.P. & Dinis, M.T. 2012. Freshwater snail *Pomacea bridgesii* (Gastropoda: Ampullariidae), life history traits and aquaculture potential. *AACL Bioflux* 5: 168-181.

Cowie, R.H. & Thiengo, S.C. 2003. The apple snails of the Americas (Mollusca: Gastropoda: Ampullariidae: *Asolene*, *Felipponea*, *Marisa*, *Pomacea*, *Pomella*): a nomenclatural and type catalog. *Malacologia* 45: 41-100.

Cowie, R.H., Hayes, K.A. & Thiengo, S.C. 2006. What are apple snails? Confused taxonomy and some preliminary resolution. In: *Global advances in ecology and management of golden apple snails* (ed. Joshi, R.C. & Sebastian, L.S.). p. 3-23. Philipine Rice Research Institute, Science City of Muñoz, Nueva Ecija, Phillipines.

EFSA. 2014. Scientific opinion on the environmental risk assessment of the apple snail for the EU. *EFSA Journal* 12: 3641-3697.

Estebenet, A.L., Martín, P.R. & Burela, S. 2006. Conchological variation in *Pomacea canaliculata* and other South American Ampullariidae (Caenogastropoda, Architaenioglossa). *Biocell* 30: 329-335.

Hayes, K.A., Cowie, R.H., Jørgensen, A., Schultheiß, R., Albrecht, C. & Thiengo, S.C. 2009. Molluscan models in evolutionary biology: apple snails (Gastropoda: Ampullariidae) as a system for addressing fundamental questions. *American Malacological Bulletin* 27: 47-58.

Hayes, K.A., Cowie, R.H., Thiengo, S.C. & Strong, E.E. 2012. Comparing apples with apples: clarifying the identities of two highly invasive Neotropical Ampullariidae (Caenogastropoda). *Zoological Journal of the Linnean Society* 166: 723-753.

Hayes, K.A., Burks, R.L., Castro-Vazquez, A., Darby, P.C., Heras, H., Martín, P.R., Qiu, J.-W., Thiengo, S.C., Vega, I.A., Wada, T., Yusa, Y., Burela, S., Cadierno, M.P., Cueto, J.A., Dellagnola,

F.A., Dreon, M.S., Frassa, M.V., Giraud-Billoud, M., Godoy, M.S., Ituarte, S., Koch, E., Matsukura, K., Pasquevich, M.Y., Rodriguez, C., Saveanu, L., Seuffert, M.E., Strong, E.E., Sun, J., Tamburi, N.E., Tiecher, M.J., Turner, R.L., Valentine-Darby, P.L. & Cowie, R.H. In press. Insights from an integrated view of the biology of apple snails (Caenogastropoda: Ampullariidae). *Malacologia*.

Ihering, H. von. 1919. Las especies de *Ampullaria* de la Argentina y la historia del Río de la Plata. In: *Primera reunion de la sociedad Argentina de ciencias naturales. Tucumán 1916*, p. 329-350, pls. 37, 38. Imprenta y Casa Editora "Coni", Buenos Aires.

Horgan, F.G., Stuart, A.M. & Kudavidanage, E.P. 2014. Impact of invasive apple snails on the functioning and services of natural and managed wetlands. *Acta Oecologica* 54: 90-100.

Hylton Scott, M.I. 1957. Estudio morfológico y taxonómico de los ampulláridos de la República Argentina. *Revista del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" e Instituto Nacional de Investigacion de las Ciencias Naturales. Ciencias Zoológicas* 3: 233-333: [2] + 233-333, 23 pls.

IUCN. 2014. *IUCN Red List of Threatened Species*. Version 2014.3. Accessed 28 November 2014.

Joshi, R. & Sebastian, L.S. 2006. *Global advances in ecology and management of golden apple snails*. Philipine Rice Research Institute, Muñoz, Nueva Ecija, Phillipines. x + 588 p.

Maldonado, M.A. & Martín, P.R. 2014. Interacciones entre dos gasterópodos dulciacuícolas invasores: *Pomacea canaliculata* vs *Physa acuta*. In: III Congreso Uruguayo de Zoología, Montevideo.

Martín, P.R., Burela, S. & Tiecher, M.J. 2013. Insights into the natural history of ampullariids from the lower Río de La Plata Basin, Argentina. *Tentacle* 21: 11-13.

Morrison, W.E. & Hay, M.E. 2011. Herbivore preference for native vs. exotic plants: generalist herbivores from multiple continents prefer exotic plants that are evolutionarily naïve. *PLoS ONE* 6:e17227.

Posch, H., Garr, A.L., Pierce, R. & Davis, M. 2012. The effect of stocking density on the reproductive output of hatchery-reared Florida apple snails, *Pomacea paludosa*. *Aquaculture* 360-361: 37-40.

Tiecher, M.J., Burela, S. & Martín, P.R. 2014. Mating behavior, egg laying, and embryonic development in the South American apple snail *Asolene pulchella* (Ampullariidae, Caenogastropoda). *Invertebrate Reproduction and Development* 58: 13-22.

Tiecher, M.J., Seuffert, M.E. & Martín, P.R. In press. Thermal biology of the South American apple snail *Asolene platae* (Caenogastropoda: Ampullariidae). *Malacologia*.

Vogler, R.E., Beltramino, A.A. & Rumi, A. 2014. Threatened gastropods under the evolutionary genetic species concept: redescription and new species of the genus *Aylacostoma* (Gastropoda: Thiaridae) from High Paraná River (Argentina–Paraguay). *Zoological Journal of the Linnean Society* 172: 501-520.

Pablo R. Martín, Silvana Burela & Fernanda M. Gurovich, Laboratorio de Ecología, INBIOSUR (UNS-CONICET), San Juan 670, (8000) Bahía Blanca, Argentina. pablorafaelmartin@gmail.com

CANADA'S LIST OF AT-RISK MOLLUSCS LENGTHENS

By Dwayne A.W. Lepitzki

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC), a group of species and conservation experts, is the independent body that assigns conservation status to species using the IUCN criteria and recommends listing and legal protection under the Canadian Species at Risk Act (see *Tentacle* 21 for details). In 2014, two molluscs were reassessed by COSEWIC and another was assessed for the first time.

Fig. 1. Dromedary jumping-slug (*Hemphillia dromedarius*). (Photo: Kristiina Ovaska)

Round pigtoe (*Pleurobema sintoxia*), a freshwater mussel confined in Canada to four watersheds in southern Ontario, was originally assessed as Endangered in May 2004. According to the Species at Risk Act, at-risk species should be reassessed by COSEWIC every 10 years. In May 2014, the status of Endangered was confirmed. Urban development, agricultural runoff and impacts from introduced dreissenid mussels (Zebra mussel *Dreissena polymorpha* and Quagga mussel *D. rostriformis bugensis*) and Round goby (*Neogobius melanostomus*) fish continue to threaten its survival in Canada.

The Dromedary jumping-slug (*Hemphillia dromedarius*) (Fig. 1) was originally assessed as Threatened in May 2003. It was reassessed as Threatened in May 2014. This relatively large slug, up to 6 cm when fully extended, was undeservedly a finalist in the 2013 Ugly Animal Preservation Society's contest but thankfully, did not win. This charismatic microfaunal species is known from fewer than 20 sites on southern Vancouver Island, British Columbia, despite a great deal of searching. The species' global range does extend southward into Washington State and extreme northwestern Oregon. Its Canadian west coast habitat, moist, older-growth (> 80 years old) forests, is fragmented by logging and threatened with the increasing frequency and severity of droughts associated with climate change.

The new species added to the COSEWIC list of at-risk molluscs is the Broad-banded forestsnail (*Allogona profunda*). In Canada, this large (shell diameter up to 3 cm) snail is known to occur currently only on Pelee Island in Lake Erie and in Point Pelee National Park, along the north shore of the same Great Lake. It was the first terrestrial mollusc outside British Columbia to be assessed as at-risk by COSEWIC. Its disappearance from neighbouring islands around Point Pelee was probably caused by over-abundant nesting Double-crested cormorants (*Phalacrocorax auritus*) (Fig. 2). Its small Canadian range and the continuing threats of shoreline erosion caused by climate change and shoreline development, trampling from recreational activities and predation by non-