

The Newsletter of the IUCN/SSC Mollusc Specialist Group
Species Survival Commission • International Union for Conservation of Nature

TENTACLE



UNITAS MALACOLOGICA

Editor – Robert H. Cowie



EDITORIAL

At the end of August an important meeting, the first of its kind, took place in Tahiti. The meeting brought together representatives of almost all the countries and territories of the Pacific islands to focus on conservation of threatened land snails, and of course there is essentially nowhere in the Pacific where land snails are not threatened. Participants saw captive-bred *Partula* species released on the iconic island of Moorea, and learned about the breeding programmes not only of partulids from French Polynesia but also of achatinellids and other species from Hawaii, and even though not in the Pacific, captive breeding of highly threatened *Poecilozonites* species from Bermuda. Notably absent, were representatives from the Ogasawara Islands of Japan. Most participants were not aware of the highly endangered status of the endemic land snail radiations on these islands, nor of the efforts to save them.

However, some time prior to the Tahiti meeting and independently of it, I had been invited to go to Ogasawara to discuss their captive breeding programme for species of *Mandarina* and other groups. And in mid-October I travelled to the islands, 1,000 km by ship from Tokyo, a 24 hour journey. The Ogasawara Islands were established as a UNESCO World Heritage Site in 2011, in part on the basis of their endemic land snail radiations. As a result, they have been able to construct a state-of-the-art conservation centre that includes a public exhibit area, a series of quarantine rooms, a veterinary facility and the main component, a large captive breeding area where a dedicated team maintains the snail cultures. It is important that these snail conservationists in Ogasawara be recognised and included in the island land snail conservation community as they are doing important work.

Reports on both the Tahiti meeting and the Ogasawara land snail conservation programme can be found in the Pacific Island Land Snail section of this issue of [Tentacle](#).

Robert H. Cowie

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NEWS

The Tony Whitten Conservation Prize - malacologists feature strongly in the inaugural 2019 Prize

From David Allen, IUCN, Cambridge, UK

Tony Whitten (1953-2017) was an inspirational conservationist who championed biodiversity across Asia and beyond. He was Senior Advisor at Fauna and Flora International (serving as Director of its Asia-Pacific programme), and before that, Senior Biodiversity Specialist at the World Bank. Alongside helping to run conservation projects across Asia, Tony undertook world-class work on the discovery and conservation of limestone cave invertebrates, saving many species from obliteration by the region's rapidly expanding cement industry, and having at least 13 new species named in his honour. He also established the [IUCN SSC Cave Invertebrate Specialist Group](#).

As a tribute to Tony and his work, the Cambridge Conservation Initiative, of which IUCN is a member, hosts the Tony Whitten Conservation Prize for early-career conservationists and biodiversity researchers from East and Southeast Asia. The prize is open to those under the age of 35 involved in any area of conservation or field biology in the region. Prizes are awarded by a panel selected by Tony's family. The panel is especially interested in hearing about work on the overlooked species and habitats that Tony was most passionate about – such as caves and karst ecosystems, and understudied invertebrates and fishes.

The judges for the first year of this prize were astonished by the quality and number of applications that they received. Of the six 2019 winners, the work of three focused specifically on molluscs.

Ayu Savitri Nurinsiyah, for her work on the land snails of Java.



Ayu Savitri Nurinsiyah

Ayu explores the diversity of land snails and has been involved in the discovery of a number of new species, including *Landouria tonywhitteni*, named in honour of Tony Whitten (Fig. 1). This species is endemic to Sukolilo karst, an area where there are conflicts between the cement industry and local people.

Nurinsiyah, A.S., Neiber, M.T. & Hausdorf, B. 2019.

Revision of the land snail genus *Landouria* Godwin-Austen, 1918 (Gastropoda, Camaenidae) from Java. [European Journal of Taxonomy](#) 526: 1-73.

Fig. 1. *Landouria tonywhitteni*, described and named by Ayu Savitri Nurinsiyah in honour of Tony Whitten (Nurinsiyah *et al.*, 2019).



Junn Kitt Foon, for his work on conserving and taxonomically reviewing land snails in Malaysia.

Junn was inspired to pursue a conservation career by Tony Whitten's books and his passion for limestone biodiversity. Working alongside Tony taught him about the need to engage with and understand stakeholders, including communities, government, conservationists and extractive companies, when undertaking conservation work.



Junn Kitt Foon

Nattawadee Nantarat, for her work on land snails in Thailand and Southeast Asia.

Nattawadee analyses the biodiversity and evolutionary relationships of land snails in Thailand and Southeast Asia to help support programmes for karst conservation. She has a particular interest in terrestrial operculate snails of the genus *Cyclophorus*.

Applications for the 2020 Tony Whitten Conservation Prize will open later in 2020 and this will be announced on the [Cambridge Conservation Initiative](#) website. Early-career malacologists from across the East and Southeast Asia regions are encouraged to apply. Applicants should be nationals of Brunei, Cambodia, China, Indonesia, Laos, Malaysia, Mongolia, Myanmar, the Philippines, Singapore, Thailand, Timor-Leste or Viet Nam.



Nattawadee Nantarat

EDIBLE FRESHWATER MOLLUSCS FROM NORTHEAST INDIA

By Anushree Jadhav, Nipu Kumar Das & N.A. Aravind

Historically, molluscs have been used as a source of food by people. The oldest record of using molluscs as food, dating back to late Pleistocene and Holocene eras, is that of a land snail, *Iberus alonensis*, from Benidorm, Spain (Fernández-López de Pablo *et al.*, 2014). There have been reports of snail farming in Europe since Roman times, and in South Asian countries during World War II, as a human food source (Vinci *et al.*, 1988; Ramakrishna & Dey, 2007). Currently, molluscs are considered a delicacy in many European countries, including France, the Netherlands, Belgium and Italy (Robert *et al.*, 2013) as well as in Latin America, Asia and Africa. Snail caviar is a luxury food item that has seen growing interest across Europe (DeMarco *et al.*, 2017). Heliculture or heliciculture are the terms used for snail farming chiefly for consumption of flesh and eggs, and for the use of slime for cosmetic purposes.

In underdeveloped countries, wild populations of freshwater molluscs (snails and clams) are extensively harvested and consumed as a cheap source of protein by economically and socially challenged communities. India has a history of snail consumption by tribal communities from the coastal, central and northeastern regions. Various classes of molluscs, such as snails, clams, oysters and squids are consumed by coastal communities in the southern part of India (Hornell, 1917). Snails (gastropods) are generally preferred in the states of Bihar, Jharkhand, Maharashtra, West Bengal and the entire northeastern region including Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura (Hornell, 1917; Ramakrishna & Dey, 2007). There are studies that show that snails are rich in calcium and substantial amounts of phosphorus, iron and zinc, notably in species like *Pomacea canaliculata*, *Pila globosa*, *Bellamya bengalensis*, *Melanoides tuberculata* and *Lamellidens marginalis* (Baby *et al.*, 2010; Ghosh *et al.*, 2017). Freshwater snails belonging to the genus *Pila* (*Ampullaria* is an objective junior synonym) are consumed for food as well as medicinal purposes in Tamil Nadu (Hornell, 1917) and other coastal regions.

Northeast India contains two biodiversity hotspots – the Himalayan Biodiversity hotspot and part of the Indo-Burma hotspot (Myers *et al.*, 2000). Around 145 tribal communities live in northeast India (Ali & Das, 2003) and almost all the tribes are dependent on various bio-resources. Among bio-resources, they rely extensively on freshwater molluscs for food and medicinal purposes. Freshwater gastropods are in great demand as they are readily available for collection and have some economic importance to the tribal community who sell them in the local market. They also act as a cheap source of protein and are eaten as food in many northeastern states, while some communities believe they possess medicinal value. To gather this traditional knowledge associated with freshwater molluscs, we conducted market surveys in northeast Indian states from July 2018 to December 2019 (Fig. 1). Our data show that communities collect 12 species of molluscs belonging to five families and seven genera. These



Fig 1. *Brotia* sp. and *Bellamya* sp. (upper panels, left and right, respectively) sold in the market by local tribes (lower panels).

include ten gastropod species, viz., *Pila globosa*, *P. olea* (Ampullariidae), *Bellamya bengalensis*, *Angulyagra* sp., *Cipangopaludina lecythis* (Viviparidae), three species of *Paludomus* (Paludomidae), *Brotia costua* (Pachychilidae) and two species of bivalves, *Lamellidens marginalis* and *Lamellidens* sp. (Unionidae).

We interacted with the vendors selling molluscs as well as with the local communities and found that they consume only freshwater molluscs and not the terrestrial species. Molluscs are mainly hand-picked from the rivers, streams and marshy areas during winter and monsoon seasons. Additionally, snails are collected from paddy fields exclusively during monsoons. Most of the vendors selling freshwater molluscs were women. According to the locals, during monsoon (June to September) and post-monsoon (October to February) seasons, the number of people selling molluscs is higher than in the summer season (March to May). Molluscs are sold not only in the main markets but also on the roadside and in small markets in many parts of northeast India. Snails are either already packed in one kilogram packets or sold loose according to the consumer's requirement. The average cost of snails during off-season is around 50 to 100 Indian rupees per mug depending on the species and 20 to 50 Indian rupees during monsoon and post-monsoon seasons. It is interesting to note that according to the locals in Mizoram, the elongated ones (*Brotia* sp.) are the females and the round ones (*Paludomus* sp.) are the males! According to our interaction with the locals, they are of the opinion that the water is too cold during the winters and thus they avoid collecting them, which could be one of the reasons for there being fewer snails in the market during this season. Another reason could be that people believe more juveniles are found during winter instead of adult snails, and juveniles are not preferred, as the people are not very fond of their taste.

Tribal communities in Manipur believe consuming snails enhances or helps maintain good eyesight and normal functioning of kidneys. Crushed snail shells are also added in the fodder of poultry as a good calcium supplement to enhance egg production.

Freshwater molluscs are being harvested from wild populations in thousands. Unfortunately, there is no updated list of freshwater mollusc species of northeast India, specifically those that are harvested. All old reports show only a few species are harvested. But our study has shown that 12 species are consumed by the people of northeast India. According to Budha *et al.* (2010), 33 % of the species from the entire Eastern Himalayan region, of which northeast India is a part, are in the IUCN Red List category Data Deficient. Apart from this, there are no data regarding the current population status in the wild for any of the freshwater molluscs. Locals are of the opinion that freshwater mollusc populations are dwindling and they also believe that this could be because of over-harvesting. In order to meet the requirements of local populations, snail farming could be introduced in these regions. Also, long-term population studies on freshwater molluscs in the wild need to be undertaken to assess population trends. Freshwater ecosystems in the northeastern region of India are threatened by pollution, construction of dams and habitat destruction (Budha *et al.*, 2010). Additionally, understanding the traditional tribal knowledge associated with freshwater molluscs is important in terms of documenting cultural and scientific heritage. The states of Manipur, Mizoram, Nagaland and part of Arunachal Pradesh share their borders with Myanmar, while Sikkim and Arunachal Pradesh have certain Chinese elements. Hence, it will be interesting to elucidate the historical biogeographical patterns of the molluscs of northeast India in addition to the possible conservation issues related to their heavy consumption.

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COLOURFUL GIANTS OF THE WESTERN GHATS: *INDRELLA AMPULLA* (GASTROPODA: ARIOPHANTIDAE)

By Sudeshna Chakraborty & N.A. Aravind

Indrella ampulla belongs to a monotypic genus of terrestrial snails in the family Ariophantidae. It was first described as *Helix ampulla* in 1850 by W.H. Benson (1850). It was subsequently placed by Godwin-Austen (1901) in *Indrella* and has remained there ever since. It is endemic to the Western Ghats of India but is widespread within the region, with its distribution ranging between 8°30' N and 13°00' N (Fig. 1). Its altitudinal range is also quite broad, extending from 150 m to about 1,800 m above sea level. The shell in adults can reach more than 55 mm in diameter, making it one of the largest species of terrestrial snails in India. Though they have well-defined shells, the animals cannot completely retract themselves into the shell. Only the head is retracted inside the peristome while the foot remains outside while resting. Individuals of this species are brightly coloured and very easy to spot. They are most active during the monsoon (June to October) season; this is the season for breeding and most ideal for sampling. Primarily, three colour morphs are present in this monotypic genus namely, red, orange and yellow. The mantle is the same colour as the body in the yellow morph, white in the orange morph, and bluish-black in the red morph. Juveniles of all the colour morphs are black and so is the shell. Apart from these widely distributed colour morphs, a combination of yellow and orange is also observed in some individuals.

The diet of *I. ampulla* includes mushrooms and decaying organic matter, and they have been seen scavenging on dead snails of the same species. They are generally not known to feed on plants. Nonetheless, some reports suggest that, being

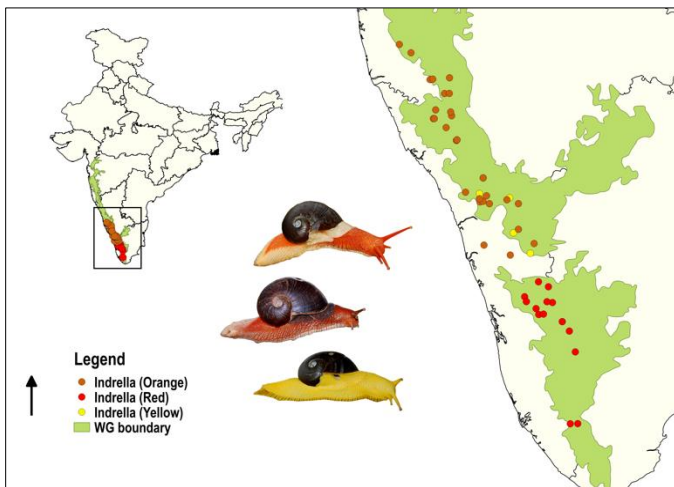


Fig. 1. Spatial distribution of the three colour morphs of *I. ampulla* in the Western Ghats (WG).

opportunistic feeders, this species feeds on fruits and flowers of cardamom (*Ellettaria cardamomum*), a commercially important spice (Sen *et al.*, 2016). On the other hand, the Western Ghats endemic cane turtle, *Vijayachelys silvatica*, preys on this species (Deepak *et al.*, 2009). Hitherto, the cane turtle is the only documented predator of *I. ampulla*, though there may be several other predators.

When threatened, individuals of this species tend to secrete immense amounts of slime that makes a sound similar to gushing of water. This extremely foamy, sticky slime is used to deter predators. An unusual thing about the animal is that it loses its colour along with the slime. For example, if a yellow individual releases excessive slime, bright yellowish patches are observed in the slime. This could be the reason that pale yellow or whitish individuals have been observed (Godwin-Austen, 1901), which were originally, probably, yellow. The same is observed in bi-coloured and orange individuals but not in red forms. The snail loses its colour completely when preserved in absolute ethanol for a long time (about a year) but this is also observed only in the yellow, orange and bi-coloured individuals and not in the red ones.

The distribution of the three colour morphs of *I. ampulla* is not uniform throughout the Western Ghats. The red morph is found only south of the well-defined low level landform, Palghat gap (10°45' N), which runs east-west across the Western Ghats. All other morphs are found north of the gap. While the ranges of orange and yellow morphs show some overlap (Fig. 2), the two have never been observed at the same site or in nearby sites. On the other hand, bi-coloured morphs have only been observed at sites close to sites with yellow morphs and have restricted distributions. The yellow morph has a very narrow range and is found only in and around the Wayanad region in the central Western Ghats. To date, there are only about half a dozen records of the yellow morph, whereas the orange morph has a broad range of both latitudinal and altitudinal distribution. Also, the orange and red forms are found in man-made habitats such as coffee and cardamom plantations. Thus, these can survive moderate levels of anthropogenic disturbance.

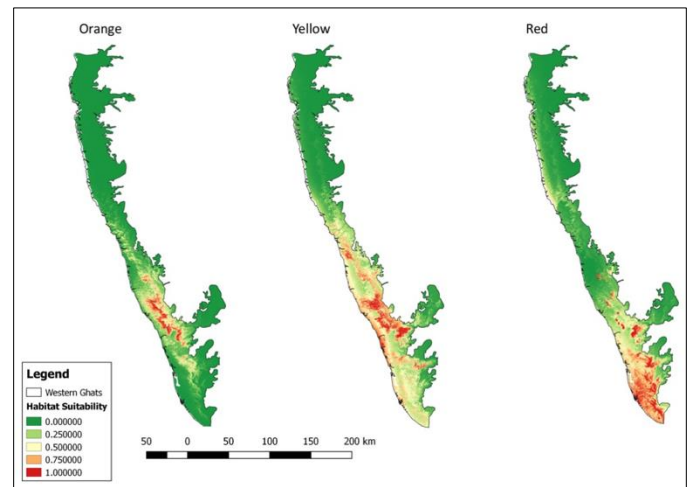


Fig. 2. Potential distribution of colour morphs of *I. ampulla* in the Western Ghats, India, based on a habitat suitability analysis.

The genetic distance (uncorrected p distance of the COI gene) between the colour morphs was around 0.6 % with the maximum being about 1.4 %. Genetically, the bi-coloured morph (yellow and orange) was almost identical to the yellow ones (< 0.5 %), while more than 1 % distant from the orange morph. On studying the anatomy of the different morphs, the bi-coloured morph was again found to be almost identical to the yellow one while some differences were observed compared to the orange morph. Phylogenetic reconstruction using a combination of nuclear and mitochondrial markers (~2,000 bp) showed that the orange and red morphs grouped together despite being allopatric. The sympatric yellow and orange morphs were, however, in separate, sister clades, while the bi-coloured and yellow morphs grouped together in the same clade. This meant that the closely distributed morphs are, genetically, more distantly related.

Indrella ampulla is endemic not only to the Indian sub-continent but is restricted only to the central and southern Western Ghats (south of 13°00' N). This calls for extensive study of the species, given that snails are very sensitive to changes in the environment. It is also important to note that this species is associated with evergreen forests of the Ghats, which are severely threatened throughout its range because of various anthropogenic activities. Despite this, almost no study, entirely focused on *I. ampulla*, has been conducted. That its status has not been assessed by IUCN further demonstrates the dearth of information regarding this species. In contrast, there is a study (Sen *et al.*, 2016) and a [newspaper report](#) that note the possibility of this species becoming a pest. More extensive studies on this species are required before giving it the title of pest.

Given the rapid development in the Western Ghats, adversely changing the environment, and fast-rising global temperatures, there is a need for immediate action in terms of data generation on various aspects of this species and for devising targeted conservation measures. The colourful and “charismatic” appearance of this species is slowly beginning to garner the attention of people who were otherwise oblivious to most other snails. For example, citizen science initiatives

such as the India biodiversity portal, iNaturalist and other social media platforms have seen a surge in photographs and distribution data of this species uploaded by amateur naturalists and photographers. Identifying the sheer potential of citizen science initiatives, we have launched a programme, MISS ([Mapping Indian Snails and Slugs](#)), in order to acquire more data on its distribution. To date, there are about 800 observations reported by citizen scientists as part of this initiative. This shows the success of *I. ampulla* as a flagship species eliminating the need for involving other taxa to attract the attention of the public and policy-makers towards much neglected snails and the invaluable ecosystem services they provide, and in turn, to advocate for their conservation.

We thank the Department of Science and Technology, Government of India, for funding (EMR/2015/00019/AS) this project.

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ON SOME EAST EUROPEAN SPECIES IN THE EUROPEAN RED LIST OF TERRESTRIAL MOLLUSCS

By Igor Balashov

The recently distributed [European Red List of Terrestrial Molluscs](#) (Neubert *et al.*, 2019) is a valuable work that is the most complete and up-to-date review of the conservation status of terrestrial molluscs in Europe. I am happy to be among its secondary coauthors, although I was involved only at a late stage regarding mainly Crimean species, and was not involved in generation of the species list. Unfortunately, a few species that are known in Europe from its eastern regions only are omitted from the [Supplementary Material](#). Some other species require additional comments.

The land snail *Prostenomphalia carpathica* Baidashnikov, 1985 (Hygromiidae) (Fig. 1) is endemic to the Ukrainian Carpathians distributed only in the single small mountain massif Chyvchyny, along the border with Romania (Fig. 2). It is the only species in the genus and its taxonomic status is

Fig. 1. Shell of *Prostenomphalia carpathica*, diameter ~ 12 mm. (Photo: A. Baidashnikov)



generally accepted and not disputed (Sysoev & Schileyko, 2009; Welter-Schultes, 2012; Balashov, 2016a; Bank & Neubert, 2017). Nevertheless, *P. carpathica* is not listed in the [IUCN Red List](#) nor in the [European Red List of Terrestrial Molluscs](#). This species has been officially listed in the Red Book of Ukraine since 1994 and is considered to be globally VU B1ab(iii)+2ab(iii) (Balashov, 2016b). Since *P. carpathica* was found next to the border with Romania it is very much expected to be found in that country as well. Therefore, it could be present in the countries of the European Union (EU). This snail lives at an elevation of about 1,000-1,400 m above sea level, along mountain streams in old spruce forests, mainly in the grass. All known populations are outside protected areas. It is threatened by the destruction of habitats, cutting of spruce forests, regulation of mountain streams, modification of their banks, construction of small hydroelectric stations (such projects in the Ukrainian Carpathians are being proposed but are opposed by the environmental movement), excessive grazing, excessive recreation and regular premeditated fires that are often used by the locals as their traditional way of removing unwanted grassy vegetation (despite it being banned) (Balashov, 2016b). There are only seven known locations of this species (Fig. 2, based on the collection of the I.I. Schmalhausen Institute of Zoology and the notebooks of A.A. Baidashnikov). According to an estimate using GeoCAT, its area of occupancy is 28 km² and extent of occurrence is 106 km², which corresponds to my previous estimation VU B1ab(iii)+2ab(iii) (IUCN, 2012).

Another omitted species is *Elia novorossica* (Retowski, 1888) (Clausiliidae) (Fig. 3). For a long time this land snail was



Fig. 2. Distribution of *Prostenomphalia carpathica*.

known only from a small area in the most western coastal foothills of the Western Caucasus near the city of Novorossiysk (Russia). In 2008-2012 three small populations were found 370 km to the north, on the Donetsk Upland in Ukraine (Fig. 3). The molluscs of this area had never been studied before, but considering that this species is associated with the best-preserved oak forests of the region in three distinct isolated locations and that it has never been found in anthropogenic environments, it was concluded that it is most probably a native relict. A few other mollusc species associated primarily with the Caucasus were also found on the Donetsk Upland, most notably *Deroceras subagreste* (Simroth, 1892), which was also associated with natural habitats. Many species of arthropods and plants associated primarily with the Caucasus are also considered to be native in such isolated parts of their ranges on the Donetsk Upland. Between the Donetsk Upland and Caucasus there is the almost forestless dry flat Kuban Lowland with low biodiversity. Considering that snails from the Donetsk populations of *E. novorossica* differ from the Caucasian ones in their morphology, habitat preferences (dead wood-dwellers instead of rock-dwellers) and are isolated geographically, these three populations were described as an endemic subspecies *Elia novorossica nagolnica* Balashov, 2013. The Donetsk Upland is naturally dominated by open steppe landscapes, while natural forests are scattered and mainly associated with valleys and ravines. Populations of *E. novorossica* inhabited old oak forests in the deep valleys (or almost ravines) of three small tributaries of the Nagolna River, 5-15 km apart from each other, with open steppe ridges and meadows in between. None of these sites is protected. The populations are much threatened by the expansion of villages in the lower regions of these small rivers, by cutting oak forests and by forestry activities intended to reduce the amount of dead wood. These locations have been in a zone of conflict since 2014, within the unrecognized so-called “Luhansk People’s Republic”, so the habitats could also be threatened by military activities. The actual area of the forest massifs supporting these populations of *E. novorossica* is less than 1 km² and their extent of occurrence is 8 km², therefore the conservation status of the subspecies, or of the Ukrainian populations of *E. novorossica*, was considered CR B1ab(iii)+2ab(iii) (Balashov, 2013). The Caucasian populations of *E. novorossica* are not protected and limited to the relatively small coastal area that extends about 100 km (Fig. 3) from the large Caucasian reserves, but there are at least 20 known sites and there seem to be no major threats to these populations. Therefore, its global status is probably LC.

The [Supplementary Material](#) table of the [European Red List of Terrestrial Molluscs](#) also does not list some other species of terrestrial molluscs that are known to occur in Europe, but are categorised as LC (“Least Concern”) or NA (“Not Applicable” – non-native in Europe), or that do not occur in Eastern Europe and have therefore not been assessed by me: *Zoogenetes harpa* (Say, 1824) (widely distributed, native), *Lauria cylindracea* (Da Costa, 1778) (widely distributed, native) and a few other native *Lauria* species, *Gibbulinopsis interrupta* (Reinhardt, 1876) (Donetsk Upland, probably non-native), *Oxychilus mingrelicus* (Mousson, 1863) (Donetsk



Fig. 3. Live snails and shells of *Elia novorossica* from Ukraine and its distribution in Russia and Ukraine.

Upland, non-native), *Parmacella ibera* (Eichwald, 1841) (Crimea, non-native), *Deroceras subagreste* (Simroth, 1892) (Donetsk Upland and Crimea, probably native), *Fruticicola schrenkii* (Middendorff, 1851) (European part of Russia, native) and *Harmozica ravergiensis* (Férussac, 1835) (several locations across Ukraine, non-native) (Balashov, 2016a; Balashov *et al.*, 2018).

The land snail *Chondrula tridens* (Müller, 1774) is listed in the [European Red List of Terrestrial Molluscs](#) with the global category NT (Near Threatened). This category could be correct for the EU, but across a very wide area in southern and eastern Ukraine, as well as in the southern part of European Russia, it is the most common species in very varied habitats, often including anthropogenic ones (e.g. Balashov, 2016a, b). Therefore, considering these thriving populations in the southern part of Eastern Europe, there is no doubt that the global status of *C. tridens* is LC.

The land snail *Pupilla bigranata* (Rossmässler, 1839) is listed in the [European Red List of terrestrial molluscs](#) and in the [IUCN Red List](#) as DD (“Data Deficient”). Recent molecular studies (Balashov *et al.*, 2019) have shown that this species is not valid. In fact, different forms of *Pupilla muscorum* (Linnaeus, 1758) and *Pupilla triplicata* (Studer, 1820) were identified as *P. bigranata* but the absence of type material and an unknown type locality does not permit determination of the correct synonymy). Therefore, *P. bigranata* should be excluded from the [IUCN Red List](#) and all other future reviews.

The conservation status of the land snail *Platyla jankowskiana* (Jackiewicz, 1979) should be changed to DD instead of VU (“Vulnerable”) as has been reported before (Balashov *et al.*, 2016; Skvortsova & Balashov, 2019). This species is either

extinct, an invalid synonym of another species or was not collected in its supposed type locality, none of which scenarios supports the VU category.

The land snail *Serrulina serrulata* (Pfeiffer, 1847) is listed as LC for Europe. In the European part of its range it is limited to the most preserved broad-leaved forests in several locations and is clearly at least NT in Europe and especially in the EU, probably VU 2ab(iii) (Balashov, 2016b). Although, its global status is LC if the Caucasian populations are considered.

It also worth mention that in my opinion the conservation statuses of some dead wood dwelling door snails (Clausiliidae) distributed in Central and Eastern Europe could be underestimated in the [European Red List of Terrestrial Molluscs](#). These species are abundant in some areas and do not correspond to the IUCN (2012) B-group criteria at a global level. However, considering the current methods of forestry management in Eastern Europe that aim to minimise the amount of dead wood, even in many protected areas (Balashov, 2016b), it is possible that several such species are VU or NT by the A2 or A3 criteria. But proper estimation by these criteria requires large amounts of data that I do not have. This concerns *Macrogastra borealis* (Boettger, 1878), *Macrogastra plicatula* (Draparnaud, 1801), *Macrogastra tumida* (Rossmässler, 1836), *Clausilia pumila* Pfeiffer, 1828 and *Pseudalinda fallax* (Rossmässler, 1836).

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IMPORTANCE OF PRIVATE PROPERTY IN CONSERVATION OF TERRESTRIAL GASTROPODS: SURVEY IN A PRIVATE FOREST IN MARYLAND, USA

By Aydin Örstan & Timothy A. Pearce

Recent studies have emphasised the increasing importance of wildlife conservation on private lands, especially when such lands are adjacent to public parks (e.g. Kamal *et al.*, 2015). [Merry-Go-Round Farm](#) is a private residential community overlooking the Potomac River in Montgomery County, Maryland. The property covers 81 ha (200 acres) that include about 80 houses with yards, several fields and wooded areas. Some of the woods appear, especially from the presence of large trees, to have been preserved uncut for several decades, perhaps at least since 1930 when the property was purchased. As a small test of whether private lands can harbour significant molluscan biodiversity, we surveyed terrestrial snails and slugs in wooded areas on the grounds of the farm. The survey was carried out by the first author during three field trips in May, October and December 2019, while the second author helped with identifications of the specimens collected and contributed to the writing of the manuscript.

We documented the following 17 species of terrestrial gastropods. The 15 snail species were collected and the two slug species were photographed in the field.

Land snails: *Anguispira fergusonii*, *Carychium exile*, *Cochlicopa lubrica*, *Euconulus polygyratus*, *Gastrocopta contracta*, *Helicodiscus parallelus*, *Mesodon thyroidus*, *Oxychilus cellarius*, *Punctum minutissimum*, *Punctum smithi*, *Stenotrema barbatum*, *Strobilops aeneus*, *Vallonia costata*, *Ventridens ligera*, *Zonitoides arboreus*.

Slugs: *Limax maximus*, *Megapallifera* cf. *mutabilis*.

Thirteen species of land snails were from a single site (39.0502 N, 77.2805 W) next to a small creek that flowed through a wooded ravine into the Chesapeake and Ohio (C&O) Canal northeast of the Potomac River (Fig. 1). At this locality both *Punctum minutissimum* and *Punctum smithi* were present (Fig. 2) and *Carychium exile* was abundant. In the same ravine the native slugs of the genus *Megapallifera* were observed on tree trunks in May (but not in October or December) (Fig. 2). *Megapallifera* species are difficult to identify from their external characteristics; we are listing the species we observed tentatively as *M. mutabilis*, because that species has been recorded previously along the Potomac River (Norden, 2008a; Steury & Pearce, 2014). We identified the *Oxychilus* specimens as *O. cellarius* because the live snails did not smell like garlic, thus eliminating *O. alliaris*, and because the anatomy of one dissected specimen was closer to



Fig. 1. The locality where 13 species of land snails were found.

that of *O. cellarius* than that of *O. draparnaudi*. Eight lots of shells collected during the survey have been deposited in the Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA (catalog numbers CM 172806-172813).

All the species we found, other than *Oxychilus cellarius* and *Limax maximus*, are native to Maryland. Once again, our findings underline the importance of forest preservation in the survival of native gastropod species (Örstan *et al.*, 2019). Also, the high proportion of native species suggests that the woods on Merry-Go-Round Farm are relatively pristine (Pearce, 2009). Merry-Go-Round Farm borders the C&O Canal National Historical Park. The native species found in the present survey were also recorded during a 2006 bioblitz in the C&O Canal National Historical Park (Norden, 2008b) and during recent surveys on Plummers Island, also owned privately, as well as in other national parks along the Potomac River (Norden, 2008a; Steury & Pearce, 2014). Our results show that woods preserved on Merry-Go-Round Farm provide continuous and enlarged habitat for the conservation of native

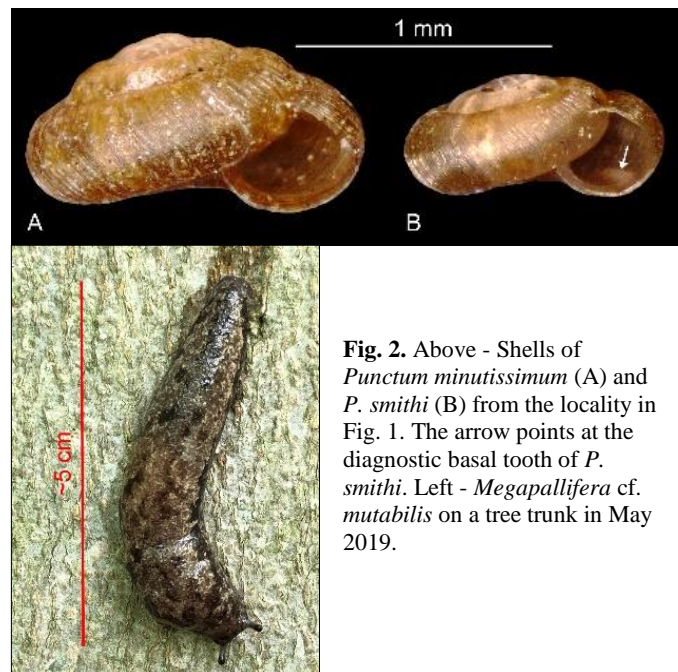


Fig. 2. Above - Shells of *Punctum minutissimum* (A) and *P. smithi* (B) from the locality in Fig. 1. The arrow points at the diagnostic basal tooth of *P. smithi*. Left - *Megapallifera* cf. *mutabilis* on a tree trunk in May 2019.

gastropods present on adjacent parkland. We hope that habitat preservation on Merry-Go-Round Farm will continue.

We thank Mr. Zafer Ecevit for making this survey possible and for his companionship during the collection trips.

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THE PACIFIC NORTHWEST LAND SNAIL *CRYPTOMASTIX DEVIA* (GOULD, 1846) UNDER CONSIDERATION FOR LISTING UNDER THE US ENDANGERED SPECIES ACT

By Edward J. Johannes

The US Fish and Wildlife Service (USFWS) had determined that the land snail *Cryptomastix devia* (Gould, 1846) (Puget Oregonian), found in the states of Washington and Oregon, USA (Figs. 1, 2), might be eligible for endangered species protection because of threats to its habitat from logging, agricultural conversion, high-intensity fires and *Acer macrophyllum* (bigleaf maple) mortality as a result of climate change (USFWS, 2011, 2012). Its absence in northern Washington may be due to glaciation during the Ice Ages. After much delay, this year the USFWS has initiated a species status assessment to determine whether listing under the Endangered Species Act (ESA) is warranted.

This snail's convoluted conservation history in the US, along with that of 43 other molluscs (19 freshwater snails, 7 slugs and 17 land snails) under President Clinton's Northwest Forest Plan (NWFP) (FEMAT, 1993), their subsequent designations as Record of Decision (ROD) species or Survey and Manage (SM) species (USDA & USDI, 1994), lawsuits to continue SM, and a petition brought by the Center for Biological Diversity and other environmental organisations for listing under the ESA (Curry *et al.*, 2008) were previously covered in *Tentacle* (Johannes, 2012, 2013). This snail is included in a list of 274 species in a lawsuit recently brought against the



Fig. 1. *Cryptomastix devia* sites (red dots) in Oregon and Washington, USA and one site (blue dot at top of map) in Victoria, Vancouver Island, Canada.

Trump administration by the Center for Biological Diversity in Portland, Oregon, USA (Johannes, 2020).

Cryptomastix devia is also a Canadian Species at Risk in British Columbia but is listed as extirpated there (Fig. 1) and is probably extinct in Canada. Recent surveys have not found this species at the two 1800s and one early 1900s sites from which it was reported (Pfeiffer, 1850; Taylor, 1889; Dall, 1905) or elsewhere in British Columbia (COSEWIC 2002, 2013).

I would like to thank Adam Baldinger (Museum of Comparative Zoology, Cambridge, USA), for providing the photo of *C. devia*.

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Fig. 2. *Cryptomastix devia* from Victoria, Vancouver Island, British Columbia (Taylor, 1889). (Photo: A. Baldinger)

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THE CENTER FOR BIOLOGICAL DIVERSITY SUES THE TRUMP ADMINISTRATION FOR FAILURE TO DECIDE ON FEDERAL STATUS FOR 274 IMPERILED SPECIES THAT INCLUDE MOLLUSCS

By Edward J. Johannes

On 20 November 2019 the Center for Biological Diversity in Portland, Oregon, USA [filed formal notice](#) of their intent to sue the Trump administration for blocking the determination of the federal status of 274 species found across the US. Years overdue, these are some of a 500 species backlog that was to be addressed by the US Fish & Wildlife Service (USFWS) in a [workplan](#) they developed in 2016.

Among the species listed in the legal filing are 21 eastern US unionid bivalves and 39 western and eastern US gastropods (terrestrial and freshwater species). Some of these molluscs were part of a 32 species petition for listing under the Endangered Species Act sent to USFWS (Curry et al., 2008; Johannes, 2012, 2013; USFWS, 2011, 2012).

The Center for Biological Diversity is looking for interested parties and expert witnesses to submit standing declarations



Fig. 1. Hoko vertigo (*Nearctula n. sp.*). This species was referred to under *Vertigo* by Frest & Johannes (1993, 1996), USDA & USDI (1994), Kelley *et al.* (1999) and in the legal filing by the Center for Biological Diversity. Found in the northern Olympic Peninsula, Washington State, USA. Logging threatens the survival of this species. (Photo: Terry Frest)

for each species listed in the litigation to be submitted to the court to show that there is an interest in the protection of these species. You can contact Noah Greenwald at +1 (503) 484-7495 or at ngreenwald@biologicaldiversity.org.

I would like to thank Jeff Miller at the Center for Biological Diversity for his input on this article.

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MOLLUSCS ASSESSED BY COSEWIC IN 2019

By Dwayne A.W. Lepitzki

Three terrestrial gastropod species were assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2019. COSEWIC is an independent body of experts that assigns conservation status to species using IUCN criteria and recommends listing and legal protection under the Canadian Species at Risk Act (see Lepitzki & Mackie, 2013, in [Tentacle 21](#) for details).

Two snails, *Mesodon zaletus* (Toothed Globe) and *Inflectarius inflectus* (Shagreen), were assessed as Endangered (EN), while *Philomycus carolinianus* (Carolina Mantleslug) was assessed as Threatened. The global ranges of all three species extend into southern Ontario. *Mesodon zaletus* was historically known from several islands on the Canadian side of Lake Erie and may still occur at three sites on the mainland where suitable habitat still exists. It was last observed alive in Canada in 1994. *Inflectarius inflectus* (Fig. 1) also was historically known in Canada from two mainland Ontario sites as well as five Canadian islands in Lake Erie. Currently, it is known only to exist in Canada on two islands. *Philomycus carolinianus* (Fig. 2) inhabits undisturbed older-growth forests and riparian areas and is currently known from several mainland sites as well as one Canadian island in Lake Erie. All three were assessed as being at risk because of their small extent of occurrences and areas of occupancy, a small number of threats-based locations, and a projected continuing decline in the quality of habitat.

For all three species, suitable habitat in Canada has been lost because of agricultural and urban development and forestry and continuing habitat fragmentation is problematic because of low dispersal abilities. Climate change, prescribed burns and invasive species were the main threats to all. Droughts, flooding and especially changes in frost regimes and spring-time temperature fluctuations under climate change are the most serious threats.



Fig. 1. *Inflectarius inflectus* (Shagreen), Middle Island, Lake Erie, Canada, May 2013. (Photo: A. Nicolai)



Fig. 2. A group of three *Philomycus carolinianus* (Carolina Mantleslug) under a log, Pelee Island, Lake Erie, May 2018. (Photo: Annegret Nicolai)

Including these three species, the total number of terrestrial gastropods confined to southern Ontario in Canada that have been assessed by COSEWIC now stands at seven. These also include: *Allogona profunda* (Broad-banded Forestsnail, EN 2014; COSEWIC, 2014), *Patera pennsylvanica* (Proud Globelet, EN 2015; COSEWIC, 2015), *Anguispira kochi kochi* (Eastern Banded Tigersnail, EN 2017; COSEWIC, 2017) and *Webbhelix multilineata* (Striped Whitelip, EN 2018; COSEWIC, 2018). Other terrestrial molluscs from southern Ontario that are currently being assessed by COSEWIC include *Discus patulus* (Domed Disc), *Neohelix dentifera* (Big-tooth Whitelip), *Ventridens intertextus* (Pyramid Dome), *Ventridens ligera* (Globose Dome) and *Strobulops aeneus* (Bronze Pinecone).

More information on COSEWIC can be found at the [COSEWIC website](#). Status reports for the three species assessed by COSEWIC in 2019 will be posted online; follow the links at the above website.

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INTERNET SHELL TRADE, A NEW THREAT TO MALACODIVERSITY

By Guoyi Zhang & Min Wu

Shells were not a bulk business target in China's economic tradition. However, this situation has changed recently. Has such shell trading affected the malacodiversity of the places where these shells come from? Is there any real-time or potential negative influence of this business practice on mollusc conservation? The story of Mr. Jing He, the largest Chinese shell trader, shows different facets of the relationship between shell exploration and conservation and sheds light on consideration of the above questions.

In 2004, He began to sell shells and shell-related goods in Shanghai. As a so-called independent researcher in conchology (guokr.com/i/0935377258/), through a private museum and internet business website (ganvana.com), he expands the business in shells. His publications, namely the books "Families of Mollusks" and "The Freshwater Bivalves of China", and the journal "Shell Discoveries" make his public image more close to a serious malacologist, although they made trouble for malacology. Despite dressing himself up as a conchology researcher and despite his infectious enthusiasm for popularisation of conchology, He targets nothing but selling shells.

Biodiversity pursuits need a scientific and operative species concept (Hong, 2016). His rude attitude towards the International Code of Zoological Nomenclature (ICZN) is exemplified in his 2018 public statement that "even now, ICZN is not the law that we must obey". He has described and published new species, most of which have been synonymized or proven to be misidentifications (e.g. in freshwater molluscs: Bogatov & Prozorova, 2017; in terrestrial molluscs: Páll-Gergely *et al.*, 2017; Zhang, 2019). Moreover, the types of such new species are kept privately (Fang, Y.F. pers. comm.; Qian, Z.X. pers. comm) rather than being deposited in qualified institutions as recommended by ICZN (1999). The purpose of such publication seems only to name the species after the collectors who usually supply the shells for free and are inspired by such action to collect more (Lu, L. pers. comm.; Wang, K. pers. comm.). The staffs of some Chinese public museums, including Zhejiang Natural Museum, Beijing Natural Museum and Tianjin Natural Museum, cooperated on these publications. These staff, most not expert in malacology, even knew neither what such papers dealt with nor the material involved (Zeng, Z., pers. comm.). This official connection means, to the public, that this manipulation will undoubtedly make his commercial life have a halo of popular science. In addition, taking group photos with well-known museum curators of malacology has provided another false impression to the public. And he co-operated with a variety of organisations of natural science popularisation and some national institutions, including Shanghai Zoo, Tsinghua University, Key Laboratory of Tropical Marine Bio-resources and Ecology (Chinese Academy of Sciences), which unintentionally helped him to package himself as a conchologist who loves popular science and nobody can say it is not a big advertisement for his shell business.



Fig. 1. At the shell auction of the “Interesting Museum”. Ji, Xiaohua (Ji, Shisan), CEO of Guokr, one of the hugely influential popular science websites of China, bidding for a shell.

All these and some popular science websites (e.g. www.guokr.com) made He an outstanding star in the field of popular science. His fans in the popular internet social network Weibo reached 4,582,000 as of 30 November 2019. Daily page views via this network reach more than 100,000. Videos of his popular science activities received many hits, e.g. 96 videos on Bilibili with a top hit rate of 76,000, the videos on Weibo with 30,000 to 359,000 hits. Meanwhile, offline shell shows also attract numerous visitors. For example, at the shell auction of the “Interesting Museum” hosted by www.guokr.com (Fig. 1), 65,000 ads were released and visitors over two days reached 28,957. He’s fans can be classified into three groups. The first is the consumer. The second is both the consumer and the shell provider. The third is the shell provider. Many shell providers are collectors from undeveloped areas where even low-priced business makes collection activities rational.

The growing page views, increasing number of fans, and shell shows result in a prosperous business depending on injury to malacodiversity. As shown by the website, there were 35,289 shell items available for sale in He’s shopfront as of 19 July 2019. Every week about 250 new items were added. Sales of shells have been assessed as stable at around 13,000 per year. The shells are not only obtained from the collectors mentioned above, but also from international shell trades through which shells from Australia, Europe, the Philippines, Thailand, the United States, Vietnam, etc. are obtained. We are suspicious of the source of many shell items sold by He, e.g. the famous *Liguus* spp. are from two natural reserves in Florida (Fig. 2).

About 42 species (19 %) that are now for sale in He’s online shell store are listed in the categories Endangered (EN) and Critically Endangered (CR) on the China Species Red List (CSRL) (Wang & Xie, 2004, 2005). Because CSRL covers only a portion of the mollusk species of China, i.e. 221 species of gastropod snails, based on the species recorded in the published “Fauna Sinica” series that include approximately 1,800 valid species (Dong, 1988, 2002; Mang, 1997; Wang, 1997, 2002; Chen & Zhang, 1999, 2004; Xu, 1999; Zhuang,

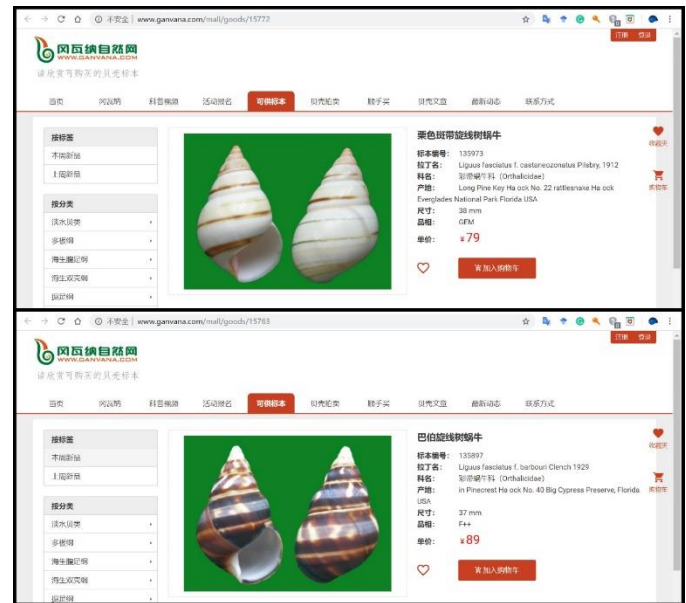


Fig. 2. *Liguus fasciatus* for sale at www.ganvana.com.

2001; Zhang, 2016; Wu, 2018), we estimate the Chinese species for sale in He’s online store “[Ganvana Nature](http://www.ganvana.com)” are more than 340 species, the number of which might be slightly reduced because of his misidentifications. Considering that Chinese shell specimens in this store number 3,971, about 11.3 % of his total stock, we estimate about 2,600 species worldwide are threatened by this business.

Although cooperating with the institutions involved in natural preservation, He says with certainty that his shell collection activities will not do harm to malacodiversity (May 28, 2010, web article). Deliberately minimizing the impact of artificial collection to dispel any further doubts the consumers might have, he usually overemphasizes that damage to habitats is the only way in which molluscs become extinct. The truth is, as for instance like the Cuban land snail *Polymita picta*, many species are becoming seriously endangered by human collection/recreational activities.

Here we just provide an example of how e-business attracts a rapidly growing number of fans who in return influence or will potentially impact biodiversity enormously. In this case, both the traders and the purchaser are wandering in the grey zone where the biodiversity-friendly world is challenged by the commercial interests and rawness of greed that is often overlooked by the professionals, institutions and lawmaking bodies.

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LAEVICAULIS HAROLDI (MOLLUSCA, VERONICELLIDAE): A 40 YEAR JOURNEY FROM NATAL (SOUTH AFRICA) TO KOLKATA (INDIA)

By Sheikh Sajjan & Basudev Tripathy

The veronicellid slug genus *Laevicaulis* Simroth, 1913 belongs to the family Veronicellidae of the order Systellommatophora (Bouchet *et al.*, 2017), distributed across the tropical and subtropical region (Gude, 1914; Forcart, 1953; Gomes & Thome, 2004; Gomes *et al.*, 2010). The slugs are normally hermaphroditic and lack an internal shell or calcareous particles (Gude, 1914; Runham & Hunter, 1970; Barker, 2001). There are eight valid species of the genus restricted to this tropical and subtropical climatic region. In the Indian subcontinent, *Laevicaulis alte* (Ferussac, 1822) and *Laevicaulis haroldi* Dundee, 1980 are so far reported, of which *L. alte* is widely distributed across India (Gude, 1914; Ramakrishna *et al.*, 2010; Raheem *et al.*, 2014; Tripathy *et al.*, 2018), Sri Lanka (Marambe *et al.*, 2011), and Nepal (Budha *et al.*, 2015), while *L. haroldi* is restricted to India (Avhad *et al.*, 2013; Magare, 2015; Khan, 2019).



Fig. 1. Dorsal and ventral side of the caterpillar slug *Laevicaulis haroldi* Dundee, 1980.

Dundee (1980) described *Laevicaulis haroldi* from Stamford Hill, Durban, in South Africa, based on a collection made by her herpetologist colleague Dr. Harold A. Dundee and Mr. Lynn Raw. The live specimens were collected on *Typha* leaves during a herpetological investigation on 23 December 1977 and the type specimens were deposited in the U.S. National Museum of Natural History, Washington DC (Dundee, 1980). *Laevicaulis haroldi* is best known for its caterpillar-like appearance and its fine wrinkled bands (Dundee, 1980; Herbert, 1997). Surveys indicate that native populations of the species are sparse and highly restricted in KwaZulu-Natal, South Africa (Herbert, 1997; Govender, 2007). Thus, the species was categorized as Endangered in the IUCN Red List (Herbert, 2013).

Despite being listed as Endangered, *Laevicaulis haroldi* is now becoming a pest in India. The species was first reported and illustrated in 2013 from the Aurangabad, Paithan and Gangapur areas of the state of Maharashtra but the authors failed to identify it properly and interpreted it as *L. alte* (Avhad *et al.*, 2013). Nevertheless, individuals of *L. haroldi* were sighted and reported from several different places in Maharashtra, viz. Nasik, Dhule, Nandurbar and Vanyavahir, as well as Ahmedabad in the state of Gujarat (Magare, 2015). Most recently, the species has been reported in New Delhi (Khan, 2019). Citizen scientists, however, have revealed the actual status of the species' dispersal into other major cities, viz. Udayapur (Rajasthan), Pune (Maharashtra), Thane (Maharashtra), Mumbai (Maharashtra), Kancheepuram (Tamil Nadu) and recently from Kolkata (West Bengal). It is quite surprising that all the above cities are in proximity to national and international airports. We believe that the species could have been introduced from Natal to India by international trade into Mumbai in 2010-2012 or through intentional human activities and dispersal to the other cities of India (Fig. 2).

The existing literature also reveals the damage caused by *L. haroldi* to commercial silk production mulberry plants, damaging the nutritive value of the plant (Avhad *et al.*, 2013; Magare, 2015). Nevertheless, detailed population assessments and assessments of the impact on native biodiversity is needed in order to understand future consequences.

We are grateful to the Director, Zoological Survey of India, for providing the necessary facilities for the study. SS is thankful to the MoEF&CC for providing a research fellowship through the National Mission on Himalayan Studies (NMHS) programme (grant NMHS-LG-2016/0011/8509-8).

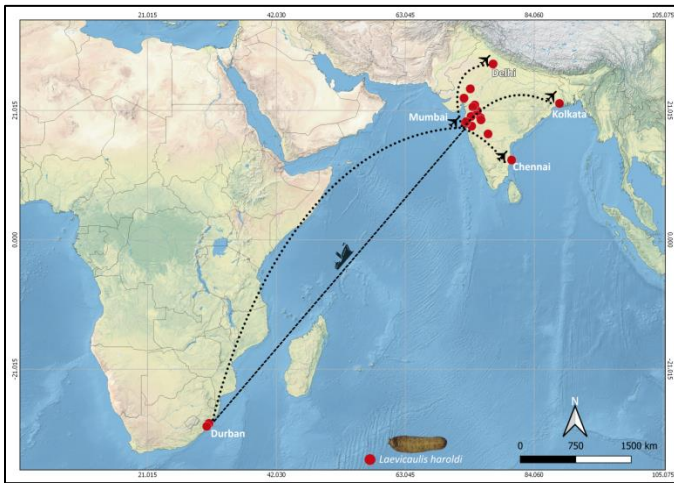


Fig. 2. The possible dispersal route of the alien caterpillar slug *L. haroldi* from Natal to Kolkata and elsewhere in India.

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POTAMOLITHUS SPP. IN THE ARGENTINE PAMPAS

By Micaela de Lucía & Diego E. Gutiérrez Gregoric

The genus *Potamolithus* is the only native representative of the family Tateidae in South America. It includes small gastropods (up to 7 mm) that inhabit rivers and streams of the Southern Cone of South America (López Armengol, 1996). Most of the species of *Potamolithus* are known only from their shells; only a few have anatomical and molecular information. In Argentina, nine species (out of the 24 present) have anatomical descriptions that include pallial organs, radula, reproductive system and external characters of the soft parts (Pilsbry, 1911; López Armengol, 1996; Miquel, 1998; Núñez, 2016; de Lucía & Gutiérrez Gregoric, 2017a, b). From the genetic point of view, only four species have information available in GenBank. There have been no studies of population level aspects in the genus.

In the [IUCN Red List](#) seven species of *Potamolithus* have been evaluated, all by G. Pastorino and G. Darrigran; four of them were classified as Least Concern and three as Data Deficient. The Argentinean coasts of the Río de la Plata are used for different purposes (port, recreation, source of drinking water and wastewater, for dumping of waste and industrial effluents, sport and commercial fishing, water sports), which could affect species of *Potamolithus*; however, the actual impact of these threats is unknown (Darrigran, 1999). Six species of *Potamolithus* have been recorded from Buenos Aires province: *P. agapetus* Pilsbry, 1911; *P. bisinuatus* Pilsbry, 1896; *P. buschii* (Frauenfeld, 1865); *P. lapidum* (d'Orbigny, 1835); *P. petitianus* d'Orbigny, 1840 and *P. orbignyi* Pilsbry, 1896 (López Armengol & Darrigran, 1998). These records are based on data from malacological collections and sampling carried out in the 1980s. It is noteworthy that in 1991 the presence of the invasive mussel



Fig. 1. Martín García Island, Buenos Aires province, Argentina. *Potamolithus* sp. and *Chilina* sp. in yellow box.

Limnoperna fortunei (Dunker, 1857) (Pastorino *et al.*, 1993) was recorded in the Río de la Plata. This species is considered an ecosystem engineer for its ability to transform the environment it colonises (Darrigran & Damborenea, 2011). The presence and abundance of the golden mussel have led to a decrease of native gastropods, displacing local populations of *Chilina fluminea* (Maton, 1809) and *Uncancylus concentricus* (d'Orbigny, 1835) on the Argentinean coasts of the Río de la Plata (Darrigran *et al.*, 1998).

The objective of this project is to know the conservation status of the genus *Potamolithus* on the Pampean region along the coast of the Río de la Plata. For this, seasonal sampling is being carried out at sites with historical records, providing the first population studies (growth and recruitment) of species in this genus and completing anatomical and molecular descriptions. These studies are part of the doctoral thesis of the first author at the Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata.

Samples were taken along the coast from Martín García Island (IMG), which is a protected area (34°11' S, 58°14' W) (Fig. 1), to Atalaya Beach (35°00' S, 57°32' W), during 2018 and 2019. The Argentinean coast of the Río de la Plata has been greatly altered by people and the invasion of *Limnoperna fortunei* (Fig. 2) in recent years, which has made it difficult to find specimens of *Potamolithus*. On IMG, specimens have been observed at various sites, and growth experiments are being carried out both in situ and in the laboratory. The first observations indicate that they reach sexual maturity at 157 days after hatching, as evidenced by a complete peristoma.

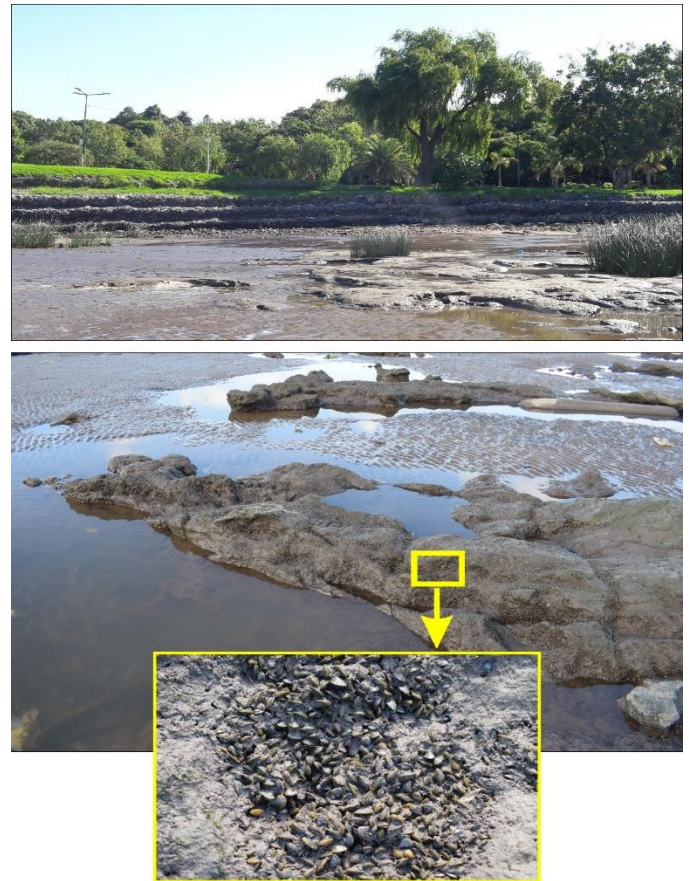


Fig. 2. Anchorena Beach (San Isidro), Buenos Aires province, Argentina. *Limnoperna fortunei* in yellow box.

As a result of the conchological, anatomical and genetic analyses, five taxonomic entities are distinguished: 1) two entities correspond to species already recorded on IMG, and both now have anatomical and molecular descriptions (*P. agapetus* and *P. buschii*); 2) one entity corresponds, based on shell characters, to *P. bisinuatus*, previously recorded on IMG but for which only conchological data are as yet available; and 3) two entities that do not correspond to any of the species recorded on IMG.

We are grateful to the ASAM (Argentine Association of Malacology) and the COA (Conchologists of America) for the awards given to the first author, which covered part of the costs of carrying out these analyses. We thank the IMG ranger staff for help with logistics and for support during the sampling, and A. Zivano for collaboration in the sampling. The first author's doctoral thesis is undertaken with the support of a doctoral grant from the Comisión de Investigaciones Científicas of Buenos Aires province.

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FURTHER SPREAD OF THE ALIEN GASTROPOD *OTALA PUNCTATA* (MÜLLER, 1774) IN MALTA

Justin Camilleri, Louis F. Cassar & Patrick J. Schembri

The helicid *Otala punctata* (Müller, 1774), native to the western Mediterranean (Martinez-Ortú & Robles, 2001), was introduced into a plant nursery near Mosta, in central Malta, with imported horticultural material sometime around 2003 (Mifsud *et al.*, 2003). From here it dispersed to establish a breeding population in the area surrounding the nursery (Barbara & Schembri, 2008, 2010)

A second population of *Otala punctata* (Fig. 1) subsequently established itself at Bahrija, a rural agricultural area, some 7 km distant from the original site of introduction. The authors investigated the distribution and abundance of *Otala punctata* at the Bahrija site, as well as that of the native helicid *Eobania vermiculata* (Müller, 1774), which has a similar ecology to that of the alien species under study and which, therefore, may be negatively affected by the introduction.



Fig. 1. *Otala punctata* from Bahrija, Malta. Scale bar 10 mm. (Photo: S. Camilleri)

Otala punctata was noted to have colonised three sectors along the Bahrija valley system, and, at the time of survey, the species occupied an overall area of approximately 0.6 km², with a mean abundance of 0.4 individuals per m². It now appears that the alien helicid has not, thus far, affected the population of *Eobania vermiculata*, as the population density of the native species remained more or less constant within the plots investigated along the valley watercourse (seasonal run-off conduit), regardless of incidence and abundance of the alien species. The density of *Otala punctata* was highest (1.98 individuals per m²), close to the presumed site of initial introduction at Bahrija (35°53'28"N, 14°20'40"E), where the first individuals were recorded (Cilia, 2012). We estimate that the yearly rate of expansion of the area of occupation of *Otala punctata* at Bahrija is 0.075 km² per year. This was calculated in terms of area at the end of a time period (T) divided by the number of years since its first occurrence (Y); therefore, T/Y = rate of expansion per year.

Otala punctata was most abundant in low virescent vegetation. In contrast, *Eobania vermiculata* was most abundant in areas where dry vegetation, mostly grasses, were predominant. This suggests a degree of habitat segregation between the alien and native snails. *Otala punctata* also showed a preference for aestivating attached to tree stumps (Fig. 2) and trunks, as well as to vines (*Vitis vinifera*), presumably to avoid predation and to evade the scorching heat at ground level (Albrecht, 2001; Herbert, 2010).

Shell measurements indicated a higher abundance of juvenile *Otala punctata* at the extremities of its distribution at Bahrija. This could indicate that the snails are actively dispersing outwards, possibly as population density increases and therefore intraspecific competition increases at the centre of the area of occurrence. The outward expansion of the *Otala punctata* population also appears to have been hindered by physical barriers, including steep escarpments, country roads, fallow or abandoned agricultural land where extensive tracts of xerophytic vegetation occur and built-up areas. It was further noted that vegetables grown at Bahrija for the local market, including cabbage (*Brassica oleracea* var. *capitata*) and broccoli (*Brassica oleracea* var. *botrytis*), often had juvenile *Otala punctata* attached. This suggests that the alien stands a good chance of being transported with agricultural produce from Bahrija to markets elsewhere, and therefore there is a high potential for the alien species to colonise new areas in the Maltese Islands.



Fig. 2. An aggregation of (mainly) *Otala punctata* aestivating attached to newly grafted *Citrus aurantium* on the upper reaches of Bahrija valley. (Photo: J. Camilleri)

Although we found that the establishment of a population of the alien *Otala punctata* does not seem to have affected the population of its closest indigenous relative (*Eobania vermiculata*), this does not mean that it may not have a negative impact on this and other local species in the future or that it will not become an agricultural pest. The spread of the alien therefore needs to be monitored and possibly controlled.

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PROBLEMS WITH THE CONSERVATION OF THREATENED SNAILS (GENUS *AYLACOSTOMA*) IN ARGENTINA AND PARAGUAY

By Manuel G. Quintana

The “Aylacostoma Programme in Yacyretá” is a conservation initiative of scientists from the Museo Argentino de Ciencias Naturales “Bernardino Rivadavia” (Argentine Museum of Natural Sciences, MACN, Buenos Aires), who in 1993 became aware of the potentially devastating effect of the Yacyretá Hydroelectric Dam on four endemic species of the genus *Aylacostoma* (Fig. 1). These *Aylacostoma* snails are ovoviviparous and up to four offspring develop in a brood pouch or adventitious marsupium where they feed on newly arrived eggs – and on their siblings – until they reach a size at which they may withstand the strong flow of their typical rapids habitat (Fig. 2). Immediately after release, juveniles seek shelter in a dense cover of green, red and golden algae growing on the parental shell (Fig. 3).

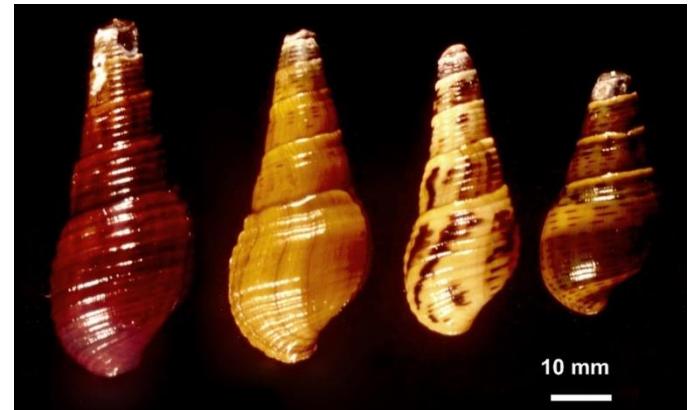


Fig. 1. The four species of *Aylacostoma*. Left to right *A. guaraniticum*, *A. chloroticum*, *A. stigmaticum*, *A. brunneum*.

Scientific interest in these snails relies on the fact that they reproduce only parthenogenetically, because all individuals are females (natural clones). Nevertheless, their status was not considered during the extensive and expensive environmental impact evaluation undertaken before the building of the dam.

Until 2018, the *Aylacostoma* Programme in Yacyretá had been developed jointly by the MACN and the Yacyretá Binational Entity (EBY). Since May 2018, there were rumours that the EBY would discontinue its commitment of annual financial and logistical support to the project. This was totally unexpected because we were not aware of any conflicts or disagreements between the partners. Therefore, in December we wrote to the newly appointed Executive Director of the EBY, Lic. E.M. Goerling Lara (a politician without any interest in biological conservation), highlighting our concerns over this issue. The response came from a member of his staff, who confirmed the decision to suspend the support. Thus, the EBY unilaterally decided to withdraw from the *Aylacostoma* Programme without formal notification or explanation of the underlying reasons. They only hinted at what was expected: that the intention was not to save expenses (...?). It is worth



Fig. 2. The original environment in the rapids of Apipé, flooded by the dam.

mentioning that the *Aylacostoma* Programme in Yacyretá was designed and implemented as a cooperation between EBY and MACN in 1994. At that time, the MACN was requested to develop a conservation plan for endemic species of the genus *Aylacostoma*, which involved captive breeding and subsequent release into the Paraná River. The primary objective was to prevent the extinction of these molluscs as a result of habitat loss (Fig. 4). Ecologists from the World Bank, the Inter-American Development Bank and the International Bank for Reconstruction and Development showed a supportive and enthusiastic attitude toward this collaborative effort. In 2000, these species were listed as Critically Endangered on the [IUCN Red List](#). This posed a challenge to the MACN, which, after overcoming a number of difficulties, accomplished the development of an ex situ breeding installation, thus serving as a repository useful not only for reintroduction and restocking purposes, but also for genome preservation. The culture originated from individuals caught in the reservoir at a depth of 8-10 m by SCUBA diving. Following the advice of IUCN experts, we informed the EBY of the importance of establishing one or more backup repositories, preferably in institutions located within the geographic range of the species. As a result, a second repository was set up in the University of Misiones in 1998. A team of their biologists received training in installation and operation procedures at the MACN, while



Fig. 3. Adult *Aylacostoma* sp. with newly released juveniles.

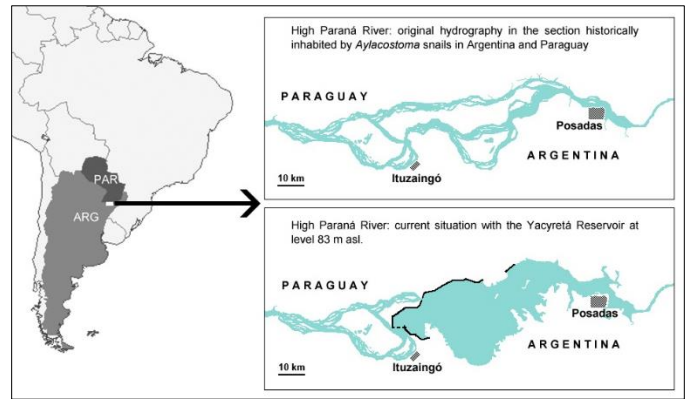


Fig. 4. Change resulting from construction of the Yacyretá Hydroelectric Power Plant reservoir.

we supervised their activities and supplied stocks of snails from our cultures on many occasions. Moreover, these scientists participated in various activities of the *Aylacostoma* Programme, including surveys, reintroduction assays, monitoring, papers and contributions in congresses, among others. Finally, a tripartite contract was signed by EBY, MACN and the University of Misiones.

Although this project may not be perceived to be as attractive as those involving the “big charismatic species” (such as giant panda and jaguar), it pursues the same objectives in terms of biodiversity conservation. We obtained satisfactory results applying rescue and ex situ cultivation for more than 20 years! However, the project failed in part because the reintroduction of snails into the river was delayed too much, despite our wishes. So far, the few trials carried out have not achieved the expected results because of the disappearance of most of the rapids of the Alto Paraná River. However, our joint effort has received awards and congratulations from researchers and conservationists, and has been recognised as an example in Latin America of how a dam operating agency assumes responsibility for adverse impacts on species of high ecological fidelity, such as the speies of *Aylacostoma*. Despite the sudden and unexpected decision of the Yacyretá Binational Entity, the *Aylacostoma* Programme must continue until the reintroduction of these snails in the river to establish persistent populations in their historical geographical range becomes possible (today there are more than 3,000 adult snails in our repository!). In this context, for field work we need the financial help of some organisation sincerely interested in critically endangered species.

For general information, see the following references:

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CONSERVATION OF NON-MARINE MOLLUSCS IN CENTRAL SOUTHERN BRASIL: NEW ADDITIONS TO THE INVENTORY OF SANTA CATARINA STATE

By A. Ignacio Agudo-Padrón & Douglas Meyer

In the course of 2019, and based on the last systematic listing of non-marine molluscs in Santa Catarina state (Agudo-Padrón, 2018), an additional four species (two native forest gastropods – a snail and a semi-slug) and two native bivalves (a clam and a mussel) have been added to the current inventory, for a confirmed total of 249 species and subspecies (including 24 alien gastropods and four alien bivalves).

The recently incorporated species (Fig. 1), which occur in malacological regions 2 and 6 of the state (Fig. 2), are: an unidentified forest snail, *Leiostracus* sp. (Simpulopsidae) (Fig. 1A) from region 2, the rare forest semi-slug *Peltella iheringi* Leme, 1968 (Bulimulidae) (Fig. 1B) from region 6, the native freshwater mussel *Diplodon* cf. *suavidicus* (Lea, 1856) (Hyriidae) (Fig. 1C) from region 6, and the native limnic clam *Eupera bahiensis* (Spix, 1827) (Sphaeriidae) (Fig. 1D) from both regions.



Fig. 1. A. Native forest snail *Leiostracus* sp., Morro da Boa Vista, Joinville Municipal District, Northern region. Shell ~ 10 mm. (Photo: Fábio Longen, Project AM collaborator)
 B. Native forest semi-slug *Peltella iheringi* Leme, 1968, Doutor Pedrinho Municipal District, Itajaí River Valley region. Specimen ~ 30 mm. (Photo: Douglas Meyer, Project AM collaborator)
 C. Native freshwater mussel *Diplodon* cf. *suavidicus* (Lea, 1856), Benedito River, Benedito Novo Municipal District, Itajaí Valley region. Shell ~ 30 mm, voucher FURB-MO 366. (Photos: Francisco Carneiro, Project AM collaborator)
 D. Native limnic clams *Eupera bahiensis* (Spix, 1827), Rio Corticeirinha, Guaramirim Municipal District, Northern region. Specimens ~ 4 mm, voucher FURB-MO 361 (Photo: Francisco Carneiro, Project AM collaborator)
 (FURB-MO: Malacological Collection of the Universidade Regional de Blumenau)

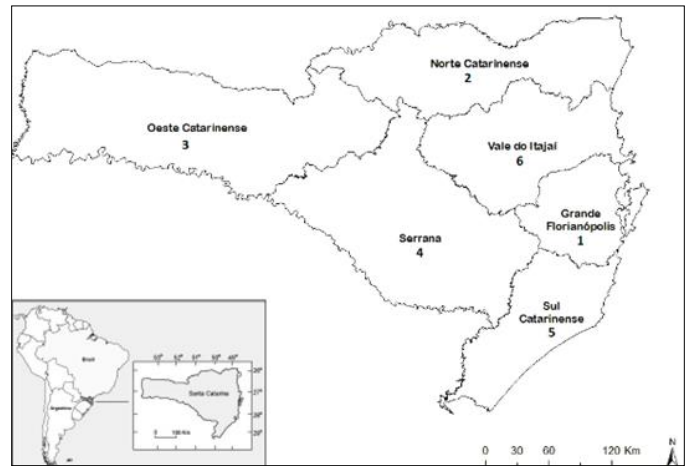


Fig. 2. Malacological regions of Santa Catarina state: Greater Florianópolis, coastal and mountain region (1); Northern region (2); Western region (3); Highlands region (4); Southern region (5); Itajaí River Valley region (6). (Map: original by A. Ignacio Agudo-Padrón, “Project AM”)

Additionally, a second new geographical record of a native forest snail in the genus *Orthalicus* Beck, 1837 (Orthalicidae) (see Agudo-Padrón, 2017), was recorded on 28 July 2019 in the São Miguel da Boa Vista Municipal District (26°41'24"S, 53°15'03"W), in the west of Santa Catarina state, by the second author of this article, local naturalist Douglas Meyer. It was apparently a young specimen ~ 10 mm in size found in a riparian strip of Atlantic Forest in the Sergeant River basin, in malacological region 3, part of the great Uruguay River basin (Fig. 3), confirming and consolidating the occurrence of this taxonomic group in the region (Agudo-Padrón 2017).

Finally, the giant native semi-arboreal forest species *Phyllocaulis boraceiensis* Thomé, 1972 – the largest known leatherleaf slug in the Americas, which can reach more than 200 mm in length – was described as being orange-brown, densely covered with small dark spots (Thomé, 1972). The holotype and most of the paratypes are from São Paulo state but one of the paratypes is from Santa Catarina state and one is from Minas Gerais state (city of Juiz de Fora). This specimen from Juiz de Fora was described as much darker in colour, which was attributed to a preservation artefact. However, detailed study of its morphology revealed that it is a new species of *Phyllocaulis* (Oliveira 2016). This new native leatherleaf slug is extremely rare and very little is known of its ecology and conservation status.

Fig. 3. *Orthalicus* sp., São Miguel da Boa Vista Municipal District, Western region (new geographical record). Young specimen ~ 10 mm. (Photo: Douglas Meyer, Project AM collaborator)





Fig. 4. *Phyllocaulis* sp. ~ 150 mm, area of the Chapecozinho River (26°46'S 52°37'W), principal tributary of the Chapecó River in the Uruguay River Basin. (Photo: Douglas Meyer)

In October 2019, Douglas Meyer found a single specimen (Fig. 4) of this species of *Phyllocaulis*, ~150 mm in length, in the area of the Chapecozinho River in the Uruguay River basin (malacological region 3 of Santa Catarina state), with the same morphological characteristics.

Expectation of other new regional malacological surprises awaits us in the near future. This brief report brings to 250 the number of non-marine species inventoried in the geographical territory of the State of Santa Catarina.

We reiterate once again that research into the conservation status of mollusc biodiversity in the state of Santa Catarina is urgent in view of the rapid changes taking place to the natural environment as a result of human activities and the parallel very rapid process of invasion by alien species. In depth studies of the basic population biology and reproductive cycles of the regional molluscs are urgently needed, in addition to middle- and long-term ecological research.

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IS CHILINA MEGASTOMA, AN ENDEMIC AND RESTRICTED DISTRIBUTION FRESHWATER SNAIL, ENDANGERED EVEN THOUGH PROTECTED?

By Ximena M.C. Ovando, Luiz E.M. Lacerda & Sonia B. dos Santos

The Iguazu Falls are among the most spectacular waterfalls in South America and one of the most beautiful in the world as they combine a high and wide structural step across a fluvial system with high water discharge in a sub-tropical environmental location that sustains an exuberant forest and high biodiversity (Steveaux & Latruesse, 2010). The falls span the Iguazu River, located on the border of Argentina (within the Iguazu National Park) and Brasil (within the Iguazu National Park) and represent the most important biological continuum in the center-south of South America (ICMBio, 2020). It has been recognised as a UNESCO World Heritage Site since 1986 and with more than 1.5 million visitors a year provides direct economic benefits. Besides the visit to the falls, other tourist attractions include hiking, rafting and rappelling (ICMBio, 2019).

The freshwater molluscan fauna of Iguazu National Park, mainly pertaining to the family Chiliniidae, is well known on the Argentinean side (Ituarte, 1997; Gutiérrez Gregoric & Rumi, 2008; Gutiérrez Gregoric & de Lucia, 2016). Currently, this family includes 24 species recorded in Argentina, eight of which are endemic to the Iguazu area (Gutiérrez Gregoric & de Lucía, 2016). *Chilina megastoma* is an endemic species described by Hylton Scott (1958) from Salto dos Hermanas (part of the Iguazu Falls on the Argentinean side). The original description of *C. megastoma* was mainly based on the shell morphology of a single specimen (Hylton Scott, 1958). Ituarte (1997) added information about its internal anatomy (radula, reproductive and nervous systems) using topotypic specimens and added two new localities: Salto San Martín and Arrechea rivulet. Also, he mentioned a sample from Brasil, but without much detail: "...and the other from a vertical cliff permanently swept by a small waterfall at [sic] the Brazilian side...". Gutiérrez Gregoric & de Lucía (2016) also mentioned the presence of *C. megastoma* in Brasil without specifying the exact locality, probably reporting Ituarte's work.

With the aim of gaining a better understanding of the molluscan freshwater fauna on the Brazilian side (Iguazu National Park) we carried out a survey in several freshwater environments during February 2018. At a single sampling point (25°41'26.052" N 54°26'14.712" E) we discovered a population of *Chilina megastoma*, which, according to the literature (above), had not yet been properly recorded for Brasil.

Chilina megastoma was recorded in a natural spring, on a vertical rocky wall converted into a fountain (Fig. 1). Specimens were found attached to the rock, exposed to the natural spring and not submerged in the fountain (Fig. 2). They were collected and fixed in 96 % alcohol (some specimens were fixed in Railliet-Henry solution for

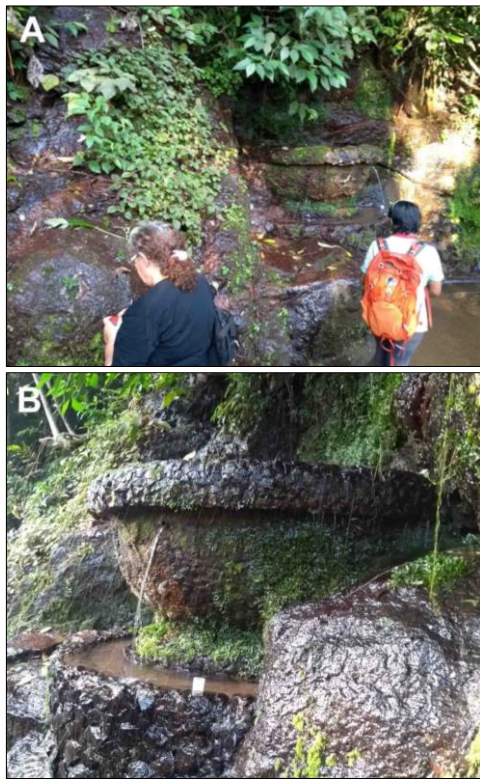


Fig. 1. Site where *C. megastoma* was collected. A, general view of the site. B, detail of the fountain on the rocky wall.

comparison with Ituarte's work). The material collected was deposited in the Malacological Collection at the Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brasil (Col. Mol. UERJ 11598). The shell matched the original description and the internal anatomy was consistent with the details presented by Ituarte (1997).

This species, similar to other *Chilina* species, inhabits waterfalls and running water in well oxygenated environments (Brace, 1983; Ovando & Gutiérrez Gregoric, 2012; Gutiérrez Gregoric & de Lucía, 2017). According to Ituarte (1997), this species seems to be endemic to restricted environments with high energy fresh water such as waterfalls, vertical cliffs and rocky walls. The occurrence of these specimens in such a restricted habitat could be explained by both an adaptive response to particular environment conditions (Ituarte, 1997; Brace, 1983) as well as by the possible formation of the Iguazu falls and its current configuration. During the 1970s, along with an intensive program of dam construction for hydroelectric power, dozens of wonderful waterfalls like Sete Quedas, São Simão, Avanhadava, and São Luiz were submerged and disappeared altogether along with their forest and fauna (Steveaux & Latrubesse 2010).

Unfortunately, the location where *C. megastoma* was found is a major tourists pathway towards the falls, near the Garganta do Diabo (Devil's Throat), which implies anthropogenic pressure and the possibility of illegal collecting of specimens (Fig. 3A). However, the biggest threat may be the construction of a rafting access point under the natural spring (Fig. 3 B, C), which we fear will impact the site and its population of *C. megastoma*, which could disappear. We hope

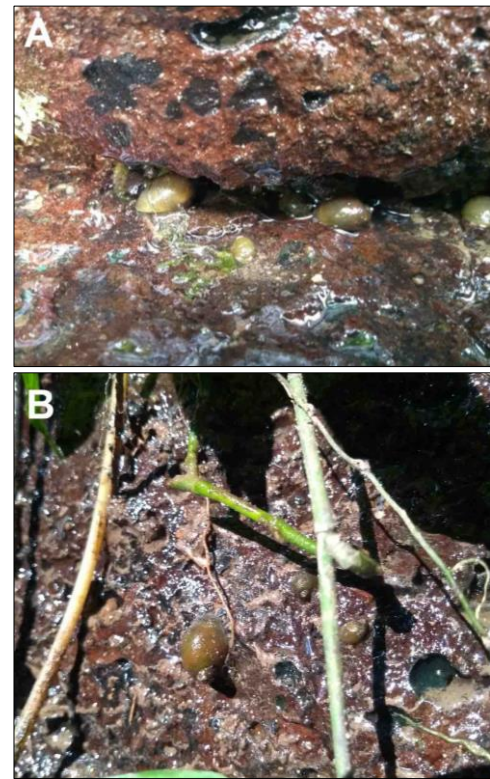


Fig. 2. A, B, Live specimens of *C. megastoma* crawling on the rock.

that through this publication, the authorities of Iguazu National Park will take the necessary measures to protect this population by reducing or removing pressure and taking the opportunity to provide the public with a small education campaign based on these novel findings. In parallel we will submit a proposal to the Chico Mendes Institute for Biodiversity Conservation (ICMBio – one of the Brazilian government's environmental agencies) to include *C. megastoma* in the next updated list of endangered molluscs of Brasil according to the IUCN criteria (restricted distribution and environment under anthropogenic pressure). Finally, in order to protect this species, we propose the installation of a structure that does not allow free access to the site and



Fig. 3. Photos showing A, the runway to the falls, and B, C, the construction work for the rafting point.

warning signage. In this way, we aim to encourage more effective preservation of habitat and the species itself.

We thank IBAMA/SISBIO for collection licenses 10812/1 and 54180-2 at the Iguazu National Park; to the staff of the PARNA Iguazu, specially Ana Claudia Muniz (Macuco Safari group) for all facilities provided. To CAPES for financial support (88887.066723/2014-00) and a fellowship to Prociência/UERJ for SBS (2019-2021). Also, we thank Joel C. Creed for revising the English.

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serious threats from non-native species. We report on the brief history of surveys and conservation of these land snails and introduce our captive breeding programmes for species that are seriously threatened in the wild.

The Ogasawara Islands are located in the northwestern Pacific approximately 1,000 km south of mainland Japan. They are composed of very small volcanic islands, and the largest island, Chichijima, is only 24 km² in area (Fig. 1). However, approximately 120 species of land snails have been found on the islands, and more than 90 % of them are endemic. Several genera, such as *Mandarina*, *Hirasea* and *Ogasawarana*, have undergone extensive adaptive radiation within the islands (Chiba, 1999; Chiba & Cowie, 2016). In 1827, Captain Frederick Beechey visited the Ogasawara Islands and collected several species of land snails (e.g. *Mandarina mandarina*), which constituted the first scientific recording of the islands’ land snails. Later, in the early 20th century, a Japanese malacologist, Yoichiro Hirase, collected a number of land snails from the islands. These snails were sent to Henry A. Pilsbry, who described the most important species.

In Ogasawara, human colonisation and habitat destruction began in 1830 on Chichijima and in 1876 on Hahajima. By 1921, approximately 60 % of the forest of these two islands had been cleared and converted to sugarcane fields or pastures. Several species of native snails went extinct in this period because of habitat loss. However, most of the inhabitants of the archipelago were evacuated to mainland Japan during the Second World War, and the US Navy occupied the islands during 1945-1967.

Because they were largely uninhabited during this period, the forests on all of the islands of Ogasawara regenerated. The forest areas of Ogasawara were mostly protected after 1968, but since then, population declines and extinctions of the native species have been documented, particularly on Chichijima, Hahajima, Ototojima and Mukojima. This has primarily been due to the introduction of non-native species after the 1940s (Chiba & Roy, 2011). So far, around 20 % of the Ogasawara land snail species have gone extinct in the wild.

Impacts of non-native species

Serious declines in the snail fauna have occurred on Chichijima since the 1990s because of predation by the large malacophagous flatworm *Platydemus manokwari* (Ohbayashi *et al.*, 2007). Although *Euglandina “rosea”* (now recognized as more than one species; Meyer *et al.*, 2017) was introduced to Chichijima before the 1970s, the impacts of this carnivorous snail on the native snail fauna have been minor. At present, *E. rosea* has become almost extinct because of predation by *P. manokwari*.

The distribution of *P. manokwari* has expanded rapidly since the 1990s and now encompasses the whole island of Chichijima. Most of the native land snail species of the island have gone extinct except on two small peninsulas in the southernmost part of the island, where the flatworm has not yet invaded or is still not abundant. Among the 25 native snail

PACIFIC ISLAND LAND SNAILS

Conservation programmes for endemic land snails in the Ogasawara Islands: captive breeding and control of invasive species

By Hideaki Mori, Mayu Inada & Satoshi Chiba

The land snail fauna of the oceanic Ogasawara Islands has offered excellent model systems for ecological and evolutionary studies. The Ogasawara Islands are registered as a UNESCO World Heritage Site, and land snails are regarded as the most crucial iconic organisms of this site. However, endemic elements of these snails have faced

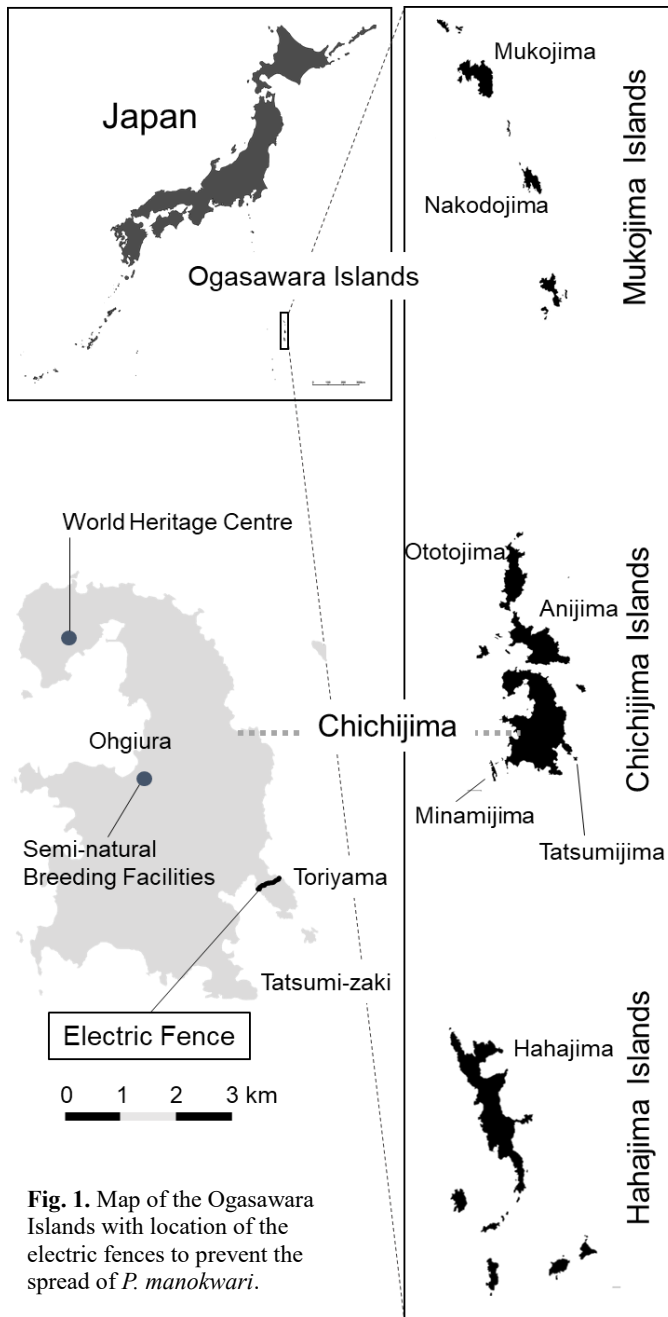


Fig. 1. Map of the Ogasawara Islands with location of the electric fences to prevent the spread of *P. manokwari*.

species recorded from Chichijima in the 1980s, 16 had become extinct on the island within 25 years because of predation by *P. manokwari*. In the case of *Mandarina*, four species seem to be extinct in the wild on Chichijima, and one species survives on only the two small peninsulas (Toriyama and Tatsumi-zaki; Fig. 1).

Declines of land snails have also occurred on Hahajima because of predation by small malacophagous flatworms such as *Bipalium* sp. (Okochi *et al.*, 2004). In addition, African big-headed ants (*Pheidole megacephala*) have caused a decline of achatinid snails (Uchida *et al.*, 2016). Overgrazing by wild goats has caused habitat loss on the Mukojima Islands, which resulted in a decline of the land snail fauna. More recently, predation by black rats has also affected the snail fauna in Anijima (Chiba, 2010).



Fig. 2. The electric fences constructed at Toriyama to prevent the spread of *P. manokwari*.

In situ conservation programmes for Ogasawara land snails

Since 2000, programmes have been implemented to mitigate the impacts of goats, black rats, African big-headed ants and *P. manokwari* on land snails. Wild goats were eradicated from Anijima, Otojima, Mukojima and Nakodojima. Aerial application of poisons was carried out on Anijima, Mukojima and other islands to eradicate black rats. Thanks to the applications in 2010 and 2016, the density of black rats has decreased in Anijima, but it has been difficult to eradicate them completely. Eradication programmes for African big-headed ants using poison baits have been implemented on Hahajima since 2015, and their distribution has decreased as a result.

A huge amount of effort has been devoted to mitigating the impacts of *P. manokwari* in Ogasawara since the 2000s. Research to develop a flatworm repellent has been conducted, and salt water and vinegar were found to be effective to some extent. However, they are not effective enough to eradicate *P. manokwari* in the wild. Alternatively, a search for attractants for *P. manokwari* has been carried out to gather, trap and kill them, but an effective attractant has not been identified so far.

The Ministry of the Environment of Japan constructed 40 cm high electric fences, 340 m in length, at the neck of the Toriyama Peninsula in the southeastern part of Chichijima in March 2015 (Figs. 1, 2). At the same time, two enclosures protecting important habitats were built inside the fences. The goal was to prevent the spread of *P. manokwari*, which had not yet invaded the area at that time. The fences collapsed and the flatworms invaded when a serious typhoon hit the island in August 2015, but the enclosures effectively prevented the invasion until the summer of 2017.

Current government measures against the impacts of *P. manokwari* are mainly focused on preventing their spread from Chichijima to other islands. Since *P. manokwari* is usually transferred with soils, various regulations restrict the transportation of any materials with soil (e.g. agricultural crops and soil stuck on the soles of shoes). These conservation programmes have been run by the Ministry of the Environment, Forestry Agency, Tokyo Metropolitan Government and the Ogasawara Village Office. The efforts

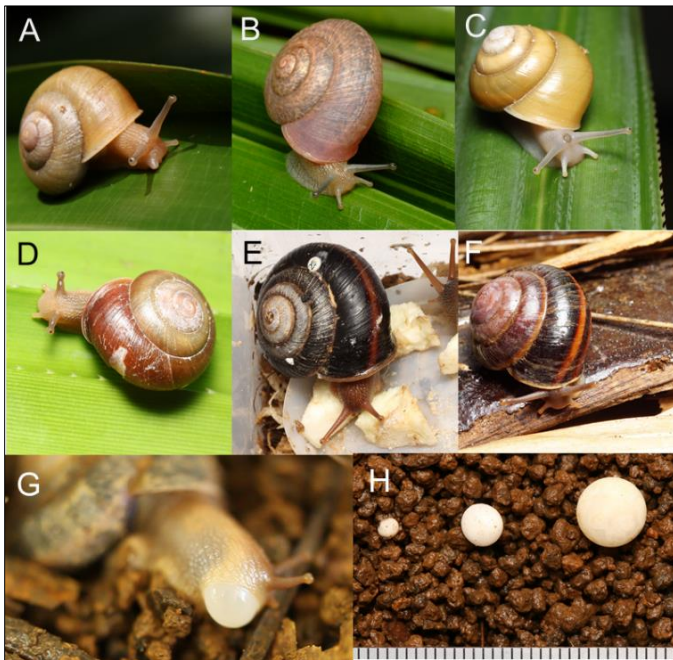


Fig. 3. The *Mandarina* species bred in captivity. A – *M. tomiyamai*, B – *M. sp.*, C – *M. suenoae*, D – *M. hirasei*, E – *M. mandarina*, F – *M. chichijimana*, G – *M. mandarina* laying an egg; H – Large eggs of *M. mandarina* (right) and of *M. suenoae* (middle) compared to one of *Acusta despecta* (left).

were also implemented under the supervision of the Land Snails Conservation Working Group.

Captive breeding programmes

The eradication of non-native species, particularly *P. manokwari*, is facing difficulties, and attempts at the in situ conservation of land snails on Chichijima have failed. One approach to prevent the extinction of native species is captive breeding and reintroduction following restoration and securing of habitats (Pearce-Kelly *et al.*, 1995). Such a programme is now under way for *Mandarina* and some other genera.

Mandarina is an endemic genus of Ogasawara comprising more than 20 species, which have shells approximately 2-3 cm in diameter. These species include both arboreal and ground-dwelling species. Most of the species of *Mandarina* lay a small number of very large eggs during each oviposition event, and approximately two years are necessary for the snails to mature (Fig. 3).

The first attempt at captive breeding of *Mandarina* was carried out in the 1990s by S. Chiba at Tohoku University. Initially, the breeding techniques used for *Partula* were used for breeding *Mandarina*, which Chiba learned at the laboratory of Bryan Clarke at the University of Nottingham. In the early 2000s, Angus Davison improved the methods for breeding *Mandarina* and succeeded in decreasing the mortality rates in the laboratory. Inducing oviposition in *Mandarina* was still difficult at that stage, but H. Mori modified the artificial diets and breeding conditions, resulting in successful reproduction of *Mandarina* species in the laboratory in the late 2000s.

The Ministry of the Environment developed a captive breeding programme for *Mandarina* on Chichijima,



Fig. 4. The World Heritage Centre laboratory on Chichijima, in which endangered land snail species of Ogasawara are bred.

collaborating with the Japan Wildlife Research Center (JWRC) and Tohoku University, in 2010. The captive breeding of *Mandarina mandarina* collected from Yoakeyama on Chichijima began in 2011. Captive breeding of Chichijima populations of *M. suenoae* started in 2012. *Mandarina hirasei* and *M. chichijimana* were later collected from Chichijima, and captive breeding of these species began.

In addition, populations of *M. hirasei* and *M. chichijimana* from the off-shore islet of Tatsumijima were brought into captive breeding in 2014. In 2015, captive breeding was established for *M. tomiyamai* and an un-named *Mandarina* species, which were seriously threatened by the impacts of black rats on Anijima. Throughout the programme, H. Mori improved the breeding techniques and succeeded in establishing breeding populations. As of June 2019, 4,311 individuals of 13 populations (i.e. six species derived from Chichijima, Anijima and Tatsumijima and four species almost extinct in the wild) are bred in the laboratory of the World Heritage Centre on Chichijima (Fig. 4). Conspecific snails from different localities are maintained separately because local populations of the same species are genetically highly divergent. The breeding stocks are managed by the Ministry of the Environment with assistance from Ogasawara village residents.

All the breeding snails are individually recorded and monitored by the team, which includes M. Inada, three researchers from JWRC and eight resident staff. To estimate the genetic variation in the breeding populations, genotypes are individually scored using microsatellite DNA. Until now, extreme decreases of genetic variation, which may cause inbreeding depression, have not been observed in the breeding populations. To avoid the risks of extinction of a genetic lineage by accident, the Tokyo Zoological Park Society started captive breeding programmes for *Mandarina* species on the Japanese mainland in 2017 with the assistance of the Ministry of the Environment. As of July 2019, 416 individuals of two species of *Mandarina* are maintained in the laboratories of four zoos in Tokyo.



Fig. 5. Facilities for breeding snails set up in the forest of the Ohgiura area on Chichijima. A – mesh net facility with electric fence. B – mesh units and C – open unit within facility A. D – portable facilities. E – open facility without mesh net.

Breeding programmes for *Mandarina* under semi-natural conditions have also been established on Chichijima. Several types of facilities were developed in the forest of the Ohgiura area, the western part of Chichijima, to breed snails. The biggest type, which was developed first, is an enclosure approximately 20 m² in area and covered by a mesh net along with an electric belt surrounding the facility to prevent the ingress of *P. manokwari* and rats (Fig. 5A). In total, 744 individuals of three species of *Mandarina* have been successfully bred in these facilities as of June 2019. Based on these results, another enclosure (approximately 4 m² in area) with an electric belt but no mesh net has been prepared. The effectiveness of its planarian exclusion system under natural conditions in which leaves, soil biota and rain are naturally supplied will be tested (Fig. 5E). At present, these captive breeding programmes are executed by the Ministry of the Environment under the supervision of the Land Snails Conservation Working Group.

Translocation programmes

The Ministry of the Environment developed a translocation plan for *Mandarina* under the supervision of the Working Group in 2019. Reintroduction has been planned for *M. chichijimana* and *M. hirasei*, which are bred in captivity but are extinct or nearly extinct in the wild on Chichijima. First, candidate sites for the release of breeding snails were searched for on Chichijima, but there were no possible sites for translocation because *P. manokwari* is expected to spread throughout the island within several years, and the species has been difficult to control. Thus, two small islands where these two species were formerly distributed were selected as candidate sites for translocation: Tatsumijima and Minamijima.

These two species have been found on Tatsumijima, but few individuals of *M. chichijimana* were recorded during surveys in 2019. The decline of the *Mandarina* snails on Tatsumijima was caused by predation by black rats, which have now been controlled with poison and bait traps for a year so far. Individuals of *M. chichijimana* and *M. hirasei* were collected from the island before the decline and have been bred in captivity; thus it will be possible to reinforce the original population from the captive population.

Both *M. chichijimana* and *M. hirasei* were recorded from Minamijima before the 1980s, but became extinct there because of habitat destruction resulting from overgrazing by goats. Vegetation on this island has been recovering after the extermination of the goats, which will enable the establishment of *Mandarina* populations. Snails from a candidate population of *M. chichijimana* for reintroduction to Minamijima were collected from the southwestern-most part of Chichijima (the area closest to Minamijima) and have been bred in captivity. In the case of *M. hirasei*, snails from a candidate population for reintroduction were obtained from the southernmost part of Chichijima, which is the closest population of *M. hirasei* to Minamijima among other populations bred in captivity.

The translocation plan for *Mandarina* basically follows the IUCN guidelines for reintroduction (IUCN/SSC, 2013), with modification specific to the needs of land snails. One of the most crucial risks in translocation is possible introduction of pathogenic organisms from the laboratories into the wild because other native snails such as *Ogasawarana* species in Tatsumijima and *Tornatellides* species in Minamijima are still present. Moreover, there is not much information regarding diseases in land snails except for a few examples (e.g. Cunningham & Daszak, 1998).

To prevent the spread of potential infection of wild snails, the candidate snails for translocation are hatched and raised under sterile conditions until they are about 3-6 months old. The level of genetic variation of the snails released can be controlled by crossing the individuals selected from the breeding stock because their genotypes are individually scored. Management of habitat conditions (e.g. vegetation, soil and control of non-native species) is also required for successful translocation.

Although there are a number of issues that need to be solved for successful translocation, the plan is an important step in the conservation of endangered snails in Ogasawara. Further improvement of breeding techniques, particularly those under semi-natural conditions, and the development of methods to control *P. manokwari* are necessary for effective conservation. However, these efforts may take a long time. The promotion of efforts to strengthen the mutual collaboration among residents, researchers, companies and the government is essential to maintain long-term conservation programmes.

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Hawaii Snail Extinction Prevention Program (SEPP)

By David R. Sischo

Habitat destruction, introduced predators, and climate change are wreaking havoc on the native terrestrial snails of the Hawaiian Islands (Hadfield, 1986; Solem, 1990; Hadfield *et al.*, 1993; Cowie *et al.*, 1995; Hadfield & Saufler, 2009). It is estimated that half of the roughly 750 described species are probably extinct (Yeung & Hayes, 2018). Recent rapid declines observed across multiple islands indicate that approximately 100 additional species may be facing oblivion



Fig. 1. Hawaiian land snail species recently established in captivity, clockwise from top left *Achatinella sowerbyana* (Oahu), *Newcombia canaliculata* (Molokai), *Laminella sanguinea* (Oahu), *Achatinella byronii* (Oahu), *Achatinella livida* (Oahu).

within the decade. On New Year's Day 2019 the last known *Achatinella apexfulva*, an Endangered tree-snail species endemic to the island of Oahu, died at 14 years of age in captivity. The probable extinction of *A. apexfulva* has highlighted the vulnerability small terrestrial snail populations have to stochastic decline in the wild and in captivity, and is a cautionary example of what the next decade holds for the remaining snail fauna of the islands without swift intervention.

In light of this extinction crisis the Hawaii Department of Land and Natural Resources (DLNR) established the Snail Extinction Prevention Program (SEPP). SEPP works with a diverse array of partners across the state to build capacity for in situ and ex situ conservation aimed at preventing further extinction. In 2016 SEPP opened its captive rearing facility. The first inhabitants of this space were seven laboratory populations of endangered tree snails in the genera *Achatinella* and *Partulina*, inherited from the University of Hawaii (UH). Building on a foundation of over 30 years of research and captive rearing efforts carried out by Dr. Michael Hadfield and his team at UH, SEPP has been able to expand operations and now rears 38 species in nine genera from five islands (Genera: *Achatinella*, *Partulina*, *Perdicella*, *Auriculella*, *Newcombia*, *Amastra*, *Laminella*, *Cookeconcha*, *Pleuropoma*), and is preparing for the likely need to accommodate more species (Fig. 1).

All species at the SEPP facility are maintained inside environmental chambers that control temperature, relative humidity, and light (Figs. 2, 3). Tree snails, family Achatinellidae and *Cookeconcha hystricella* (Endodontidae), are maintained on native host plants that are brought in from the field, from which the snails glean algae and fungus from plant surfaces and are supplemented with a cultured native fungus



Fig. 2. Chambers that control relative humidity, temperature and light are used to rear snails in the SEPP captive rearing lab.

(*Cladosporium* sp.) grown on potato dextrose agar. Snails in the families Amastridae and Helicinidae are maintained on a diet of decaying leaves of several native host plants, cultured *Cladosporium* sp., and a small amount of fresh vegetation. Snail terraria are cleaned on a two-week cycle. During cage cleanings, the cages are sterilised, vegetation and fungus are replaced, and the populations are censused.

Hawaiian land snail rearing relies heavily on native vegetation collected by staff from high elevation mountainous areas on the island of Oahu. Unfortunately, this feeding regimen precludes zoos and other institutions outside Hawaii from participating in rearing efforts. As SEPP seeks to expand its partnership network to increase redundancy of critical captive populations, a completely cultured or manufactured diet is being pursued. If successful, institutions across the US and the world could participate in Hawaiian snail propagation.

While the SEPP facility has turned into more of an ark than it was intended to be, the main objective of returning species to the landscape remains. To recover species in the wild, SEPP



Fig. 3. Large tree and ground dwelling snails are reared in modified commercially available terraria.



Fig. 4. Recently completed predator-proof fence on the island of Oahu.

and partners across the state are using a combination of predator control and predator exclusion.

In areas where the predatory snails *Euglandina rosea* (now known to be a complex of at least two species) is not present, rodent control has been effective at decreasing predation (Hadfield & Saufler, 2009). A combination of GoodNature brand multi-kill rat traps and traditional snap traps, spaced in a grid around a target snail population, at 5-10 m intervals is used. Using GoodNature's long lasting lures, traps only need to be checked on a 3-4-month interval. In areas where *E. rosea* is present it is inadvisable to conduct rat control as rats also prey on *E. rosea*, a far worse predator.

When possible, predator-proof fencing is used to protect populations with barriers to keep out all known invasive molluscivores, including three species of rats, Jackson's chameleons, and *E. rosea* (Hadfield, 1986; Hadfield *et al.*, 1993; Hadfield & Saufler, 2009; Holland *et al.*, 2010). The most recent fences were designed by the Army Natural Resources Program and are made with walls of high-density polyethylene (HDPE) and capped with a rolled metal hood (Rohrer *et al.*, 2012). The smooth sides and the rolled hood exclude rodents and chameleons. Three barriers that are mounted onto the outside of the wall prevent *E. rosea* from crossing. These include a flange that skirts the fence at a 15-degree angle, rows of upside-down cut copper wire mesh, and electrical wires (Fig. 4). To date, 11 of these reserves have been constructed across the islands of Oahu, Maui and Lanai, with five more in the planning stages.

Removing predators from inside the reserves has been challenging, particularly for *E. rosea*. These predators reproduce quickly and can be difficult to find. Eliminating them from inside a reserve requires sustained effort. To date, the strategy that has been most effective includes removing most ground-cover vegetation and leaf litter and conducting searches on a regular basis for a period of months. Removing vegetation and leaf litter increases detection probability by reducing habitat complexity and eliminates areas suitable for *E. rosea* egg clutches.



Fig. 5. *Amastra intermedia*.

Until recently many of the reserves had been constructed around habitat harbouring existing wild populations of rare snails. However, recently SEPP and partners have begun reintroducing species from captive propagation.

Since 2017, over 1,200 snails of six species have been released into protected habitat: *Achatinella lila*, *Achatinella mustelina*, *Amastra intermedia*, *Amastra spirizona*, *Laminella sanguinea* and *Cookeconcha hystricella*. SEPP and its partners across the state are primed to release thousands of snails into predator-free reserves over the next several years.

While the future is grim for many unprotected wild populations of Hawaiian land snails, a partnership approach that integrates in situ and ex situ conservation has quickly changed the status of many Hawaiian snail species. For example, in 2015 the last known wild individual of *Amastra intermedia* (Fig. 5) was evacuated from the field. Fortunately, Dr. Daniel Chung, Associate Researcher at the Bishop Museum, has maintained this species in captivity for many years in the Museum's Malacology Department. From this source population, sub-populations have been established at the SEPP captive rearing facility and the Honolulu Zoo. To date all three institutions have contributed hundreds of snails for releases into a predator-proof reserve built by the Army Natural Resources Program.

Amastra intermedia probably went extinct in the wild in 2015. With the cooperation of four entities, this species was back on the landscape in sizable numbers in less than two years. Moving forward, collaboration at this scale will be needed if we are to intervene in the onslaught of Hawaiian land snails facing extinction in the coming years.

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For more information about the Snail Extinction Prevention Program please contact the author.

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Monitoring of introduced and endemic terrestrial gastropods in the Juan Fernandez archipelago

By Viviana M. Castillo, Hernán González & Alexis Yáñez

The Juan Fernandez archipelago (JFA) constitutes the geographic area of Chile that exhibits the highest risk with regard to the presence of alien species that have been introduced into the country, since it exhibits a high degree of endemism: 46 endemic species of terrestrial gastropods representing the families Achatinellidae, Charopidae, Punctidae and Succineidae have been reported (Odhner, 1922; Stuardo & Vargas, 2000; Letelier *et al.*, 2014; Miquel & Araya, 2015). The aforesaid is reinforced by the fact that the islands in this archipelago were declared a Biosphere Reserve by UNESCO in 1977, because of the large number of endemic species.

On the other hand, we know that seven species of alien terrestrial gastropods have established themselves and spread in these islands, the snails *Cornu aspersum*, *Oxychilus cellarius* and *O. alliarius*, and the slugs *Milax gagates*, *Deroceras reticulatum*, *D. invadens* and *Lehmannia valentiana*, the expansion of which in the archipelago has put indigenous species in danger (Hutchinson *et al.*, 2014; Letelier *et al.*, 2014) because of the lack of natural predators and limited competition from the native fauna.

Monitoring was carried out during 2012-2019 on Robinson Crusoe and Santa Clara islands. On the former, we found both endemic and alien species; on the latter, only endemic taxa. As regards the alien species, we found eight species (Table 1), for the first time recording the presence of the slug *Limacus flavus* (Table 1, Fig. 1A) on Robinson Crusoe Island. *Limacus flavus* is a native European species that has extended its distribution to other locations around the world (Thomas *et al.*, 2010). The presence of this species in continental Chile was previously reported (Valdovinos *et al.*, 2005). However, the presence of *L. flavus* in the islands had only been reported for the Chiloe islands (Valdovinos *et al.*, 2005). Although the ecological impact of this species with respect to the endemic gastropod species of the JFA is unknown, Thomas *et al.* (2010) indicated that *L. flavus* is a highly invasive species that is closely associated with synanthropic areas. However, the species has been reported principally to attack stored goods (Godan, 1983).

We also detected endemic species of Achatinellidae, Succineidae and Punctidae that have previously been described from these islands (Odhner, 1922) (Table 2, Figs. 1B-C). We detected endemic and alien species coexisting in the same biotope and associated with different plant species (Tables 1, 2).

| Table 1. Introduced molluscs collected on Robinson Crusoe Island during 2012-2019. | |
|---|--|
| Species | Host/plant species |
| <i>Deroceras invadens</i> <i>Deroceras reticulatum</i> | Home gardens, <i>Eucalitus robuslus</i> , <i>Pinus radiata</i> , <i>Amomyrtus luma</i> , <i>Bohemeria excelsa</i> , <i>Eryngium blupleuroides</i> , <i>Myrceugenia fernandeziana</i> , <i>Sophora fernandeziana</i> , fern, in the soil. |
| <i>Lehmannia valentiana</i> | Home gardens, <i>Myrceugenia fernandeziana</i> . |
| <i>Limacus flavus</i> <i>Milax gagates</i> | Compost, in the soil. <i>Eucalitus robuslus</i> , <i>Amomyrtus luma</i> , <i>Drimys confertifolia</i> , in the soil. |
| <i>Comu aspersum</i> | Home gardens, <i>Fraxinus excelsior</i> , <i>Robinia pseudoacacia</i> , <i>Eucalitus robuslus</i> , <i>Junglans regia</i> , <i>Drimys winteri</i> , <i>Amomyrtus luma</i> , weeds, <i>Raphithamnus venusus</i> , <i>Bohemeria excelsa</i> , <i>Coprosoma pyriformia</i> , <i>Dendroseris litoralis</i> , <i>Myrceugenia fernandeziana</i> , under wood, in the trash, adhered to the base of domestic gas cylinders. |
| <i>Oxychilus alliaris</i> <i>Oxychilus cellarius</i> | <i>Pinus radiata</i> , <i>Amomyrtus luma</i> , <i>Bohemeria excelsa</i> , <i>Coprosoma pyriformia</i> , <i>Eryngium blupleuroides</i> , <i>Gunnera peltata</i> , <i>Dendroseris litoralis</i> , in the soil. |

| Table 2. Endemic molluscs collected on Robinson Crusoe (RC) and Santa Clara (SC) Islands during 2012-2019. | |
|---|--|
| Species | Host/plant species |
| <i>Fernandezia bulimoides</i> <i>Fernandezia splendida</i> <i>Fernandezia cilyndrella</i> <i>Tomatellina aperta</i> <i>Tomatellina bilamellata</i> <i>Tomatellina plicosa</i> (RC) | <i>Dietes iridiodes</i> , <i>Pittosporum crassifolium</i> , <i>Myrceugenia fernandeziana</i> , <i>Drimys confertifolia</i> , <i>Coprosoma olivieri</i> , <i>Coprosoma pyriformia</i> , <i>Fagara mayu</i> , <i>Washingtonia filifera</i> , <i>Erigeron fernandezianus</i> , <i>Peperomia berteroaana</i> , <i>Blechnum cordatum</i> , <i>Haloragis masatierrana</i> , <i>Libertia chilensis</i> , <i>Eryngium bluperoides</i> , <i>Dendroseris litoralis</i> , <i>Eucalitus robuslus</i> . |
| <i>Omalonyx gayana</i> (RC) | <i>Amomyrtus luma</i> , <i>Peperomia berteroaana</i> . |
| <i>Succinea cummingi</i> <i>Punctum depressum</i> (RC) | <i>Bohemeria excelsa</i> . |
| <i>Succinea texta</i> <i>Tomatellina</i> sp. <i>Fernandezia</i> sp. (SC) | <i>Bohemeria excelsa</i> . |

The establishment of alien terrestrial molluscs on Robinson Crusoe Island is clear, *Cornu aspersum* being the species that has established itself with the greatest success. Similarly, the presence of the carnivorous *Oxychilus cellarius* and *O. alliaris* create a substantial risk for the endemic species present in the JFA.

The monitoring of these species makes it possible to evaluate the vulnerability of these island areas, which is why it is very important to promote the conservation of the endemic species. Our monitoring has made it possible to georeference both endemic and alien species and even to protect endemic species via Law No. 19473, known as the Chilean Hunting Act (SAG, 2018), which protects both vertebrate and invertebrate animal species, restricts capturing them, requires application for permits from the Chilean government, and penalises people who do not respect the regulations. Under this law, endemic species have been categorised as species with reduced population densities (category S) and in danger of extinction (category P). In addition, inspection strategies have been implemented as a mitigation measure with respect to the entry of alien species of terrestrial gastropods, including inspection of cargo and/or tourist vessels travelling from the continent to the islands, as well as inspection of vessels travelling between the islands.

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A successful translocation of the giant carnivorous land snail *Powelliphanta traversi* ‘form *latizona*’ (Rhytididae), from Levin to Khandallah (Wellington, New Zealand)

By Phil Parkinson & Rodrigo B. Salvador

The New Zealand indigenous snail genus *Powelliphanta* belongs to an ancient Gondwanan lineage with relatives in the Rhytididae from Tasmania and New South Wales in Australia (Stanisic *et al.*, 2010, 2017). All species are carnivorous and agnathous, preying on earthworms and ingesting them like strands of spaghetti. The species are very large, some reaching 9 cm in diameter. They are long-lived, reaching at least 20 years and are one of the most impressive terrestrial invertebrates of New Zealand.

There are 14 nominal species recognised within *Powelliphanta* (MolluscaBase, 2019) and almost 60 subspecies and infra-subspecific entities, many neither formally described nor named (28 non-nominotypical subspecies listed on MolluscaBase); all are threatened and vulnerable to varying extents. They are local endemics with restricted habitats, legislatively protected under the New Zealand Wildlife Act, 1953, Schedule 7. Many of them are practically restricted to national parks with species management plans.

The first *Powelliphanta* to be described was *Helix hochstetteri* Pfeiffer, 1862, which was later assigned to *Paryphanta* Albers, 1850; other *Paryphanta* species and subspecies were described in 1880, 1888, 1901 and 1930, mostly by A.W.B. Powell.

O’Connor (1945) erected the subgenus (later genus) *Powelliphanta* to accommodate all species except the type, *Paryphanta busbyi* (Gray, 1840). The latter has markedly different anatomy and other shell features and is now classified in a different subfamily.

Concern about the conservation status of these large and attractive snails began early, as collectors noted the papers of Powell, and added specimens to personal collections. Accounts of past practices in collecting *Powelliphanta* can be found in *Wellington Shell Club Bulletin* numbers 1 and 3 (no date but probably 1967, not printed). Correspondence regarding over-collecting can also be found as early as 1968 (*Wellington Shell Club Bulletin* number 12, 1968: 2-3). Meads *et al.* (1984) gave a brief overview of the conservation status of each recognised taxon recorded at that time. The most recent comprehensive account regarding *Powelliphanta* conservation is a report from the Department of Conservation (Walker, 2003), but there is also a doctoral thesis (Waterhouse, 2014) focussing on conservation of *P. patrickensis* Powell, 1949.

The conservation of *Powelliphanta*, however, has a checkered past. The protection of the remote Mount Augustus population became a *cause célèbre* in New Zealand. The species had been first seen in 1996, but the Department of Conservation was unaware of it until 2004. By then, almost the entire natural habitat had been removed by a coal-mining operation and a translocation plan for the snails (the population of which was estimated as fewer than 500 individuals) was proposed. The plan was poorly delineated (condemned by the Royal Forest and Bird Protection Society and the Green Party) and poorly conducted, starting in 2006. The full story can be found on Wikipedia (2019, and references therein). The species was formally described in 2008 as *P. augusta* Walker, Trewick & Barker, 2008. Morris (2010) visited the relocation site and reported that the larger trees had died and introduced weed species had invaded; in his words, the “once complex mosaic of dense, low sub-alpine scrub and deep undisturbed litter has gone”. The last part is key, as concerns about the viability of relocating species with very specific food or terrain requirements is genuine; for instance, Waterhouse (2014) recommended the use of undisturbed native sites or “vegetation direct transfer” as preferable restoration types for *P. patrickensis*. Morris (2010) also reported that *P. augusta* had a 30 % mortality rate after 18 months at the relocation sites, which, given the species’ biology, was considered an unsustainable rate in the long run.

The unhappy story of *P. augusta* stands in contrast to the experience of the Khandallah population of *Powelliphanta* (Fig. 1), relocated with no fuss in 1944. This subspecies was first described as *Paryphanta traversi latizona* Powell, 1949 from Greenaway’s Bush, near Levin, on the southern portion of New Zealand’s North Island. Later, Powell (1979: 342) relegated most subspecies to “forms” without taxonomic status, including *latizona*. Preliminary studies, however, suggested that *latizona* may be distinctive enough for at least subspecific status (Walker, 2003: 29).

Regardless of its taxonomic status, the “*latizona*” population is now confined to three forest remnants. The largest area, traditionally known as Greenaway’s Bush, is partly privately



Fig. 1. Empty shell of *Powelliphanta traversi* ('form' *latizona*) found in Khandallah Park in 2019.

owned (the western end) with the remainder being in the Makahika Scientific Reserve. The other two much smaller areas, Benton's Bush and Kohitere Covenant, are native forest remnants within Kohitere Pine Plantation, just south of Greenaway's Bush. Walker (2003: 30) estimated the population size was around 10,000 snails and although most of the habitat is now legally protected and pest control is regularly undertaken, the small range makes the population vulnerable.

Powell (1946: 118) reported that a hundred snails from Greenaway's Bush "were liberated in a small forest reserve on the plain about two miles north of Levin the locality being within the former range of typical *traversi*. At the same time Mr. A.C. O'Connor liberated 40 examples of the Greenaway's snails at Khandallah. A duplicate series of 50 snails from Greenaway's have been prepared and are now deposited in the Auckland Museum as a standard

to check any possible future variation in these newly established colonies. Both reserves were thoroughly searched prior to the liberation and proved to be without large snails."

Meads *et al.* (1984) reported that the original population from Greenaway's Bush still existed, noting that "the deep moist litter layer under the decaying fern fronds provided good habitat" and that "many live snails were found". They concluded that these facts and the low damage rate gave that population a lower conservation priority than other colonies of the species although, as it was "confined to a small forest remnant, formal protection of the habitat is required" (Meads *et al.*, 1984).

Nothing further has been heard of the hundred snails sent to the unnamed reserve "about two miles north of Levin", but the 40 snails sent to Khandallah have left offspring, which are illustrated from dead shells (Fig. 1). To date, no effort has been made to estimate the size or extent of this population. The most recent specimen collected was found freshly dead (stomped on and crushed) on 8 October 2019 in the middle of a very well-used walking and running track.

The Khandallah population is mentioned in the Greater Wellington Regional Council's (2015: 5) plan for western Wellington forests for 2015-2018, but only incidentally, regarding its presence in Khandallah Park. The "Threatened Species list" in the plan classified the Khandallah population as "Threatened – Nationally endangered" under the New

Zealand Threat Classification System, which is sometimes at odds with the IUCN system. The plan cites Walker's (2003) report as source.

No other snail is considered endangered in this region, although there are at least two endemic species known to be scarce or of limited distribution and potentially vulnerable. The main threats to the Khandallah population are likely to remain rats, opossums, itinerant runners and fossicking collectors, despite the fact that this population has survived largely unnoticed for over 70 years since its introduction to an area in frequent recreational use and without predator-proof fencing.

The well-known protected area Zealandia (formerly Karori Wildlife Sanctuary), which does have a predator-proof fence, is located further south on the same Wellington hills, with similar terrain and established forest cover. The Zealandia reserve would potentially be an alternative refuge for the Khandallah population if the need arose.

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Representatives of all 13 species of *Partula* maintained in the international breeding programme now reintroduced back onto their islands of origin

By Trevor Coote & 26 others

When 1,896 individuals of *Partula varia* and 522 of *P. rosea* were released onto the island of Huahine on 4 September 2019, this meant that all 13 species maintained ex situ in the breeding programme – 10 of which are Extinct in the Wild – have now been reintroduced back onto their original home islands in French Polynesia, leaving just one subspecies of *P. suturalis* to be repatriated (Table 1).

Table 1. Numbers of *Partula* individuals released on their native islands in French Polynesia in 2015-2019.

| Species | 2015 | 2016 | 2017 | 2018 | 2019 | Total |
|------------------------------|------------|--------------|--------------|--------------|--------------|---------------|
| Moorea | | | | | | |
| <i>Partula mooreana</i> | - | 592 | 344 | - | - | 936 |
| <i>P. suturalis vexillum</i> | - | 374 | 290 | 171 | 210 | 1,045 |
| <i>P. taeniata simulans</i> | - | 67 | - | 549 | 360 | 976 |
| <i>P. tohiviana</i> | - | 639 | 950 | 766 | 710 | 3,065 |
| <i>P. taeniata nucleola</i> | - | 100 | 206 | 201 | 219 | 726 |
| <i>P. mirabilis</i> | - | - | - | 10 | 60 | 70 |
| Tahiti | | | | | | |
| <i>P. affinis</i> | 48 | 201 | 129 | 240 | 182 | 800 |
| <i>P. hyalina</i> | 1 | 8 | 90 | 71 | 12 | 182 |
| <i>P. nodosa</i> | 220 | 877 | 1,777 | - | 2,528 | 5,402 |
| Raiatea | | | | | | |
| <i>P. dentifera</i> | - | 96 | - | - | - | 96 |
| <i>P. tristis</i> | - | 38 | - | - | - | 38 |
| <i>P. hebe</i> | - | 81 | - | - | - | 81 |
| Huahine | | | | | | |
| <i>P. varia</i> | - | - | - | - | 522 | 522 |
| <i>P. rosea</i> | - | - | - | - | 1,896 | 1,896 |
| Total | 269 | 3,073 | 3,786 | 2,008 | 6,699 | 15,835 |

Partula releases 2019

During 2019 a total of 6,699 individuals of nine species (ten taxa) were released onto three islands (Table 2), bringing the total number of *Partula* released to nearly 16,000 over five years (Table 1). Of those released in 2019, over 2,500 were *P. nodosa* destined for Papehue Valley on Tahiti and this species has now accounted for more than one third of all the released snails since 2015. The shipment in July contained *P. nodosa* from Artis Zoo in Amsterdam as well as those from the US collections. Both Edinburgh (May) and the Zoological Society of London (ZSL) (August) sent *Partula* from the programme for release on Moorea (*P. tohiviana* [Fig. 2], *P. suturalis vexillum*, *P. taeniata simulans*, *P. t. nucleola*) and Tahiti (*P. affinis*, *P. hyalina*). The August release on Moorea was

Table 2. *Partula* release details for 2019.

| Species | Location | Release date | Release date | Number released |
|------------------------------|-------------------------------------|--------------|--------------|-----------------|
| Moorea | | | | |
| <i>Partula tohiviana</i> | Afareaito Valley | 1 May 19 | 28 Aug 19 | 710 |
| <i>P. suturalis vexillum</i> | Afareaito Valley | 13 May 19 | 28 Aug 19 | 210 |
| <i>P. taeniata simulans</i> | Afareaito Valley | 13 May 19 | | 360 |
| <i>P. taeniata nucleola</i> | Afareaito Valley | | 28 Aug 19 | 219 |
| <i>P. mirabilis</i> | Afareaito Valley | | 28 Aug 19 | 60 |
| Tahiti | | | | |
| <i>P. affinis</i> | Faarapa Valley | 14 May 19 | | 182 |
| <i>P. nodosa</i> | Papehue Valley | 1 Jul 19 | | 2528 |
| <i>P. hyalina</i> | Papehue Valley | 1 Jul 19 | | 12 |
| Huahine | | | | |
| <i>P. varia</i> | Afaahiti Valley/ Mata'ire'a Hill | | 4 Sep 19 | 522 |
| <i>P. rosea</i> | Afaahiti Valley/ Mata'ire'a Hill | | 4 Sep 19 | 1896 |
| Total | | | | 6,699 |



Fig. 1. Local class involved in the release of *Partula varia* and *P. rosea* on Huahine

planned to take place on the second day of the international 'Āreho seminar (Brocherieux & Cowie, see this issue of *Tentacle*, p. 36) in the presence of the seminar participants. The week after the end of the seminar, for the first time two species from Huahine, which had been the centre of the shell jewellery trade until the extinctions, arrived in four crates from Chester Zoo. The release was accompanied by local people, including a class of schoolchildren (Fig. 1) who were learning about their natural and cultural heritage, and local television was present for a news article.

Results for 2019

The general procedure for marking, shipping, collection and quarantine has become routine (see *Tentacle* 24, 25, 26, 27). This year, though, a protocol was now established for the actual preparation and release of the *Partula* into the field. It was decided from previous experience that the best method was to mark and prepare the release pots the day before with a base of dry tissue and place one on each of the tanks that contained the snails destined for release. The snails would then be fed, lightly sprayed with water and in the morning



Fig. 2. *Partula tohiviana*.



Fig. 3. *Partula nodosa*.

would be taken from the tanks, placed in the dry pots, which were covered with Clingfilm (plastic wrap) and held in place by a rubber band. Only on release would the cover be removed and the interior of the pots and the trunk and foliage above the pot sprayed to encourage the snails to quickly disperse and ascend away from any potential danger.

Moorea and Tahiti

This year only *Partula mooreana* (previously released in 2016 and 2017) and *P. suturalis strigosa* (yet to be repatriated) were not released into established sites in Afareaito Valley on Moorea.

- *Partula taeniata simulans* had been released in May and individuals were seen in the last monitoring, all three being unmarked and presumed Moorean-bred. There were very few deaths and its future looks promising.
- The other subspecies *Partula taeniata nucleola* also produced young as it had done in previous years and one adult from the 2018 release was recorded. Again, this taxon appears to be content in its natural habitat.
- Only 10 *Partula mirabilis* had been released in 2018 but the 60 individuals this year were placed in a tree at another site. Three months later three were seen together about 4 m high in the foliage. A few dead shells were recovered.
- The response on release of *Partula suturalis vexillum* has not changed over the years. They disperse rapidly out of view and very few dead shells are found. During the last monitoring just one individual was seen over 4 m high in one of the trees. There seems no major concern for the survival of this taxon as the estimated mortality based on dead shells is very low, observed at less than 5 % (Table 3).
- In contrast, a number of the large and conspicuous dead shells of *Partula tohiviana* were recovered not long after release. Mortality is estimated at about 25 % during each release year (Table 3). There are occasional New Guinea flatworm (*Platydemus manokwari*) victims but in the past individuals have been seen from previous releases and unmarked young are sometimes recorded.



Fig 4. *Partula varia* dispersing rapidly into foliage on Mata'ire'a Hill.

Representatives of all three of the species from Tahiti were released into their regular locations: Papehue Valley (*Partula nodosa*, *P. hyalina*) and Faarapa Valley (*P. affinis*).

- The most successful species in the breeding programme, *Partula nodosa* from Tahiti (Fig. 3), accounted for 38 % of the *Partula* released this year and 34 % in total since 2015. The snails regularly disperse into the canopy into complex habitat. A number of shells were recovered as usual but during the last monitoring newborn/unmarked young juveniles were recorded at 11 of the 27 release trees.
- A handful of *Partula hyalina* were released this year. This species is listed as Vulnerable on the IUCN Red List as it is still extant and widespread in the wild and is of lower priority. It disperses quickly and there are few deaths.
- *Partula affinis* is another species that disperses quickly out of site into high and complex foliage and this year was no exception. A higher estimated mortality rate (35 %, though this is probably an overestimate because of the number of juveniles released) was recorded (Table 3) and it does not look as robust in the wild as *P. nodosa*. Its chances of long-term re-establishment are unclear.

Huahine

All the species released onto Tahiti and Moorea in 2019 have been released before. The reintroduction of the two species onto Huahine for the first time was a fascinating experiment. More than on any other island the release of *Partula* (known in Tahitian as 'āreho) captured the interest of local people because of their use in local artisanry. A final survey into the status of the New Guinea flatworm, *Platydemus manokwari*, had been carried out earlier in the year and had suggested that the infestation recorded in 2017 had most probably peaked, and it was decided to send the *Partula* for release based on this information.

Two locations had been selected for release. The first was on Mata'ire'a Hill behind Tefano *marae* on the archaeological site that faces the cultural museum. In a solitary Tahitian chestnut or *mape* tree 87 *Partula rosea* and 134 *Partula varia* (Fig. 4) were released. This was a convenient and picturesque

spot for the class of children and the TV cameraman to access. However, the majority of both species were released into nearby Afaahiti Valley, which had been opened for the first time by the landowners who recounted when they had collected thousands of *Partula* from their valley in the past for the making of shell necklaces and crowns.

There was a marked species-specific response to the release of the two species into novel conditions. *Partula varia* attempted to disperse from the pots so rapidly that they ended up emerging in clumps and falling to the ground. In order to prevent their exposure to the largely ground-dwelling predatory *Platydemus manowari*, it was decided to leave the Clingfilm cover in place and simply punch a hole in the surface so that the snails could emerge individually. In total contrast, *P. rosea* were very sluggish and many were still in their pots the following day.

The first monitoring took place on the day after release when about 30 dead shells were recovered. Eight flatworms were recorded and it is likely that the dead snails were victims of predation. In one instance a live *P. manokwari* was found inside a pot of *Partula varia* about 3 m from the ground. For logistical reasons the next monitoring was one month later. This time large numbers of dead shells were recovered and it was clear that mortality had been considerable. Although over 400 shells had been collected this amounted to just 16 % of the total released. However, a better estimate of mortality is gained when just adults are recorded as they are more likely to be found. Then about 20 % of the *P. varia* and 35 % of the *P. rosea* had been lost to date (Table 3). With four people searching thoroughly in the leaf litter this seems a reasonable estimate but curiously not a single flatworm was seen.

In the absence of the predator a further explanation is sought for the loss of snails. From the start the sub-optimal habitat had been a concern but any release onto Huahine had been dependant on the goodwill of local landowners and most of the habitat on the island had been badly degraded. It was fortunate at least that the sites selected had been guaranteed free from the severe insecticide spraying that takes place over much of the island. In addition, there had been a drought and conditions were very dry. The trees were mainly bare-trunked with foliage very high. The strategy had been to encourage the snails to disperse rapidly into the high branches where they would be safer from *P. manokwari*. However, it seems that, having quickly emerged from their pots, they had a long, dry haul into the high foliage and too long a time with nothing to eat en route. It is likely that exhausted many simply fell where they either died or become victims of *P. manokwari*. This strategy of encouraging rapid, high dispersal may have proved especially problematic in the case of *P. rosea*, a slow disperser. The hope is that the arrival of the rainy season would aid those that had survived to feed and reproduce. The next intensive monitoring is due in March 2020.

Raiatea

The search for the best potential release location on Raiatea, and a continuing update on the status of *P. manokwari*, continued throughout the year and a final check will be made early in 2020 in the hope of a 2020 release for the three

species in the breeding programme. The first attempt in Faaroa Valley in 2016 ended in the one confirmed release failure of the programme. It was the first time that *P. manokwari* had come to our attention as a serious threat to the released *Partula* populations after the gradual decline of *Euglandina rosea*. The dead shells of at least a third of the *Partula hebe* and *P. garrettii* (formerly *P. tristis*) released, and almost a half of the *P. navigatoria* (formerly *P. dentifera*), were recovered. Then shortly after, the release site was cleared for plantation and any surviving snails were lost. There had to be a rethink. Hamoa Valley, where the *Partula navigatoria* in the breeding programme had been collected in the 1990s, seemed an obvious choice for a future release because 1) the habitat is very good and it may have been the last place where *Partula* survived on Raiatea (1998) and 2) one half is private land and a known hiking trail and thus avoids any conflict of interest with the agriculture department. In 2017 a severe infestation of *P. manokwari* on Raiatea had been confirmed, notably in this valley, but at the end of 2019 only one *P. manokwari* was seen in two potential release sites in Hamoa Valley, although as mentioned, the survey came at the end of a long, dry spell.

Conclusion

This year, 2019, saw the completion of the reintroduction of all 13 species and one of two additional subspecies being maintained in the international breeding programme. No other global conservation programme comes close in terms of the number of species extinct in the wild being repatriated to their ancestral home. There have now been five years of reintroductions onto the four Society Islands where all of the released taxa originated. On Moorea and Tahiti, despite the presence of the New Guinea flatworm, *Platydemus manokwari*, at all release sites, the rapid dispersal and very low mortality rate has exceeded expectations. On Huahine there was some concern about the number of dead shells recovered a month after the first reintroduction there but current conditions and sub-optimal habitat rather than predation may have contributed to the majority of the losses. It is hoped that a final survey into the status of *P. manokwari* on Raiatea will lead to the first release on that island since the ill-fated effort of 2016. To date almost 16,000 *Partula* tree snails have been released directly into natural habitat. Future shipments from the breeding programme for releases will be smaller in number, except maybe in the unique case of *Partula nodosa*. Focus will then turn to selected longer term monitoring in the coming years in the hope that

Table 3. Post-release mortality of *Partula* released in 2019.

| Species | Number released 2019 | Number of adults found | Number of adults dead | Adults % dead |
|------------------------------|----------------------|------------------------|-----------------------|---------------|
| Moorea | | | | |
| <i>Partula tohiviana</i> | 710 | 257 | 66 | 25.68 |
| <i>P. suturalis vexillum</i> | 210 | 151 | 7 | 4.64 |
| <i>P. taeniata simulans</i> | 360 | 116 | 3 | 2.59 |
| <i>P. taeniata nucleola</i> | 219 | 130 | 9 | 6.92 |
| <i>P. mirabilis</i> | 60 | 35 | 6 | 17.17 |
| Tahiti | | | | |
| <i>P. affinis</i> | 182 | 39 | 14 | 35.9 |
| <i>P. hyalina</i> | 12 | 12 | 2 | 16.67 |
| <i>P. nodosa</i> | 2,528 | 1,300 | 158 | 12.15 |
| Huahine | | | | |
| <i>P. varia</i> | 1,896 | 853 | 175 | 20.51 |
| <i>P. rosea</i> | 522 | 233 | 80 | 34.33 |
| Total | 6,699 | 3,126 | 520 | 16.63 |

reintroductions can lead to re-establishment of at least some of the species released.

This conservation progress has only been possible because of the long-term collaboration between the French Polynesian environmental agencies and the international zoo community together with IUCN's SSC Conservation Planning, Mollusc and Reintroduction Specialist Groups, with additional funding support from the Mohamed bin Zayed Species Conservation Fund.



Some key partulid conservation publications

- Coote, T. *et al.* 2019. Fourth year of *Partula* species reintroductions into natural habitat on Tahiti and Moorea. [Tentacle 27: 35-38](#).
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- Trevor Coote, Conservation field biologist, Partulid Global Species Management Programme: partula2003@yahoo.co.uk
- Sam Aberdeen, EEP *Partula* Studbook Keeper, Zoological Society of London
- Christophe Brocherieux, Direction de l'environnement, Government of French Polynesia
- Ross Brown, Collection Manager, Marwell Wildlife
- Mark Bushell, Curator of Invertebrates, Bristol Zoological Society
- Paul Buzzard, Director of Conservation, Detroit Zoological Society
- Dave Clarke, International *Partula* Studbook Keeper, Zoological Society of London
- Maartje de Vries, Lead *Partula* keeper, Royal Artis Zoo
- Matai Depierre, Direction de l'environnement, Government of French Polynesia
- Jo Elliott, Animal Collection Manager, Royal Zoological Society of Scotland
- Glenn Frei, *Partula* Species Survival Plan Coordinator and *Partula* SSP Studbook Keeper, St Louis Zoo
- Gerardo García, Curator of Lower Vertebrates & Invertebrates, North of England Zoological Society
- Justin Gerlach, Chair - Terrestrial and Freshwater Invertebrate Red List Authority (IUCN/SSC)
- Sandra Honigs, Curator, Landeshauptstadt Düsseldorf, Der Oberbürgermeister, Aquazoo - Lössbecke Museum
- Bob Merz, *Partula* Species Survival Plan Coordinator, St Louis Zoo
- Bobbi Miller, Manager Wildlife Conservation, Woodland Park Zoo
- Pete Mohan, Director of Animal Operations, Detroit Zoological Society
- Sarah Robinson, Conservation, Royal Zoological Society of Scotland
- Claude Serra, Direction de l'environnement, Government of French Polynesia
- Jamie Sincage, Zoological Manager, Disney's Animal Kingdom,
- Ed Spevak, Curator Invertebrates, St Louis, Zoo
- Christoph Schwitzer, Director of Conservation, Bristol Zoological Society
- Janos Szánthó, Conservation projects, Artis Royal Zoo
- Miri Tatarata, Chief, Direction de l'environnement, Government of French Polynesia
- Scott Wilson, Head of Field Programmes, North of England Zoological Society
- Tim Woodfine, Director of Conservation, Marwell Wildlife
- Paul Pearce-Kelly, International *Partula* programme coordinator, Zoological Society of London

'Āreho, natural and cultural heritage: report of a seminar on land snail conservation, August 2019, Tahiti



By Christophe Brocherieux & Robert H. Cowie

'Āreho, in the Tahitian language, refers to partulid tree snails, which as we know have suffered from decline and extinction throughout their Pacific island range. In many cases this was caused by the deliberate introduction of the carnivorous snail

Euglandina spp. as a biological control agent intended to control the invasive giant African snail *Lissachatina fulica*. That control was not successful but native snails were heavily impacted. Since the 1980s, the French Polynesian government has participated in and contributed to the International Partulid Conservation Programme coordinated by the Zoological Society of London (ZSL), which has enabled the survival, within international zoos, of numerous partulid species. The success of this work has led to the release of snails into the wild from 2015 onwards in order to reconstitute in situ populations. The initial results have been encouraging and spur the continuation of this programme, for which the French Polynesian Environment Department (Diren) wishes to strengthen regional and local collaboration.

In this context, Diren organised and funded an international seminar that took place from 26 to 29 August 2019, on the island of Tahiti, entitled “*Areho*, natural and cultural heritage”. The objective was to share experiences with Pacific countries and territories and with international experts familiar with these issues in their own regions. The goal was to develop a common vision for the Pacific region regarding the conservation of its natural and cultural heritage. The meeting was opened by the President of French Polynesia, M. Edouard Fritch, in the presence of the Minister for the Promotion of Languages, Culture, Communication and the Environment, M. Heremoana Maamaatuaiahutapu (Fig. 1).



Fig. 1. Opening ceremony. Foreground, left to right: Paul Pearce-Kelley, unidentified hidden person, President of French Polynesia, M. Edouard Fritch, Minister of Culture and Environment, M. Heremoana Maamaatuaiahutapu, Robert Cowie, Trevor Coote.

The seminar took place over four days as follows, with development of a final consensus statement that appears at the end of this article.

Day 1 – presentations

- Paul Pearce-Kelley, Zoological Society of London: Summary of the *Partula* snail conservation programme
- Robert Cowie, University of Hawaii: Partulidae and other threatened snails in the Pacific Islands

- Diarmaid Ó Foighil, University of Michigan: The ecology of persistence in the Partulidae of the Society Islands
- Joanne Elliott, Scotland, Edinburgh Zoo: Captive *Partula* management at Edinburgh Zoo
- Gerardo Garcia, United Kingdom, Chester Zoo: Preventing extinction: the Bermuda land snails’ story
- David Sischo, Hawaii, Department of Land and Natural Resources: Hawai‘i snail extinction prevention program
- Bruno Fogliani, New Caledonia, New Caledonia Agronomical Institute: The Bulime snails of the Isle of Pines
- Brenda Andre, Vanuatu, Department of Tourism: Tourism and the protection of ecological and culturally significant areas
- Sunny Ngirmang, Palau, Bureau of Cultural and Historical Preservation: Managing cultural landscapes and natural resources
- Debra Laan, Federated States of Micronesia, UNDP-GEF / Ridge to Reef Project Coordinator: Areho, Polynesian Natural and cultural heritage workshop
- Robert Curry, Northern Mariana Islands, DFW: Research and conservation of Partulidae in the Northern Mariana Islands
- Else Demeulenaere, Guam, Center for Island Sustainability: Terrestrial conservation at the Center for Island Sustainability
- Lino Purcell, Samoa, Division of Environment and Conservation: Terrestrial snails conservation works in Samoa
- Lesieli Tuivai, Tonga, Department of Environment: Conservation status of land snail fauna in Tonga
- Ngatokotoru Puna, Cook Islands, Environment Service: Clean, green & sustainable Cook Islands
- Christophe Brocherieux, French Polynesia, Department of the Environment: The French Polynesia conservation programme

These 16 presentations by scientists and country/territory representatives revolved around three complementary themes:

- Local situations and technical results concerning *Partula* conservation programmes,
- Snail conservation programs other than for *Partula*,
- Management of land areas and terrestrial biodiversity.

Several key issues stood out from all the presentations:

- Cultural heritage, although little known, is real;
- There are many species of snails that are often unknown to policy makers and the general public;
- The situations are disparate, and vary according to the available means and local priorities;
- Threats are numerous and common: habitat destruction, presence of predators (snails and carnivorous worms, rodents, pigs, ungulates...);
- Encouraging successes have been achieved for some, with the use of advanced technologies in particular, but for others, the financing of actions remains a major difficulty;



Fig. 2. Field trip to Moorea. Trevor Coote pointing out *Partula* just a few metres from the shore in Opunohu.

- Regulations for the protection of spaces and species have been established for some countries (Vanuatu, New Caledonia, Palau, Cook Islands, French Polynesia).

The following questions and issues were discussed during the exchanges:

- The need for assistance with technical protocol for breeding and knowledge improvement (Hawaii, Guam, Samoa, Marianas);
- The involvement of local communities and respect for traditional customs and practices (Vanuatu, Palau, New Caledonia, Cook Islands);
- The cost and means of maintaining a program over time (University of Michigan);
- The impact of the tourism industry on the environment and the need to set thresholds to comply with (Federated States of Micronesia) as well as the acceptable level of resource extraction without risking the extinction of the species (Tonga, New Caledonia);
- Administrative difficulties in acting on legally protected species (Guam, ZSL).

Day 2 – field trip to Moorea

- Visit to a relict population of *Partula* in a coastal area, by the roadside in Opunohu (Fig. 2)
- Release of 600 *Partula* in mape forest in Opunohu
- Workshop on conservation threats and opportunities: identify threats (reversible/non-reversible), prioritize threats, identify possible solutions. Outcomes summarised in Table 1.

Day 3 – Museum visit, workshop

Museum of Tahiti and the Islands (Punaauia, Tahiti).

- Unveiling of a spinner-dolphin sculpture made by the Mata Tohora, an association to protect emblematic marine species
- Guided tour of the exhibits
- Presentation of an inventory of collections owned by French museums and that used French Polynesian *Partula* shells; visit the collection of antique ornaments made with *Partula* shells (Fig. 3)



Fig. 3. Partulid necklaces in the Museum of Tahiti and the islands.

Discussions focused on the interrupted sharing of information including the place *Partula* occupied in French Polynesian culture. It seems important for conservation that people take ownership of this heritage in order to be convinced of the need to safeguard it.

Workshop on the involvement of local populations in conservation

Local populations are an intermediary for conservation programmes that cannot be overlooked. Their essential role in the success and sustainability of conservation actions is reinforced by the multiplicity and isolation of the Pacific islands. Issues discussed included:

- Land tenure – private and government land
- The importance of media coverage – especially cultural heritage
- Continuity of programmes initiated internationally, should be by local people
- In-depth analysis of successful conservation operations involving local communities should make it possible to identify good practices, which should be exchange among jurisdictions
- Traditional values and emblematic species could be the driving force behind conservation
- Community involvement required communication adapted to the target audience, yet all had to share a common vision of conservation actions.

| Threats | Objectives | Possible actions |
|---|--|---|
| Habitat Disruption (by degradation and/or introduced species - predators, competitors, parasites, diseases...) | Stop introductions, carry out control or even eradication actions | Biosecurity, general surveillance, local control |
| | Start working on priority areas? Include snails in decisions made, in the development of protected areas, improve knowledge | Mitigate through reserves, refuge areas or even translocation Pilot studies |
| Insufficient awareness | Raise awareness of the importance of natural heritage | Carry out awareness campaigns in schools, among the population, politicians |
| Insufficient financial resources | Increase funding | Investors, governments and other funders |
| Resource overexploitation | Improve management and education, reduce collections from the wild | Legislation, its enforcement, public awareness, substitution for other products |
| Climate change | Be truly proactive, increase knowledge to identify threat mechanisms | Conduct monitoring programs, raise awareness and educate, study translocation opportunities |



Fig. 4. Gerardo Garcia leading development of the final seminar statement.

Day 4 – develop final seminar statement

STATEMENT BY THE PACIFIC COUNTRIES

WE, THE PACIFIC COUNTRIES THAT PARTICIPATED IN THE “*ĀREHO*, NATURAL AND CULTURAL HERITAGE” FIRST REGIONAL WORKSHOP ORGANISED BY THE FRENCH POLYNESIA GOVERNMENT FROM 26 TO 29 AUGUST 2019, RECOGNIZE THAT:

- The Islands of the Pacific are home to a significant diversity of land snails, with over 6,000 species found nowhere else in the world;
- Land snails represent a significant portion of the biodiversity of the Pacific Islands and play a remarkable role in ecosystem function;
- Snails from the Pacific Islands are intricately associated with the cultures of Oceania: they were used for ornamental purposes (necklaces, crowns, set of jewels...) and are still a food resource for some communities. These species are therefore part of a cultural heritage shared by several countries in the region.
- Pacific Island land snails are under multiple pressures such as habitat loss, the introduction of invasive predators, over-exploitation and climate change, which are leading to population declines at an alarming rate.

WE, THE PACIFIC COUNTRIES, RECOMMEND CARRYING OUT THE FOLLOWING ACTIONS FOR THE COMING YEARS:

In terms of cooperation,

Working together to ensure our natural and cultural heritage is safeguarded for future generations.

In terms of engaging local populations,

We wish to strengthen the involvement of local populations, by:

1. Them reclaiming their natural and cultural heritage through their native snail species;
2. Integrating local communities’ knowledge and cultural expression into conservation planning;
3. Involving educators, museums, artists and other resource

persons in the developing of awareness tools and programmes to better increase and celebrate the value of snails within communities;

4. Raising awareness among community leaders, politicians and decision-makers to enable them to take greater ownership.

In terms of networking and communication,

We urge that the states and territories cooperate to develop conservation initiatives in the region, and to share experiences and knowledge with the aim of addressing common threats, by:

1. Establishing a network to share information and to connect people across Oceania and the wider world;
2. Holding regular meetings to share experiences;
3. Appointing a national liaison in every country.

In terms of management,

To ensure the conservation of species and habitats, we recommend coherent regulatory frameworks be implemented that guide conservation and management measures at a national and regional scale, and that suit each country’s cultural, political, demographic and geographical context by:

1. Undertaking surveys and updating species inventories;
2. Implementing management actions, including habitat protection and restoration, conservation, breeding and even translocation programs;
3. Developing effective detection, control and eradication of invasive species;
4. Monitoring programs on a regular basis for measuring success;
5. Establishing or reviewing legislation regarding the preservation of species, including through their sustainable exploitation where appropriate;
6. Implementing a sustainable funding mechanism for in situ conservation.

And in terms of research,

We advocate working to enhance knowledge of the ecology of native snails and their introduced predators as a foundation for optimizing conservation efforts, by:

1. Assessing impact of current and future threats;
2. Assessing impact of invasive species, studying their biology, and developing control and eradication methods;
3. Using natural history museum collections in order to assess demographic and genetic trends;
4. Developing conservation breeding programs;
5. Incorporating research from sociological, archaeological and cultural studies.

Our snails move slowly but are dying out rapidly.

We must act fast to save them.

Together, we can!

We thank all the participants for a very productive meeting and all those involved in organising the meeting and making it run smoothly, especially Vaeoho and Teva.

Christophe Brocherieux, Direction de l’environnement, Papeete, Polynésie française. christophe.brocherieux@environnement.gov.pf
Robert Cowie, editor of Tentacle – [details](#) at the end of this issue.

MARINE MATTERS

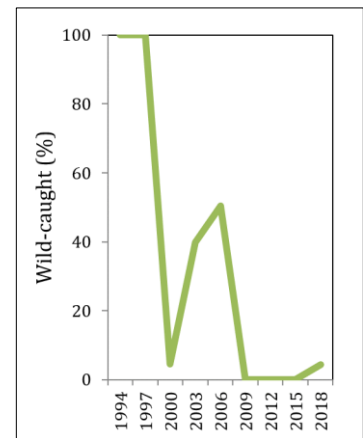
Indonesia's new protected species list a step back for marine mollusc conservation

By Vincent Nijman & Chris R. Shepherd

On 12 January 1987, 12 species of marine molluscs were added to Indonesia's list of protected species through a decree from the Minister of Forestry (*Surat Keputusan Menteri Kehutanan No 12/Kpts/II/1987*). These species were *Hippopus hippopus* (bear paw clam), *H. porcellanus* (China clam), *Tridacna crocea* (saffron-coloured giant clam), *T. derasa* (southern giant clam), *T. gigas* (giant clam), *T. maxima* (small giant clam), *T. squamosa* (fluted giant clam), *Charonia tritonis* (Triton's trumpet), *Cassis cornuta* (horned helmet), *Tectus niloticus* (commercial top shell), *Turbo marmoratus* (marbled turban) and *Nautilus pompilius* (chambered nautilus) (Noerjito & Maryanti, 2001). All these species were, and, albeit illegally, continue to be traded commercially both domestically and internationally (Nijman *et al.*, 2015; Nijman & Lee, 2016; Nijman, 2019). The decree was later consolidated into the *Act of the Republic of Indonesia No. 5 of 10 August 1990 concerning the Conservation of Living Resources and their Ecosystems Government (Undang-undang Republik Indonesia No 5 tahun 1990)* and *Regulation 7 concerning the Preservation of Plants and Animals of 27 January 1999 (Peraturan Pemerintah No 7 tahun 1999)*. Act No 5 states that: "Any and all persons are prohibited to (a) Catch, [...], transport, and trade in a protected animal in a live condition; (b) Keep, possess, [...] transport, and trade in a protected animal in a dead condition; (c) Transfer a protected animal from one place to another, within or outside Indonesia (d) Trade, keep or possess [...] bodies, or other parts of a protected animal or the goods made of parts of the animal, or transfer from one place in Indonesia to another, within or outside Indonesia". Penalties that can be imposed when these laws are broken can total fines of up to IDR 100,000,000 (~USD 7,500) and/or imprisonment for up to five years.

Of the 12 protected species, all but *Charonia tritonis* (Triton's trumpet), *Cassis cornuta* (horned helmet), *Tectus niloticus* (commercial top shell) and *Turbo marmoratus* (marbled turban) are included in Appendix II of the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES) regulating all commercial international trade. In September 2015 all species of nautilus were included on Appendix II in order better to regulate their international trade (TRAFFIC, 2016). This left *Allonautilus scrobiculatus* (crusty nautilus) as the only Indonesian marine mollusc included in CITES as not protected (Nijman, 2019). No export quota has been allocated that allows for the commercial international trade in *A. scrobiculatus* but Indonesia allows the export of maricultured *Holopuss* and *Tridacna* clams (these are exported as captive-born under CITES terminology) but export of wild-caught individuals has continued during this period. Between 1992 and 2018 Indonesia exported 4,755 wild-caught and 30,630 maricultured giant clams (*Tridacna* spp.), alive or as shells, and as can be seen from Fig. 1 the proportion of wild-caught individuals has seen a steady

Fig 1. Percentage of wild-caught giant clams *Tridacna* spp., alive or as shells, exported out of Indonesia, based on a three-year period (source: CITES trade database). In total over 35,000 individuals were exported.



decline to the extent that at present very few wild-caught individuals are exported (e.g. 555 individuals in 2018). Export of wild-caught individuals over this period should not have been allowed, as wild specimens of the species were protected under Indonesian law.

In July 2018, Indonesia released the long awaited new protected species list. Rather than ensuring that this list makes Indonesia's legislation correspond more closely with CITES, a number of CITES listed species were removed from the list and those that should have been added, i.e. *A. scrobiculatus* (crusty nautilus), were not. On the latest official list, none of the *Tridacna* species is included, nor are *Tectus niloticus* (commercial top shell) or *Turbo marmoratus* (marbled turban). All these are the species that are traded commercially in the largest numbers.

Confusingly, on the website of the Ministry of the Environment and Forestry (*Kementerian Lingkungan Hidup dan Kehutanan*), five of the eight *Tridacna* species (*T. crocea*, *T. derasa*, *T. gigas*, *T. maxima* and *T. squamosa*) are included. While either the exclusion of the commercially traded species on the official list or the inclusion of some of these on the Ministry's list may be oversights, it is a situation that needs to be clarified to ensure unlawful or unsustainable trade (Fig. 2) in these species does not continue to be a threat to their continued survival. It is feared that now these species are no longer on the protected species list, the numbers of wild-caught specimens in trade may increase significantly.

Harvest and trade in species that are not protected is regulated under *Regulation of the Minister of Forestry No. 447/Kpts-II/2003* concerning administration directive of harvest or capture and distribution of wild specimens (Soehartono & Mardiasuti, 2002). This regulation states that an annual provincial quota is set for all species that can be harvested from the wild. Harvest of species for which no quota has been set, in excess of quotas that have been set, or outside provinces for which quotas have been set, is prohibited, even when the species concerned is not considered protected. Quotas have been set for two (previously?) protected species, i.e. *T. gigas* (giant clam) and *Tectus niloticus* (commercial top shell) (*Kementerian Lingkungan Hidup dan Kehutanan*, 2018). For the giant clam, the current quota states five million kg of dead shells ("fossil shells") can be harvested from the Moluccas (a province in eastern Indonesia); live individuals cannot be harvested. For the commercial top shell 36,000 kg can be



Fig. 2. Seizure of 2,200 kg of giant clams (*Tridacna gigas*) by the Indonesian authorities in the province of Lampung in southern Sumatra in August 2014. (Photo: BKSDA Lampung)

harvested, i.e. 15,000 kg from the island of Sulawesi, 8,000 kg from Papua, 6,000 kg from Sumatra and 7,000 kg from the Moluccas and the eastern Lesser Sunda Islands. As for all the other species, including *Allonautilus scrobiculatus*, there are no harvest or trade quotas for wild-caught specimens in 2018. However, it is not known if, following the changes in protected status, there are plans to introduce quotas for any of these species in the coming years.

These data indicate that international demand for these species of ornamental shells persists, and immediate action should be taken to mitigate this. We strongly recommend that at a minimum all *Tridacna* species, *Tectus niloticus* (commercial top shell), *Turbo marmoratus* (marbled turban) and *Allonautilus scrobiculatus* (crusty nautilus) be included as protected species under *Government Regulation No. 20, 2018*.

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RECENT PUBLICATIONS RELEVANT TO MOLLUSC CONSERVATION

Freshwater Mollusk Biology and Conservation



Freshwater Mollusk Biology and Conservation, formerly *Walkerana* is the on-line journal of the [Freshwater Mollusk Conservation Society](#), based in North America. In 2019, it published two issues: volume 22, number 1, with three papers, and number 2, a special issue with the proceedings of the 2018 Freshwater Mollusk Health And Disease Workshop, with a forward and eight papers. All issues are available on-line at the journal's website, with open access.

Volume 22, number 1

- Christian, A.D., Atwood, A., Bethel, D., Dimino, T., Garner, N., Garrison, J.R., Gulich, L. & McCanty, S. 2019. Baseline qualitative and quantitative mussel surveys of the Mill River system, Massachusetts, prior to final dam removal. *Freshwater Mollusk Biology and Conservation* 22: 1-11.
- Dudding, J., Hart, M., Khan, J., Robertson, C.R., Lopez, R. & Randklev, C.R. 2019. Host fish associations for two highly imperiled mussel species from the southwestern United States: *Cyclonaias necki* (Guadalupe Orb) and *Fusconaia mitchelli* (False Spike). *Freshwater Mollusk Biology and Conservation* 22: 12-19.
- O'Brien, C., Maine, A., Nez, D. & Box, J.B. 2019. A comparison of glochidial shells of the freshwater mussels *Anodonta californiensis*, *Anodonta kennerlyi*, *Anodonta nuttalliana*, and *Anodonta oregonensis*. *Freshwater Mollusk Biology and Conservation* 22: 20-24.

Volume 22, number 2

- Bradley, M.E. & Waller, D.L. 2019. A special issue of *Freshwater Mollusk Biology and Conservation* - Proceedings of the 2018 Freshwater Mollusk Health and Disease Workshop - A forward to the special issue. *Freshwater Mollusk Biology and Conservation* 22: 25.
- Waller, D.L. & W.G. Cope. 2019. The status of mussel health assessment and a path forward. *Freshwater Mollusk Biology and Conservation* 22: 26-42.
- Haag, W.R. 2019. Reassessing enigmatic mussel declines in the United States. *Freshwater Mollusk Biology and Conservation* 22: 43-60.
- Wengström, N., Söderberg, H., Höjesjö, J. & Alfjorden, A. 2019. Mass mortality events in freshwater pearl mussel (*Margaritifera margaritifera*) populations in Sweden: an overview and indication of possible causes. *Freshwater Mollusk Biology and Conservation* 22: 61-69.
- Leis, E., Erickson, S., Waller, D. [L.], Richard, J. & Goldberg, T. [L.] 2019. A comparison of bacteria cultured from unionid mussel hemolymph between stable populations in the upper Mississippi River basin and populations affected by a mortality event in the Clinch River. *Freshwater Mollusk Biology and Conservation* 22: 70-80.
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- McElwain, A. 2019. Are parasites and diseases contributing to the decline of freshwater mussels (*Bivalvia*, Unionida)? *Freshwater Mollusk Biology and Conservation* 22: 85-89.
- Wolf, T.M., Miller, P., Primus, A. & Travis, D.A. 2019. Aquatic disease risk analysis: applications for the conservation and management of freshwater mollusks. *Freshwater Mollusk Biology and Conservation* 22: 90-97.
- Ciparis, S., Rhyne, G. & Stephenson, T. 2019. Exposure to elevated concentrations of major ions decreases condition index of freshwater mussels: comparison of metrics. *Freshwater Mollusk Biology and Conservation* 22: 98-108.

Journal of Threatened Taxa

All issues for 2019 (volume 11), and the first four for 2020 (Volume 12), of the [Journal of Threatened Taxa](#) are available on-line now.

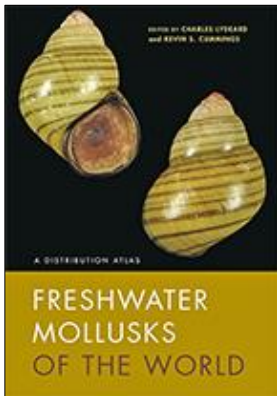
New book on freshwater molluscs

Freshwater Mollusks of the World. A Distribution Atlas. Edited by Charles Lydeard & Kevin S. Cummings. Johns Hopkins University Press, Baltimore, USA. 256 p.

Published in 2019. Can be ordered now on the [publisher's website](#).

From the publisher's website:

“There are more species of freshwater mollusks – well over 5,000 – than all the mammal species of the world. Freshwater mollusks are also arguably the most endangered fauna on the planet. Yet few references exist for researchers, shell enthusiasts, and general readers who are interested in learning more about these fascinating creatures. In *Freshwater Mollusks of the World*, Charles Lydeard and Kevin S. Cummings fill that void with contributions from dozens of renowned mollusk experts.



“Touching on 34 families of freshwater gastropods (snails) and nine families of freshwater

bivalves (mussels and clams), each chapter provides a synthesis of the latest research on the diversity and evolutionary relationships of the family. The book also includes

- a look at how evolving DNA sequencing data techniques help shed light on mollusk taxonomy
- distribution maps of each family's biogeographic locales
- a representative photo and distribution map for each of the freshwater mollusk families
- the latest information on each family's conservation status – and how to reverse the habitat destruction, modification, and pollution that threatens it
- a discussion of the ecological and economic damages caused by invasive mollusk species, as well as their role as disease vectors

“Mollusks provide us with amazing biogeographical insights: their ancient fossil record goes back over 500 million years, and their distribution patterns are a reflection of past continental and climate changes. The only comprehensive summary of

systematic and biodiversity information on freshwater mollusk families throughout the world, this reference is a must for malacologists, limnologists, ichthyologists, stream ecologists, biogeographers and conservation biologists.”

Contributors: Christian Albrecht, Rüdiger Bieler, Bert Van Bocxlaer, David C. Campbell, Stephanie A. Clark, Catharina Clewing, Robert H. Cowie, Kevin S. Cummings, Diana Delicado, Hiroshi Fukuda, Hiroaki Fukumori, Matthias Glaubrecht, Daniel L. Graf, Diego E. Gutiérrez Gregoric, Kenneth A. Hayes, Yasunori Kano, Taehwan Lee, Charles Lydeard, Nathaniel T. Marshall, Paula M. Mikkelsen, Marco T. Neiber, Timea P. Neusser, Winston Ponder, Michael Schrödl, Alena A. Shirokaya, Björn Stelbrink, Carol A. Stepien, Ellen E. Strong, Maxim V. Vinarski, Amy R. Wethington, Thomas Wilke.

The Sound of a Wild Snail Eating

Elisabeth Tova Bailey, original edition 2010. Algonquin Books of Chapel Hill, Chapel Hill, North Carolina, USA.



Here is my usual notice of this delightful book, which I continue to thoroughly recommend. It was originally reviewed in [Tentacle 19](#) (2011). The memoir recounts the author's year-long observation of a forest snail, *Neohelix albolabris*. The original book was published in the USA in 2010, but it has been translated into various languages, most recently, in 2019, Spanish (above left) and Catalan (above right). The Spanish edition will also be distributed in Mexico, Colombia, Peru, Costa Rica, Chile, Uruguay and Argentina. For links to the publishers of these editions please see the [author's website](#). An [audiobook](#) edition is available as a Kindle or hard CD. And there is an award winning short film adapted from it (see [wildsnailfilm.org](#) for upcoming screenings).

Other publications of interest

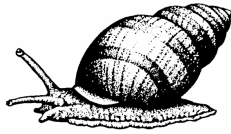
This is not a comprehensive list but simply a list of publications that I have happened to come across, additional to those mentioned elsewhere in this section. If you want to have your publications listed in the next issue of *Tentacle*, please send details to me, Robert Cowie, the editor of *Tentacle*.

Barahona-Segovia, R.M., Riveros-Díaz, A.L., Zaror, S., Catalán, R. & Araya, J.F. 2019. Shelter, ecophysiology and conservation status of *Plectostylus araucanus* (Pulmonata: Bothriembryontidae) in the fragmented Bosque Maulino, central Chile. [Revista Mexicana de Biodiversidad](#) 90: e902703.

Burlakova, L.E., Campbell, D. & Karatayev, A.Y. 2019. Status of Rare endemic species: molecular phylogeny, distribution and conservation

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IUCN/SSC AND MOLLUSC SPECIALIST GROUP NEWS AND ANNOUNCEMENTS



www.iucn.org/

All news and announcements provided by Mary Seddon, chair of the [Mollusc Specialist Group](#) (MSG) of the IUCN [Species Survival Commission](#) (SSC). Additional items by the editor.

SSC plan 2020-2024: Assess-Plan-Act

In the next Quadrennium SSC is moving to a model that focuses away from undertaking assessments towards planning and acting to get conservation benefits for all species, not just threatened species. More funding will be put in place to enable small conservation activities that will enable local level species assessments, whilst also incorporating planning for activities (often multi-species/habitat plans), and where possible enable local people to put implement actions that benefit species. See several funding opportunities below.

Post 2020 biodiversity targets

IUCN is currently engaged with other NGOs making proposals for goals and targets to be considered during the Conference of the Parties to the Convention of Biodiversity in October 2020. These goals are being set for 2030 and 2050, and discussion is ongoing on their formulation. The changing status of species on the [IUCN Red List](#), the percentage of areas that are protected and the introduction of IUCN Green Lists and IUCN Key Biodiversity Areas (KBAs) are tools that could be used for monitoring the extinctions of species, making progress in conserving species and protecting areas considered to be of high biodiversity value.

IUCN Red List updates

In 2019 the [Red List](#) had three updates, with molluscs featuring in two of these. In the July update, one of the notable additions was the Scaly Sea Pangolin, [Chrysomallon squamiferum](#) (Fig. 1), one of a series of hydrothermal vent molluscs that are being assessed by Elin Thomas and Julia



Fig. 1. *Chrysomallon squamiferum*.

Sigwart (Queens University, Belfast). A session at the World Conservation Congress is planned on Deep Sea Biodiversity and potential threats. In the December update one of the other notable species was the Mediterranean Fan Mussel, [Pinna nobilis](#) (Fig. 2), that has undergone a dramatic

decline in the last three years, with some subpopulations losing 100 % of mature individuals.

In 2020 there will be two, possibly three, updates. We anticipate that the submissions queue will contain more hydrothermal vent molluscs, species of abalone, West African freshwater molluscs, Australian land snails, Israeli land snails and more freshwater bivalves among many others from various ongoing projects.



Fig. 2. *Pinna nobilis*.

Updated version of the Red List Guidelines now available

The Guidelines for Using the IUCN Red List Categories and Criteria have now been updated to [version 14](#) (August 2019). This version brings in a new set of guidelines and tools to help assessors to decide whether to list a species as Extinct or as Critically Endangered (Possibly Extinct), clarification of what is meant by “rapidly” in the definition of location, and guidance on the appropriate category to use for plants and fungi that are now only represented by seeds or spores in storage facilities. Please make sure you have the latest version of this important document by going to the [Resources and Publications page](#) on the Red List website, scrolling down and clicking on “Guidelines and Brochures”. Then select the “Guidelines for Using the IUCN Red List Categories and Criteria” The new [tools](#) for calculating the probability of a species being extinct are also available to download from the Red List website.

IUCN Plan for KBAs based on molluscs: monitoring protocols

In June 2019, a small group of freshwater specialists (dragonflies, molluscs, fish and freshwater plants) met to follow up on a proposed monitoring protocol for newly designated Key Biodiversity Areas (KBAs) in Morocco. The field testing phase proved interesting in that previously unrecorded species were found that merited adding as species of conservation interest (trigger species) for some KBAs, as well as finding that the quality of habitat in some KBAs had declined radically since Red List assessments ten years ago. The results demonstrated the need for field validation of KBAs that had been based on desk-top studies. Recommendations are being made to the KBA steering group on future needs for the monitoring protocols.

IUCN World Conservation Congress 2020

Given the COVID-19 situation, it remains to be seen whether the congress will take place – Robert Cowie, *Tentacle* editor.

The [next IUCN congress](#) will be held from 11 to 19 June 2020 at Parc Chanot in Marseille, France. The IUCN World

Conservation Congress is where the world comes together to set priorities and drive conservation and sustainable development action. IUCN's 1,300+ government, civil society and indigenous peoples' member organisations vote on major issues, action that guides humanity's relationship with our planet for the decades ahead. There are likely to be over 10,000 participants in Marseille (France) discussing important issues ahead of the next Conference of the Parties on the Convention on Biodiversity in October 2020. This year sees the end of the decade of the [Aichi plans](#) for halting biodiversity loss and new goals and targets are currently being formulated for 2030 and 2050. The full programme should be available in March 2020 and will include workshops, knowledge cafes and traditional conference sessions.

European Association of Zoos and Aquaria May 2020

The EAZA (European Association of Zoos and Aquaria) Conservation Forum, scheduled to take place from 19 to 23 May 2020, hosted by Zagreb Zoo, Croatia, has been cancelled.

From the [EAZA website](#): "In the light of the COVID-19 outbreak being classed as a global pandemic by the World Health Organisation, and in line with guidance from them and other sources, EAZA has made the difficult decision to cancel this event. We have been in contact with our host, and we intend to examine solutions that may allow elements of this meeting to proceed remotely by teleconference, or at a later date. We will be in touch with registered delegates to provide further details of how and when we will proceed with these activities and potential refunds."

Grants

Recovery of Species on the Brink of Extinction

The next deadline to submit a proposal for the Recovery of Species on the Brink of Extinction funding opportunity is 10 April 2020. The following one is 9 October 2020. This opportunity comes from a partnership between National Geographic, Fondation Segré and IUCN SSC and its goal is to halt further biodiversity decline by implementing species conservation plans for individual species and groups of species. For more information see the [request for proposals](#) on the IUCN SSC website.

IUCN SOS Rapid Action Grants

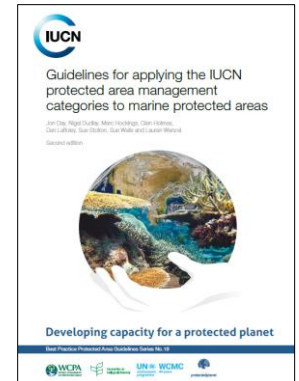
As part of the IUCN SOS (Save Our Species) African Wildlife initiative, funded by the European Union, SOS is supporting civil society organisations in responding to conservation emergencies facing terrestrial threatened species in continental Sub-Saharan Africa. These [Rapid Action Grants](#) are designed to enable responses to new and emerging threats. Recently, SOS awarded the first two of these grants to projects responding to urgent threats facing Cape vultures in Botswana and lions in Cameroon. Rapid Action Grants of up to €25,000 are still available for organisations looking to respond to a conservation emergency facing any terrestrial threatened species in continental Sub-Saharan Africa.

Publications

New guidelines for applying the IUCN protected area categories to marine protected areas

Day, J., Dudley, N., Hockings, M., Holmes, G., Laffoley, D., Stolton, S., Wells, S. & Wenzel, L. (eds.) (2019). [Guidelines for Applying the IUCN Protected Area Management Categories to Marine Protected Areas. Second edition](#). IUCN, Gland, Switzerland. 36 p.

IUCN and the World Commission on Protected Areas (WCPA) have published a new and updated edition of the Guidelines, first published in 2012. The new guidelines apply the most recent definitions and provide clarity in respect of which areas qualify as marine protected areas and should be counted towards global and national targets. This is particularly important as we move towards assessing progress towards the 2020 marine component of Aichi Target 11, and for setting new targets in the post-2020 Global Biodiversity Framework being developed. There are plans to translate this new edition into the other official IUCN languages (French and Spanish) as soon as possible.

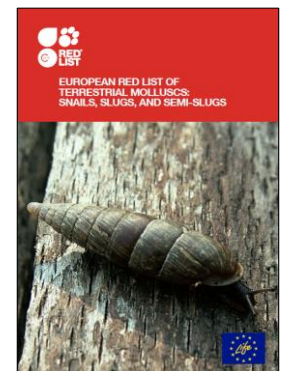


European Red List of terrestrial molluscs

Neubert, E., Seddon, M.B. & 39 others. 2019. [European Red List of Terrestrial Molluscs: Snails, Slugs, and Semi-slugs](#). IUCN: Cambridge, UK, Brussels, Belgium.

From the Assessment Scope (p. 2):

"This IUCN European Red List provides an assessment for the 2,480 species of terrestrial mollusc species known to be present in the European region at the start of 2019. Of these species, 11 are considered Not Applicable (NA) for assessment as they are not native to the European region. The number of species constantly changes as their taxonomy is revised and new species are described; a further 15-20 species have been described for the European region since this Red List assessment was completed. Updates can be found on the MolluscaBase database, which represents the taxonomic backbone used in this project.



"The data presented in this report comprise 1,233 species assessed between 2009 and 2011 and a further 1,261 species that were assessed between 2015 and 2018 (of which 14 were first assessed in the first phase but reassessed as the result of significant new data or changes in taxonomic concept)."

MEETINGS 2020-2021

This is not a comprehensive list of mollusc and conservation related meetings but includes those for which people have sent me details and the major ones that I am generally aware of without doing a thorough search. Sorry, not much to report this year – Robert Cowie, *Tentacle* editor.

Conchologists of America 2020 convention



Given the COVID-19 situation, it remains to be seen whether the convention will take place – Robert Cowie, *Tentacle* editor.

From the convention [website](#): The 2020 COA convention will take place 15-16 June (field trips) and 17-21

June (meeting) in Melbourne Florida, USA. For more information, visit the [COA Conventions website](#).

Annual meeting of the American Malacological Society - cancelled



The 2020 annual [AMS](#) meeting, scheduled for 13-17 July in the Florida Keys, has been cancelled. The 2021 meeting is planned to be in Canada.

Euromal 2020 convention



Given the COVID-19 situation, it remains to be seen whether the convention will take place – Robert Cowie, *Tentacle* editor.

The 9th European Congress of Malacological Societies (EUROMAL 2@2@) will take place 6-11 September

2020 at Prague, Czech Republic, hosted by the Czech University of Life Sciences. Details on thematic sessions, symposia and registration are available on the [conference website](#), [facebook](#) or e-mail: k.douda@gmail.com.

International Congress for Conservation Biology 2021



The [Society for Conservation Biology](#) (SCB) 30th International Congress for Conservation Biology (ICBB) will be held in 2021. Two nations in Africa are under consideration to host it, with an announcement on the final destination expected soon.

INTERNET RESOURCES

These are just a few of the many websites dealing with mollusc conservation, and with molluscs and conservation in general.

IUCN Red List

The entire *IUCN Red List of Threatened Animals* can be searched at the following address: www.iucnredlist.org

IUCN Invasive Species Specialist Group

The [ISSG website](#) includes details of the Aliens-L listserv and the ISSG newsletter, *Aliens*.

Unitas Malacologica

[Unitas Malacologica](#) (UM) is the worldwide society for malacologists and malacology. Its aim is to further the study of Mollusca by individuals, societies and institutions worldwide. UM has provided financial support for the production of *Tentacle* in the past and I urge all readers to become members. The UM website has links to many interesting and useful sources of malacological information, including all the UM newsletters, which have a lot of information complementing information in *Tentacle*.

Mollusca list

The MOLLUSCA listserv is intended as an informal forum for discussions of molluscan biology. There are over 700 subscribers. From time to time it has something of interest related to conservation. To subscribe to the list send e-mail to molluscalist@lists.berkeley.edu with the word Subscribe in the subject line. You will get a reply soon after saying that your name has been added. You will then receive anything that is posted to the list. To post to the list, send email to molluscalist@lists.berkeley.edu. MOLLUSCA is maintained and managed by David R. Lindberg of the University of California Museum of Paleontology, Berkeley, USA.

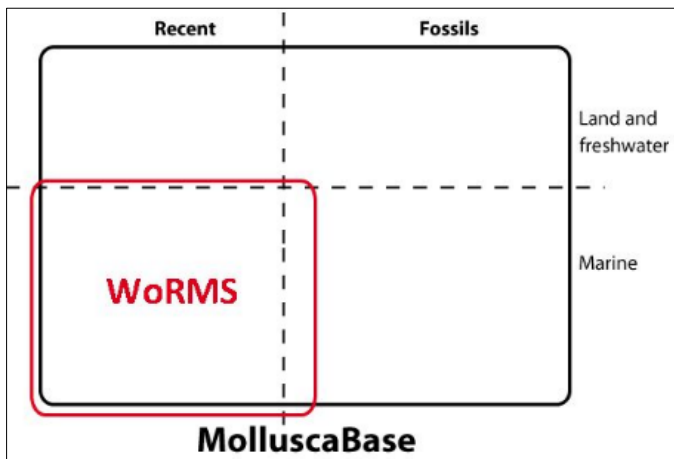
MolluscaBase

[MolluscaBase](#) is a taxonomically oriented database that aims to provide an authoritative, permanently updated account of all molluscan species.

Subject to availability, the following information is provided for taxa included in MolluscaBase:

- Accepted (valid) name
- Classification (presented with a parent/child hierarchy)
- Synonyms
- Reference of original description and other relevant literature sources
- Type locality and distribution
- Stratigraphic range
- Traits (environment, feeding type, host/parasite relationship) and notes
- Images

The recent, marine component coincides with the Mollusca entries in the World Register of Marine Species ([WoRMS](#)), whereas the non-marine and fossil components are not



displayed in the WoRMS interface, although the former are increasingly being added.

MUSSEL database project

The [MUSSEL Project](#) is an on-going study aimed at the global revision of the classification of the Unionoida, otherwise known as freshwater mussels. The two principle investigators, Daniel L. Graf and Kevin S. Cummings, combine their efforts to maintain an efficient malacological strike force equally capable of working in remote collection localities or urban mollusc collections. Toward this end, they are compiling an exhaustive database of all Recent described unionoid species and genera. This database will eventually serve as the basis for a universal synthesis and revision of freshwater mussel taxonomy.

Mollia

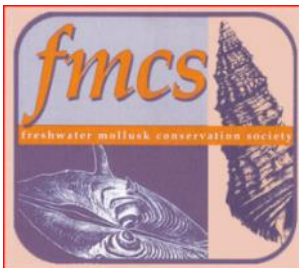


The [MOLLIA](#) web site includes instructions to authors, subscription information and links to malacological journals. It also allows you to subscribe to the MOLLUSCA listserver (above).

MOLLIA, like MOLLUSCA, is maintained

by David Lindberg at the University of California Museum of Paleontology, Berkeley, USA.

Freshwater Mollusk Conservation Society



The [Freshwater Mollusk Conservation Society](#) (FMCS) is devoted to the advocacy for, public education about and conservation science of freshwater molluscs, North America's most imperiled fauna. Its website has an

excellent page of [links](#). The FMCS now publishes the journal [Freshwater Mollusk Biology and Conservation](#) (formerly *Walkerana*) and has all issues on-line and available, including volume 1, which includes Jack

Burch's *Identification of Eastern North American Land Snails* and two-part *North American Freshwater Snails*.

Malacological Society of Australasia



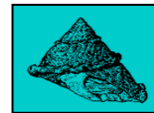
The [Malacological Society of Australasia](#) is networked with the leading conservation organisations and is working with the IUCN Mollusc Specialist Group to list Australia's threatened and endangered species of molluscs. The society publishes the journal [Molluscan Research](#).

American Malacological Society



The homepage of the [American Malacological Society](#) carries a link to its [conservation policy](#) and to the [AMS Conservation Committee Imperiled Species Newsletter](#). Student research grants are available.

Western Society of Malacologists



The [WSM](#) home page carries links to membership, conferences, grants, and other news.

Brasilian Society of Malacology



The [Sociedade Brasileira de Malacologia](#) (SBMa) welcomes malacological researchers, professionals and students, Brazilian and foreign, as well as aficionados of molluscs, having as its main objective

to encourage the study of malacology, promoting knowledge of molluscs and its dissemination at all cultural levels, and taking reasonable measures to preserve the Brazilian mollusc fauna.

Conchologists of America



The homepage of the [COA](#) carries a link to a number of pages dealing with its [conservation policy and conservation issues](#). Research grants are available.

Unio listserver

[Unio](#) is an unmoderated internet listserver focusing on the biology, ecology and evolution of freshwater unionid mussels. The list is sponsored by the Florida Institute of Technology and administered and managed by Rick Tankersley (rtank@fit.edu).

Haus der Natur – Cismar

The [Haus der Natur](#) homepage carries a link to a page on mollusc conservation in Germany, as well as other links.

The National Museum of Wales – Mollusca

The [Mollusca page](#) of the National Museum of Wales provides information on the global projects on molluscs underway based in Cardiff. The museum's [Mollusca collection database](#) is searchable.

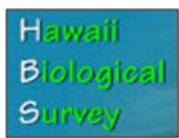
Illinois Natural History Survey

The [Illinois Natural History Survey's mollusc page](#) has much information on the mussels of North America, with links to other mussel sites.

Caucasian Snail Project

The [Caucasian Land Snails Project](#) is a major collaborative effort. The website is maintained by Bernhard Hausdorf, mollusc curator at the Zoological Museum, Hamburg University.

Hawaii Biological Survey

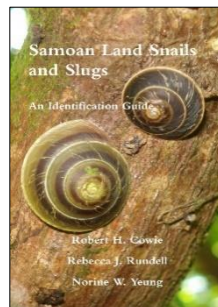


The [Hawaii Biological Survey](#) (based at the Bishop Museum, Honolulu) web site has searchable databases and much additional information on most Hawaiian organisms, including both indigenous (99 % endemic)

and non-indigenous land and freshwater snails, endangered species, and so on.

Samoa Snail Project

The [Samoa Snail Project](#) had as its goals assessing the diversity and historical decline of the native Samoan non-marine snail fauna, as a first step in its conservation. It is part of the Bishop Museum's [Pacific Biological Survey](#). In 2017 an inexpensive illustrated paperback guide to the Samoan Islands land snail fauna was published (see [Tentacle 26](#)).



Tropical land snail project at the Natural History Museum, London

The [Tropical Land Snail Diversity](#) site provides access to the Sri Lankan and South and South-east Asian snail projects of Fred Naggs, Dinarzarde Raheem and colleagues. There are some marvellous photos of brightly coloured snails.

CLEMAM: Check List of European Marine Mollusca

The [Check List of European Marine Mollusca](#) database provides a list of taxonomic references concerning all molluscan taxa living in marine waters of Europe.

Field Museum land snails

The on-line database of Chicago's [Field Museum mollusc collections](#) contains information for over 158,000 lots (a lot is a collection of a single species taken from a single locality on a single occasion), including over 2,500 type lots, of land snails.

Australian marine invertebrates

[Overview of the Conservation of Australian Marine Invertebrates](#) by W. F. Ponder, P. Hutchings & R. Chapman (588 p.), published in July 2002.

CITES

The [Convention on International Trade in Endangered Species of Wild Fauna and Flora](#) (CITES). The majority of information relates to mammal and bird trade, but a number of molluscs are listed in the [Appendices](#).

Other useful links

www.manandmollusc.net/
www.staff.uni-mainz.de/lieb/

TENTACLE – PUBLICATION GUIDELINES AND INFORMATION

Disclaimer 1: *Tentacle* is not issued for purposes of zoological nomenclature. All or any names or nomenclatural acts in it are disclaimed for nomenclatural purposes. See the *International Code of Zoological Nomenclature*, Fourth Edition, Article 8.

Disclaimer 2: Views expressed in *Tentacle* are those of the authors of individual articles. They do not necessarily reflect the views of the Editor, nor of the Mollusc Specialist Group, the Species Survival Commission or of IUCN.

Tentacle is a web-based newsletter, accessed at www.hawaii.edu/cowielab/Tentacle.htm, where all issues are available. Guidelines for submission of articles to *Tentacle*, and other related IUCN links are also on this website.

If you plan to submit something to *Tentacle*, please read the following guidelines. Carefully following the guidelines will make the life of the editor a lot easier!

Your submission **must be explicitly** relevant to **mollusc conservation**.

I usually make only editorial changes to submitted articles and in the past have accepted almost everything sent to me. However, before I accept an article I will assess whether it really includes anything **explicitly relevant to mollusc conservation** and whether any conclusions drawn are supported by the information presented. For example, **new records of non-native species will not be accepted unless there is a clear and significant relevance to mollusc conservation**. So, fully explain the conservation relevance in your article and be sure not to speculate too wildly. Unjustified statements (even if probably true) do a disservice to conservation as they permit our critics to undermine our overall arguments. *Tentacle*, however, is not a peer-reviewed publication and statements made in *Tentacle* remain the authors' responsibilities.

I stress that *Tentacle* is not a peer-reviewed publication. Please do not see *Tentacle* as an easy way to get your original data published without going through the rigours of peer review. ***Tentacle* is a newsletter** and so it is primarily **news items** that I want, including summaries of your ongoing studies, rather than full, data-rich reports of your research. Those reports should be submitted to peer reviewed journals. I will increasingly decline to publish articles that I feel should be in the peer-reviewed literature, especially if they are long.

There is, therefore, a **limit of three published pages**, including all text, illustrations, references, etc., for all articles that I accept for publication in *Tentacle* (though I reserve the right to make rare exceptions if I consider it appropriate).

Please make every effort to format your article, including fonts (Times New Roman), paragraphing styles, heading styles, and especially citations, in a way that makes it easy for me simply to paste your article into *Tentacle*, which is created in Microsoft Word. Please pay special attention to the format (paragraphing, fonts, font sizes, etc.) in past issues. **TEMPLATES FOR ARTICLES ARE AVAILABLE. Conformance to the guidelines has improved – perhaps because of my many many reminders! But it still takes many many hours to format your submissions – please do it for me! Especially, please pay very careful attention to the format of references in the reference lists, especially punctuation – it still takes inordinate amounts of time deleting commas, inserting colons, changing journal titles to italics, putting initials after not before names, deleting parentheses around dates and so on. Here are examples of how it should be done – please follow them very carefully:**

Cowie, R.H., Régnier, C., Fontaine, B. & Bouchet, P. 2017.

Measuring the sixth extinction: what do mollusks tell us? *The Nautilus* 131(1): 3-41.

Cowie, R.H., Evenhuis, N.L. & Christensen, C.C. 1995. *Catalog of the Native Land and Freshwater Molluscs of the Hawaiian Islands*. Backhuys Publishers, Leiden. vi + 248 pp.

Cowie, R.H. 2011. Snails and slugs. In: *Encyclopedia of Invasive Introduced Species* (ed. Simberloff, D. & Rejmánek, M.), p. 634-643. University of California Press, Berkeley.

Also note that **illustrations and tables must fit in a single column**, so make sure your maps, diagrams and tables are readable and show what you intend when they are reduced to this size.

Metric Système International units are used throughout *Tentacle*. Please do not use miles, inches, gallons, etc.

Tentacle is published using **British English** not American English, e.g. “mollusc” not “mollusk”!

Printing and mailing of *Tentacle* has been supported in the past by [Unitas Malacologica](http://www.mollusc.org), the international society for the study of molluscs, for which the Mollusc Specialist Group is most grateful. To become a member of UNITAS, go to its website and follow the links to the application.

Membership of the Mollusc Specialist Group is by invitation. However, everyone is welcome to submit articles to *Tentacle* and to promote its distribution as widely as possible. Since I announce the publication of each new issue to all who are on my *Tentacle* e-mail distribution list, please keep me updated with your current e-mail address so that you do not drop off the list. I also announce the availability of each issue on the MOLLUSCA listserver (for details, see [p. 47](#) of this issue of *Tentacle*) and the Unitas Malacologica members e-mail list.

As always, I reiterate that the content of *Tentacle* depends on what you send me. So I encourage anyone with anything relevant to mollusc conservation to send me something now, and it will be included in the next issue (published once a year, usually in January, or at least soon thereafter).

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In order to keep these details up to date, please inform the editor, Robert Cowie, of any changes or corrections.

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