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

Although this issue of *Tentacle* is shorter than last year's (62 vs. 78 pages, 24 vs. 28 main articles), there is plenty of interest for everyone. Three things about this issue strike me in particular. First, ten of the 15 miscellaneous articles (green headings) are about freshwater species, mostly mussels, from North, Central and South America, Australia and Morocco, but also snails, from India, South America, Sierra Leone and Borneo; perhaps this high proportion of articles reflects the serious threats faced by many freshwater molluscs around the world. Second, *Tentacle* has never published an article specifically about Rwanda (though it was touched on in an article about the Congo Basin in issue 25, in 2017), nor an article about Sierra Leone, which together with the article from Morocco, means that this issue, unusually, contains three African contributions. I would like to see much more from Africa in future issues. And third, three articles are about continent-wide collaborative efforts, in North America, South America and Europe, at various stages of development, all focussed on freshwater mussels. So, as usual, a diverse set of articles, if fewer than I would like.

All the articles in the Pacific island land snails / captive breeding section are indeed only from the Pacific, although in the past there have been articles about Bermuda, São Tomé, Mauritius, the Desertas Islands, the Juan Fernandez Islands and others. Oceanic island land snails are, as we all know, some of the most threatened land snails in the world and I think it is important to make them as highly visible as possible; one way to do this is by publishing many articles about them in *Tentacle*. Over the last few years I have been encouraging those working on island land snail conservation to submit articles every year, and with nice photos. Notably, the people in the Ogasawara Islands (Japan), now members of the Mollusc Specialist Group, have contributed several articles since I visited them in 2019.

I encourage everyone to send me something for next year, however short.

Robert H. Cowie

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NEWS

Clam makes comeback from extinction off shores of Croatia

From Reuters, 8 December 2023. Complete Article (with photos). Reporting by Antonio Bronic, writing by Daria Sito-Sucic, editing by Andrew Heavens [slightly modified and illustrated; see also Only 20 Croatian noble pen shells left alive in Adriatic Sea by Lauren Simmonds, Total Croatia, 11 May 2023. Ed.]

PULA, Croatia Dec 8 (Reuters) - A huge clam that was on the verge of extinction has made a comeback, with a surge in numbers in waters off Croatia, marine biologists say.

The clam, known as the noble pen shell or *Pinna nobilis* (Fig. 1), started dying out as a deadly pathogen spread in parts of the Mediterranean around 2016.

Fig. 1. Live specimen of *Pinna nobilis*, in Levanto, Liguria, Italy. (By Hectonichus - own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=22843302)

Numbers plummeted across the region and, until recently, scientists in Croatia only knew of around ten surviving in their corner of the Adriatic.

Then last year a diver spotted a group of 20 near the shore in the north of the Istria peninsula.

“The news sounded incredible. It was impossible they were alive”, said Sandro Dujmovic of the Natura Histrica organisation which manages Istria’s protected areas.

This year biologists managed to collect about 100 young specimens and take them to an aquarium.

“It was a sign that they are still reproducing themselves”, Dujmovic told Reuters.

The clams, whose shells can grow as much as 120 cm (4 feet) across, play an important ecological role by filtering sea water and allowing other organisms to flourish.

In the aquarium in the Adriatic town of Pula, they are kept in specially filtered water, clear of the parasites that can attack them.

“We keep (them) here primarily to secure the cleanest possible environment for them ... and try to strengthen them as much as possible to become resistant and capable to survive a possible return to the sea”, biologist Nikolina Premate said.

Dujmovic and Premate said it was too early to say what had caused the comeback, but Croatia’s government was funding more research.

“A network of institutions and individuals has been created along the Adriatic coast who are checking, searching, collecting”, Dujmovic said.

Journal of Conchology is now fully open access and digital only

From the Journal’s website.[slightly modified; Ed.].

Published twice a year, the *Journal of Conchology* contains scientific papers and short communications on molluscs with emphasis on promoting conservation, biogeography and taxonomy. The contents cover, typically, descriptions of new species from anywhere in the world and reports concerning the ecology, distribution and status of molluscs. Both living and fossil molluscs are dealt with.

In addition the *Journal* publishes, obituaries and book reviews. Being a scientific publication papers are published only after review by referees. The *Journal* is subscribed to by learned institutions world-wide, and is a flagship publication for the Society. Members and non-members may submit contributions to the Honorary Editor. Here are detailed instructions for authors on how to submit articles to the *Journal of Conchology*.

Open Access Statement

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Publication Fees

Journal of Conchology does not charge Article Processing Fees as standard; however, non-members will be charged UK£100 once their paper is ready for publishing. Members of the Conchological Society of Great Britain & Ireland may submit and publish for free, but non-members are encouraged to either join the Society or pay the fee. If the paper is of considerable size then the fee may be larger. Authors will be queried on submission of their manuscript and a fee agreed before processing of manuscripts.

Fee Waiver

Authors without institutional support who are unable to meet the fees can enquire about the Cameron Fund. This is a small

amount generously donated by Robert Cameron to assist those that cannot afford to pay a publication fee. The Society does however encourage those that can pay to do so, so that the Cameron Fund, which is a finite amount of money, can be used by those that really need it.

The 5th Canadian Freshwater Mollusc Research Meeting 2023

From The North Grenville Times, Ontario, Canada, 30 November 2023. Article by Fred Schueler & Aleta Karstad, as part of a campaign by a local biologist to make natural history into "news" [slightly modified; Ed.].

Streams, ponds, and lakes support a diverse range of species of snails and bivalves (clams and mussels), with fascinating life histories and diversely beautiful shells, which are important elements of aquatic ecosystems. Every two years, the Centre for the Study of Inland Waters in Burlington hosts a Canada-wide meeting on freshwater Molluscs – https://www.cfmrm2023.com/. In the post-meeting message sent by the organizing committee: "…a huge shout out to all our presenters and sponsors…this meeting was by far our largest. It is amazing to see how much the Canadian mollusc community has grown since the first meeting nearly a decade ago. The breadth and scope of research being undertaken by all of you is truly amazing and inspiring!"

Fig. 1. Species from Fragile Inheritance presentations at the Freshwater Mollusc Meeting. Left: *Cipangopaludina chinensis* (Chinese mystery snail); centre: *Planorbella campanulata* (belmouth ramshorn snails); right: *Sagittunio nasutus* (eastern pondmussel).

North Grenville's Fragile Inheritance Natural History presented three papers at the meeting, summarised below, though a threat of illness meant we could not attend in person:

Exploring the Upper St. Lawrence River and its tributaries for unionid mussels including *Sagittunio nasutus* (eastern pondmussel) with Kate Schwartz, Matthew Windle, Emma Ehrenfeld, Elizabeth Hall, Elizabeth Grohmann and Alisha Ng of the St. Lawrence River Institute. Before zebra mussels (*Dreissena* spp.) invaded the Great Lakes, the eastern pondmussel (*Sagittunio nasutus*) was one of the most abundant and widespread native mussel species in the lower Great Lakes, but it was nearly wiped out by fouling by zebra mussels. When we found this species in Lyn Creek, west of Brockville in 2005, this was the second known surviving population in Canada. We and others have found a few more remnant populations, but the species lives in slow-moving mucky-bottom sites, and can be hard to find. This summer, we worked with the River Institute to search the upper St. Lawrence and its direct tributaries for this and other native mussel species, using a combined approach of environmental DNA (eDNA) and timed searches. From June to October, 20 sites in tributaries and 40 in the St. Lawrence River were sampled for eDNA, and we await the outcome of the analyses of these samples.

Declines in abundance of *Cipangopaludina chinensis* (Chinese mystery snail) with Naomi Langlois-Anderson of South Nation Conservation.
Chinese mystery snails are remarkable because of their huge size (up to 60 mm high), and uniform dark colouration. Introduced to the Pacific Coast for food by oriental immigrants in the 19th Century, and to many places throughout eastern North America as aquarium snails through the 20th century, these are now widespread in Ontario, often as amazingly abundant populations. We reviewed our records, and found that we had observed seven apparent declines, four sites where the population appeared stably common or abundant, seven sites where they were abundant and three where they were sparse at one visit, and two sites where they appeared at places we had previously repeatedly visited. We have found them as nearby as Winchester and the Rideau at Carleton University, but have not seen any in Grenville County. The declines may be due to control efforts, predation by mammals, onset of zebra mussel populations or drought. We cannot certainly assign any of the declines to a particular cause, but we will be looking out for evidence through the 2024 field season.

Drawdowns of Doom: biodiversity impacts of water level management in impoundments
Triggered by observations of frog and snail mortality at the Kemptville Creek dam in Oxford Mills, we are on a campaign to get recognition of the mortality of aquatic species that lowering water levels behind dams brings about. Drawdowns are nominally done to protect infrastructure and provide reserve capacity to hold back water during spring flooding, but it is important that their impacts on the life in the impoundments be noticed and studied, so that these can be taken into account when planning water level management.

The meeting had lots of presentations on distribution, sampling methods, toxic threats and recovery methods, though because the many species of native mussels are the ones with Species-at-Risk funding, there was a heavy emphasis on these species in southwestern Ontario. Offsetting the neglect we saw of some subjects in the meeting will inform our field work for the coming year: hybridization between eastern and western stocks of common mussels in eastern Ontario and western Quebec, the apparent decline in zebra mussel populations, and annual movements of mussels in stream and lake bottoms. We are updating our manual of identification of molluscs and other large aquatic invertebrates, and can send a copy to anyone who is interested.

Frederick W. Schueler and Aleta Karstad, Fragile Inheritance Natural History, North Grenville, Ontario, Canada. bckcdb@istar.ca

SAVING ANIMALS FROM EXTINCTION THROUGH AZA SAFE – NORTH AMERICA'S FRESHWATER MUSSELS

By Monika Böhm & Jacob Harmon

North America, especially the southeastern USA, represents a major hotspot for freshwater mussels (Böhm *et al*., 2021), and the importance of freshwater mussels in aquatic ecosystems is not lost on the continent's zoos and aquariums. Whether it be Higgins' Eye (*Lampsilis higginsii*), Sheepnose (*Plethobasus cyphyus*), or Winged Mapleleaf (*Quadrula fragosa*) (all three federally listed as endangered), and everything in between, many facilities are already supporting major conservation initiatives in their region, often in collaboration with federal or state agencies. This involvement in freshwater mussel conservation can take different shapes: from propagating mussels to field conservation and survey efforts, and from educational school programmes to engagement with the millions of visitors that visit zoos and aquariums every year.

The Association of Zoos and Aquariums (AZA) is dedicated to the advancement of zoos and aquariums in the areas of conservation, education, science and recreation. It represents more than 235 facilities in the USA and overseas, which collectively draw more than 200 million visitors every year. Overall, AZA has more than 200 member institutions in the USA and Canada alone. One of the main ways in which AZA organises concerted conservation among its members is via its Saving Animals From Extinction (SAFE) programme (Ripple *et al*., 2021). SAFE programmes help to protect threatened animals by building on established recovery plans and history of commitment, prioritising collaborations and knowledge sharing between AZA institutions, implementing strategic conservation and stakeholder engagement and measuring conservation progress.

North American Freshwater Mussel SAFE (Fig. 1) represents the 37th AZA SAFE programme and the fourth one focused on invertebrates, after Coral, North American Monarch and Sunflower Sea Star. The programme, co-led by Jacob Harmon from the National Mississippi River Museum and Aquarium and Monni Böhm from the Global Center for Species Survival at the Indianapolis Zoo (also a member of the IUCN SSC Mollusc Specialist Group), was announced just in time for the 2023 AZA Annual Conference in Columbus, Ohio. Needless to say, the team's first port of call was to celebrate the programme announcement with as many potential programme partners as possible, especially at the Aquarium Conservation Partnership reception, which was held at the Watters Aquatic Conservation Center (Fig. 2).

But now the work is starting in earnest. By June 2024, the programme will have a 3-year plan in place that focuses on advocacy, research, restoration and recovery, and education and engagement on freshwater mussels. For this, the co-leads are enlisting the invaluable help of a steering committee to oversee the work, representing institutional partners, but also including an IUCN SSC Mollusc Specialist Group liaison, an education advisor, and other special advisory roles.

Fig. 1. North American Freshwater Mussel SAFE programme logo.

Thankfully, as mentioned above, there is already considerable mussel expertise within the AZA network. Take a look at these facilities, all key partners in the new AZA SAFE programme:

- In partnership with the Genoa National Fish Hatchery and the Iowa Department of Natural Resources (DNR) among others, the National Mississippi River Museum and Aquarium houses freshwater mussel propagation cages and Submersible UPwelling SYstems (SUPSYs) on their Ice Harbor dock. Mussel glochidia transform off the fish and settle in the cages, while the SUPSYs are used to grow mussels to stocking size and engage guests in on-going conservation efforts in the Upper Mississippi River Basin.
- The Greensboro Science Center houses a mussel propagation lab committed to the conservation of North American freshwater mussel species. They have worked with state agencies for five years to build and establish this programme.
- The Watters Aquatic Conservation Center, run by Columbus Zoo & Aquarium and in partnership with the Ohio State University, the City of Columbus, Ohio Department of Natural Resources and the Ohio Division of Wildlife, has five primary objectives: 1) health assessment of mussels using metabolomics and transcriptomics; 2) fish host identification experiments to determine which fish host species can be used by mussel larvae for transformation into juveniles; 3) propagation efforts to transform mussel larvae on host fish and grow them out to a releasable size for introductions in their native ranges (including leading-edge in-vitro techniques that bypass the fish stage and transform juveniles in the laboratory); 4) providing temporary refugia for mussels

Fig. 2. Visit to the Watters Aquatic Conservation Center during the AZA Annual Conference in Columbus, Ohio.

removed from situations where there have been environmental disasters or mitigation sites involving translocations; 5) education and outreach to diverse audiences such as regional schools, zoo guests, parks, visiting scientists and government decision makers.

- As an agency of the state of Minnesota, the Minnesota Zoo prioritises conservation programmes in the state, and freshwater mussels are a key component of their local conservation portfolio. A full-time biologist coordinates their mussel conservation activities, including: 1) head-starting juvenile mussels to support recovery efforts led by the Minnesota Department of Natural Resources; 2) conducting research to inform husbandry and reintroduction science; 3) implementing outreach and educational programming to raise awareness and encourage public action.
- The Kansas City Zoo & Aquarium has worked with the Missouri Department of Conservation, US Fish and Wildlife Service and Missouri State University for the past two decades in nurturing multiple species of freshwater mussels and helping to return them to native habitats in four states.

Other institutions are still very much at the start of their mussel journey, and the purpose of the new AZA SAFE programme will be to provide guidance, share resources and establish a support network for these new institutions to make their journey as smooth as possible. Some may want primarily to establish visitor outreach and engagement programmes about freshwater mussels, and link these with meaningful education on wider freshwater conservation issues. Others may want to find ways to participate in field conservation efforts, surveys and monitoring – think BioBlitzes for freshwater mussels, for example. Others, in turn, may increase their engagement in mussel conservation through conservation funding and support for the IUCN SSC Mollusc Specialist Group. For example, the Indianapolis Zoo has recently established the Global Center for Species Survival, a collaboration with the IUCN Species Survival Commission. Through the Global Center, the zoo supports activities by the IUCN SSC Mollusc Specialist Group, from species assessment to planning and action, including communications and outreach. The zoo has also actively started to fund freshwater mussel conservation projects, specifically supporting Indiana's brand-new mussel propagation facility run by the Muncie Sanitary District, in partnership with The Nature Conservancy and Indiana Department of Natural Resources.

One thing is clear – by activating AZA organisations around the perilous situation of freshwater mussels and combining new voices and audiences with those efforts already underway, the programme aims to achieve significant conservation gains by capturing visitor's hearts and minds and meaningfully engaging with the wider stakeholder community. If you would like to find out more about the AZA North American Freshwater Mussel SAFE programme, please do not hesitate to contact the programme leads via the email addresses below!

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SOS – SAVE OUR SNAILS: A CRY FROM THE AZORES

By António M. de Frias Martins

The Azores are a relatively young archipelago, isolated in the center of the North Atlantic. It is not surprising, then, that its terrestrial and freshwater malacofauna amounts to only 131 species, including ellobiids (Martins, 2011, 2019). However, this relative paucity in species number is overshadowed by its uniqueness, for about 45% are endemic; moreover, when the ongoing project of description of the suspected undescribed species is complete, the number of endemics is expected to rise to 57% (Martins, 2005, 2011; Harris *et al*., 2013). The distribution of these endemics throughout the archipelago is not at all homogeneous, in part because of the different ages of the islands and their arrangement in three groups spread over 600 km. Intra island speciation owes much to recurrent volcanic activity imposing population isolates. In summary, the Azores are truly a natural laboratory where evolution can be caught red-handed.

Yet, this seemingly small malacological paradise has been severely experiencing the harsh effects of climatic change, most visibly on the oldest, endemically richest but not the largest island, Santa Maria.

The roots of Santa Maria Island date back 6 My, but recent studies have concluded that the island has sunk, having re-emerged 3.5 My ago (Ramalho *et al*., 2017). It is only 97 km^2 and 580 m at its highest point, Pico Alto. Nevertheless, it has as many single island endemic species (19 plus four now presumed extinct) as the remaining islands combined (Martins *et al*., 2023). From the 1990s on, a persistent decline in numbers of specimens has been observed, leading to the increasing rarity of some species so that a handful of them have not been seen at all for the past 20 years (Martins *et al*., 2023).

Fig. 1. *Leptaxis minor*, endemic species of Santa Maria.

Alerted to this dramatic situation by scientists from various places, the Azorean government put together, in 2020, a proposal later approved as Project LIFE SNAILS NAT/PT001377, now in progress. The purpose of the project is to:

- **Reduce fragmentation of historical areas of distribution,** through the establishment of an integrated mosaic of ecological corridors that interconnect with waterlines and remaining spots of high-quality habitat;
- **Increase area of suitable habitat**, through (re)naturalisation of forests by diversification of trees and shrubs and (re)naturalisation of hedgerows and fences along the margins of pastureland;
- **Improve habitat quality**, by learning which environmental parameters control endemic-rich areas, and controlling invasive plants, restricting cattle access and ensuring nature-based solutions favouring humidity and moisture in soil and ground cover;
- **Repopulate the intervening areas**, by transfer of leaf-litter from endemic-rich areas;
- **Raise public awareness**, for people are the privileged guardians of their own biodiversity and natural heritage.

Three species were selected because of their IUCN status: *Plutonia angulosa* (Critically Endangered), *Oxychilus agostinhoi* (Critically Endangered) and *Leptaxis minor* (Endangered; Fig. 1), all restricted to Pico Alto.

Intervention on the habitat is in full progress, thus raising hopes to give survivors a chance, and the people of Santa Maria, proud of their unique natural heritage, have adopted snails as a banner to promote the island in a sustainable, nature-friendly way (Fig. 2).

We only hope to succeed…

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Fig. 2. From Santa Maria with love!

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LIVING ON THE EDGE: PROPOSED CONSERVATION STATUS OF *CREMNOCONCHUS* SPECIES OF THE WESTERN GHATS, INDIA

By N.A. Aravind & Anushree Jadhav

The genus *Cremnoconchus* is an endemic group of iconic littorinid species of freshwater habitats (Aravind *et al*., 2016) restricted to the central and northern Western Ghats of India, a globally recognised biodiversity hotspot (Myers *et al*., 2000). The species of this genus are point endemics, restricted to spray zones of the waterfalls in central (12° to 16° N) and northern Western Ghats (north of 16° N). Recently, with support from Re:Wild and the IUCN SSC Mollusc Specialist Group, we undertook an extensive survey in the central and northern Western Ghats. This report describes the initial results of the assessment of the genus *Cremnoconchus*.

A comprehensive approach was employed to assess the status of all known species. Historical sites, where the species were previously reported, as well as new sites, were surveyed in December 2022, January 2023 and October 2023. At each waterfall, the following parameters were recorded: 1) population density per square meter in at least three 1 m^2 plots, 2) surrounding land use and land cover, 3) threats such as garbage

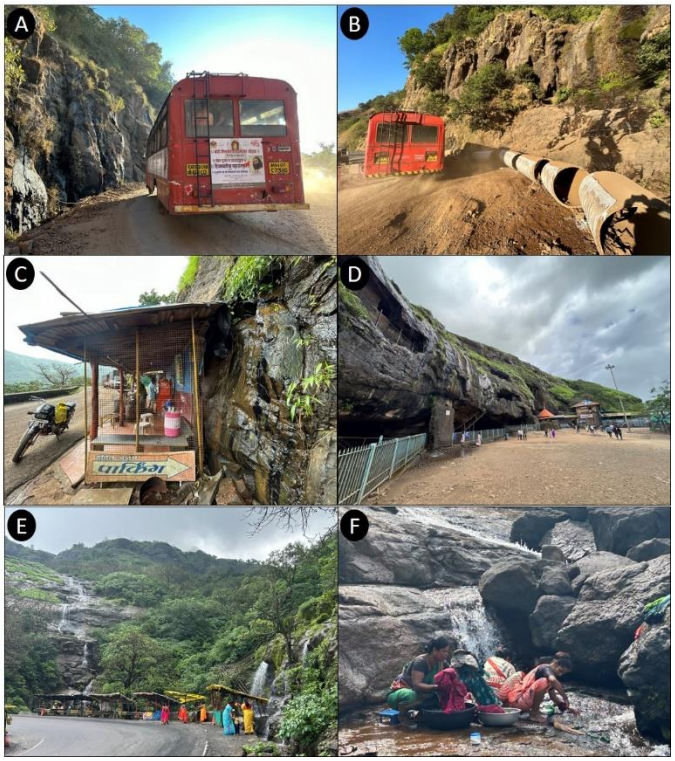

Fig 1. Different types of threats recorded during the survey. A - traffic next to *Cremnoconcus* habitat in Mahableshwar; B - road widening and traffic in Mahabaleshwar; C - small shop covering *Cremnoconchus* habitat in Varandah; D - *Cremnoconchus* habitat in Karli modified; E - Makeshift and temoprary food stalls at Malsej; F - washing and cleaning.

dumping, pollution, and direct human use (if any), and roads and traffic intensity (Fig. 1). Additionally, DNA barcodes for the cytochrome c oxidase subunit 1 gene were generated, following the methodology outlined by Saha *et al*. (2022), to distinguish species from the northern Western Ghats, as a prior study (Reid *et al*., 2013) reported the presence of *C. syhdrensis*, *C. conicus* and *C. canaliculatus*, which are similar in external appearance, from multiple localities. Specifically for the Pune district, a land use and land cover map was developed for two time periods, namely 1985 and 2023, to assess changes in land use and land cover (LULC). This was deemed necessary as most of the sites where *Cremnoconchus* was found are in this region. The final assessment was grounded in an analysis of distribution patterns, presence in protected areas or not, threats, total area (area of occupancy) and population density.

Table 1. Summary of the assessment of *Cremnoconchus* distribution, population and threats. PA – protected area(s)

Species	Number of localities	Total Area (m^2)	Population density (range) m^{-2}	Threat	In PA?
C. syhdrensis	1	<1,000	3 (2-5)	Very high	No
C. conicus	2	<1,000	28 (20-40)	Very high	No
C. canaliculatus	2	<1,000	27 (20-40)	Very high	No
C. hanumani	1	<500	10 (5-15)	Very low	Yes
C. globulus	1	<500	10 (2-15)	Very low	Yes
C. castenea	1	<1,000	Not assessed	Very low	Yes
C. agumbensis	1	<100	(0-1)[1]	Very high	Yes
C. dawaraki	1	<500	8 (2-15)	Very high	No
C. cingulatus	1	<500	10 (2-15)	Very high	No

[1]Three sites were surveyed but only one specimen was found so no mean is given.

Table 2. Threats faced by members of the genus *Cremnoconchus* of the Western Ghats based on the integrative assessment approaches.

Species	Threats
C. syhdrensis	Next to a main road. High traffic, tourism, land use and land cover change, pollution. Climate change might be a big threat.
C. conicus	Roadside waterfalls. High traffic, land use and land cover change, pollution, garbage. Proposed road expansion in the type locality. Climate change might be a big threat.
C. canaliculatus	Roadside waterfalls. High traffic, land use and land cover change, pollution, garbage. Proposed road expansion in the type locality. Climate change might be a big threat.
C. hanumani	No direct threats as of now, though trekking and recreation to a small extent. But these are minor. Climate change might be a big threat.
C. globulus	No direct threats as of now, though trekking and recreation to a small extent. But these are minor. Climate change might be a big threat.
C. castenea	No direct threats as of now, though trekking and recreation to a small extent. But these are minor. Climate change might be a big threat.
C. agumbensis	Within a protected area, but roadside falls. High traffic, land use and land cover change, pollution, garbage. Proposed road expansion in the type locality, very low population density. Climate change might be a big threat.
C. dawaraki	Roadside waterfalls. High traffic, land use and land cover change, pollution, garbage. Proposed road expansion in the type locality. Climate change might be a big threat.
C. cingulatus	Roadside waterfalls. High traffic, land use and land cover change, pollution, garbage. Proposed road expansion in the type locality, low population density. Climate change might be a big threat.

The distribution pattern, based on both field and molecular analyses, suggests that nearly all species are confined to a single waterfall, except *C. canaliculatus* and *C. conicus*, which are each found in two waterfalls. No specimens were discovered in historical sites such as Karli, Sinhaghad and Vadagoan. The area of occupancy is less than 1,000 m^2 for species in the northern Western Ghats and one species in the central Western Ghats, and less than 500 m^2 for species in other parts of the central Western Ghats, except for *C. agumbensis*, which has an area of less than 100 m^2. Population density ranged from 1 to 20 individuals per square metre. Generally, species in the central Western Ghats exhibit lower population density than those in the northern Western Ghats (Table 1). With the exception of three species from the central Western Ghats, namely *C. hanumani*, *C. globulus* and *C. castenea*, all other species face high to very high levels of threats from various human activities (Table 2). The analysis of land use and land cover in the Pune district revealed a 16% increase in built-up areas since 1985, accompanied by a 16% reduction in cropland. Shrub forest cover had diminished by 4%.

Therefore, based on this integrative analysis (comprising field surveys, population density assessment, threat evaluation, spatial analysis and molecular analysis), we recommend that *C. syhdrensis*, *C. conicus*, *C. canaliculatus*, *C. agumbensis*, *C. dawaraki* and *C. cingulatus* be classified as Critically Endangered, and that *C. hanumani*, *C. globulus* and *C. castenea* be classified as Endangered (Table 3). As indicated in Table 1, these latter three species are located within protected areas, benefiting from the highest level of conservation through a habitat protection approach. However, it is noteworthy that *C. agumbensis*, despite occurring within a

protected area, is in close proximity to a busy road, and furthermore, this site is earmarked for road expansion, rendering this species highly threatened. A summarised overview of the distribution, population and threats is presented in Table 2.

Conservation Action Plan

Based on the findings of the field studies, the three species in the central Western Ghats, namely, *C. hanumani*, *C. globulus* and *C. castenea*, do not require an extensive management effort as they are located within protected areas and benefit from a high level of conservation. However, for the remaining species, a comprehensive approach is essential, involving measures such as upstream pollution control, land use and land cover management, augmentation of canopy cover, maintenance of consistent water flow throughout the year and regulation of access and usage by humans to prevent dumping. The stakeholders responsible for implementing these measures encompass the State Forest Department, the State Revenue Department and local communities. Priority should be given to capacity-building and awareness activities for all concerned stakeholders to ensure the long-term conservation of these iconic freshwater species in the Western Ghats of India.

Table 3. *Cremnoconchus* species reported from lotic systems of the Western Ghats, India, with their current and proposed conservation status.

Species	Current	Proposed
C. syhadrensis	Endangered	Critically Endangered
C. conicus	Vulnerable	Critically Endangered
C. canaliculatus	Endangered	Critically Endangered
C. dwaraki	Not Evaluated	Critically Endangered
C. agumbensis	Not Evaluated	Critically Endangered
C. cingulatus	Not Evaluated	Critically Endangered
C. castanea	Not Evaluated	Endangered
C. hanumani	Not Evaluated	Endangered
C. globulus	Not Evaluated	Endangered

We thank the SSC for an EDGE Internal Grant (GG-0000000477) that funded this project. We also thank Ashok Captain, Karthick Bala and Radhakrishnan for help during the field work.

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CONSERVATION UPDATE – FRESHWATER MUSSELS OF AUSTRALIA AND CAPTIVE BREEDING TRIALS FOR *HYRIDELLA GLENELGENSIS* – AUSTRALIA'S RAREST FRESHWATER MUSSEL

By Michael W. Klunzinger, Timothy D. Fernando & Hugh A. Jones

Species Conservation status

In last year's issue of *Tentacle*, a summary of the conservation status of freshwater mussels in Australia was provided (Klunzinger, 2023), which highlighted increasing threats and recent listings. Some of Australia's freshwater mussel species for which we have data (and probably others for which we do not) are facing declines from severe droughts, habitat loss from channel change caused by extreme erosive floods, impacts from livestock and salinity, and other problems.

Following last year's update, the Murray-Darling River mussel, *Alathyria jacksoni* Iredale, 1934 (Fig. 1), has been nominated for threatened status (Klunzinger *et al*., 2023a [unpublished]) and is now under consideration for listing under the Commonwealth of Australia Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (see DCCEEW, 2023). The species' range spans four states, i.e. Queensland (Qld), New South Wales (NSW), South Australia (SA) and Victoria (Vic), so an assessment at the national level was advised by several state governments. Results from recent surveys by Sheldon *et al*. (2020) showed that the species has suffered significant mortality from severe droughts since 2000, particularly in the Darling (Baaka) River, throughout much of its northern range in NSW. Subsequent work by Wright *et al*. (2022) confirmed that the species does not tolerate emersion. Surveys in November 2023 failed to detect young mussels, which suggests that recruitment may be failing. Additionally, the relatively high abundance of the invasive common carp (*Cyprinus carpio*), a non-host fish that does not support metamorphosis of glochidia to the juvenile stage (Walker *et al*., 2014), is a cause for concern (Klunzinger *et al*., unpublished).

Fig. 1. Recent surveys of the Murray-Darling River mussel *Alathyria jacksoni* by Michael Klunzinger in the Darling (Baaka) River, November 2023. (Photo of M.W. Klunzinger collecting *A. jacksoni*: Saul Gonzalez Murcia)

Table 1. Updated conservation status of Australian freshwater mussels (Hyriidae). Taxonomy follows Ponder *et al*. (2023).

Scientific Name	IUCN Red List	State Listing	EPBC[3]
Velsunioioninae			
Alathyria condola	DD (pending)	-	-
Alathyria jacksoni	DD	-	Under assessment
Alathyria pertexta pertexta	-	-	-
Alathyria pertexta wardi	-	-	-
Alathyia profuga	-	-	-
Lortiella froggatti	-	-	-
Lortiella opertanea	-	-	-
Lortiella rugata	-	-	-
Velesunio ambiguus	-	-	-
Velesunio angasi	-	-	-
Velesunio moretonicus	NT	-	-
Velesunio wilsonii	-	-	-
Westralunio carteri	VU	VU[1]	VU[3]
Westralunio inbisi inbisi		Nomination in preparation[1]	Nomination in preparation
Westralunio inbisi meridiemus		Nomination in preparation[1]	Nomination in preparation
Hyriinae: Hyridellini			
Cucumerunio novaehollandiae	LC	-	-
Hyridella australis	-	-	-
Hyridella depressa	-	EN[2]	-
Hyridella drapeta	-	-	-
Hyridella glenelgensis	CR	CR[2]	CR
Hyridella narracanensis	NT	EN[2]	Nomination in preparation

State Legislation for listed species:[1]*Biodiversity Conservation Act 2016* (Western Australia), [2]*Flora and Fauna Guarantee Act 1988* (Victoria), [3]EPBC – Environment Protection & Biodiversity Conservation Act 1999 (Commonwealth of Australia).

There are several PhD students currently working on freshwater mussels of Australia, with conservation being a major theme in their studies. Michelle Hobbs (Griffith University, Qld) is undertaking a PhD under the supervision of Fran Sheldon, Mark Kennard and Sue Jackson on the ecology of freshwater mussels of eastern Australia, their roles in the ecosystem and Indigenous biocultural knowledge of mussels. In Western Australia (WA), Jake Daviot (Murdoch University), with supervisors Alan Lymbery, Stephen Beatty and Alan Cottingham, has been working in partnership with Water Corporation on using artificial refuges for the conservation of *Westralunio carteri* Iredale, 1934.

As a result of a taxonomic split and the description of an additional species of *Westralunio* from south-western Australia (*Westralunio inbisi* Klunzinger *et al*., 2022), the status of *W. carteri* now needs re-evaluating. Thus, nominations are being prepared to update the status of *W. carteri* and *W. inbisi* under the WA Biodiversity Conservation Act 2016.

A field trip is planned for February 2024 to evaluate the status of *Hyridella narracanensis* (Cotton & Gabriel, 1932) in Tasmania. The species is listed as Endangered in Victoria, but its status in Tasmania needs to be assessed to determine if it qualifies for listing under Tasmanian legislation or nationally under the EPBC Act.

The conservation status of many of Australia's freshwater mussels has yet to be assessed and the current data in the IUCN Red List will require updating as most listings are now nearly a decade old. We are working hard to resolve this with collaborators and expect that new assessments and data

Fig. 2. Broodstock of the criticially endangered Bocara Timbonn (Glenelg freshwater mussel, *Hyridella glenelgensis*) being collected from population strongholds by ARI Victorian scientists Dr. Tarmo Raadik (top left) and Timothy Fernando (top right). (Photos: Timothy Fernando and Tarmo Raadik)

updates will be forthcoming. The current conservation status of Australia's freshwater mussels is provided in Table 1 (updated from last year's *Tentacle* article).

Captive breeding trials of *Hyridella glenelgensis*

An action statement for Australia's critically endangered freshwater mussel *Hyridella glenelgensis* (Dennant, 1898) was published by the Government of Victoria, under the state's Flora & Fauna Guarantee Act 1988 (DEECA 2023). The species' plight and subsequent threatened species status listing were brought to light following an influential publication by Playford & Walker (2008). The Action Statement and its implementation complement the FFG Act strategy entitled "Protecting Victoria's Environment – Biodiversity 2037" with a vision that "Victoria's biodiversity is healthy, valued and actively cared for". In line with this vision, a team of Victorian Government scientists, led by the Arthur Rylah Institute (ARI) for Environmental Research (Chris Jones, Jarod P. Lyon, Tarmo A. Raadik, Timothy D. Fernando and Ben Iscaro) and the Victorian Fisheries Authority (Brett Ingram and Sam Fawke) was assembled to trial captive breeding of *H. glenelgensis*. The team consulted with experienced freshwater mussel biologists Conor Wilson (Parks Victoria) for his work on *Margaritifera margaritifera* (Linnaeus, 1758) in Northern Ireland (Wilson 2011; Wilson *et al*., 2012; Reid *et al*., 2013), Hugh A. Jones (University of New South Wales) for his work with host fishes on several eastern Australian freshwater mussel species (Jones, 2014) and Michael Klunzinger (Griffith University) for his work with host fishes of the vulnerable *Westralunio carteri* Iredale, 1934 (Klunzinger *et al*., 2012).

Individuals of *H. glenelgensis* were collected from population strongholds in early September 2023 during the onset of the Australian spring and taken into captivity (Fig. 2). Females

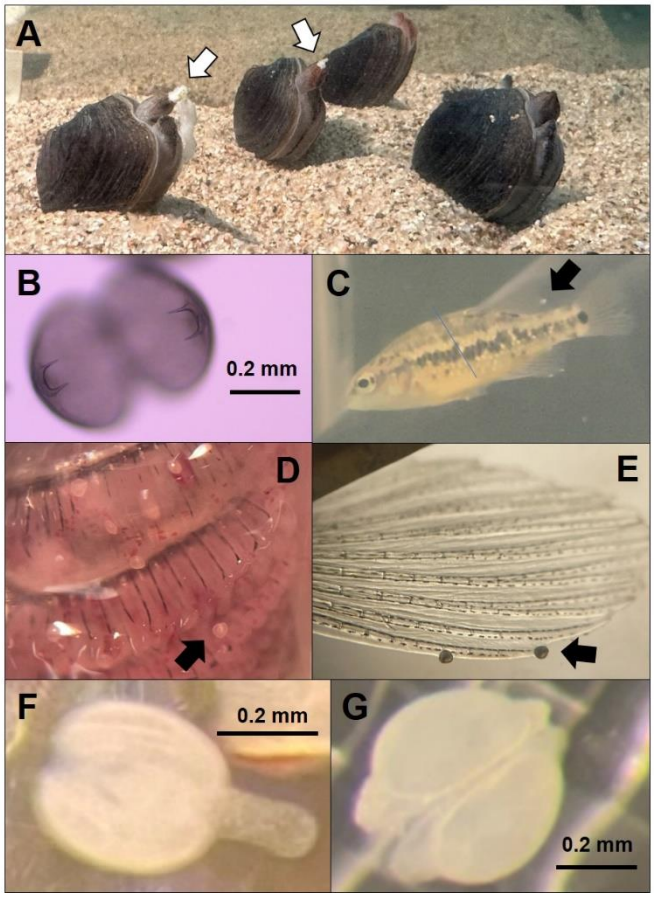

Fig. 3. Female *H. glenelgensis* releasing mesoconglutinates (white arrows) (A), which contain the characteristic double-hooked glochidia (B). Glochidia (black arrows) attached to fins of variegated pygmy perch (C) and the gills (D) and fins (E) of common galaxias host fishes, which metamorphosed to the juvenile mussel stage (F). A six-week-old juvenile showing early shell formation (G). (Photos: A, C-G, Tim Fernando; B, Brett Ingram)

released conglutinates containing mature glochidia shortly after arrival (Fig. 3), which were then presented to two locally occurring native fish species, common galaxias (*Galaxias maculatus*) and variegated pygmy perch (*Nannoperca variegata*), which is listed as vulnerable under the EPBC Act. Glochidia of *H. glenelgensis* successfully attached to the fins and gills of each fish species and juveniles appeared around four weeks later. The trial also added valuable information about the morphology of the glochidia and release mechanism and one of the few instances of 'mesoconglutinate' release in Australian freshwater mussels (Klunzinger *et al*., 2023b). The captive adult population has now been transferred to the Victorian Snob's Creek Conservation Hatchery with plans to continue to develop captive breeding of the species as an insurance population to safeguard against extinction. ARI scientists are currently tracking the growth of a juvenile, which has survived the initial stages of metamorphosis, and it is continuing to be cared for at the ARI aquarium facilities.

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THE ECOSYSTEM AND SOCIOCULTURAL VALUE OF *DIPLODON CHILENSIS*: AN ENDANGERED FRESHWATER BIVALVE FROM SOUTHERN SOUTH AMERICA

By Claudio Valdovinos & Pablo Fierro

Ecosystems worldwide provide essential benefits to humanity, collectively known as ecosystem services. Freshwater ecosystems contribute significantly to these services by providing vital resources (Vaughn, 2018). Freshwater bivalves, such as *Diplodon chilensis* (Hyriidae) from southern South America (Fig. 1), are a notable example, playing fundamental roles in these ecosystems (Valdovinos *et al*., 2021). This species stands out in Chilean aquatic ecosystems because of its size (up to 14 cm) and population density (up to 500 individuals/m^2), making it one of the ecologically most relevant invertebrates in many lakes and some rivers in central and southern Chile. Its geographic distribution in southern South America covers Chile from the Limarí River (30°S) to the Ofqui Isthmus (46°S), spanning a disjointed territory of approximately 1,800 km from north to south (Valdovinos & Pedreros, 2007). This bivalve is also found on the Argentinian side of the Andes, from Mendoza (33°S) to Chubut (46°S). Despite its extensive geographic range, many populations of this species face a high degree of threat, especially in the northern part of its range. Among the main threats are changes in physical habitat (Figs. 2-3), water pollution (primarily eutrophication and sedimentation) and global climate change (see Peredo *et al*., 2005; Valdovinos & Pedreros, 2007).

Despite gaps in scientific knowledge, *D. chilensis* is the freshwater invertebrate species with the most scientific information available in southern South America. However, this species is almost completely ignored by Chilean society, including those responsible for formulating biodiversity conservation policies. Recently, our research group secured funding in Chile from the National Agency for Research and Development (ANID) for a project titled: 'Ecosystem engineers: megafiltering bivalves create biogeochemical hot-spots in southeastern South American lake bottoms (2023-2025)'. One of the specific objectives of this project is to contribute to the conservation of *D. chilensis* as a means of supporting the conservation of aquatic ecosystems in which these bivalves play an active role in ecosystem structure and function. This article aims to examine and discuss the critical role that this bivalve plays in the context of ecosystem services. The goal is to emphasise the relevance of *D. chilensis* populations and raise awareness of the negative repercussions that their decline could have on society.

Fig. 1. High densities of *Diplodon chilensis* in the bottoms of Laguna Chica de San Pedro (Chile). On the shells, feces and pseudofeces derived from their intense water column filtration activity are observed. (Photo: C. Valdovinos)

Diplodon chilensis has been an essential component in the lives of Indigenous peoples in central and southern Chile, having been integrated into their diets and cultures (Prates & Marsans, 2007). This bivalve is distinctive for being the only freshwater mollusc featured in the diets of prehistoric communities in Chile and Argentina, maintaining its presence in the diets of the Mapuche and local populations to the present day. Historical uses of *D. chilensis* extend to the use of its shells as ornaments, tools and household utensils. The oldest archaeological site linked to its use is in Monte Verde in southern Chile, dating back 12,500 years, while in the former Tagua-Tagua lagoon (Chile), evidence of its continuous use over millennia has been discovered (Jackson & Jackson, 2008). In particular, at Tagua-Tagua, *D. chilensis* shells have been found in ritual contexts, such as funerary offerings placed on the faces of the deceased, revealing a profound spiritual and practical connection with this organism. The presence of *D. chilensis* in archaeological records is extensive, with additional findings documented by various researchers.

Currently, the extraction of *D. chilensis* for consumption is very infrequent, mainly carried out by Mapuche and local communities in southern Chile. Some Mapuche communities still use its sharp shells as razors. Furthermore, *D. chilensis*

Fig. 2. Individuals of the bivalve *Diplodon chilensis* and the gastropods *Chilina fluctuosa* and *Heleobia* sp., dead on the bottom of the Aconcagua River Basin (Chile) because of desiccation caused by intensive water extraction for agricultural use. (Photo: C. Valdovinos)

has inspired the names of geographical locations and local narratives, highlighting its influence on Chilean toponymy and folklore. Although there is no established commercial fishery for it, attempts have been made to investigate its cultivation, indicating an interest in its potential for sustainable use.

From an ecological perspective, *D. chilensis* plays a significant role as a biofilter in water purification, effectively removing both organic and inorganic suspended particles and notably improving water clarity in eutrophic ecosystems (Valdovinos *et al*., 2021). It exhibits a high filtration rate, which, when combined with its abundance in certain habitats, significantly influences ecosystem dynamics. It has been demonstrated to be effective in mitigating organic waste produced by the salmon industry and in treating waters contaminated by domestic sewage. These applications underscore the species' ability to contribute to ecological balance and restoration. Recognising these qualities, the Chilean Undersecretariat of Fisheries and Aquaculture (SUBPESCA) has supported the relocation of *D. chilensis* specimens from Lake Villarrica and Lake Lleu-lleu to Lake Lanalhue, with the aim of assisting in the recovery of the latter water body affected by eutrophication.

Diplodon chilensis plays an essential role in nutrient recycling and storage in aquatic ecosystems. It feeds on suspended particles in the water column, primarily phytoplankton, transforming them into tissues, shells and biodeposits, such as faeces and pseudofaeces, while also releasing dissolved nutrients (Soto & Mena, 1999). It also contributes to nutrient dynamics by excreting soluble substances that can be used by algae and heterotrophic bacteria, thereby influencing aquatic food webs (Vaughn, 2018). Despite its importance, the details of these processes in *D. chilensis* have not been exhaustively studied, although previous research has explored its role in energy transfer and its relationship with nutrient levels in lakes. The correlation

Fig. 3. Mass mortality of *Diplodon chilensis* on the shores of Lake Caburga (Chile), due to an extreme decrease in the lake's water level. (Photo: C. Valdovinos)

between *D. chilensis* abundances and the trophic status of water bodies suggests a significant association with the ecological condition of these ecosystems.

With regard to its function in aquatic food webs, *D. chilensis* plays a significant role as a vital supplier of nutrients and energy in a bottom-up process. In lakes and certain rivers, it forms dense aggregations that can exceed 500 individuals/m^2, turning these areas into hubs of biological activity that support the food chain. The nutrients excreted and deposited by *D. chilensis* in the form of biodeposits promote the growth of benthic microalgae, and in turn, other macroinvertebrates that feed on them thrive. Additionally, this species serves as a dietary link for various predators, including the southern river otter ('*huillín*', *Lontra provocax*), fish, birds and anomuran freshwater crabs of the genus *Aegla*.

Diplodon chilensis, like many other molluscs (Vaughn, 2018), contributes physical structure to its environment through its shells, creating biogenic habitats that benefit other organisms and play a role in biogeochemical cycles. Although the rate of shell production and decomposition, as well as the volume of accumulated material, has not been specifically quantified for *D. chilensis*, its contribution to habitat structuring is undeniable. This species tends to colonise soft bottoms within the photic zone, forming aggregations that promote richer and more diverse communities of macroinvertebrates compared to similar habitats devoid of these bivalves. The shells offer protection against currents and predators, serving as secure refuges within the sediments. Certain species such as the oligochaete *Chaetogaster limnaei* and the gastropod *Chilina dombeyana* have been observed to use the shells as habitats, emphasising the importance of *D. chilensis* in creating and modifying living spaces for other organisms in aquatic ecosystems.

From an environmental perspective, *D. chilensis* is a key indicator and monitoring organism for environmental change, capable of recording historical alterations. This species, characterised by its longevity, abundance, sessile nature and

ability to bioaccumulate contaminants in its soft tissues and shells, reflects the trophic status of aquatic ecosystems (Risk *et al*., 2010). The population responses of *D. chilensis* have been linked to water quality and the levels of nutrients and trace metals present in its habitat. The molecular responses of these bivalves to varying water quality conditions have also been extensively studied, providing a deeper understanding of their interaction with the environment. Using these properties, methods have been developed to employ *D. chilensis* in toxicity bioassays and for water quality monitoring, especially in the detection of trace metals and pesticides. The records within their shells offer valuable sclerochronological information, linking lake trophic levels and trace metal concentrations in the water column over time. Thanks to its biological and ecological profile, *D. chilensis* has been recommended as a bioindicator for assessing water quality in northern Patagonia, especially in Lake Villarrica (Chile). Furthermore, its use as a paleobioindicator has been suggested, allowing for inferences about the historical conditions of lacustrine ecosystems in the region, providing an invaluable perspective on the evolution of these habitats over time.

In conclusion, freshwater bivalves, such as *D. chilensis*, are among the most threatened organisms, with significant extinctions occurring in the northern part of their distribution in Chile. Phenomena like mass strandings, possibly linked to algal blooms, pollution and drought, serve as indicators of ecological disturbances that endanger the integrity of the ecosystem services provided by these molluscs (Valdovinos & Fierro, 2024). Conducting a comprehensive assessment of the ecosystem services discussed in this review is crucial, encompassing economic, sociocultural, and ecological aspects, in order to emphasise their importance to the community and policymakers. Proactive strategies, such as relocation for conservation and management purposes, are in development but require greater momentum and recognition (Lopes-Lima *et al*., 2014).

Evaluation of the impact of the loss of ecosystem services provided by unionids to freshwater ecosystems and society as a whole is still an emerging field (Vaughn, 2018). Conservation efforts should focus on the protection of unionids as catalysts for the health of aquatic ecosystems. Quantitative information on the contribution and magnitude of ecosystem services across various species, habitats and environmental conditions is needed. The challenge of maintaining and restoring these services is interdisciplinary and requires collaboration among scientists, economists and the community, among other stakeholders (Valdovinos & Fierro, 2024).

I thank my deceased Chilean malacologist colleagues, Dr. José Stuardo and Prof. Esperanza Parada, for providing me with valuable information about the ecology of *D. chilensis*. I also thank the National Agency for Research and Development (ANID) for financing Fondecyt project No. 1231.

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POMACEA AMERICANISTA: ALMOST ONE HUNDRED YEARS OF UNAWARENESS

By Abril Soria, Silvana Burela, María Emilia Seuffert, Fernanda Gurovich & Pablo R. Martín

Apple snails (family Ampullariidae), especially those belonging to the genus *Pomacea*, are usually seen as troublesome invaders and agricultural pests rather than targets for conservation studies and projects (Martín *et al*., 2013). *Pomacea americanista* (Ihering, 1919) was first described as *Ampullaria americanista* from the Iguazú Falls (Argentina) and Encarnación (Paraguay) but almost a hundred years passed before the first studies of its ecology and natural history were published (Gurovich *et al*., 2017, 2018). This freshwater snail has a large shell, with a short spire and wide last whorl and an aperture that is closed by a corneous operculum. The shell's external surface is smooth, with brown spiral bands. It shows sexual dimorphism with the males being smaller, with a convex operculum and the edge of the aperture expanded. Egg laying is aerial with hundreds of pale pink calcareous eggs that are laid on substrates emerging from the water (Fig. 1).

Fig. 1. Female of *Pomacea americanista* laying eggs in the laboratory

The experimental demography of this apple snail indicates that its biotic potential and resilience are lower than those of congeneric invasive species (Gurovich *et al*., 2018). Despite its large size and its conspicuous egg masses the presence of *P. americanista* in the Iguazú Falls, surrounded by two of the most visited national parks in South America, goes unnoticed.

This species is known only from the Alto Paraná and Iguazú Rivers and some of their tributaries, where it inhabits rocky substrates in fast-flowing reaches and waterfalls (Hylton Scott, 1958; Gurovich *et al*., 2017). Its natural restricted distribution has been reduced in recent years and because of this and various threats it was recently categorised as Endangered in the Red Book of Argentinian Molluscs (Asociación Argentina de Malacología, in press). One of the main threats it faces is habitat degradation and loss due to the construction of hydroelectric dams that affect the few river reaches where it has been recorded and also nearby sections that were presumably habitable.

Until 1958, only three localities were known for this species (Fig. 2): Encarnación City and the Urugua-í Stream in the Upper Paraná and the Iguazú Falls on the Iguazú River (Hylton Scott, 1958). Recently, one more population was recorded in a tributary of the Iguazú, the San Francisco Stream (Gurovich *et al*., 2017). The maximum distance between these localities along these watercourses is only 450 km, although presumably it could have extended further upstream and downstream from the known records. Within a radius of 311 km from the Iguazú Falls, there are a total of nine dams.

Upstream from the mouth of the San Francisco Stream in the Iguazú River, there are six dams located in Brasilian territory.

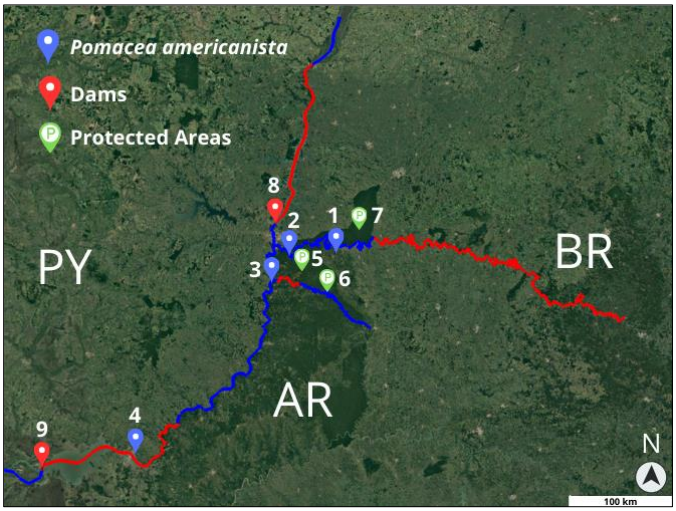

Fig. 2. Satellite map showing *P. americanista* records: 1 - San Francisco Stream; 2 - Iguazú Falls; 3 - Urugua-í Sream; 4 - Encarnación City; the main protected areas: 5 - Iguazú National Park; 6 - Urugua-í Provincial Park; 7 - Iguaçu National Park; and the main dammed reaches: 8 - Itaipú Dam; 9 - Yacyretá Dam. AR - Argentina; BR - Brasil; PY - Paraguay. The courses of the rivers and streams mentioned in the text are highlighted in blue and the dammed sections in red. Dark green areas represent original vegetation (tropical humid forest) and light green ones where it has been replaced by crops, orchards and pastures.

Of the total 1,320 km of extension of the Iguazú River, 466 km (35% of the total river without taking into account the tributaries) have been impounded by these dams, converting these reaches into lentic environments, probably not very suitable for *P. americanista* according to the sites where it has been recorded. In addition, two large dams were built on the Paraná River that have probably affected possible habitats of the species. One of them, the Itaipú Dam (Paraguay-Brasil), is located just 21 km and 64 km upstream from the mouths of the Iguazú River and the Urugua-í Stream, respectively, in the Paraná. Itaipú has dammed around 120 km of the Alto Paraná River and has submerged the Guairá Falls, a set of waterfalls not smaller than those of the Iguazú, and probably inhabited or habitable by this species. In turn, the Yacyretá Dam (Paraguay-Argentina) has modified 170 km of the Paraná River upstream of the dam, with the tail of the reservoir extending upstream beyond one of the first records of *P. americanista*, the city of Encarnación. A dam has also been built that dammed a 40 km stretch of a stream inhabited by this species, the Urugua-í. In recent years we have not been able to find specimens of this species in the sections of these last two watercourses where it had been previously recorded.

On the whole, without taking into account the tributaries, 750 km of rivers and streams have been dammed within the basins inhabited or habitable by this species. These dams not only transformed the rapids and waterfalls that are the known habitat of *P. americanista* into lentic environments with still water and high siltation, but also generated downstream changes in hydrological regimes in sections of the rivers not directly affected by dams. When water is released to generate the extra hydroelectric power required during working days there is an increase in the water level downstream, which can

Fig. 3. San Francisco Stream (Misiones Province, Argentina) with high turbidity after rains.

cover the eggs masses deposited when the water level was lower (Gurovich *et al*., 2017), potentially affecting their viability and integrity (Pizani *et al*., 2005).

Another threat that *P. americanista* faces is land use change. The hydrographic basins where it lives were once covered by tropical humid forests that have been heavily impacted by deforestation (Fig. 2), with the Iguazú National Park (677 km^2) and the Urugua-í Provincial Park (840 km^2) in Argentina and the Iguaçu National Park (1,852 km^2) in Brasil standing out among the largest remnants of the forests. This intense deforestation favours the erosion of the red lateritic soils and the movement of sediments into rivers during rains, which increases the turbidity of the water and siltation on hard bottoms (Fig. 3), the known microhabitats of this species.

Because of these and other threats such as invasive species, pollution and climate change, more studies on the status of *P. americanista* and implementation of conservation measures are necessary (Martín *et al*., 2015; Gurovich *et al*., 2017, 2018). We aimed to obtain more evidence on the global conservation status of *P. americanista*, extending our study to neighbouring countries, as well as its future trends under global climate change, to better understand the threats it faces and to propose measures both for its conservation as well as that of other native gastropods inhabiting the same environments. We also aim to disseminate the knowledge obtained to local communities, technicians and decision-makers to support the implementation of necessary conservation measures.

To this end, information on the historical distribution will be collected from visits to museum collections in Argentina, Uruguay, Paraguay and Brasil. To determine the current distribution of the species, sampling campaigns will be carried out in Argentina, where new sites will be sampled along the Alto Paraná and Iguazú Rivers and tributaries. The records will be georeferenced and mapped through the GeoCAT program (Bachman *et al*., 2011) to estimate the extent of occurrence (EOO) and area of occupancy (AOO) used in the IUCN assessments. Bioclimatic data from 1970 to 2000 for the locations of records of this species will be used to develop a model of its ecological niche and this will be projected under different future climate scenarios to estimate whether the suitable area will decline, increase or remain unchanged, and whether its geographic range will be displaced (Seuffert & Martín, 2024).

Based on the projected sampling, a more detailed characterisation of the habitat of *P. americanista* and its oviposition microhabitat will be carried out. In addition, the impact on egg laying of artificial floods in the Iguazú River will be evaluated in the field at the Iguazú National Park. Fresh egg masses deposited on natural or artificial substrates will be selected, observed and photographed daily for three weeks (Gurovich *et al*., 2017) to determine their submersion frequency, disintegration, time until hatching and viability.

The project also aims to develop a mass breeding method for the species and to identify possible sites to reintroduce populations of the species. Eventually, proposals will be submitted to the relevant authorities for reintroduction, using these ex situ populations as a source, and annual monitoring of the success of these reintroductions will be carried out.

In addition, surveys will be conducted among Iguazú National Park staff, visitors and local people to evaluate the level of knowledge of this species. On this basis, outreach activities will be implemented aimed at Iguazú National Park staff, its visitors and local communities to disseminate information about this and other native freshwater snails, their conservation status and the importance of protecting these less-known species that are also part of the natural heritage. Once the activities have been carried out, the surveys will be repeated to evaluate their impact on the perception of ampullarids and other native snails by the different social actors, seeking to adjust and improve their efficiency. This is expected to increase the public awareness and to have a positive impact on the conservation prospects of *P. americanista*.

In an environmental context that is increasingly challenging for the survival of freshwater molluscs, it is necessary to know the threats they face and to take action before they disappear. Although the negative impacts on the habitats of *P. americanista* will probably continue and even increase, good adaptation to laboratory breeding (Gurovich *et al*., 2018), added to *ad hoc* niche models to select reintroduction sites and the chances offered by social media to raise awareness and interest in this and other native snails, allows us to have some hope that their extinction could be avoided in the short and medium term.

This project constitutes the PhD project of Abril Soria at the Departamento de Biología, Bioquímica y Farmacia, Universidad del Sur (Argentina). Fieldwork in the Iguazú National Park will be developed under Project # NEA256 of the Administración de Parques Nacionales (Argentina).

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TROUBLE IN THE SKY ISLANDS: HABITAT LOSS AND POACHING THREATEN ENDEMIC LAND SNAIL SPECIES OF *CATHAICA* AND *PSEUDIBERUS* ON ISOLATED MOUNTAINS IN CHINA

By Guoyi Zhang & Yan Xu

The study of island biodiversity is an important topic in conservation biology, with famous examples like partulid snails on oceanic islands. Insular land snails are particularly vulnerable to extinction, and insular regions often exhibit high biodiversity and endemism, especially of terrestrial Mollusca (Chiba & Cowie, 2016). While approaches to insular biodiversity and conservation are conventionally applied to true islands surrounded by water, they can be extended to nontraditional islands, such as isolated mountain peaks (Brown, 1978), sometimes referred to as ‘sky islands’ (McCormack *et al*., 2009). This article presents a case study of the threats faced by nontraditional insular malacofaunas: *Cathaica* and *Pseudiberus* in the Tai Mountains and Yimeng Mountains of China (Zhang *et al*., 2021; Zhang & Wade, 2023).

Fig. 1. A - the plank road of Baodugu, Zaozhuang; B - *Pseudiberus tectumsinense pingi* contaminated by paint.

Fragile insular environments are more susceptible to human-induced disturbances than other environments. The Tai Mountains and Yimeng Mountains are surrounded by anthropogenic landscapes, and the forests in these two mountain ranges are isolated from each other. This isolation provides an ideal environment for speciation under the nontraditional insular model. Within this region, *Cathaica* spp. occur from the mountain bases to the peaks, while most *Pseudiberus* spp. exclusively inhabit the peaks (von Martens, 1873; Gredler, 1882; Yen, 1935; Zhang *et al*., 2021; Zhang & Wade, 2023). Notably, *Pseudiberus* spp. have small isolated populations, making genetic drift and speciation more likely in these species groups (Zhang *et al.*, 2021). In general, the lack of comprehensive field studies and conservation regulations for newly-published species pose challenges to the conservation of short-range endemic species, and *Pseudiberus* and *Cathaica* are no exceptions. The case of Baodugu in Zaozhuang City, Shandong Province, exemplifies the issues faced by these snails in this locality and will be elaborated on in this article. In Baodugu, *Cathaica multicostata* and *Pseudiberus tectumsinense pingi* are endemic to this region. This situation is common in the Tai Mountains and Yimeng Mountains (Zhang *et al*., 2021; Zhang & Wade, 2023).

Between 1920 and 1923, the biodiversity of Baodugu benefited from the efforts of Mr. Meiyao Sun, the leader of the Shandong Autonomous Army and a key figure in the Lincheng Outrage. Few people could access Baodugu, their mountain base. However, since 1992, Baodugu has been designated as a national forest park (Zaozhuang Municipal Chronicle Editorial Board, 2016), leading to significant impacts on biodiversity.

The loss of habitat is a crucial factor contributing to biodiversity degradation. Despite the National Forest Park Management Measures (China State Forestry Administration Order, No. 27) stipulating strict control over the establishment of man-made attractions (Article 4) and prohibiting unauthorised stalls and the illegal hunting of wild animals (Article 18), these management measures prove ineffective for biodiversity protection. Traders persist in raising poultry within the habitats of *Cathaica multicostata* and *Pseudiberus tectumsinense pingi*, which are only recorded in Baodugu.

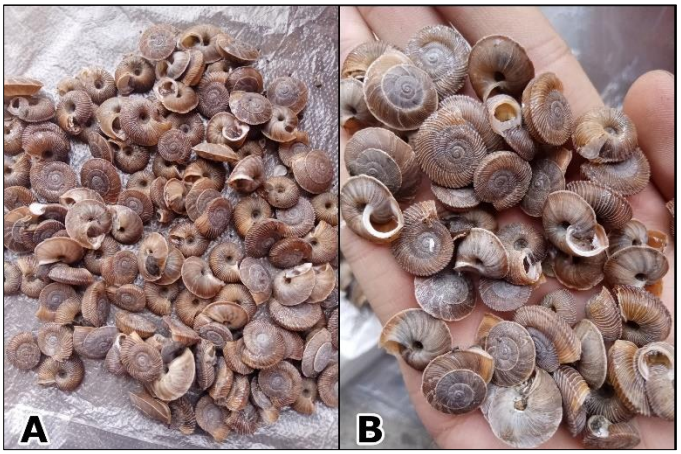

Fig. 2. *Cathaica multicostata* and *Pseudiberus tectumsinense pingi* sold by Mr. Jian Wang.

Over the past five years, in addition to artificial entertainment venues like Airsoft, new artificial plank roads have been constructed in the scenic area. To facilitate visitor exploration at the mountain summit, the construction of artificial amenities, such as plank roads, are often closely adjacent to cliff faces, where the cliffs serve as the primary habitats of *Pseudiberus* and *Cathaica* species (Fig. 1).

Regarding Article 18, forest parks have not implemented methods to monitor invertebrate collection. However, large-scale collection of land snails by humans is another significant factor contributing to population loss or possibly even extinction (Brescia *et al.*, 2008; Foon, 2014; Naggs, 2014; Cowie *et al.*, 2017; Zhang & Wu, 2020). The collecting activities of Mr. Jian Wang are noteworthy (Fig. 2). At the request of some enthusiasts and driven by profit motives, Mr. Wang conducted large-scale collections of *Pseudiberus* and *Cathaica* in Baodugu and its surrounding areas. He collected over 200 *Pseudiberus* and *Cathaica* from Baodugu annually, including subadults and adults, and sold them online (via Alibaba Xianyu or WeChat, at least since 2020). A further challenge is the fragmented nature of China's internet platform, making it difficult to obtain the necessary statistical information through search engines, hindering a comprehensive assessment of such frenzied collection behaviours. Based on the authors' experience with the distribution of *Cathaica* and *Pseudiberus* from Baodugu, Mr. Wang consistently collected every snail encountered. Assuming that all adult specimens collected by Mr. Wang in 2022 are mature and that immature specimens were born in 2023, and based on the percentage of immature specimens to the total specimens collected (30% for *Pseudiberus tectumsinense pingi*) it seems that this species does not exhibit a rapid reproductive rate. By the third year, the population of *Pseudiberus* is destined to decrease to 10% of its current level if the ongoing collection practices persist. However, Mr. Wang has already achieved this over many years. Although 88% for *Cathaica multicostata* is deemed acceptable to prevent its extinction, the future remains uncertain if exhaustive collection behaviours persist. Considering these circumstances, it is crucial to regularly conduct IUCN or list of endangered and protected species of China assessments and ensure that established laws are adhered to and management measures are implemented effectively.

Thanks go to Junn Kitt Foon (Australian Museum) for his helpful comments and suggestions.

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FRESHWATER MUSSEL PROJECT IN CENTRAL AMERICA

By Yasmín Quintana & Kentaro Inoue

Central American freshwater mussels (Mollusca: Bivalvia: Unionida) are understudied and under-assessed nationally and regionally. At least 94 species are reported from Middle America (i.e. Mexico and Central America) (Graf & Cummings, 2021; Cummings & Tiemann, 2023). However,

Fig. 1. Field survey in Costa Rica.

the current taxonomy of these mussels is based on one monograph published almost 100 years ago (Frierson, 1927), and the true richness is unknown. In 2023, we conducted surveys to expand the Shedd Aquarium's collaborative freshwater mussel research programme in Central America. This effort is part of the target of the Center for Species Survival: Freshwater to better understand freshwater mussel diversity in the region. The project includes collaborations with researchers from the El Salvador Ministry of Environment, Universidad de Costa Rica and Universidad de San Carlos de Guatemala.

We surveyed for freshwater mussels in the watersheds of the Río Lempa, Río Goascoarán and Río Grande San Miguel in El Salvador and basins in Guanacaste and Alajuela provinces in Costa Rica (Fig. 1). Preliminary results indicate the presence of three native species each in El Salvador and Costa Rica, including the endemic *Nephronaias lempensis* Marshall, 1926 and *Nephronaias tempisquensis* Pilsbry, 1920, respectively in El Salvador and Costa Rica.

Fig. 2. Specimens of *Mycetopoda subsinuata* (Sowerby, 1868), the "mushroom foot", collected in El Salvador.

Additionally, the invasive *Sinanodonta woodiana* (Lea, 1834) was found in both countries, indicating widespread distributions of the species in Central America. In 2024, we will continue reviewing specimens and genetic material collected and increase efforts in Guatemala, El Salvador and Costa Rica.

In Central America, only El Salvador has assessed the conservation status of freshwater mussel species at a national level, including *Mycetopoda subsinuata* (Sowerby, 1868) (Fig. 2), *Nephronaias lempensis* and *N. goascoranensis* (Lea, 1858) in its Official List of Threatened and Endangered Wildlife Species (Ministerio de Medio Ambiente y Recursos Naturales, 2023). Taxonomic revisions and molecular phylogenetic analyses resulting from this project will enable us to assess the conservation status of species in Central America and work with local authorities to plan for their conservation.

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SIERRA LEONE'S FRESHWATER BIODIVERSITY IN PERIL: GENUS *SIERRAIA*

By Hassanatu Patrick, Jonathan Johnny & Christian Albrecht

Sierra Leone, a small West African country, is home to a remarkable variety of biodiversity and landscapes. The country is situated on the south-west coast of West Africa, bordered by Liberia and Guinea. Rural communities in Sierra Leone rely on biodiversity for fuelwood (energy), medicines, food and other essential commodities (Koroma *et al*., 2021; Johnny *et al*., 2022). Anthropogenic activities such as constant wildfires, slash-and-burn agriculture, deforestation, urbanisation, land degradation, mining, wetland destruction, illegal hunting and logging, and overgrazing are eroding and causing the loss of biodiversity resources. Sierra Leone belongs to the Northern Upper Guinea freshwater ecoregion, which is characterised by distinct fish fauna but also endemic invertebrate species such as freshwater crabs. Freshwater systems are particularly threatened and many freshwater species are essential to local human community livelihoods in Sierra Leone (Johnny *et al*., 2023).

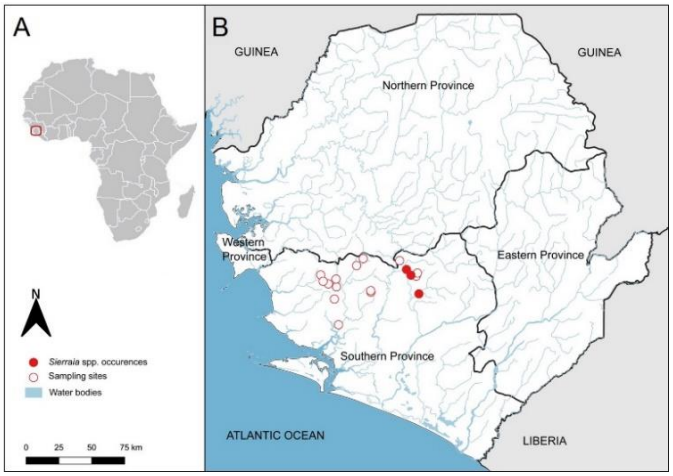

Fig. 1. A - location of Sierra Leone in Africa; B - locations of the sampling sites, with occurrences of *Sierraia* spp.

The freshwater gastropod fauna of Sierra Leone is relatively poor but includes a couple of range-restricted taxa, specifically in the families Ampullariidae and Bithyniidae. Data on freshwater molluscs are generally scanty for Sierra Leone and information is absent since the late 1980s (Nagel, 1991). Hubendick surveyed freshwater gastropods in Sierra Leone in detail in the 1950s (Hubendick, 1977), while Brown (1988) revised the bithyniid genus *Sierraia* and added three new species to the formerly monotypic genus. The current status of the vast majority of these endemic species is unknown because of the lack of experts, as well as lack of baseline data on their distribution, abundance, life history, physiology, morphology, diet and other essential factors.

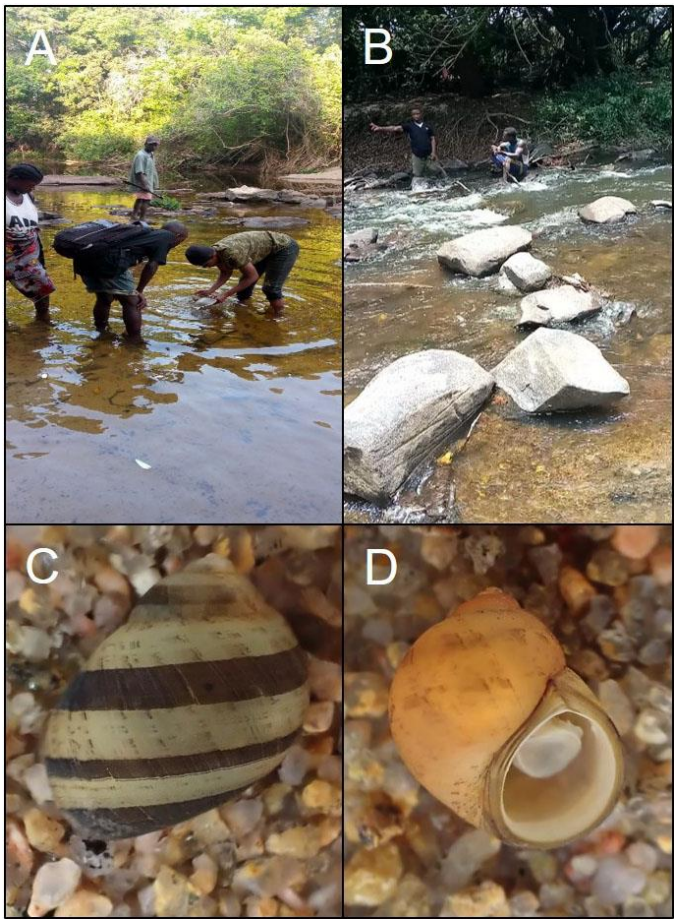

Fig. 2. A, B - habitats and sampling; C - *Sierraia whitei*; D - *Sierraia leonensis*. (Photos: H. Patrick)

The bithyniid genus *Sierraia* is endemic to Sierra Leone (Brown, 1988). The genus includes the type species *S. leonensis* and three other species: *S. outambensis*, *S. whitei* and *S. expansilabrum* (Brown, 1988). These snails are restricted to perennially flowing rivers and are potentially threatened (Brown, 1988). *Sierraia* has also not been the subject of any research in recent decades. In fact, there has been no new information on the threats, usage or population status of the species for the last 40 years. *Sierraia* spp. live in major rivers and these are often at risk because of human activities such as mining, pollution, charcoal and fuel wood burning, and land clearing for agriculture in coastal and riverine areas. Three species of *Sierraia* are currently classified as threatened according to the IUCN Red List (VU for *S. expansilabrum* and *S. leonensis*, CR for *S. outambensis*).

In the light of this situation, a new initiative at Njala University in Sierra Leone was started, intending to assess freshwater mollusc diversity and distribution as well as socio-economic value and conservation status (Johnny *et al.*, 2023). A pilot project addressed specifically *Sierraia* in Moyamba district in the Southern Province of Sierra Leone (Fig. 1). This study sampled 17 water bodies, including ponds, rivers, streams and brackish water (Fig. 2). *Sierraia* populations were only found in two rivers (River Kasinnie and River Tebay). Human activities around the studied water bodies are ever increasing, which is affecting the resident aquatic biodiversity.

It was apparent that conditions in the freshwater bodies in the study region are currently unfavourable for gastropods because of human activities such as farming, mining, fishing, sewage disposal and pollution (Fig. 3). Additionally, climatic stress on freshwater bodies and riverine areas further exacerbates the situation. For example, Dr. Peter T. White previously (1982-1985) found very abundant *Sierraia* populations in River Tebay and River Taia close to Njala University campus (Brown, 1988). The current research, despite extensive field work, did not record any *Sierraia* populations in River Taia, possibly because of human activities leading to habitat destruction and the consequent loss of populations in this river. This shows that *Sierraia* is threatened by human activities, leading to serious decline and eventual loss. Given that *Sierraia* spp. (Fig. 2.) are range restricted with an uneven distribution, they could easily go extinct if human activities within their range are not regulated and monitored.

Based on the field surveys conducted in 2022 and 2023, the present conditions of the freshwater habitats have led to the loss of many benthic organisms in the rivers. Locals residing along the river banks (River Taia) have also reported not seeing *Sierraia* or even fish species since the river became polluted and turbid (Fig. 3).

Unfortunately, it is most likely that several of the endemic species are in danger or on the brink of extinction, not only in

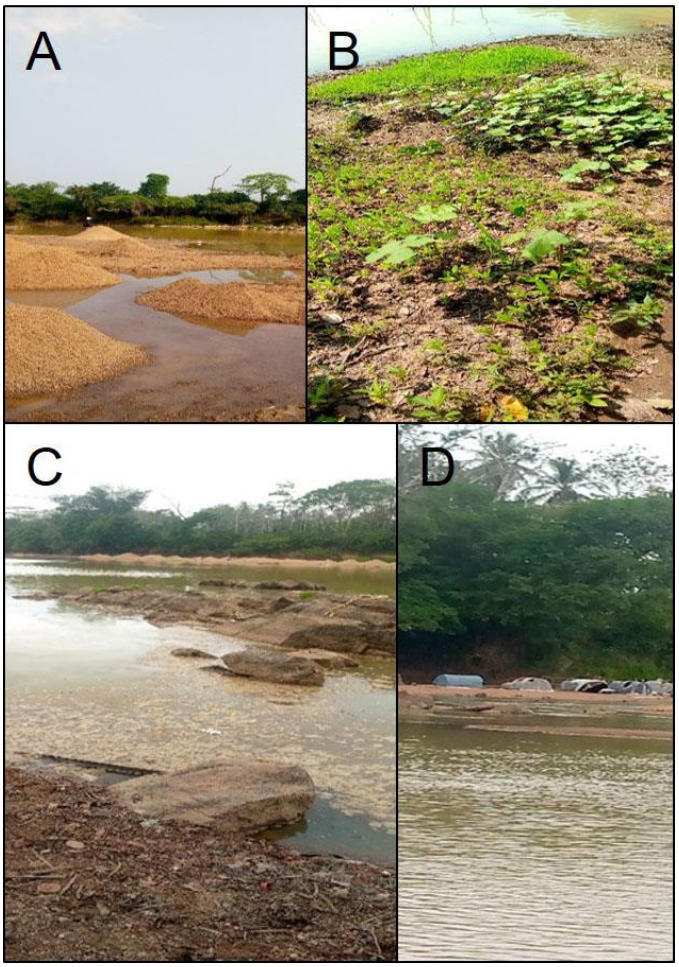

Fig. 3. Threats to habitats of *Sierraia* species. A - sand mining; B - agricultural practices along riversides; C - domestic pollution; D - illegal fishing activities. (Photos: H. Patrick)

the genus *Sierraia*. Immediate action is required to prevent the loss of the unique freshwater mollusc communities in riverine systems in Sierra Leone. Despite the decline and loss of species, there is also significant potential for undiscovered and undescribed gastropod biodiversity, particularly in special habitats such as rapids and waterfalls in the short coastal rivers. Therefore, it is crucial to assess the status of freshwater mollusc communities in Sierra Leone. Highlighting the severe anthropogenic pressure freshwater systems currently face in Sierra Leone is the first step to public awareness as a prerequisite to conservation action.

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EATING AN ENDANGERED SPECIES? THE NECESSITY TO RESOLVE THE TAXONOMY AND STATUS OF A THREATENED PACHYCHILID TO ADDRESS FOOD SECURITY AND CONSERVATION CONCERNS

By Ting Hui Ng

In Asia, freshwater molluscs are important for food security, especially for inland communities (Jadhav *et al.*, 2023). In Sabah, the Malaysian territory at the northeastern tip of Borneo, freshwater snails including those in the family Pachychilidae, have long been a food source locally, with shells being found in middens of Late Pleistocene to early Holocene human-inhabited caves in eastern parts of the territory (Piper, 1988; Albert *et al.*, 2022). Today, pachychilids are still eaten and can occasionally be found for sale in markets (Fig. 1A).

Among the pachychilds being sold, are one or more of the ten *Sulcospira* species that have been described from Borneo

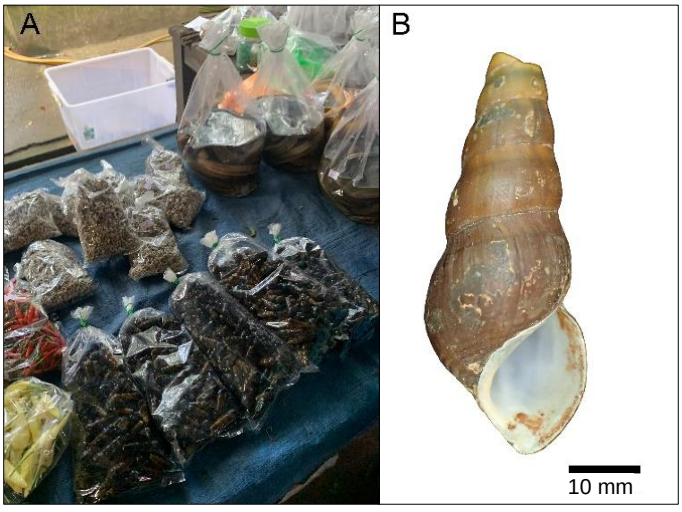

Fig. 1. A - Pachychilids being sold among other fresh produce at a local market outside Kota Kinabalu, Sabah. B - *Sulcospira pageli* sensu lato with the tip of its apex cut off, as is common for snails that are sold for consumption.

Table 1. *Sulcospira* species described from Borneo. Current names of the states and countries of the type localities are in square brackets.

Scientific Name	Type Locality
Sulcospira agrestis (Reeve, 1860)	Borneo
Sulcospira brookei (Reeve, 1860)	Borneo
Sulcospira circumstriata (Metcalfe, 1851)	Borneo
Sulcospira clavaeformis (Brot, 1874)	Borneo
Sulcospira hippocastanum (Reeve, 1860)	Borneo
Sulcospira pageli (Thiele, 1908)	"Britisch Nord-Borneo" [Sabah, Malaysia]
Sulcospira pontificalis (von dem Busch, 1853)	Borneo
Sulcospira sadongiensis (Brot, 1894)	"River Sadong, Sarawak" [Sarawak, Malaysia]
Sulcospira schmidti (Martens, 1908)	"Sungei Guleh, W. d. Sangkulirang-Bai" [Eastern Kalimantan, Indonesia]
Sulcospira schwaneri (Schepman, 1896)	Borneo

(Table 1), including *Sulcospira pageli* (Fig. 1B). This species, which was described from Sabah (known at that time as the colonial 'British North Borneo'), is the only freshwater gastropod from Borneo that is listed as Endangered by the IUCN (Rintelen, 2020). At the time of its assessment in 2011, *Sulcospira pageli* was found to be extant only in Sabah and one other locality in southeast Borneo, in the Indonesian province of Kalimantan (Fig. 2; Rintelen, 2020).

Although GBIF preserved specimen data from various international museums indicate that several extant pachychilid species have been recorded throughout Borneo (Fig. 2), it is uncertain if *Sulcospira pageli* is among those records because most have not been updated with the latest taxonomy and some may not have been accurately identified (GBIF.org, 2024). Based on morphological examination of material deposited at the BORNEENSIS Collection, Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, *S. pageli* sensu lato has been recorded throughout Sabah (Fig. 2; Ng *et al.*, 2017). The species appears to be well-distributed throughout the territory in protected and non-protected areas alike (Fig. 2).

However, the highly plastic nature of pachychilid shells necessitates further analysis (including molecular analysis) to verify the identity of *Sulcospira* spp. in Sabah and elsewhere in Borneo. Despite extensive research that has been conducted on the systematics of Pachychilidae in Southeast Asia, the taxonomic status of *Sulcospira pageli* remains unresolved (Köhler & Dames, 2009; Rintelen, 2020). *Sulcospira schmidti*, originally described from eastern Kalimantan (Table 1, Fig. 2), was once synonymised with *Sulcospira pageli* (Köhler & Glaubrecht, 2001, 2002), but later recognised as a distinct species (Köhler & Dames, 2009). It is vital that the species be accurately identified and their distributions in southeastern Borneo documented.

The consumption of freshwater snails in Sabah has not been formally documented to date, and harvesting of pachychilds probably occurs on very small scales and opportunistically, with additional catch being sold alongside other produce at weekly markets (e.g. MeLvyn Ben, 2020). However, without correct species delimitation, it is uncertain which *Sulcospira* species are being collected and if these include unassessed but potentially least concern species, alongside the Endangered

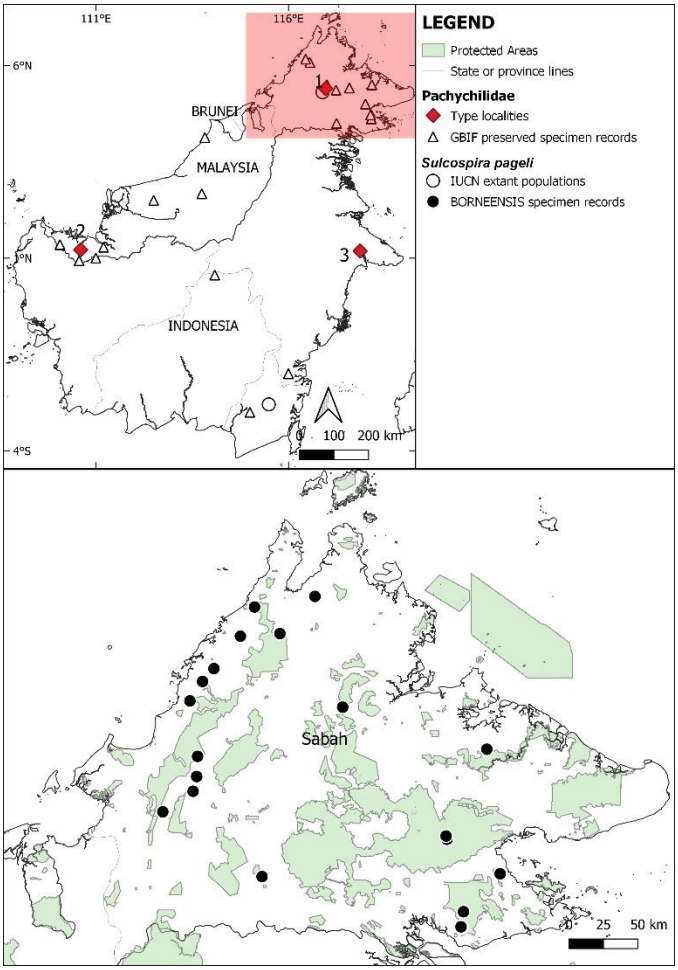

Fig. 2. Records of Pachychilidae in Borneo. Top - overview of Borneo, with the Malaysian territory of Sabah shaded; bottom - Sabah. The type localities indicated by the red diamonds are those of *Sulcospira pageli* (1), *S. sadongiensis* (2) and *S. schmidti* (3). Data from Ng *et al*. (2017), Sloan *et al*. (2019), Rintelen (2020), GBIF.org (2024).

Sulcospira pageli. Given the importance of freshwater fisheries and aquaculture for addressing food security needs (Zhang *et al.*, 2022; FAO, 2022), pachychilds have the potential to feature in the future diets of many Bornean local communities, not just the inland ones. A better understanding of the status and distribution of *Sulcospira* species in Sabah would allow the relevant authorities to identify populations either for effective conservation action or for the promotion of sustainable harvesting and aquaculture.

I thank Thor Seng Liew for comments on the draft of this article.

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PALE MANTLESLUGS (*PALLIFERA DORSALIS*) IN COMMERCIAL SHIPMENTS OF HORTICULTURAL PRODUCTS IMPORTED TO ISRAEL – A REQUEST FOR MORE INFORMATION

By Henk K. Mienis, Svetlana Vaisman & Oz Rittner

[Editor's note. I do not now generally accept notes of new records of introduced species, unless there is a clear and explicit conservation context. Tentacle is a conservation newsletter and not an alien species newsletter, though I understand that there can be overlap between these two topics when an invasive species has a conservation impact. I am making an exception for this article only because it is a request for additional information about an alien species, and since Tentacle *has a wide malacological readership I considered it appropriate. This does not set a precedent.]*

The pale mantleslug *Pallifera dorsalis* (A. Binney, 1842), family Philomycidae, is native to the United States (Pilsbry, 1948; Hubricht, 1951; Schileyko, 2007) and Canada (Grimm *et al.*, 2009). It is easily recognised by the fact that the mantle covers almost the entire length of the slug and has a single, central darker line over its entire length (Fig. 1). Only the tip of the tail is usually visible and projects from under the rear end of the mantle.

Records outside its natural range are not known from the Palaearctic region, so we were surprised to receive five samples of slugs fitting the description of this species from inspectors of the Plant Protection and Inspection Services (PPIS), stationed at Ben Gurion Airport near Lod in Israel over the last two years. The slugs were all found in commercial horticultural shipments arriving from nurseries in the Netherlands, as follows.

PPIS MOL 671: Three specimens in a shipment of *Dieffenbachia* cuttings, 27 March 2022
PPIS MOL 730: Three specimens in a shipment of *Philodendron* cuttings, 8 December 2022
PPIS MOL 779: One specimen in a shipment of potted *Calathea*, 30 April 2023
PPIS MOL 856: One specimen in a shipment of *Syngonium* cuttings, 11 January 2024
PPIS MOL 857: One specimen in a shipment of *Alocasia* cuttings, 11 January 2024

Three firms in the Netherlands were involved with these shipments but we have not been able to ascertain whether these slugs are indeed living on their premises.

Fig. 1. Pale mantle slug, *Pallifera dorsalis*, intercepted from a shipment of horticultural products arriving in Israel from the Netherlands. (Photo: Oz Rittner)

Another possibility is that these exporters buy cuttings of house plants from commercial growers in North America and resell the merchandise immediately after its arrival in the Netherlands on the well-known International Flower Bourse in Aalsmeer.

Although it does not seem to be a plant pest, shipments containing foreign slugs like *Pallifera dorsalis* are usually rejected at the port of entry in Israel.

We are interested in receiving additional information concerning transport and introductions of *Pallifera dorsalis* outside its natural North American range.

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A NETWORK OF SITES FOR CONSERVATION OF FRESHWATER BIVALVES IN SOUTH AMERICA: A POSSIBLE DREAM?

By Cristhian Clavijo & Igor C. Miyahira

Freshwater bivalves are key organisms in their environments. Thus, measures to protect these animals are essential in freshwater ecosystems, including for preservation of water quality. However, freshwater bivalves are rarely considered when a protected area is created (Miyahira *et al.*, 2022), and therefore, the actual recorded occurrences of freshwater bivalves in protected areas of South America must be considered casual. It is clear that these occurrences are important for bivalve conservation, but directed efforts are needed to ensure the proper conservation of these animals. Moreover, in some protected areas, invasive and native species occur together, reinforcing the need for a good management plan (Miyahira *et al.*, 2023).

The La Plata Basin is the second largest in South America, shared by five countries (Argentina, Bolivia, Brasil, Paraguay and Uruguay) and drains an area of 3,286,875 km^2 and contain the second largest diversity of freshwater bivalves in South America, with 89 species 29 of those endemic (Pereira *et al.*, 2014; Cuezzo *et al.*, 2020). This rich fauna is under severe threat by invasive species, habitat modification and global change (Miyahira *et al.*, 2022).

In order to better understand the bivalve fauna of La Plata Basin, we conducted a large sampling effort of the basin, especially in poorly investigated areas. These field trips were sponsored by the Mohamed bin Zayed Species Conservation Fund (MBZ 222529602 and 202524562). After this great sampling effort in La Plata Basin, which included areas of Argentina, Brasil, Paraguay and Uruguay, it was clear to us that invasive species were widespread and that habitats are seriously modified (Clavijo & Miyahira, 2021; Bassó *et al.*, 2022; Carballo *et al.*, 2022; Clavijo & Bassó, 2022; Miyahira *et al.*, 2024).

At this moment, we ask ourselves “is a protected area designed for freshwater bivalves a possible dream?” Stepping beyond academia, we decided to go a step further and not only propose areas for the conservation of bivalves (e.g. areas with high diversity or endemism) but also try to make them real. As biologists, sometimes we identify areas of high diversity but usually do not make direct efforts to turn them into real protected areas. It is very important to undertake theoretical studies of freshwater bivalves but we usually do not take direct actions.

Fig. 1. Laguna de Arnaud, a site with great potential for conservation of freshwater bivalves and a tool for education.

Fig. 2. Monitoring of Laguna de Arnaud was included in the local teacher training programme.

There is a song called *Prelúdio* by the Brasilian singer Raul Seixas, which says that a dream that you dream alone is only a dream, but a dream that you dream together is reality. We know that alone it will be impossible to achieve this goal, i.e. establish a protected area for freshwater bivalves. Thus, we contacted researchers, stakeholders, teachers and local people to establish a network of people interested in bivalve conservation. Despite being very important for ecosystem functioning, freshwater bivalves are not charismatic to the general audience and are usually ignored, although Santos (2011) suggested that molluscs can be used as flagship species. People only care about conserving what they know. In order to start a network of sites for the conservation of freshwater bivalves in South America, we proposed a workflow that includes a definition of a site for the conservation of bivalves, an application form for admission, a form for the evaluation and a guide for implementation of the sites. Additionally, thanks to the support of the MBZ (MBZ 222529602), we evaluated and made contacts to establish sites in each of the countries that make up the La Plata River basin. As of now we have started the process to declare two sites and identified two more with good conditions.

The “Laguna de Arnaud” is a floodplain lake connected to the Olimar Grande River, next to Treinta y Tres city (Department

of Treinta y Tres, Uruguay). Although this lake is part of the neighboring Patos-Merin basin, it includes species from La Plata River basin and its integration in this first stage was considered strategic. In this lake can be found an interesting diversity of bivalves, including some considered rare, such as *Leila blainvilliana* (Lea, 1834) and *Cyanocyclas guahybensis* (Marshall, 1927), and a great total density of native bivalves (>800 individuals recorded per hour). The survey and monitoring of this lake was included in the local teacher training programme (Figs. 1 and 2). The future teachers, motivated by the richness of the lake and the opportunity for it to be used as an open-air classroom, suggested and began the process to declare the lake a protected site at the municipal level.

In Argentina, the "Lagunas de la Defensa" are a series of artificial lagoons resulting from the extraction of materials (mainly sand and clay) for construction of the defense of the city of Rincón and others nearby (Province of Santa Fe) against the floods of the Paraná River. These artificial lakes are near Lake Setubal, a site noted for its high diversity of bivalves in the 1960s (Bonetto & Ezcurra, 1962), which is currently invaded by *Corbicula fluminea* and *Limnoperna fortunei* while the native species have almost disappeared. The meetings with local stakeholders were positive and negotiations for the establishment of a protected area are moving forward. Public information sessions for local people are planned to take place this year.

There is a third possible site for which negotiations are at an earlier stage. The "Corrego Baixo" is a small karstic stream in Nobres, Mato Grosso (Brasil). This river caught the attention of researchers around 2005 and has been monitored since then. Its diversity of 11 bivalve species is threatened by changes in land use, so the conservation site will ensure the preservation of such a valuable place. We have already established a collaboration with local researchers and educational outreach actions must be taken soon.

Sometimes, for the conservation of bivalves, it is not necessary to create new protected areas; it is enough to include these animals within the focal objects of the management plans of already created protected areas. "Carrizales del Paraná" is a national protected area in Paraguay that includes the town of Cerrito where nine native species of bivalve have been recorded. However, invasive species have also been found there (Miyahira *et al*., 2024). With a focus on freshwater biodiversity, this is a good opportunity to establish a site for the conservation of bivalves in Paraguay. This could be a fourth site to be included in the network.

Finally, for Bolivia, no conservation sites have been identified, since there is no good knowledge of the diversity and distribution of native bivalves (Clavijo *et al*., 2023). We plan a large sampling effort in Bolivia during 2024. The first author already surveyed the local collections (La Paz and Santa Cruz), and the information available in the mussel-project website (Graf & Cummings, 2023).

We have not fully achieved our goal yet, but we have had positive feedback from these actions, which will continue throughout this year. No government in the world will protect a species because we are saying it is "cool"! They need practical and direct benefits from the measures undertaken. The presence of a site for the conservation of bivalves can be associated with clean water conditions and can promote ecotourism. Moreover, all governments have environmental responsibilities, and supporting a site for bivalve conservation can help to attain their objectives (or obligations).

Even if we succeed in protecting these areas, they are small areas, and alone will not be able to ensure a future for freshwater bivalves of La Plata Basin. However, we are throwing some light on the problem and hope that this attracts the attention of more people. We believe these pioneer areas are an important first step to creating a network of sites that can achieve the conservation of the bivalve diversity of La Plata Basin.

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TERRESTRIAL MOLLUSCS OF NYUNGWE NATIONAL PARK, A BIODIVERSITY HOTSPOT IN THE ALBERTINE RIFT, RWANDA

By Mary Cole & Edmond Twagirayezu

We participated in a graduate summer school hosted by Professor Beth Kaplin, Director of the Centre of Excellence in Biodiversity and Natural Resource Management (CoEB) at the University of Rwanda and sponsored by the Volkswagen Foundation. Recognising the importance of science-based decision-making to support economic transformation and sustainable development goals, the CoEB promotes the understanding, monitoring and cataloguing of biodiversity, ecosystem functioning, climate change impacts and adaptation, and science-policy linkages. The focus of the summer school was on building capacity for biodiversity sampling, taxonomy and collections management of selected taxon groups that have importance in the region, including land snails. There were two components: a field school in Nyungwe National Park from 22 to 28 August 2023 followed by natural history collection management from 29 August to 1 September at CoEB's facilities in Huye (also known as Butare). There were three participants in the mollusc team: Mary Cole of the East London Museum, South Africa, was invited as a trainer and the students were Edmond Twagirayezu, an intern at the CoEB, and Pierre Batumike Cishibanji from the Centre de Recherche en Sciences Naturelles and a masters student at the Université de Développement Durable en Afrique Centrale in the Democratic Republic of Congo (DRC). There were 37 participants in total from Rwanda, DRC, South Africa, Uganda, Kenya and the United States, and this year other teams worked on reptiles, amphibians, bats, freshwater invertebrates, pollinators and plants.

Nyungwe National Park, referred to simply as Nyungwe, covers over 1,000 square kilometers and together with the contiguous Kibira National Park in Burundi is the largest single tract of montane forest remaining in East or Central Africa (Fig. 1). In prehistoric times montane forest occupied one-third of the present-day Rwanda and once covered the length of the Albertine Rift, which runs from north to south along Rwanda's western border. The Albertine Rift is

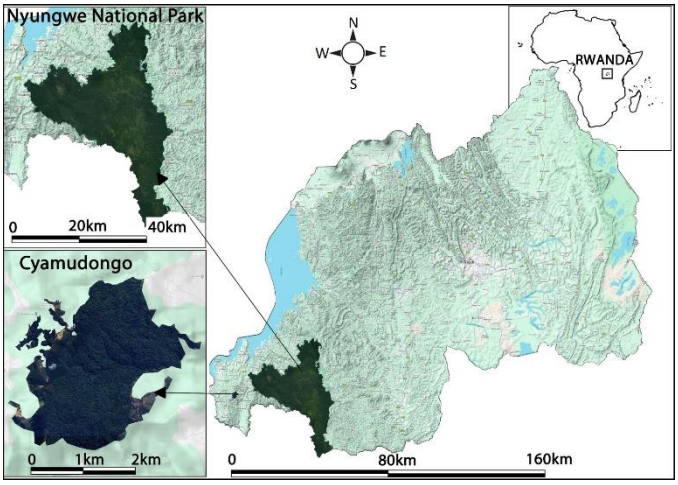

Fig. 1. Location of Rwanda in East-Central Africa and location of Nyungwe National Park and Cyamudongo in southwest Rwanda.

recognised as one of the most important regions for conservation in Africa by, among others, Birdlife International, World Wildlife Fund, Conservation International and the Wildlife Conservation Society (Plumptre *et al*., 2007; Seimon, 2012). Nyungwe was one of six highest ranking sites for conservation prioritisation out of 38 protected and unprotected areas within the Albertine Rift, based on numbers of both endemic and globally threatened species of plants, endemic butterflies and four vertebrate taxa (Plumptre *et al*., 2007). This assessment showed that the Albertine Rift supports more than half of continental Africa's bird species and nearly 40% of its mammal species. Land snails have been systematically sampled only in the northern part of the Albertine Rift in Uganda (Wronski & Hausdorf, 2008, 2010), the eastern slopes of the Rwenzori Moutains in Uganda (Wronski *et al*., 2016) and in Nyungwe National Park (Boxnick *et al*., 2015). Prior to the study of Boxnick *et al*. (2015), early expeditions yielded only seven species from Nyungwe (Thiele, 1911) with only two additional species recorded since then, and a total of only 25 species from Rwanda (Martens, 1897; Preston, 1913; Pilsbry, 1919; Verdcourt 1967, 1970). A more detailed summary and literature list was provided by Boxnick *et al*. (2015).

Nyungwe was declared a forest reserve in 1933. It gained national park status in 2005 and has been managed by African Parks since 2020 in a partnership with the government's Rwanda Development Board. The park feeds two of the world's largest rivers, the Congo and the Nile, and provides a significant portion of Rwanda's freshwater (African Parks, 2024). We worked at localities near Gisakura village on the western side of Nyungwe. There is a network of well-maintained hiking trails we used to get around the forest (Fig. 2), and two African Parks rangers were participants in the field school. We also sampled two sites in the Cyamudongo Forest, an isolated patch of only 300 hectares approximately 10 km south-west of the main Nyungwe forest block (Fig. 1). According to herpetologist Harald Hinkel, who came to Rwanda and Cyamudongo in the late 1980s from Germany and has remained in the country ever since, Cyamudongo

Fig. 2. The mollusc team at the start of a hiking trail.

Fig. 3. Mary Cole (centre) shows Pierre Batumike Cishibanji (left) and Edmond Twagirayezu how to extract the body from its shell so the two can be stored separately.

harbours an extraordinary abundance of species, with several known only from this forest. He and several partners were responsible for the preservation of this tiny forest patch, and now it is managed as part of Nyungwe. Here we were fortunate to come across a family of chimpanzees. During the field school we focussed on collecting methods and how to process specimens in the evenings. We did not attempt quantitative sampling, but searched in leaf litter, on leaves and other living vegetation, among roots, under moss on rocks and any other microhabitats we thought suitable for sheltering snails and slugs. We took a few leaf litter samples to scrutinise in the laboratory, but they served essentially for training purposes since we did not go through them all in the time available.

At the CoEB we continued processing specimens, including separating shells from bodies (Fig. 3), and we assigned catalogue numbers to approximately 190 specimen lots. These form the start of a mollusc collection in Rwanda at CoEB. With only a couple of days there before participants parted

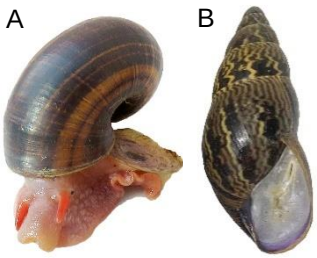

Fig. 4. A - *Maizania elatior*. B - *Limicolaria martensiana*; it being the dry season, several of the specimens we collected had an epiphragm.

Fig. 5. Three species in subfamily Sheldoniinae (Urocyclidae), identified by Torsten Wronski and Bernhard Hausdorf. Dissection may enable further identification.

ways, only a few specimens were identified to species (Figs. 4a, b). Mary Cole aimed to empower the students as to how to go about identifying species themselves by making available literature on East and Central African snails and introducing them to online resources such as the Biodiversity Heritage Library and MolluscaBase (which includes up to date nomenclature of land snails). A long list of terminology necessary for mollusc identification was covered. Mary Cole and Edmond Twagirayezu have been in much communication subsequently, since the latter has the specimens to hand, while the former has provisional identifications in her notes. Torsten Wronski and Bernhard Hausdorf, two of the authors of the previous study in Nyungwe (Boxnick *et al*., 2015), helped greatly to identify species from photos sent to them (Fig. 5) and T. Wronski sent us the literature used in each case, drawing our attention to specific pages. Now the aims are to add our data to the CoEB's database, to maintain the collection in good order and identify material further if there is an opportunity. The historic collections of Rwandan snails are at several European museums, notably the Zoologisches Museum Hamburg, the Museum für Naturkunde in Berlin and AfricaMuseum in Tervuren (Belgium).

We recorded 45 species; nine (20%) were identified to species level. Interestingly, four of these were not recorded by Boxnick *et al.* (2015). These authors sampled 50 20 x 20 m plots, concentrating along the main road, during October when there is generally higher rainfall than during our survey at the height of the dry season. Participants working on other taxa came across molluscs during their sampling, and several of these were species we did not collect ourselves (e.g. Fig. 6). The dominant families in both our study and that of

Fig. 6. An impressive slug, 6.7 cm long, presented to us by a member of the pollinator team, Thacien Hagenimana.

Boxnick et al. (2015) were Achatinidae (in particular species of Subulininae, previously classified as Subulinidae), Urocyclidae and Streptaxidae. Of the 102 species recorded by Boxnick *et al*. (2015), only two of the nine species recorded in Nyungwe prior to that study were present in their material. Our findings support their suggestion that the actual land snail species richness is higher than the recorded number. It is also likely that a proportion of the unidentified species in both studies are endemic to Nyungwe and that there are undescribed species among them. One of the most common species in Cyamudongo, *Nothopalus* sp. (Fig. 7), was not found by us in Nyungwe. Although we did not sample quantitatively and therefore cannot draw comparisons, and Boxnick *et al*. (2015) did not sample in Cyamudongo, it was apparent that the species richness and abundance of molluscs at Cyamudongo was impressive. Rwanda is the most densely populated country in continental Africa and natural habitats in its section of the Albertine Rift remain only in national parks. Nyungwe, including the outlying Cyamudongo, represents a key area for rainforest conservation in Africa.

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PSEUDUNIO MAROCANUS (MOLLUSCA: BIVALVIA) AS A FLAGSHIP SPECIES FOR THE CONSERVATION OF THREATENED FRESHWATER SPECIES IN MOROCCO

By Mohamed Ghamizi, Hassan Benaissa, Wafa Dhaiouir, Mokhtar Benlasri, Fayçal Ait Boumallassa & Mary Seddon

Freshwater molluscs from the Mediterranean basin are amongst the most threatened species in the region (Van Damme *et al*., 2010; Böhm *et al*., 2020). The Moroccan freshwater pearl mussel, *Pseudunio marocanus* (Pallary, 1918) (Fig. 1), was listed among 100 of the most threatened species in the world by Baillie & Butcher (2012) and recognised by Edmondstone *et al*. (2022) as one of 50 fantastic freshwater species worthy of conservation actions.

This species was originally listed on the IUCN Red List under the name *Margaritifera marocana* (and it still is) but

Fig. 1. *Pseudunio marocanus* (CR) from the El Abid river, type locality of the species.

following taxonomic research it has been reassigned to the genus *Pseudunio* (see Lopes-Lima *et al*., 2018). The species is endemic to Morocco and was assessed as Critically Endangered in the IUCN Pan-African Freshwater Assessment project (Van Damme *et al*., 2010; Gomes-dos-Santos *et al.*, 2019). This species is closely related to Spengler's freshwater mussel, *Pseudunio auricularia*, an endangered species in France and Spain (Araujo *et al*., 2009). In the same river basin there is another freshwater bivalve that is also endemic to Morocco. This species, *Unio foucauldianus* Pallary, 1936 (Fig. 2), is also considered to be Critically Endangered on the IUCN Red List (Van Damme *et al*., 2010; Benaissa *et al*., 2019; Gomes-dos-Santos *et al.*, 2019).

Over the last 10 years, considerable efforts have been made by an international research team to study all of the localised populations of freshwater unionid bivalves in Morocco to determine their range, their habitats and to assess the numerous threats to these species (Sousa *et al*., 2016; Benaissa *et al*., 2022).

It is notable that the river catchment where both *Pseudunio marocanus* and *Unio foucauldianus* are found also contain

Fig. 2. *Unio foucauldianus* (CR) from the N'Fiss river; it has disappeared from the Abid river.

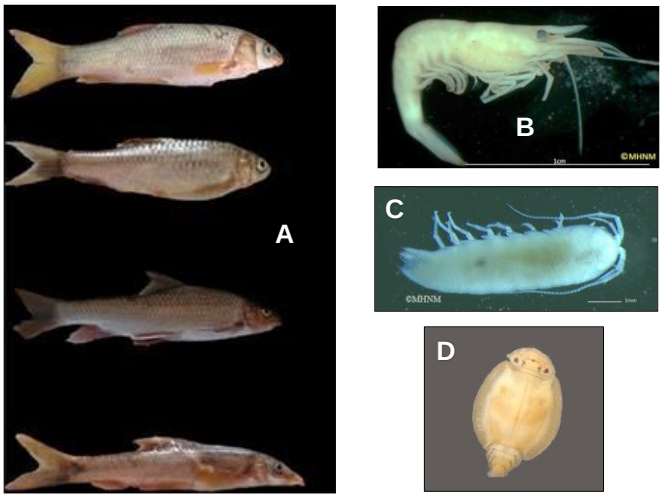

Fig. 3. Freshwater species living at the same site as the targeted flagship mollusc, *Pseudunio marocanus*.
A - Fish: from top, *Luciobarbus ksibi*, *Carasobarbus fritschii*, *Pterocapoeta maroccana*, *Luciobarbus zayanensis*. B - Shrimp: *Dugastella marocana* (EN) endemic to the Tamda source [spring] of the El Abid basin. C - Isopod crustacean, genus *Typhlocirolana*. D - Insect, Ephemeroptera: *Prosopistoma maroccanum*.

various fish species (Cyprinidae) that are considered Vulnerable on the IUCN Red List (e.g. species in the genera *Carasobarbus*, *Luciobarbus* and *Pterocapoeta*). These were considered important taxa for the designation of the key biodiversity area (KBA) of the El Abid river (Garcia *et al*., 2010; Darwall *et al*., 2015).

A new project has been established supported by the SEGRE SOS species grants foundation starting in January 2024. This will be to address conservation of the endemic pearl mussel of Morocco. *Pseudunio marocanus* will be used as a flagship species for the conservation of other endemic freshwater species that live in the same river catchment (Fig. 1). This will include four species of fish (Fig. 3), which act as host fish during the life-cycle of *P. marocanus* (Benaissa *et al*., 2022); the other Critically Endangered freshwater bivalve species (Fig. 2); two species of endemic crustaceans, one of which is classified as Endangered (EN) (Figs. 3B, 3C), and a recently discovered endemic species in the El Abid river, *Prosopistoma maroccanum* (Insecta, Ephemeroptera; El Alami *et al*., 2022) (Fig. 3D).

The El Abid river project site (Fig. 4), was highlighted as a candidate for designation as a Key Biodiversity area for the Western Mediterranean region by the IUCN Freshwater team (Darwall *et al*., 2015). It is also recognised as an Alliance for Zero Extinction (AZE) site for *Dugastella marocana* and is located on the outskirts of the Moroccan Mgoune Geopark recognised by UNESCO. The riparian forest and the riparian strip made up of annual and perennial vegetation are degraded and the bare soil promotes erosion and turbidity of water (Fig. 5), producing large quantities of sediment and creating unfavourable conditions for the survival of filter-feeding fish and mussels as this sediment clogs their gills.

Through an integrated approach involving partners, local

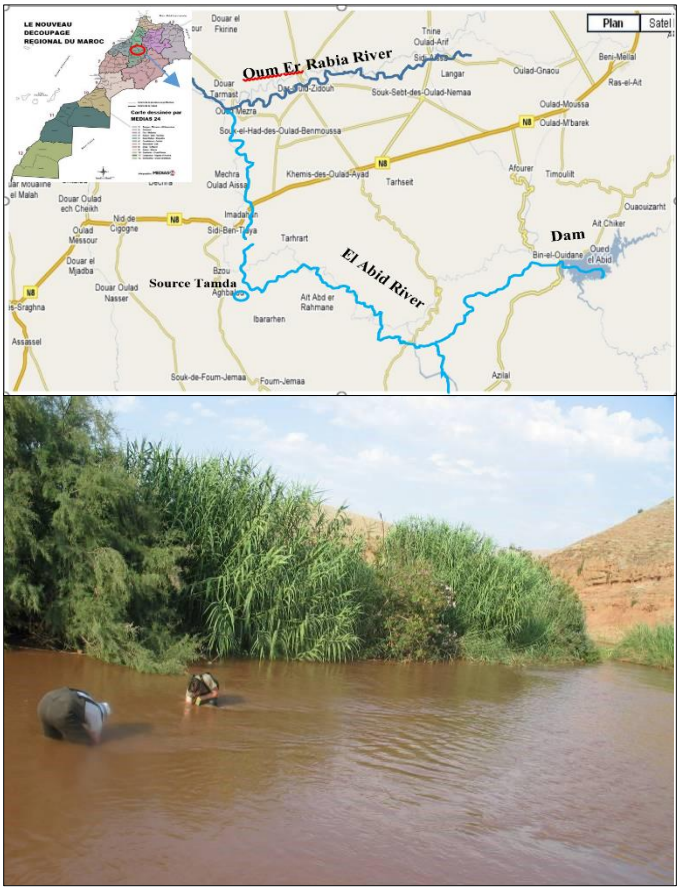

Fig. 4. Project site: El Abid river, type locality of *P. marocanus*, the main tributary of the Oum Er Rabia river. See location on the map of the source [spring] Tamda targeted by the restoration under the project.

populations and doctoral students (co-authors of this article) from the Museum of Natural History of the University Cadi Ayyad in Marrakesh, this project aims to do the following.

- Update data on the distribution of the species. It was present in seven stations in Oued El Abid (Sousa *et al*., 2016). The most downstream site is located 7 km upstream of the confluence with the Oum Er Rabia river and the furthest upstream at 54 km from the confluence (Fig. 4)
- Update data on the use of aquatic resources by local populations
- Carry out actions that will mitigate the threats to target species, through awareness campaigns, cleaning, restoration of mussel habitats damaged by silting, and planting of riparian forest
- The above will lead to designation of a protected area for the threatened species of the Tamda source [spring].

Our actions are inspired by the recommendations and guidance of Lopez-Lima *et al*. (2018) and experiments carried out on the European pearl mussel, an example of the LIFE project "Restoration of the pearl mussel habitat in Belgium" (LIFE02 NAT/B/008590) and the National Action Plan for *Margaritifera margaritifera.*

Part of the project will be working with focus groups at a series of workshops to consult and create a series of

Fig. 5. The degraded riparian strip and turbidity of the water of El Abid river are the most serious threats for *P. marocanus* and its fish hosts.

conservation actions that will restore and conserve species and habitats. These workshops will also enable strengthening of their capacities by integrating the concepts of ecosystem services, nature-based solutions, the theory of change advocated by the IUCN global framework for biodiversity conservation, and supporting Morocco's efforts to meet the objectives of the global decade for restoration of ecosystems.

Two documents, in addition to the deliverables, will be developed at the end of this project:

- Document for classification of the project site as a Ramsar site, to be submitted to the competent authorities, to support the conservation of target species.
- A project proposal to set up an Environmental Education Station (EES) in the site to promote scientific and educational culture on the conservation of threatened species in wetlands.

We thank ANEF (Agence Nationale des Eaux et Forêts du Maroc) for authorisations to collect aquatic samples and use electric fishing to study the fish hosts of the mussels. Thanks to colleagues Manuel Lopes-Lima, Ronaldo Sousa, Amilcar Texiera and Simone Varandas for the rich and fruitful collaboration that resulted in the characterisation of the habitat and distribution in Morocco of *Pseudounio marocanus*. We dedicate this work to the bivalve specialist Rafael Araujo, Museo Nacional di Ciencias Naturales of Madrid, who passed away in 2021 and who initiated our work on this species. Thanks to the Fondation Segré for their financial support of this project.

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LEARNING ABOUT *MEGALOBULIMUS* - THE GIANT ATLANTIC FOREST SNAIL

By Sonia B. Santos, Amanda P. Elias, Juliana S. Ferreira, Matheus P. Mendes & Edilaine C.R. Ribeiro

Education is one of the pillars of conservation, especially when it comes to non-charismatic invertebrates such as terrestrial molluscs (Ovando *et al*., 2009). In this context, the project "Malacology at School" promotes the dissemination and popularisation of science about molluscs, in formal and non-formal learning spaces, aiming to increase knowledge and awareness of these animals among elementary and high school students (Santos *et al*., 2019, 2022). To achieve these objectives, activities are developed applying different methodologies that stimulate curiosity and learning, highlighting the importance of molluscs in nature and their interactions with people.

Megalobulimus spp., known as "aruá-do-mato" are the largest terrestrial snails in Brasil, with 57 currently recognised species (Salvador *et al*., 2024), living mainly in the Atlantic Forest. Some species, such as *Megalobulimus ovatus* (Müller, 1774) and *M. oblongus* (Müller, 1774), are listed as threatened in the Rio de Janeiro Red List (Bergallo *et al*., 2000).

During the the workshop "Strategies and actions for Atlantic Forest Conservation in the State of Rio de Janeiro" (Bergallo *et al*., 2009) these species were proposed as umbrella and flagship species (Santos *et al*., 2009; Santos, 2011).

Considering that you cannot preserve what you do not know, we participated in the Environmental Week, promoted by UERJ's Center for Environmental Studies and Sustainable Development (CEADS), in the Municipality of Angra dos Reis, from 5 to 7 June 2023, introducing the native land snails *Megalobulimus* ("mega") and teaching how to differentiate them from *Lissachatina fulica* (Bowdich, 1822), the giant African snail, an invasive species.

We visited five public schools, two on the mainland and the others on the island ("Ilha Grande") (Figs. 1, 2). The region where the schools are located corresponds to "Costa Verde" (the "Green Coast"), located west of Rio de Janeiro. It is an area with important forest remnants (SOS Mata Atlântica, 2003). The appearance of *Megalobulimus* is common during the rainy seasons in the small townships bordering the forest. However, as in urban areas, we find *Lissachatina fulica*, even in school backyards, and it is important to undertake action to protect *Megalobulimus*.

Miranda *et al*. (2015) and Miranda and Pecora (2016) analysed the interactions between *Megalobulimus paranaguensis* (Pilsbry & Ihering, 1900) and *Lissachatina fulica* in a niche overlap study, finding no negative effects. They suggested that the main factor affecting the conservation of the native species is probably environmental alteration brought about by the degradation and suppression of the forest and the efforts to control the invasive species. We agree with these conclusions, as the two species can be confused by people.

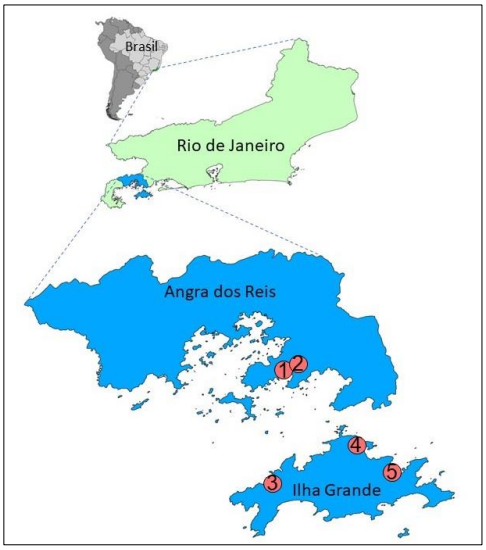

Fig. 1. Location of schools visited in Angra dos Reis Municipality, Rio de Janeiro State. 1- Municipal School Júlio Cesar de Almeida Laranjeira; 2 - Municipal School of Youth and Adult Education Professor Fabiano Avelino, city of Angra dos Reis; 3 - Municipal School General Silvestre Travassos, village of Araçatiba; 4 - Municipal School Monsenhor Pinto Carvalho, village of Enseada das Estrelas; 5 - Municipal School Brigadeiro Nóbrega, village of Abraão.

We showed the students living specimens and shells, talking about the main differences between the animals and their shells (shape of the apex, shape of the body whorl, shape and thickness of the outer lip of the shell, number and size of eggs), using specimens (Fig. 3) and posters (Fig. 4). Observing the living animals, the students could note the absence of the mouth lip in *Lissachatina fulica.* Students were not allowed to touch living *L. fulica*, a known host of the rat lungworm.

In total, 34 classes were held, involving 233 students from preschool to 8th grade of fundamental school and two classes of young people and adults (50 students). Regardless of the group, the interest and curiosity were enormous (Figs. 5, 6), and participants were able to note the differences between the native and the invasive giant snails. The activity was successful in managing to show the differences to the students

Fig. 2. Some of the team involved in the activities developed during the Environmental Week in front of Municipal Schools. A - E.M. Júlio Cesar de A. Larangeira (Angra dos Reis); B - E.M. General Silvestre Travassos (Araçatiba).

Fig. 3. A box of mixed "acatina" and "mega". The students are invited to handle and identify the shells, observing the differences.

Fig. 4. Example of a poster we use in activities with students, stressing the main shell differences and biological aspects.

and their teachers. Thus, education is an important tool for conservation of our native *Megalobulimus* species, not only to teach people about the differences between them and the invasive giant African snail but also to develop empathy and love for snails!

We thank the Department of Education, Youth, and Innovation of the Municipality of Angra dos Reis, especially Ms. Norielen Martins for her kind attention and all the facilities provided; the heads of the schools visited for their warm welcome; to CEADS for infrastructure and facilities provided; and to Cetreina/UERJ for student scholarships to APE, ECRR and JSF.

Fig. 5. Some moments during the activities, showing the interest in snails among children and teenagers.

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Fig. 6. From fundamental school to adult classes: all learning about and loving *Megalobulimus*.

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PACIFIC ISLAND LAND SNAILS – AND EX-SITU BREEDING PROGRAMMES AROUND THE WORLD

A momentous year for *Partula* conservation

By Justin Gerlach & Paul Pearce-Kelly

Since 2015 attempts have been ongoing to try to re-establish species of *Partula* back in the wild in French Polynesia. The conservation breeding programme currently maintains 13 species, 11 of which are listed as Extinct in the Wild, one Critically Endangered and one Vulnerable on the IUCN Red List. By the start of 2023 releases into the wild were considered to have failed for five species, but results for the others were more encouraging. There had been some positive signs of individuals surviving for up to two years and at least some breeding, but no clear confirmation of population establishment.

From the first release until the end of 2019 16,018 snails had been released [the number given in *Tentacle* 28 (15,835) was incorrect] and further releases were planned for 2020. The COVID pandemic forced the releases to be abandoned at the last minute and travel restrictions within the islands severely curtailed monitoring. In the midst of this our field conservationist, Trevor Coote, died of COVID (see *Tentacle* 29). Trevor's untimely loss was a severe blow, removing a valuable source of knowledge and experience from the programme.

During the years of the pandemic the programme struggled with the loss of the information from the field and increasing pressure on the zoos with snails that should have been released, as well as all the other pandemic pressures. However, in April 2023 we were able to recommence reintroductions. In that month 5,694 snails of seven species were transported from London, Edinburgh and St. Louis zoos and released on Tahiti and Moorea by the *Partula* Global Species Management Programme and the French Polynesian Direction de l'environnement. At the same time surveys were undertaken on Raiatea and Huahine to identify future release sites for other species.

The April 2023 releases included several innovations. Most significantly the enamel paint that was used to mark released snails was changed to a UV reflective paint. This had been suggested by Gerardo Garcia in 2019 based on his experience with *Poeciolozonites* in Bermuda (e.g. see *Tentacle* 29), but this was our first opportunity to try it. It makes a considerable difference to the ease with which the snails can be seen, with a UV torch revealing their presence in the dark canopy at least 5 m away (Fig. 1). A drone was also used to search for snails out of sight in the canopy but no snails were found in the low-light forest conditions. Future surveys were planned using a UV torch attached to the drone but these proved unsuccessful (see below).

As part of research into the releases, the species released on Moorea were watched for 24 hours after release. These night observations proved unexpectedly revealing, with each species

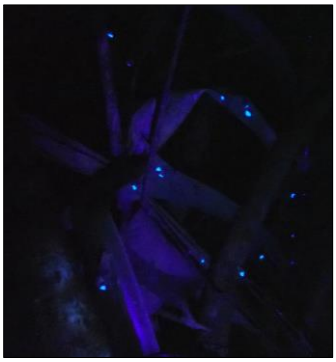

Fig. 1. Released *Partula* marked with UV reflective paint seen at night by the light of a UV torch.

Fig. 2. Wild-born subadult *Partula taeniata*.

exhibiting a different movement pattern. Some emerged from the release pots very gradually over 24 hours while others dispersed rapidly for a short distance, or straight up into the canopy. One species, *Partula affinis*, seemed to be gregarious, with groups of snails emerging together and roosting in clusters. These species differences are remarkable considering that all these species have been kept in identical, artificial conditions for the past 30 years, yet they still retain distinct behaviours. The night observations also found *Platydemus manokwari* flatworms to be far more abundant than had been expected; they were seen foraging in large numbers, but the only ones found eating were consuming millipedes. Two species of which, both invasive, were highly abundant.

Success of these releases was again unclear. On Tahiti mortality was very high, with many losses to flatworms. This was particularly the case for the slow dispersing, gregarious *P. affinis*. Despite the abundance of flatworms in the night observations on Moorea, the releases there suffered far less predation. Positive signs were the observation of newborns of several species and, in the case of *P. taeniata*, sightings of snails released as juveniles in 2019 that had grown to maturity as well as wild-born adults (Fig. 2). This gave us ground for optimism for at least some species.

During the releases some research projects were set up to investigate the rate of shell decomposition and climate patterns. Collaboration with the Direction de l'environnement was strengthened and a new collaboration established with the Fare Natura ecomuseum on Moorea. There Kirahu Howard will be doing a three-year diploma on improving the success of *Partula* reintroductions. As part of this, Fare Natura will be contributing to the conservation breeding programme.

The large numbers of some *Partula* species in zoos and the research initiatives from the April release led us to plan a second release in September. The aim of this was to release more snails, reduce the mortality rate using anti-predator barriers inspired by the experiences of the April releases, test the drone/UV torch combination, and discuss plans for a

Fig. 3. *Partula varia* being released on Huahine.

Partula reserve at Fare Natura. In this second release of the year 2,458 snails were released on Tahiti, Moorea and Huahine. The Huahine release of *P. varia* was particularly significant (Figs. 3 and 4). The last attempt on that island, in 2019, ran into problems immediately as it coincided with a period of exceptionally hot and dry weather. Within a day of release in 2019 dead shells were being found in abundance and all the released animals probably died within a few months. This time we selected a damper site with more complex vegetation and were fortunate in that the weather was ideal for snails. The landowners of the release site were very keen to be involved and to monitor the snails, as they used to collect *Partula* for necklace-making until their extinction in the mid-1990s. Twenty-four hours after release just a single death was recorded, an exceptional result that makes us optimistic for the future of this species.

Releases on Moorea also progressed well although extremely heavy rain and strong winds made the release unusually challenging, particularly as we repeated the night observations. The torrential rain again favoured survival of the snails. Mortality was relatively low and many snails from the

Fig. 4. Released *Partula varia*.

Fig. 5. *Partula nodosa* release tree protected from flatworms by salt-soaked fabric strips.

April release were located. Good numbers of wild-born snails were found at the *P. taeniata* site and very fresh shells of wild-born adult *P. tohiveana* were collected. The former is a species that has a few relict populations surviving in the wild and would be expected to be one of the easiest to re-establish. *Partula tohiveana*, on the other hand, is an ecological specialist and listed in the IUCN Red List as Extinct in the Wild. It is very encouraging that we found evidence that populations have been established of both generalist and specialist species.

On Tahiti more *P. nodosa* were released. In April these had suffered high levels of predation by *Platydemus manokwari*, with many being killed by flatworms inside the release pots. In September, release trees were protected by tying strips of fabric soaked in a salt solution around their bases (Fig. 5). This effectively deterred the flatworms, with no flatworms in the release pots and the only fatalities being among the small number of snails that fell onto the ground. As a result a good number of snails could be seen several metres above ground. This release recorded the fewest deaths of this species so far and the presence of newborn snails descended from the April release once again gives cause for optimism. Adding a UV torch to the drone did not help us locate more snails; the resolution of the camera is just too low for finding small snails in complex vegetation. In contrast, camera traps on a time-lapse setting proved surprisingly useful in monitoring movement out of the release pots. We are considering whether more sophisticated cameras may help with monitoring, particularly in less accessible sites.

The detailed monitoring undertaken by the Direction de l'environnement this year has given us a good picture of progress and the increasing number of wild-born snails being found finally gives us the evidence that populations are becoming established. With a post-pandemic revitalisation of the field programme, 2023 seems to be the year that *Partula* started to make a come-back.

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Rediscovery of the critically endangered endemic tree snail *Partula obesa* in Alofi (Wallis and Futuna, South Pacific Islands)

By Jean-Yves Hiro Meyer

In the last issue of *Tentacle* (*issue* 31, March 2023) I mentioned the necessity of organising another field expedition to Wallis and Futuna (South Pacific) in order to explore other sites in search of the endemic tree snail *Partula obesa* Pease, 1868 (synonym *Partula subgonochila* Mousson, 1871), especially on the island of Alofi where we were unable to find this species during our previous field trip in December 2022. We have now achieved success during a field trip in December 2023, again with the crucial support of the Service Territorial de l'Environnement (Department of Environment) for funding and logistics.

After five days of intensive field survey across the whole island of Alofi, hiking back to its highest summit (Mt. Kolofau, 420 m), following the interior and coastal trails to Loka and pointe Sauma located on the northeast side, and the trail leading to Vaika beach (Fig. 1) on the southwest side, we eventually found a single population represented by three adults, three juveniles and three very young ones in a relictual native forest at about 90 m elevation in Mulivai (Fig. 2).

Fig. 1. Aerial view of Vaika beach on the southwest side of Alofi with its dense native forest.

Fig. 2. Left, *Partula obesa* adult. Right, Jean-Yves ("Soane Ive") Meyer showing a *Partula obesa* (arrowed) living under the large fronds of the native bird's nest fern (*Asplenium nidus*) in Mulivai, island of Alofi.

The bad news is that we also managed to reach the very end of pointe Vele on the eastern point of Futuna, crossing very dense native forest on raised and sharp limestone, but did not find any other *Partula obesa* population apart from the single one discovered in 2022.

Based on these field observations made in 2022 and 2023, the Service Territorial de l'Environnement has recently contacted partulid conservation experts (Paul Pearce-Kelly of the Zoological Society of London and Eric Bairrao Ruivo and Baptiste Mulot of the Zoo de Beauval in France) to try to set up a rescue plan in order to save the last living individuals of *Partula obesa* from imminent extinction.

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Progress in translocation of *Mandarina* snails in the Ogasawara Islands

By Hideaki Mori, Mayu Inada, Tsukasa Waki & Satoshi Chiba

The diversity of land snails and the process of evolutionary radiation that led to them is a core scientific component of the natural heritage of the Ogasawara Islands, for which the islands are globally recognised, and for which they were inscribed as a World Natural Heritage Site in 2011. However, since the 1990s, the impact of non-native predators such as flatworms (*Platydemus manokwari*) and rats has continued to increase (Chiba, 2010; Chiba & Cowie, 2016), and in recent years, the number of species extinct in the wild has been increasing day by day, especially on the Chichijima Islands. Therefore, ex-situ conservation techniques have been developed by researchers since 2004 and by the Ministry of the Environment since 2011, with priority given to the conservation of *Mandarina* species in captivity (Mori *et al*., 2020).

However, ex-situ conservation is not a perfect solution because of the possible effects of inbreeding under captivity (Price & Hadfield, 2014) and species extinction caused by infectious diseases (Cunningham & Daszak, 1998). It would be better to conduct reintroduction and re-establish populations in the wild as soon as the environment within the habitat has improved and becomes suitable. In the Ogasawara Islands, captive breeding techniques for *Mandarina* have been established (Mori *et al*., 2020), but as there is still no flatworm control technique, we decided to start with reinforcement on Tatsumijima Island (Fig. 1), where the flatworm is as yet absent and rodents have been eliminated (Mori *et al*., 2021).

This is the first official case of snail translocation to the wild in Japan, and because of the risk of impact on the susceptible ecosystem of these oceanic islands, the methods are being carefully discussed with the Ogasawara land snail Working Group of experts that guides the programme. The following is a summary of the improvements made for releasing the snails into the wild over the past three years.

Breeding methods to prevent invasion of commensal organisms

When releasing captive snails into the wild, it is necessary to avoid the introduction of associated parasitic organisms that could affect the wild population. In order to prevent the unintentional release of other organisms into the wild, all possible measures were taken during the rearing process. In the breeding lab, soil and vegetables are used for rearing *Mandarina* (Mori *et al*., 2020), but considering the risks of invasion of microorganisms, paper and artificial mixed food are used instead in a separate room set up for rearing those snails that will be released (Mori *et al*., 2021). The hands and

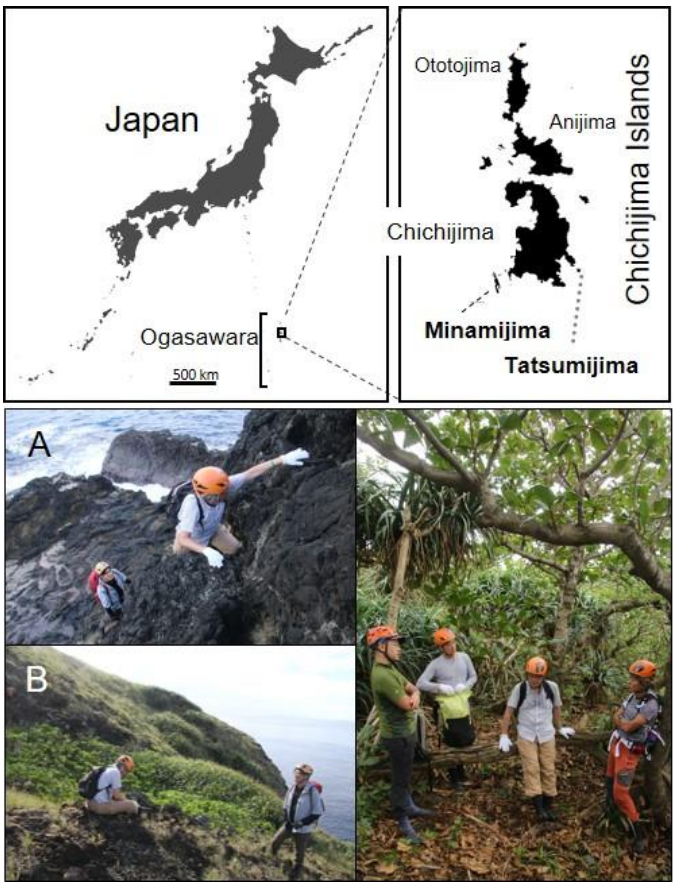

Fig. 1. Map and environment of Tatsumijima in Ogasawara where the reinforcement of *Mandarina* snail populations was conducted. A - The whole coast of the island is cliffs about 50 m high; B - Most of the cliff top plateau is grassland; C - Snails remain in a small area of tropical almond forest surrounded by dense pandanus vegetation.

clothing of the people undertaking the breeding, including their shoes, are also carefully cleaned. Particular attention is paid during transfer of eggs from the breeding lab to the separate pre-release room, with eggs being carefully washed with distilled water, then promptly transferred to the separate room and placed in cases filled with damp artificial soil. Since cleaning with water may not completely eliminate associated organisms, using ethanol or vinegar instead is being tested and if hatching and subsequent survival rates are not affected, we will consider adopting this as an alternative method.

Quarantine for oceanic island ecosystem

A quarantine for parasites in *Mandarina* was carried out, referring to examples of pre-release testing during the reintroduction of snails in Tahiti. There have been no confirmed cases of mortality caused by parasites in *Mandarina*, but examining snails for possible infection by nematodes of the genus *Phasmarhabditis*, which is lethal to snails in mainland Japan (Waki & Sawahata, 2019) was conducted just in case. Candidate snails (20-30 individuals) were dissected and tissues were cultured for two weeks to check for nematodes. In the first year of testing, no nematodes were detected, and snails were released as scheduled. However, nematodes were found in some snails in the second year and genetic analysis revealed that they were free-living nematodes (*Oscheius* sp.). Although they were thought to have no negative impact on snails, it is likely that nematodes were present in the gastrointestinal tract or on the body surface. On the basis of prior research that nematodes are sensitive to desiccation and nematodes in the digestive tract of snails were eliminated by fasting for a period of time (Sudhaus, 2018), similar starvation treatments were tried out and most nematodes were eliminated in one week and completely in two weeks. Nevertheless, as a long-term starvation treatment could increase snail mortality, the duration of treatment was reconsidered and a ten day fasting period was implemented for candidate snails before release. Along with nematodes, free-living mites and ciliates were also identified, but elimination of ciliates was difficult even with fasting. Regarding the results of all possible measures, consultation with the Working Group concluded that if no high-risk organisms were found, it was not necessary to completely eliminate the organisms, and the translocation to the wild should be prioritised to avoid extinction of the wild population. What is important is to document what has been done and what has not. Based on the results of the second year, rearing methods were thoroughly revised, and as a result, no nematodes were detected in the third year of testing.

Growth stages suitable for release

To lower the risks of introducing unwanted organisms to the wild, the first year of translocation started by releasing eggs. Subsequently, hatchlings with a short rearing period were also released (Mori *et al*., 2021). However, the rediscovery of young individuals quickly became difficult, with an assumption that the survival rate was not high (Table 1). Aiming for faster establishment of released snails and with the progress in developing methods identifying and eliminating associated organisms, more mature juveniles and adults are now selected for release. Currently, snails are reared for a longer period in anticipation of releasing more adults.

Table 1. Number of snails released and survival on Tatsumijima in 2020-2022.

Species	Release stage	Nov 2020	Feb 2021	Feb 2022	Nov 2022	Total
Mandarina hirasei	Eggs	152	-	-	-	152
	Juveniles	-	118	149	179	446
	Adults	-	23	25	-	48
	Total	152	141	174	179	646
	Recaptured one year later	0	12	18	46	
Mandarina chichijimana	Eggs	27	-	-	-	27
	Juveniles	-	19	114	146	279
	Adults	-	-	7	3	10
	Total	27	19	121	149	316
	Recaptured one year later	0	0	1	34	

Effective release locations

In the first year of translocation, eggs and juveniles were first introduced into mesh enclosures (Mori *et al*., 2021) to monitor the hatching rate and initial mortality. This method may have been useful not only for data collection, but also for a gradual establishment of released snails by retaining them for one to two months in a stable environment. During this period, the hatching rate was 50.0% in *M. hirasei* and 55.6% in *M. chichijimana*. The initial mortality of juveniles was 1.4% in *M. hirasei* and zero in *M. chichijimana* when kept in the enclosure. Since basic information on the hatching rate and initial mortality were obtained, from the second year individuals were released directly into moist areas of vegetation that had been selected as good environments during the pre-release monitoring.

In the first year, the adjacent edges of two vegetation types were selected for suitable sites of translocation where the benefits of both could be combined: soft, large tropical almond (*Terminalia catappa*) leaves as a food resource and hard, thick pandanus (*Pandanus boninensis*) leaves for moisture retention on the forest floor. However, the dense forest of pandanus trees, made monitoring difficult such that the results of the reinforcement were difficult to ascertain. Post-release monitoring is important, so establishing a tracking technique, and selecting a release environment where monitoring is easy even after snails move, needed to be taken into account as a condition for selecting potential locations for release, and overall, releases took place at locations that facilitated good evaluation.

Tags for tracking snails

Monitoring needs to distinguish the released populations from the wild population on Tatsumijima because what we are doing is “reinforcement.” In that sense, identification tags are important to record growth, mortality and migration of released snails. In the first year, all snails were marked with hollowed-out paper tags glued on their shells, except for small juveniles just after hatching, which were marked with gel polish fluorescing under UV light. Because the tags often

Fig. 2. Recaptured *M. hirasei* (A and C) and *M. chichijimana* (B and D). Arrows show tags on the shell: blue - paper tag, yellow - gel polish tag, white - numbers written with coloured markers, red - PIT tag.

came off, a method in which long-term attachment was confirmed was used from the second year. The technique involves marking individuals with identification numbers using pigmented markers and coating the surface with a highly transparent glue over the numbers (Fig. 2). Since snails tend to hide in the leaf sheath of pandanus and under the litter on the forest floor, a search method currently used in outdoor breeding facilities was used. PIT tags (9 and 12 mm, depending on shell size; BioMark co. Inc.) attached to shells of larger snails facilitated ease of search using a PIT tag reader even if the snails were not directly visible (Fig. 2).

The results of these improvements are starting to appear. Up to and including the release in February 2022, the recapture rate decreased after six months to a year and it was assumed that many snails had died, but released snails were recaptured at a high rate even a year after the release in November 2022 (Table 1). In addition, snails released as juveniles are beginning to mature and an increase in population densities of *Mandarina* on the island will be expected in the following season as they join the breeding population.

The outcomes of the translocation trial on Tatsumijima are reflected in the next initiative, reintroduction to Minamijima. The reintroduction took place in December, 2023. Using the revised methods applied in the case study on Tatsumijima, 85 *M. hirasei* and 88 *M. chichijimana* were prepared and released into a mesh enclosure to monitor the initial survival rate. The trial on Minamijima Island will probably pose new challenges because of its poor vegetation and harsh environment, but we are aiming to facilitate establishment of *Mandarina* populations on the island as on Tatsumijima.

We are grateful to Rintaro Shigeno of Toho University for analyses of parasites. Also many thanks to Koh Ashizawa and the breeding team at the Ogasawara World Heritage Centre. This project is a part of conservation programmes run by the Ministry of the Environment.

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Hawaii Snail Extinction Prevention Program (SEPP)

By David R. Sischo

The Snail Extinction Prevention Program (SEPP) is a partnership recovery effort hosted by the Hawaii Department of Land and Natural Resources. Aimed at preventing the mass extinction of land snails in the Hawaiian Islands, the programme works with a diverse array of partners and land holders across the state to manage snail populations directly and to facilitate research and conservation. SEPP has a fully staffed captive rearing facility on Oahu, and field biologists on Oahu and Maui. The following is a brief update on noteworthy captive rearing and reintroduction efforts and research activities.

By proclamation, the Governor of Hawaii, Dr. Josh Green, declared 2023 the Year of the *Kāhuli*, setting off a year-long celebration of land-snail diversity in the islands. Festivities included murals (Fig. 1), snail-themed art and clothing, the release of a documentary featuring Hawaiian land-snail conservation, and other outreach events and activities. The year culminated with a *Kāhuli* Festival at the Bernice Pauahi Bishop Museum in Honolulu. The year-long effort was aimed at increasing awareness of the rich, and incredibly imperiled, land snail biodiversity in the islands. Overall, this outreach blitz was a success.

SEPP captive rearing update

The SEPP lab currently maintains 40 species of rare and endangered land snails from five islands. Most of these populations no longer have wild counterparts and exist solely

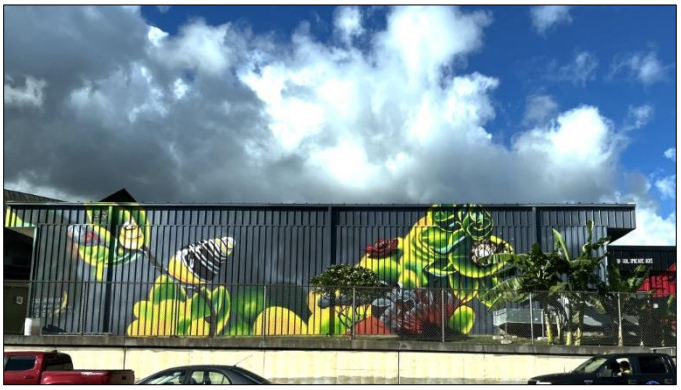

Fig. 1. Native snail mural along the H1 freeway in Honolulu.

in captivity. As of 31 December 2023, over 9,000 snails resided in the SEPP lab.

In June of 2023, SEPP moved into a new laboratory space in Pearl City, Oahu. The new facility is double the size of the previous space, increasing the capacity for captive rearing. All snails were moved at once in a caravan of 12 state government vehicles and two law enforcement escorts (Fig. 2). The spectacle made the local news and may have been a world record for the most critically-imperiled species on a freeway at any one time!

Multi-institution captive rearing collective

SEP, in partnership with the Malacology Department at the Bishop Museum, and the Honolulu Zoo, was awarded a grant from the U.S. Fish and Wildlife Service to open captive rearing laboratories at both institutions. The purpose of the project is to split vulnerable populations that exist only in captivity (Fig. 3), creating redundancy as a hedge against extinction. After several years of planning and modifying spaces, both new labs will open in 2024. The new laboratory spaces will be public facing, taking inspiration from zoos participating in the International Partulid Programme's captive rearing efforts. Once open, this will be the first time the public will be able to see these animals in captivity, as the SEPP lab is not open to the public.

Research Updates

SEPP is involved in many research projects aimed at improving captive rearing and field conservation efforts. While it is premature to report results, below I have summarised several noteworthy ongoing projects that may be of interest to readers.

Post-translocation monitoring

It has been observed in Hawaii that captive snails released into protected habitats wander farther than expected following reintroduction. To better understand this behaviour, SEPP is using photo-identification software to track individual post-release movement patterns of *Achatinella concavospira*, reintroduced into two different predator-proof fenced units. Preliminary results indicate movement pattern differences between snails released into habitat that already have existing wild snails, verses habitat that does not. Results will inform future reintroduction efforts.

Fig. 2. During the SEPP laboratory move, officers and wildlife biologists formed a human chain to quickly load vehicles with the precious cargo. A caravan of 12 state vehicles transported the snails to their new lab space in Pearl City.

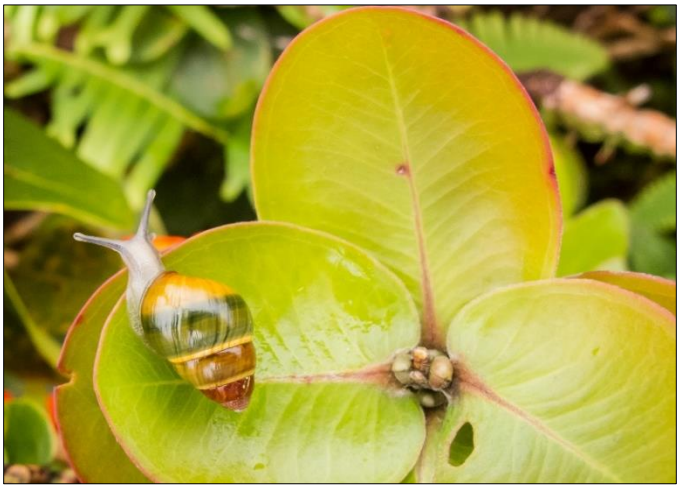

Fig. 3. *Achatinella lila*, one of the first targets for transferring to the new labs at the Bishop Museum and the Honolulu Zoo. This species is believed to be extinct in the wild and now only exists in the SEPP captive rearing lab.

Testing Partula diet with Hawaiian snails

Current practice for rearing Hawaiian tree snails involves providing leafy native vegetation collected from the field as well as a native leaf fungus cultured on potato dextrose agar. The snails feed on the biofilm on the leaves, made up of many species of fungi, algae and bacteria. We do not yet fully understand the feeding ecology of Hawaiian tree snails, specifically what components of this biofilm are important for snail survival. Thus, we continue to rely on wild-collected leaves as a substrate and food for captive colonies. Leaf collection is labour intensive and restricts captive rearing efforts to facilities in proximity to native vegetation and where leaf

collection is possible. This significantly limits captive rearing potential. We hope to move towards a rearing methodology that decreases reliance on wild-collected vegetation.

We tested the diet created by the International Partulid Programme for captive colonies of *Partula* spp. with the Hawaiian tree snail *Auriculella ambusta*. Treatments included *A. ambusta* maintained on native vegetation and cultured fungus on potato dextrose agar, and those maintained on native vegetation, cultured fungus, and offered the *Partula* diet as a supplement. Preliminary results indicate that the snails in the treatment supplemented with the *Partula* diet laid significantly more eggs, and had greater hatching success, than the treatment with native vegetation and cultured fungus alone. These results are very encouraging and suggest further experimentation is warranted.

Detection dogs

SEPP has contracted with Rogue Detection Teams, a company specialising in training detection dogs for conservation purposes. In the spring of 2024 SEPP will be working with the Rogue Detection Teams staff to assess the efficacy of training dogs to detect *Euglandina* species and Jackson's chameleons, two of the worst introduced predators of Hawaiian land snails. If the effort works, dogs would be used to help clear habitat of predators, and to detect incursions of predators in areas protected by predator-proof fences. Results will be reported in future issues of *Tentacle*.

Many thanks to our colaborators and funding partners at the U.S. Fish and Wildlife Service, the Hawaii Department of Land and Natural Resources, the Paul G. Allen Foundation, the Bernice Pauahi Bishop Museum, The Honolulu Zoo, The University of Hawaii, the Army Natural Resources Program, Pulama Lanai, and Puukukui Watershed Partnership.

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

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MARINE MATTERS

Cone snail Red List workshop 2.0 – preliminary report from Frankfurt 2023

By Julia Sigwart & Julia Silva Beneti

In 2011 Howard Peters and colleagues organised a workshop in Chicago, to complete and review Red List assessments for all living species of cone snails. This resulted in 632 species of Conidae being added to the global Red List in 2013, as the first comprehensive assessment of a marine mollusc group (or any marine clade, apart from some corals). The group has appeared on illustrations of summary data for the global Red List under the heading "various marine gastropods" from the start, but has only recently been expanded to include other families. Conidae remains the largest marine mollusc assessment project to date. The project to complete Red List assessments for all living *Conus* was explicitly intended to provide a baseline for future decadal updates (Peters *et al*., 2013). The majority of species were assessed as Least Concern (~75%) or Data Deficient (~14%), with the remaining 67 species in Threatened or Near Threatened categories. The major threats to species at risk were coastal development and other habitat degradation impacting species with small ranges.

One key result was highlighting the threatened status of endemic speices in Cape Verde (Cabo Verde), the only area where species were then assessed as Critically Endangered. Cape Verde is recognised as a hotspot for terrestrial and marine species, including endemic cone snails (Peters *et al*. 2016) and other marine molluscs that have not yet been assessed for the Red List (Cunha *et al*., 2017).

The situation has changed since the time of the original cone snail Red List assessments. In April 2022 Cape Verde implemented new legislation to protect all endemic flora and fauna (Conselo de Ministros, 2022). Trade in any endemic species is now strictly prohibited, thus removing the (legal) trade in high value shells endemic to this region.

The last decade has seen a continuous expansion of research on Conidae and related species, including extensive work on taxonomy and systematics, with many species newly described, or reinstated as widespread species are spltit based on re-examination with molecular evidence. Global Red List assessments are subject to updating after 10 years. With this in mind, the Senckenberg Ocean Species Alliance proposed a follow up workshop to re-assess the Conidae, including reassessment of the original species and additional new species that have been recognised since the original project.

To follow up on these developments and in line with the goal of regular ten-year updates to global Red List assessments, the Senckenberg Ocean Species Alliance (SOSA) organised a follow up Red Listing workshop. We invited as many of the original participants as possible, and 14 experts, enthusiasts and Red List facilitators gathered in Frankfurt, Germany, for a week in mid December 2023 (Figs. 1 and 2).

Fig. 1. Specimens of Conidae in the collection of the Senckenberg Museum, Frankfurt, Germany.

Fig. 2. Participants in the 2023 SOSA cone snail Red List workshop, from left to right: Sandra Müller, Sigrid Hof, Aoife Molloy, Mary Seddon, Gregoire Maniel, Howard Peters, Monika Böhm, Felix Lorenz, Julia Sigwart, Nicolas Puillandre, Julia Beneti, Loïc Limpalaer, Eric Monnier, Manuel Jimenez Tenorio, Hugh Morrison.

The workshop successfully completed draft reassessments for all 632 species that were previously assessed, and added approximately 150 additional new assessments. The draft assessments still require further review as well as new map data, which will be undertaken by the SOSA team in 2024. The reassessments are likely to be published in a later update to the IUCN Red List in early 2025. Meanwhile we can provide some preliminary observations on the comparison of the assessment outcomes from >10 years ago and now.

The assessments of cone snails now include an increased number of species with restricted ranges. A number of taxonomic revisions mean previously widespread taxa are now recognised as clusters of species with smaller distributions. Not all species with restricted ranges are necessarily endangered; threatened categories reflect a threat. As was true a decade earlier, the major threat to cone snails is coastal development when habitat changes could wipe out a population, often of small inconspicuous species not targeted by the shell trade.

It is also interesting to note the importance of the shell trade as a source of important information about the population status of many large or rare species. The worldwide community of shell collectors is relatively small and does not appear to represent a major threat to the survival of cone snail species. However, in some cases of endemic species with restricted ranges, local over-collecting for international sale could jeopardise the species as a whole. The changing price point of high value shells reflects shifts in availability – when a desirable species becomes more difficult to obtain, the price increases – and in some cases this information could be incorporated into assessments.

The overall percentage of species in threatened categories has not increased significantly. Among reassessments, there are approximately equal numbers increasing and decreasing in status. While the Cape Verde endemic species are now protected and are therefore less threatened, there are other species with new data and new information about threats. Indeed, there is one species of cone snail which sadly now appears to be extinct.

When these assessments are submitted for publication, this will represent the first time we can compare Red List status of an entire marine mollusc group over time.

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Increasing capacity for marine invertebrates with the IUCN global Red List

By Julia Sigwart, Julia Silva Beneti, Anne Helene Tandberg & Torben Riehl

The Senckenberg Ocean Spcecies Alliance (SOSA) is a ten year project (funded through 2031) to promote taxonomy and conservation of marine invertebrates, including molluscs. One of the main pillars of SOSA is collaboration with the IUCN global Red List and working to combat the long-recognised under-representation of marine and invertebrate species in global conservation.

In December 2022, the IUCN Species Survival Commission re-instated the Marine Invertebrate Red List Authority (MIRLA) with one of us (JS) as the current coordinator and committee chair. This serves as the new hub for Red List assessments of any species that are not served by a current specialist group (Sigwart *et al*., 2023). Another important aim is to expand the capacities of the existing specialist groups, such as increasing work on marine molluscs in collaboration with the Mollusc Specialist Group (chaired by Mary Seddon). One example is the recent cone snail workshop, reported on page 39 of this issue of *Tentacle*. SOSA will fund two full time positions for conservation biologists supporting marine invertebrate Red List activities, starting in 2024.

For the next two years, a priority for SOSA + MIRLA is a focus on CITES protected species that do not have global Red List assessments. The largest fraction of relevant species are cold-water corals, but there are also important molluscs that are CITES protected but have never been Red Listed. Among these marine molluscs, the work is mainly supporting the outstanding volunteers who are actively developing assessments for relevant species such as Tridacnidae and "*Strombus*" *gigas*.

The lack of marine species in the Red List has been a focus of recent criticism but is a well known, long standing problem. Species based conservation is not a typical approach for marine invertebrates. This means that the people with the greatest expertise in the species, usually do not have experience with the Red List or conservation approaches (and vice versa). One of our goals is to increase capacity for marine invertebrate conservation by providing training and guidance for applying the Red List approach to these species.

The Red List remains a highly visible and well recognised conservation tool that serves as an unparalleled communication tool to draw attention to species in peril. This communication is needed for marine molluscs now, more than ever. If you are interested in getting involved, please get in touch! The best way to stay informed is to subscribe to the SOSA newsletter (sosa.senckenberg.de)

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Adapting management and conservation approaches for the diamondback squid, *Thysanoteuthis rhombus* Troschel, 1857

By Diego Deville

The diamondback squid, *Thysanoteuthis rhombus* Troschel, 1857, is considered the single representative of the family Thysanoteuthidae Keferstein, 1866. They are large, muscular, oceanic squids that live in tropical and subtropical oceanic waters worldwide (Fig. 1). They have a lifespan of approximately one year, but their growth rates are fast and they are mature at around seven months. Adults of this species reach a dorsal mantle length of up to 1 m and weights of up to 30 kg (Nigmatullin & Arkhipkin, 1998).

In Japan, diamondback squids have significant economic value, with fishery landings of up to 4,900 tons between 1998 and 2003 (Nigmatullin *et al*., 1995; Bower & Miyahara, 2005). Harvesting is increasing in other countries such as the Philippines (Dickson *et al*., 2000), while exploratory fisheries targeting this species have been successfully carried out in New Caledonia, Fiji, Vanuatu, Tonga, Martinique, Cook Islands, Saint Lucia, Maldives, Dominican Republic, Jamaica

Fig. 1. Diamondback squid, *Thysanoteuthis rhombus*, collected off Tarragona (Spain). Currently preserved in the Marine Biological Reference Collection of the Marine Sciences Institute of Barcelona (CBMR-CSIC, Guerrero *et al*., 2020).

and Canary Islands (Aiken *et al*., 2007; Herrera-Moreno *et al*., 2011; CRFM, 2012; Escánez-Pérez *et al*., 2012; Nimoho *et al*., 2014; Republic of Maldives, 2018; Moore *et al*., 2023). Meanwhile in Mexico, Honduras and India these squid could also represent potential harvested resources as suggested by the reports of adults and egg masses (Brown *et al*., 2022; Rajikumar *et al*., 2022; Alejo-Plata *et al*., 2023). This trend suggests an escalating fishing pressure on *Thysanoteuthis* in the coming years. Responsible harvesting and conservation of diamondback squids requires biodiversity assessment and stock boundary delineation.

Deville *et al.* (2023) hypothesised that ocean currents and biogeographic barriers in tropical and subtropical areas could have influenced gene flow among *Thysanoteuthis* populations, potentially leading to cryptic speciation. This is because diamondback squid rely solely on horizontal dispersal linked to ocean drift currents, with reduced active swimming for feeding and spawning (Miyahara *et al*., 2008; Onitsuka *et al*., 2010). Their analyses of three mitochondrial genes indicated that *Thysanoteuthis* encompasses at least three cryptic putative species distributed in different ocean basins primarily in warm waters (Fig. 2).

As no morphological differences are known among these cryptic species, their morphological diagnosis aligns with the features described for the genus *Thysanoteuthis*. Deville *et al.* (2023) proposed nomenclatural changes for diamondback squid species and the resurrection of three synonymised species within *Thysanoteuthis*. These authors considered that the first species, *Thysanoteuthis major* (Gray, 1828), can be found in the northern Pacific Ocean, northern Indian Ocean and at the boundaries of the Indian Ocean and the southern Atlantic Ocean (Fig. 2). The second species, *Thysanoteuthis rhombus* Troschel, 1857, is distributed in the northern and southeastern Atlantic Ocean and the Mediterranean Sea (Fig. 2). The third species, *Thysanoteuthis* cf. *filiferum* (Hoyle, 1904), with its type locality in the Marquesas Islands, is the most distinct within the genus and is anticipated to be distributed in the southeast Pacific Ocean and around New Zealand (Fig. 2).

Deville *et al*. (2023) could not relate the distribution of each cryptic species with the two groups of diamondback squid described by Sajikumar *et al*. (2020) and Nigmatullin *et al*. (1995) that differ in distribution (tropical and subtropical), growth rates, and spawning time. Instead, Deville *et al*. (2023)

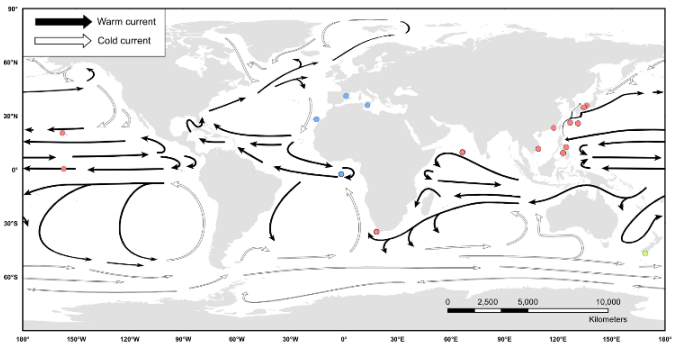

Fig. 2. Locations of cryptic species of *Thysanoteuthis*. Species are indicated by red (*T. major*), blue (*T. rhombus*) and green (*T.* cf. *filiferum*) points. Adapted from Deville *et al*. (2023).

indicated that these groups are present within each cryptic species, representing populations with different adaptive potentials in response to dissimilar environmental pressures in tropical and subtropical areas (Eizaguirre & Baltazar-Soares, 2014). Hence, a conservation plan for *Thysanoteuthis* species should not omit the adaptive potential of these populations.

For the time being, *Thysanoteuthis* can be defined as a mixed stock fishery for which unequal harvesting may lead to under- or over-exploitation of each cryptic species (Allendorf *et al*., 2008). Considering that the highest fishery landings are reported in Japan and that in other areas there are only exploratory fisheries, the highest contribution to the current mixed-stock fishery is accounted for by the cryptic species in the North Pacific. Current management policies focused on this cryptic species are established in Japan (Okinawa), the Maldives and the waters of Hawaii and other United States Pacific Islands. Together these policies include closed seasons, prohibition and restriction of certain fishing methods and vessel size, obtaining of licenses for harvesting and processing, and informing about fishing areas.

Large genetic divergence between allopatric species can be associated with local adaptation, genetic drift or biogeographic barriers (Bickford *et al*., 2007). Hence, the findings of Deville *et al*. (2023) highlight the necessity of creating (or extending) policies for the cryptic species found in the Atlantic and Mediterranean, and that in the southeastern Pacific, depending on the harvesting intensity exerted on them. Conservation and management strategies for *Thysanoteuthis* should also include determining the contribution of each cryptic species to the mixed-stock fishery using mitochondrial markers for the identification of each cryptic species. Moreover, for establishing effective and sustainable conservation policies for the three cryptic species, it is crucial to understand the biology of possible stocks, which can exhibit temporal and spatial integrity through random mating (Ihssen *et al*., 1981). Therefore, a vital next step for *Thysanoteuthis* conservation in regions where fishing is ongoing or anticipated is to thoroughly characterise these species at both inter- and intra-specific levels (Carvalho & Hauser, 1994). Additionally, exploratory fisheries should continue to be undertaken in areas such as the tropical western and eastern Atlantic Ocean, southern Indian Ocean and southern Pacific Ocean regions, as they may harbour potential additional cryptic species of *Thysanoteuthis* (Deville *et al*., 2023).

I thank Gustavo Sanchez and Fernando Fernández-Álvarez for their valuable comments to improve a draft of this manuscript.

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Submission of *Nautilus* assessments completes the first IUCN assessment of all known cephalopods

By Monika Böhm, Gregory J. Barord, Sophie Ledger & Louise Allcock

Cephalopods (squid, octopus, cuttlefish and nautiluses) have been the subject of IUCN Red List assessment for around the last decade (Allcock, 2011; Böhm & Allcock, 2016). First assessments for select species were published in 2012, especially cuttlefish, but progress stalled as project funding ran out. By 2020, a dedicated team of volunteers had managed to finalise and publish assessments for all octopus, squid and cuttlefish species known at the time. The results, probably unsurprisingly, showed high levels of data deficiency. Only seven of the 750 species published were assessed in categories other than Least Concern (324 species) or Data Deficient (419 species): the Giant cuttlefish (*Sepia apama*) and the Kaharoa Octopus (*Octopus kaharoa*) as Near Threatened, two *Opisthoteuthis* octopus (*O. massyae* and *O. calypso*) as Vulnerable, another *Opisthoteuthis* (*O. mero*) as well as *Cirroctopus hochbergi* as Endangered, and finally *Opisthoteuthis chathamensis* as Critically Endangered (Barratt & Allcock, 2012; Headlam *et al.*, 2019; Lyons & Allcock, 2014a-e).

Fig. 1. *Nautilus samoaensis*, recently described by Barord *et al*., 2023) from American Samoa. (Photo: Greg Barord)

That meant that only the nautiluses remained unassessed – but this is about to change. As you read this, all assessments for *Nautilus* (Fig. 1) and *Allonautilus* are in the submissions queue for the IUCN Red List of Threatened Species. While there are nowhere near as many species of nautiluses as there are squid, octopus and cuttlefish, these last few assessments were probably involved the most work, given taxonomic uncertainty and the CITES status of the group. In addition, just as we thought we had completed the assessment, three new species were described by Greg Barord and team last year (Barord *et al*., 2023), giving species status to populations previously treated as *Nautilus pompilius*-like subpopulations.

After several rounds of changing taxonomic concepts in the IUCN Species Information Service (SIS – the database behind the IUCN Red List), splitting off subpopulations to assess them at the species level, and mapping and re-mapping distributions, these assessments are now undergoing final review (and hence may still be subject to change). They will probably result in assessments ranging from Data Deficient to at least Near Threatened. So watch out for nautiluses arriving on the Red List in 2024, as a baseline to drive forward conservation for these incredible species.

Allcock, L. 2011. Red List of globally threatened species: cephalopods. *Tentacle* 19: 51.
Barord, G.J., Combosch, D.J., Giribet, G., Landman, N., Lemer, S., Veloso, J. & Ward, P.D. (2023) Three new species of *Nautilus* Linnaeus, 1758 (Mollusca, Cephalopoda) from the Coral Sea and South Pacific. *ZooKeys* 1143: 51-69.
Barratt, I. & Allcock, L. 2012. *Sepia apama*. The IUCN Red List of Threatened Species 2012: e.T162627A931625.
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Headlam, J., Allcock, L. & Allen, G. 2019. *Octopus kaharoa*. The IUCN Red List of Threatened Species 2019: e.T163340A1000039.
Lyons, G. & Allcock, L. 2014a. *Opisthoteuthis massyae*. The IUCN Red List of Threatened Species 2014: e.T163141A976478.
Lyons, G. & Allcock, L. 2014b. *Opisthoteuthis calypso*. The IUCN Red List of Threatened Species 2014: e.T176050A1425064.
Lyons, G. & Allcock, L. 2014c. *Opisthoteuthis mero*. The IUCN Red List of Threatened Species 2014: e.T162917A953097.
Lyons, G. & Allcock, L. 2014d. *Cirroctopus hochbergi*. The IUCN Red List of Threatened Species 2014: e.T163337A999635.
Lyons, G. & Allcock, L. 2014e. *Opisthoteuthis chathamensis* (errata version published in 2020). The IUCN Red List of Threatened Species 2014: e.T163144A184253216.

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RECENT PUBLICATIONS RELEVANT TO MOLLUSC CONSERVATION

Journal of Threatened Taxa

All issues for 2023 (volume 15), and the first two for 2024 (volume 16, numbers 1 and 2), of the *Journal of Threatened Taxa* are available online now, open access. The journal occasionally has articles about molluscs.

Freshwater Mollusk Biology and Conservation

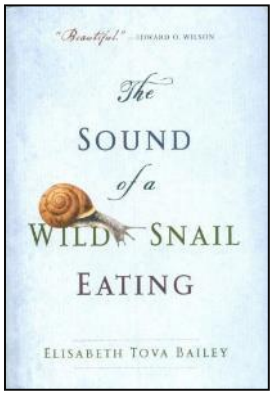
Freshwater Mollusk Biology and Conservation, formerly *Walkerana*, is the on-line journal of the Freshwater Mollusk Conservation Society, based in North America. In 2023, it published one issue: volume 26, number 2, with four papers. All issues are available on-line at the journal's website, with open access.

Volume 26, number 2

Steevens, J., Kunz, J., Wang, N., Barnhart, C. & Ciparis, S. 2023. Survival and growth of juvenile mussels in an outdoor pond after 28-day laboratory exposure to aqueous zinc. *Freshwater Mollusk Biology and Conservation* 26: 45-53.
Porto-Hannes, I., Sassoubre, L.M., Sansom, B.J. & Morris, T.J. 2023. Applying environmental DNA methods to inform detection of *Simpsonaias ambigua* under varying water velocities in a river. *Freshwater Mollusk Biology and Conservation* 26: 54-68.
Inoue, K., Snow, J.M., Schnoenecker, K.M. & DeMartini, J. 2023. Mussels propagated from a single broodstock female retain most population-level genetic variation but have altered genetic structure. *Freshwater Mollusk Biology and Conservation* 26: 69-77.
Ferreira-Rodríguez, N., Liu, X., Wu, X., Vaughn, C.C. & Pardo, I. 2023. Freshwater mussels in the bycatch of a snail fishery in the Poyang Lake region, China: a potential conservation opportunity. *Freshwater Mollusk Biology and Conservation* 26: 78-82.

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. For links to the publishers of these editions please see the author's website. It is available for Kindle, as an audiobook and as an MP3 CD. And there is an award winning short film adapted from it (see wildsnailfilm.org for upcoming screenings).

Film of the book available

The film of the book (around 15 minutes) is available for screenings to malacology and other groups and departments. Anyone interested in such a group screening for their lab or department should send an e-mail to info@wildsnailfilm.org. I have seen the film and can recommend it highly – it is as delightful and thought provoking as the book.

Freshwater Molluscs of Australia – a forthcoming book on their diversity, biology, ecology and conservation

By Winston F. Ponder & Michael W. Klunzinger

Despite being the driest continent, Australia has a diverse range of freshwater habitats that harbour a unique collection of freshwater molluscs, with more than 400 described endemic species from 25 families of gastropods and bivalves. Many species occupy very narrow ranges, these mostly in temperate lotic habitats and in arid zone artesian springs associated with the Great Artesian Basin.

This edited book, now in advanced preparation, contains contributions from a wide range of experts. It will highlight the composition, biogeography and diversity of the fauna, as well as reviewing the habitats that they occupy. Additional

chapters will cover conservation methods of study, ecology, genetics, dispersal, reproduction and life history, food and feeding, aspects of physiology, parasitology, archaeology, economic uses (including their use as bioindicators) and fossil history.

The text will be fully referenced with high-resolution illustrations and up-to-date information and as such will be an important reference work for a wide range of biologists, ecologists and land managers.

This book is intended to complement our online Lucid key and information resource for the Australian freshwater mollusc fauna.

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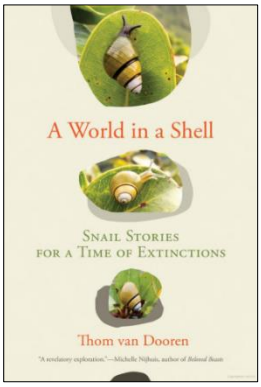
A World in a Shell – Snail Stories for a Time of Extinction

Thom van Dooren, 2022. MIT Press, Cambridge, USA.



From the publisher's website *[slightly modified; Ed.]:*

Following the trails of Hawaii's snails to explore the simultaneously biological and cultural significance of extinction.

In this time of extinctions, the humble snail rarely gets a mention. And yet snails are disappearing faster than any other species. In *A World in a Shell*, Thom van Dooren offers a collection of snail stories from Hawaii – once home to more than 750 species of land snails, almost two-thirds of which are now gone. Following snail trails through forests, laboratories, museums, and even a military training facility, and meeting with scientists and Native Hawaiians, van Dooren explores ongoing processes of ecological and cultural loss as they are woven through with possibilities for hope, care, mourning and resilience.

van Dooren recounts the fascinating history of snail decline in the Hawaiian Islands: from deforestation for agriculture, timber, and more, through the nineteenth century shell collecting mania of missionary settlers, and on to the contemporary impacts of introduced predators. Along the way he asks how both snail loss and conservation efforts have been tangled up with larger processes of colonisation, militarisation and globalisation. These snail stories provide a potent window into ongoing global processes of environmental and cultural change, including the largely unnoticed disappearance of countless snails, insects and other less charismatic species. Ultimately, van Dooren seeks to cultivate a sense of wonder and appreciation for our damaged planet, revealing the world of possibilities and relationships that lies coiled within a snail's shell.

Editor's note – Various people well known to readers of *Tentacle*, including Mollusc Specialist Group members, appear in *A World in a Shell*.

Other publications of interest

This is by no means 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.

Ahmed, H., Ahmed, I. & Aravind, N.A. 2023. An updated checklist of non-marine molluscs of the western Himalaya. *Journal of Threatened Taxa* 15(12): 24368–24395.

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Bolotov, I.N., Konopleva, E.S., Vikhrev, I.V. & Kondakov, A.V. 2024. An alarming tendency towards freshwater mussel misidentification in scientific works may bias endangered and invasive species management. *Aquatic Conservation Marine and Freshwater Ecosystems* 34(1): e4061.

Braley, R.D. 2023. A population study of giant clams (Tridacninae) on the Great Barrier Reef over three-decades [sic]. *Molluscan Research* 43(2): 77-95.

Bullis, M.K. & Rundell, R.J. 2023. Deep genetic divergence over small geographic scales in cryptic allospecies of the threatened *Semperdon* land snails of Belau (Republic of Palau, Oceania) (Stylommatophora: Charopidae). *Malacologia* 66(1/2): 61-80.

Camus, L., Poli, P., Delaugerre, M.-J., Dréano, S., Cucherat, X., Natali, C. & Guiller, A. 2023. Unexpected and spatially structured genetic diversity of the relict population of the endangered Corsican land snail *Tyrrhenaria ceratina*. *Conservation Genetics* 24: 661-672.

Caril, A., Bernabe, J., Aggabao, M.J., Bantigue, P.C., Guinto, A., Gabriel, E.M., Roderos, A.R., Ellorin, R.J., Naca, A. & Saguil, N. 2024. Establishing baseline data for conservation via a comparative species survey of marine macro-molluscs (bivalves and gastropods) from a disturbed-commercialized and a protected reserve coastal area in the Philippines - a tale of two coastal barangays. *The Malacologist* 82: 12.

Chen, Z.-G., Xie, G.-L., Dai, Y.-T., Ouyang, S. & Wu, X.-P. 2023. A new species of *Coccoglypta* Pilsbry, 1895 from China (Gastropoda, Camaenidae). *Molluscan Research* 43(3-4): 205-210.

Cowie, R.H., Fontaine, B. & Bouchet, P. 2023. Non-marine molluscs. In: *The Living Planet – the State of the World's Wildlife* (ed. Maclean, N.), p. 288-310. Cambridge University Press, Cambridge.

Das, K. & Aravind, N.A. 2024. Molluscan fauna of Meghalaya's limestone caves: understanding diversity and threats for conservation. *The Malacologist* 82: 13.

Decker, O., Foon, J.K., Köhler, F., Moussalli, A., Murphy, N.P. & Green, P.T. 2023. Fire severity is an important driver of land snail declines after the black summer bushfires in Australia. *Biological Conservation* 279: 109906.

Dinkins, G.R., Engman, A.C., Bajo-Walker, B., Clark, Z.W., Wolbert, J., Hecke, K. & Alford, J.B. 2023. Status and distribution of freshwater mussels in the Louisiana section of Bayou Bartholomew. *American Malacologial Bulletin* 39(1): 60-84.

Dobbs, K.D.R., Lynn, T.J., Bruce, M.R., Reyes-Prieto, A., Samways, K.M., Curry, R.A. & Duffy, M.S. 2023. Freshwater mussel glochidia infesting anadromous Gaspereau below a hydroelectric generating station: implications for mussel conservation. *Hydrobiologia* 851: 617-632.

Douda, K., Zieritz, A., Vodáková, B., Urbańska, M., Bolotov, I.N., Marková, J., Froufe, E., Bogan, A.E. & Lopes-Lima, M. 2024. Review of the globally invasive freshwater mussels in the genus *Sinanodonta* Modell, 1945. *Hydrobiologia* Online early.

Ekin, İ. 2023. Endemic microsnail *Sheitanok amidicus* (Caenogastropoda: Hydrobiidae) additional locations, distribution, shell morphology, and near-threatened. *Journal of Conchology* 44(5): 431-438.

Ekin, İ. & Şeşen, R. 2023. First live imagery, morphological insights, and new locations of the near-threatened endemic microsnail *Sheitanok amidicus* (Caenogastropoda: Hydrobiidae) from southeast Turkey. *Molluscan Research* 43(3-4): 188-195.

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Foon, J.K., Green, P.T. & Köhler, F. 2023. Delineating *Paralaoma annabelli*, a minute land snail impacted by the 2019-2020 wildfires in Australia. *Records of the Australian Museum* 75(1): 51-64.

Gallagher, K.M. & Albano, P.G. 2023. Range contractions, fragmentation, species extirpations, and extinctions of commercially valuable molluscs in the Mediterranean Sea – a climate warming hotspot. *ICES Journal of Marine Science* 80(5): 1382-1398.

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Hauck, L.L., Atkinson, C.L., Homyack, J.A., Penaluna, B.E., Mangum, C., Coble, A.A., Nettles, J., Thornton-Frost, J.E. & Fix, M.J. 2023. Molecular identity crisis: environmental DNA metabarcoding meets traditional taxonomy – assessing biodiversity and freshwater mussel populations (Unionidae) in Alabama. *PeerJ* 11: e15127.

Huang, S., Edie, S.M., Collins, K.S., Crouch, N.M.A., Roy, K. & Jablonski, D. 2023. Diversity, distribution and intrinsic extinction vulnerability of exploited marine bivalves. *Nature Communications* 14: 4639.

Hyman, I.T., Caiza, J. & Köhler, F. 2023. Dissecting an island radiation: systematic revision of endemic land snails on Lord Howe Island (Gastropoda: Stylommatophora: Microcystidae). *Zoological Journal of the Linnean Society* 197(1): 20-75.

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Martins, A.M. de F. 2023. Revision of the Lauriidae Steenberg, 1925 (Gastropoda: Stylommatophora: Pupilloidea) on the Azores islands, with the description of seven new species. *Açoreana* 11(4): 673-750.

Martins, A.M. de F., Henriques, D.V. & Cameron, R.A.D. 2023. The Azorean endemic snails are disappearing! Who is to blame? *Açoreana* 11(4): 653-672.

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Meira, A., Byers, J.E. & Sousa, R. 2024. A global synthesis of predation on bivalves. *Biological Reviews* Online early.

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Ruellan, H.Y., Stodola, K.W., Stodola, A.P. & Tiemann, J.S. 2023. Predicting suitable habitat for surrogate species of critically imperiled freshwater mussels to aid in translocations. *Freshwater Science* 42(3): 296-314.

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Schulz, L., Wessely, J., Dullinger, S. & Albano, P.G. 2023. The climate crisis affects Mediterranean marine molluscs of conservation concern. *Diversity and Distributions* 30(3): e13805.

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Smith, D., Abeli, T., Bruns, E.B., Dalrymple, S.E., Foster, J., Gilbert, T.C., Hogg, C.J., Lloyd, N.A., Meyer, A., Moehrenschlager, A., Murrell, O., Rodriguez, J.P., Smith, P.P., Terry, A. & Ewen, J.G. 2023. Extinct in the wild: the precarious state of Earth's most threatened group of species. *Science* 379(6634): eadd2889.

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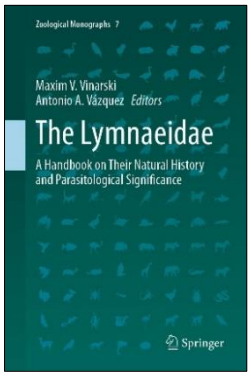
Stagliano, D.M. 2023. Western pearlshell (*Margaritifera falcata*) extirpation in the Smith River, Montana, with a possible link to warming water temperatures. *Western North American Naturalist* 83(2): 254-263.

Stanford, B.C., Lepitzki, D.A., Taylor, M.K. & Rogers, S.M. 2023. Pooled whole genome sequencing of the endangered Banff Springs snail, *Physella johnsoni*, reveals genetic separation to *P. gyrina* and cryptic micro-geographical genetic structure. *Conservation Genetics* 24: 783-791.

Vinarski, M.V. 2023. Conservation of the Lymnaeidae. In: *The Lymneidae. A Handbook on Their Natural History and Parasitological Significance. Zoological Monographs 7* (ed. Vinarski, M.V. & Vázquez, A.A.), p. 447-470. Springer, Cham. [This multi-authored book has numerous chapters, many of which will interest readers of *Tentacle*; see the Table of Contents]



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IUCN/SSC AND MOLLUSC SPECIALIST GROUP NEWS AND ANNOUNCEMENTS

www.iucn.org/

News and information provided by Mary Seddon, chair of the Mollusc Specialist Group (MSG) of the IUCN Species Survival Commission (SSC).

IMPORTANT – Future Directions for the Mollusc Specialist Group

As we move towards the end of the IUCN planning quadrennium, an opportunity arises to input ideas for the next four years IUCN work plan. This programme is still very much focussed on species conservation, development of tools, understanding climate change impacts and moving to species conservation action plans. As part of the planning process, we will be sending out a survey to all IUCN SSC Mollusc Specialist Group members in May 2024 to ask for your ideas about how the Mollusc Specialist Group should be structured and what projects we should look at developing in addition to the projects already ongoing. I hope you will contribute to this process, as it will help future planning.

IUCN Red List updates 2024

This year the Red List database will be updated twice during the year. Submission of a Red List assessment by the dates listed does not guarantee whether it will be published by the first proposed date. These schedules may change but at present the submission and target publication dates are:

Version	Submission target date	Publication date
2024-1	29 March 2024	27 June 2024
2024-2	19 July 2024	22 October 2024

Outputs from the ConFreMus project 2023

The European Union (EU) funded ConFreMus (Conservation of Freshwater Mussels) project is working together as an official project partner with the IUCN EU Pulse Project (also funded by the EU) to produce an IUCN European Freshwater Bivalve Conservation Action Plan as a joint effort that is meeting project outcomes for both these EU funded projects. It will be referred to the EU policy office for their input and possible use in pushing in-country actions.

There have been various meetings of ConFreMus participants during 2023 bringing together experts on freshwater bivalves in Europe. The major meeting in January 2023 started the process of creating a unified Conservation Action Plan for all of the Freshwater Bivalves, including the Sphaeriidae. The planning process is still ongoing and the full report including policy recommendations should be completed by April 2024. Two particularly notable synthesis/review papers were published; their abstracts are reproduced here.

A global synthesis of predation on bivalves

Meira, A., Byers, J.E. & Sousa, R. 2024. A global synthesis of predation on bivalves. *Biological Reviews* Online early.

Predation is a dominant structuring force in ecological communities. In aquatic environments, predation on bivalves has long been an important focal interaction for ecological study because bivalves have central roles as ecosystem engineers, basal components of food webs, and commercial commodities. Studies of bivalves are common, not only because of bivalves' central roles, but also due to the relative ease of studying predatory effects on this taxonomic group. To understand patterns in the interactions of bivalves and their predators we synthesised data from 52 years of peer-reviewed studies on bivalve predation. Using a systematic search, we compiled 1334 studies from 75 countries, comprising 61 bivalve families (N = 2259), dominated by Mytilidae (29% of bivalves), Veneridae (14%), Ostreidae (8%), Unionidae (7%), and Dreissenidae and Tellinidae (6% each). A total of 2036 predators were studied, with crustaceans the most studied predator group (34% of predators), followed by fishes (24%), molluscs (17%), echinoderms (10%) and birds (6%). The majority of studies (86%) were conducted in marine systems, in part driven by the high commercial value of marine bivalves. Studies in freshwater ecosystems were dominated by non-native bivalves and non-native predator species, which probably reflects the important role of biological invasions affecting freshwater biodiversity. In fact, while 81% of the studied marine bivalve species were native, only 50% of the freshwater species were native to the system.

In terms of approach, most studies used predation trials, visual analysis of digested contents and exclusion experiments to assess the effects of predation. These studies reflect that many factors influence bivalve predation depending on the species studied, including (i) species traits (e.g. behaviour, morphology, defence mechanisms), (ii) other biotic interactions (e.g. presence of competitors, parasites or diseases), and (iii) environmental context (e.g. temperature, current velocity, beach

exposure, habitat complexity). There is a lack of research on the effects of bivalve predation at the population and community and ecosystem levels (only 7% and 0.5% of studies respectively examined impacts at these levels). At the population level, the available studies demonstrate that predation can decrease bivalve density through consumption or the reduction of recruitment. At the community and ecosystem level, predation can trigger effects that cascade through trophic levels or effects that alter the ecological functions bivalves perform. Given the conservation and commercial importance of many bivalve species, studies of predation should be pursued in the context of global change, particularly climate change, acidification and biological invasions.

Review of the globally invasive freshwater mussels in the genus *Sinanodonta* Modell, 1945

Douda, K., Zieritz, A., Vodáková, B., Urbańska, M., Bolotov, I.N., Marková, J., Froufe, E., Bogan, A.E. & Lopes-Lima, M. 2024. Review of the globally invasive freshwater mussels in the genus *Sinanodonta* Modell, 1945. *Hydrobiologia* Online early.

In this review, we synthesize the current knowledge of the biology, ecology, and impact of *Sinanodonta* freshwater mussels (Bivalvia, Unionidae), native to East Asia, that have successfully invaded Europe, Central America, North Africa, and several Asian regions. The main introduction pathways of *Sinanodonta* were reconstructed based on DNA sequence data and distribution records. We show that invasive lineages of *Sinanodonta* belong to three species, namely, *S. woodiana* s. str. ("temperate invasive" lineage), *S. pacifica* ("tropical invasive" lineage), and *S. lauta*. Their generalist fish-dispersed larvae, short life span, high fecundity, use by humans for multiple purposes, and ability to establish populations in anthropogenically disturbed conditions were identified as crucial traits driving their invasions. Information on the consequences is scarcer, but *Sinanodonta* can impact native species through larval parasitism, host fish/food competition, and parasite transmission. In addition, ecosystem effects through their filtration – biodeposition – excretion activity and the occurrence of massive die-offs were detected. Ecosystem services and disservices have not yet been quantified, even at local scales, and management methods in the invasive range are understudied. A better understanding of *Sinanodonta* ecology, impacts, and management options is urgently needed to make informed decisions and set realistic and impactful restoration goals.

Additional ConFreMus project publications

Geist, J., Thielen, F., Lavictoire, L., Hoess, R., Altmueller, R., Baudrimont, M., Blaize, C., Campos, M., Carroll, P., Daill, D., Degelmann, W., Dettmer, R., Denic, M., Dury, P., de Eyto, E., Grunicke, F., Gumpinger, C., Jakobsen, P.J., Kaldma, K., Klaas, K., Legeay, A., Mageroy, J.H., Moorkens, E.A., Motte, G., Nakamura, K., Ondina, P., Österling, M., Pichler-Scheder, C., Spisar, O., Reis, J., Schneider, L.D., Schwarzer, A., Selheim, H., Soler, J., Taskinen, J., Taylor, J., Strachan, B., Wengström, N. & Zając, T. 2023. Captive breeding of European freshwater mussels as a conservation tool: a review. *Aquatic Conservation: Marine and Freshwater Ecosystems* 33(11): 1321-1359.

Ollard, I. & Aldridge, D.C. 2023. Declines in freshwater mussel density, size and productivity in the River Thames over the past half century. *Journal of Animal Ecology* 92: 112-123.

Sousa, R., Zając, T., Halabowski, D., Aksenova, O.V., Bespalaya, Y.V., Carvalho, F., Castro, P., Douda, K., da Silva, J.P., Ferreira-Rodríguez, N., Geist, J., Gumpinger, C., Labecka, A.M., Lajtner, J., Lewin, I., Lopes-Lima, M., Meira, A., Nakamura, K., Nogueira, J.G., Ondina, P., Ożgo, M., Reis, J., Riccardi, N., Shumka, S., Son, M.O., Teixeira, A., Thielen, F., Urbańska, M., Varandas, S., Wengström, N., Zając, K., Zieritz, A. & Aldridge, D.C. 2022. A roadmap for the conservation of freshwater mussels in Europe. *Conservation Biology* 37(2): e13994.

Register mollusc conservation projects

The new reporting system created by the IUCN SSC Chair's office is now in operation. It allows members to add projects into the official reporting by SSC to the main IUCN members. The advantage of adding your projects into the SSC data system is that there may be small funding opportunities that occur over the course of the year, but these are only open to officially registered projects. Last year two members got funding for their projects, one project was funded by the SEGRE Foundation to work on freshwater bivalves in Morocco (see the article by Ghamizi *et al*. on p. 27 of this issue of *Tentacle*). Smaller funds were obtained to work on *Cremnoconchus* species in India (see the article by Aravind & Jadhav on p. 6 of this issue of *Tentacle*).

If you think your project could contribute to knowledge relevant to mollusc conservation and is working in the areas of Red List Assessments, Green List assessments, Conservation Genetics or Field surveys, then please contact Monika Böhm (email: mbohm@indyzoo.com) and provide a few paragraphs to describe your project. We will require a title, geographical area, taxonomic group and basic description of the project to be undertaken and any current funding sources.

Online training courses

Facilitating species conservation planning workshops

Dates:

- 30 September - 22 November 2024 (closing date for applications is 9 September 2024)
- 3 February - 21 March 2025 (closing date for applications is 13 January 2025)

Registration fee: US$300

This is an introductory species conservation planning course, offered by the IUCN Conservation Planning Specialist Group (CPSG). The target audiences are government wildlife agency staff, IUCN SSC Specialist Group members and other conservation professionals working in zoos, aquariums, universities or field programmes, responsible for the development of species conservation plans. By the end of the course, participants will be able to: 1) apply the CPSG Species Conservation Planning Principles and Steps to the design and facilitation of species conservation planning processes; 2) demonstrate the role of the facilitator in consensus-based decision making; and 3) select facilitation tools to help groups solve problems, make decisions and develop plans. Click here to find out more about the course and how to apply to an upcoming session.

Wildlife disease risk analysis

Dates:

- 28 August - 25 October 2024 (closing date for applications is 5 August 2024)

Registration fee: US$500

This is an introductory course on the IUCN Guidelines for Wildlife Disease Risk Analysis (WDRA). This course is designed to equip participants with an understanding of how to put the guidelines into practice. Our target audiences are government wildlife agency staff, IUCN SSC Specialist Group members and other conservation professionals and veterinarians working in zoos, aquariums, universities or field programmes, responsible for planning for disease management at the interface between people, places and wildlife. By the end of the course, participants will be able to: 1) recognise and justify situations where a WDRA process can contribute to wildlife conservation, domestic animal health care and public health protection; 2) explain how the principle of One Health and the science of epidemiology are applied to a WDRA; and 3) design a workshop to effectively engage multiple stakeholders in completing a WDRA. Click here to find out more about the course and how to apply to an upcoming session.

Ex situ conservation assessment

Dates: Self-paced (no closing date for applications)
Registration fee: US$300

The IUCN Conservation Planning Specialist Group (CPSG) is partnering with The Nature Conservancy to bring ex situ conservation assessment training to a global audience through a seven-module online course. An ex situ conservation assessment leads in situ and ex situ species experts through the five-step decision process of the IUCN SSC Guidelines on the Use of Ex Situ Management for Species Conservation to evaluate the value and feasibility of vasrious ex situ activities for conservation of a species. Incorporating pre-recorded lectures, readings and case studies from conservation practitioners across the globe, course participants will learn the steps and techniques for assessing ex situ conservation options for their species. This process is applicable to all taxa (fauna, flora and fungi) and can be conducted as a single species or multi-species evaluation. This course will be of value to wildlife managers and researchers, government wildlife authorities, IUCN Specialist Groups, staff in zoos, aquariums, botanic gardens and wildlife rescue centers, people working with biobanks, and anyone involved in planning for the conservation and management of wildlife. The aim is to equip course participants with the knowledge and skills needed to undertake a collaborative, multi-stakeholder ex situ conservation assessment, either as a stand-alone exercise or as part of a broader, integrated conservation or collection planning process. This course promotes collaboration between the field and ex situ communities to support development of effective conservation strategies for all threatened species using the One Plan approach. Click here to find out more about the course and how to apply.

New global freshwater mollusc assessment project

The IUCN Biodiversity Assessment and Knowledge Team (BAKT) freshwater programme is managed by Catherine Sayer in Cambridge, UK. Recently they have secured funding to complete the Global Assessment of all Freshwater Mollusca. This project follows on from the various regional assessment projects carried out in Europe, Asia, Africa and South America over the last 13 years. It will involve publishing Red List assessments of all formally described species of freshwater molluscs. The project started in January 2024 and runs for three years. We have already started to contact key project members, many of whom are members of the IUCN Species Survival Commission Mollusc Specialist Group. As a first step to the assessment process, we are cross-checking the species list in MolluscaBase with a species list of all freshwater molluscs in the Red List to identify the missing species requiring assessment.

Over the next six months we will be reaching out to people in North America, South America, Asia and Australia as these are key gap regions to assess for this project. If you have any interest in contributing to this project, please contact the Chair, Mary Seddon, at mary.molluscsg@gmail.com.

MEETINGS 2024 and 2025

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. Robert Cowie, *Tentacle* editor.

2025 World Congress of Malacology (XXII WCM) and Brasilian Malacological Meeting (XXIX EBRAM)

We invite all to join us at the Unitas Malacologica (UM) World Congress of Malacology (XXII WCM) in August 2025 on the premises of the Rebouças Convention Center and the Butantan Institute, in São Paulo, Brasil. Every three years the congress is held in different countries, and this will be the first time it will be held in Latin America. As it is the year of the Brasilian Malacology Meeting (XXIX EBRAM), we joined forces with Sociedade Brasileira de Malacologia (SBMa) to co-host the event. We count on the participation of professionals and students of biological sciences and related areas (oceanography, geology, veterinary science, environmental science, among others), representatives of public agencies, governmental and non-governmental institutions, promoting a valuable international scientific exchange of research and

ideas in malacology and related areas. It will be very gratifying to be able to provide the possibility for many Latin American students (at different training levels from undergraduate to postdoctoral) to participate in an event of this size. We will highlight activities related to technology, biodiversity, conservation, malacoculture, alien and invasive species, bioindicators, medical and applied malacology, anthropogenic and climate interference, and other areas. At the same time, the proposed scientific programme aims to answer current questions involving molluscs. The congress traditionally brings together professionals from various countries around the world, generating extremely valuable institutional exchange for national and international science.

It will be a pleasure to share this meeting with you! More details soon! Please pay attention to our websites:
https://www.unitasmalacologica.org/
https://sbmalacologia.com.br/

President Dr. Lenita de Freitas Tallarico – UNITAS Malacologica
President Dr. Eliane Pintor de Arruda – Sociedade Brasileira de Malacologia

2024 Joint meeting American Malacological Society (AMS) Western Society of Malacology (WSM) International Heterobranch Workshop (IHW)

The 90th American Malacological Society meeting will be held jointly with the 57th meeting of the Western Society of Malacology (WSM) and the 7th International Heterobranch Workshop (IHW). The joint meeting will take place from 4 to 7 August 2024 in Los Angeles, California at the Hilton Pasadena hotel and conference center.

The meeting will open the evening of 4 August with a welcome reception on the hotel's outdoor patio during registration. Each day will have a morning symposium with invited speakers. The topic of the AMS President's Symposium (5 August) will be "Molluscs in symbiosis: mechanisms and diversity". A symposium hosted by WSM (6 August) will feature research on the ecology and evolution of terrestrial molluscs. And the IHW will host a symposium (7 August) on marine heterobranchs. The meeting will also include a symposium on molluscs in education and outreach, focusing on work using molluscs to convey science to diverse student groups and indigenous communities. This is being organised by the AMS's Justice, Equity, Diversity and Inclusion (JEDI) Committee and will feature invited speakers and a panel discussion, and a hosted lunch for students pending sponsorship of the event. There will also be contributed oral and poster presentation sessions. Note that the deadline for submission of abstracts for talks and posters is 21 June.

For more information see the conference website, or email the AMS president, Patrick Krug (pkrug@calstatela.edu).

10th Euromal Conference

Natural History Museum of Crete

Meeting dates: 15-20 September 2024
Location: Cultural Conference Centre of Heraklion, Crete, Greece
Organisers: Hellenic Malacological Society and the Natural History Museum of Crete
Website: euromal2024.gr
Contact email: euromal2024@gmail.com

We are pleased to announce the forthcoming conference of the European Malacological Societies in Crete (Greece).

The motto of EUROMAL 2024 is "The slow side of life on a rapidly changing planet". The aim of the conference, among other things, is to highlight the importance of molluscs in our efforts to understand and address anthropogenic impacts on the environment.

Therefore, for EUROMAL 2024 all aspects of research concerning diversity, function, ecology, evolution, behavior, utility and conservation of extant and fossil molluscs in the 21st century are welcome. The meeting will continue the successful tradition of the past EUROMAL congresses, and we invite everyone with an interest in molluscs to join EUROMAL 2024 in Heraklion and to present and discuss their work.

Details and key dates can be found on the website.

Conchologists of America 2024 convention

The 2024 convention of the Conchologists of America will be held at the Hilton Melbourne hotel in Melbourne, Florida, USA. The convention will have an Olympics theme, with the Games taking place in Paris this year. The convention will run from 12 to 16 June. For more information, please see the Convention website.

North American Paleontological Convention

The 12th North American Paleontological Convention (NAPC) will be held at the University of Michigan from 17 to 21 June 2024. The NAPC brings together professionals, graduate and undergraduate students, amateur palaeontologists and interested members of the public from all over the world, and covers all branches of palaeontology, including vertebrate, invertebrate, palaeobotany, micropalaeontology, palaeo-

related organic and inorganic geochemistry, palaeoecology, palaeoclimatology and astrobiology.

More information can be found at the conference website.

Society for Conservation Biology Congresses 2024-2025

European Congress for Conservation Biology (ECCB 2024)
Biodiversity Positive by 2030
Bologna, Italy
17-21 June 2024
Visit the meeting website

North America Congress for Conservation Biology (NACCB 2024)
Celebrating Diversity in Conservation From Summit to Sea
Vancouver BC, Canada
23-28 June 2024
Visit the meeting website

International Congress for Conservation Biology 2025
SCB's 32nd International Congress for Conservation Biology will take place in Brisbane/Meanjin, Australia, 15-20 June 2025 at the Brisbane Convention & Exhibition Centre (BCEC). See the congress website.

INTERNET RESOURCES

These are just a few of the many websites dealing with mollusc conservation, with molluscs and conservation in general, and available collection databases. If you would like me to include any new ones or to update any of the current ones, please send details to me, Robert Cowie, editor of *Tentacle*.

IUCN Red List

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

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*. UM also makes small grants available to students for both research and travel to the triennial UM World Congress of Malacology. To become a member of UNITAS, go to its website and follow the links to the application.

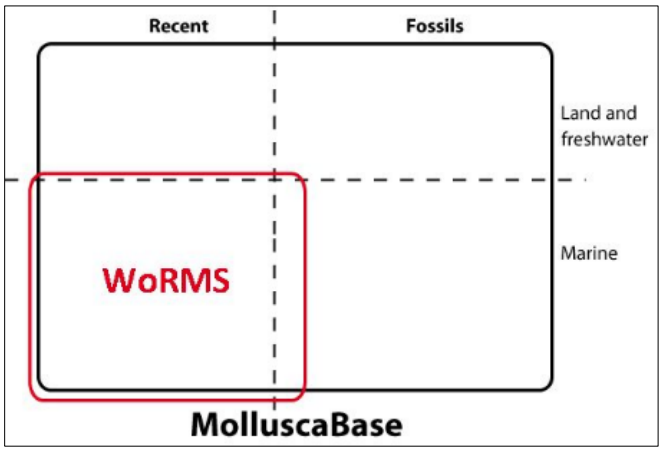
IUCN Invasive Species Specialist Group

The ISSG hosts the Aliens-L listserver. You can subscribe to the list here.

Mollusca list

The MOLLUSCA listserver is an informal forum for discussions of molluscan biology. There are over 700 subscribers. You can subscribe to the list here. Once your subscription is approved, you will receive anything that is posted to the list, and be able to post to the list. To post to the list, send email to molluscalist@listserv.dfn.de. The list is now managed by Julia Sigwart of the Senckenberg Museum, Frankfurt, with David Lindberg and Gerhard Haszprunar.

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.

[Ed. note: In the near future the MolluscaBase home page will be revised and updated, and will be called "About".]

American Malacological Society

The homepage of the American Malacological Society carries a link to its Conservation Policy. and Imperiled Species Newsletter. Student research grants are available (scroll down on the homepage). Many useful links are provided on the Resources page, including links to malacological museum collection databases.

The Malacological Society of London

The Malacological Society of London is dedicated to the advancement of research and education on molluscs. It is an international organisation based in London, UK, and welcomes as members all who are interested in the scientific study of molluscs.

The Society was founded in 1893, with the objectives "to advance education, research and learning for the public benefit in the study of Mollusca from both pure and applied aspects".

The main activities of The Society are to:

Publish the *Journal of Molluscan Studies*.
Distribute a bulletin, *The Malacologist*, to Society members (also freely available online).
Make awards for research and travel to students of malacology and non-salaried applicants.
Award prizes for outstanding contributions in the field of molluscan biology.
Organise meetings and symposia.
Promote education and awareness about molluscs.
In 2022, a new initiative was launched to help support more students from across the world in their malacological studies. More information on this here.

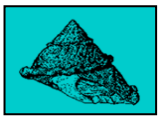
Freshwater Mollusk Conservation Society

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*.

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.

Western Society of Malacologists



The WSM home page carries links to membership, conferences, grants, and other news.

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*.

Brasilian Society of Malacology

The Sociedade Brasileira de Malacologia (SBMa) welcomes malacological researchers, professionals and students, Brasilian 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 Brasilian mollusc fauna.

Haus der Natur – Cismar

The Haus der Natur homepage carries a link to a page on mollusc conservation and responsible collecting, as well as other links.

The Natural History Museum, London

The collections database of the Natural History Museum can be searched via the Museum's Data Portal.

The Smithsonian Institution National Museum of Natural History, Washington

The Invertebrate Zoology collections, including Mollusca, can be searched online.

Florida Museum of Natural History Invertebrate Zoology Collection

The collection database, including Mollusca, can be searched online.

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.

National Zoological Collection of India type specimens illustrated online

The Zoological Survey of India now has online information, including illustrations, for the type collections of the National Zoological Collection of India, including molluscs.

Field Museum land snails

The online database of Chicago's Field Museum mollusc collections contains information for most of its 143,000 land snail lots, including over 2,500 type lots. Freshwater lots (45,000) and most marine lots (90,000) are yet to be fully databased.

Museum of Comparative Zoology (MCZ) collections, Harvard University

The MCZ has migrated its legacy specimen records from multiple independent sources, including the Malacology Collection, to a single centralised database, MCZbase.

Academy of Natural Sciences, Philadelphia, Malacology Collection

The Malacology Collection database contains records related to 460,000 lots maintained in the Malacology Department.

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.

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).

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.

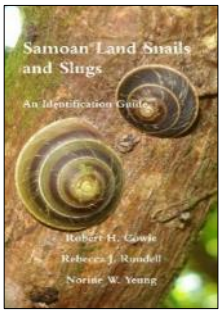
MUSSEL database project

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 Graf and Kevin 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.

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.

Samoan Snail Project



The Samoan 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).

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.

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.

Morphobank

MORPHOBANK
HOMOLOGY OF PHENOTYPES OVER THE WEB &
A database of peer-reviewed morphological matrices

MorphoBank is an online resource for evolutionary research and phylogenetic studies that hosts peer reviewed scientific data in the form of over 1,000 morphological character matrices and over 150,000 scientific images. Scientists around the globe can collaborate together to build, publish, curate and permanently host morphological phylogenetic matrices.

Other useful links

www.manandmollusc.net/ https://www.molluscs.at/
https://australian.museum/learn/animals/molluscs/
https://kids.kiddle.co/Mollusc

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 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! And please look at recent issues to help guide you.

Your submission **must** be **explicitly** relevant to **mollusc conservation** and the conservation relevance must be **specific to the study you are reporting**.

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 and specifically relevant to mollusc conservation** and whether any conclusions drawn are supported by the information presented. For example, **new records of non-native species and lists of non-native species will not be accepted unless there is a clear and significant relevance to mollusc conservation**. Also **reports of biodiversity surveys will not be accepted unless there is a clear and specific conservation significance of the survey**. So, fully explain the specific 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 – ASK ME IF YOU HAVE NOT RECEIVED ONE.

Conformance to the guidelines has improved – perhaps because of my many many reminders! But it still takes untold 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 enormous 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., Bouchet, P. & Fontaine, B. 2022. The Sixth Mass Extinction: fact, fiction or speculation? *Biological Reviews* 97: 640-663.

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 p.

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.

Please provide links to references if available.

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. **Any text on a figure must be large enough to read**.

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

Tentacle is published using **British English** not American English, e.g. mollusc not mollusk, centre not center, favour not favor, realise not realize, etc.

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 page 51 of this issue) 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-March).

IUCN SSC MOLLUSC SPECIALIST GROUP

This membership list includes taxonomic and conservation expertises, to the extent they are known. In order to keep your details up to date, please inform the chair of the IUCN SSC Mollusc Specialist Group, Mary Seddon, and the editor of *Tentacle*, Robert Cowie, of any changes or corrections, especially regarding expertises. If there is any information you do not want to be public, please also inform us.

The list is in two parts: Official Members and Other Contributors. The former are currently listed on the IUCN official register of members of the IUCN SSC Mollusc Specialist Group. The latter are people who may have served on the Mollusc Specialist Group in the past or have provided assistance on enquiries, all of whom we acknowledge for their continued support of the work of the Group, although they are not currently listed on the IUCN official register of members.

Chair
Mary B. Seddon, Okehampton, UK. mary.molluscsg@gmail.com

Editor (*Tentacle*)
Robert H. Cowie, University of Hawaii, Honolulu, USA. cowie@hawaii.edu www.hawaii.edu/cowielab/

Name	Country	Taxonomic Expertise			Conservation Expertise								
		Marine molluscs	Freshwater molluscs	Land snails	Assessment	Survey & monitoring	Red List trainer	Habitat status & restoration	Conservation breeding	Conservation genetics	Environmental legislation	Invasive species	Wildlife trade
Official Members													
Christian Albrecht Justus Liebig University, Giessen	Germany		X		X	X				X			
David Aldridge University of Cambridge, Cambridge	UK		X			X				X		X	
Louise Allcock National University of Ireland, Galway	Ireland	X			X								
Maria Rosario Alonso Universidad de la Laguna, Tenerife	Spain			X	X								
Jose Arrebola Burgos Universidad de Sevilla, Sevilla	Spain			X	X				X				X
Thierry Backeljau Royal Belgian Institute of Natural Sciences, Brussels	Belgium	X		X	X					X		X	
Igor Balashov Schmalhausen Institute of Zoology, Kiev	Ukraine			X	X	X							
Gary Barker Landcare Research, Hamilton	Australia / New Zealand			X	X								
Gregory Barord Des Moines, Iowa	USA	X			X								
Arthur Bogan North Carolina State Museum of Natural History, Raleigh	USA		X		X	X			X				
Monika Böhm Global Center for Species Survival, Indianapolis Zoo	USA	X	X		X		X						

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Official Members (continued)													
Ivan Bolotov Northern Arctic Federal University, Arkhangelsk	Russian Federation		X		X			X					
Khadija Boulaassafer Cadi Ayyad University, Marrakech	Morocco		X		X				X				
Prem Budha Tribhuvan University, Kathmandu	Nepal		X	X	X	X							
Viviana Castillo Servicio Agrícola y Ganadero, Santiago	Chile			X		X						X	
Chong Chen Japan Agency for Marine-Earth Science and Technology, Yokosuka	Japan	X			X	X							
Satoshi Chiba Tohoku University, Sendai	Japan			X		X			X				
Simone Cianfanelli Museo di Storia Naturale dell'Università degli Studi di Firenze	Italy		X	X	X	X			X			X	
Stephanie Clark Invertebrate Identification Australasia, Chicago, Illinois	USA		X		X	X							
Cristhian Clavijo Museo Nacional de Historia Natural, Montevideo	Uruguay		X		X	X							
Mary Cole East London Museum	South Africa			X	X	X							
Robert H. Cowie University of Hawaii, Honolulu, Hawaii	USA		X	X	X	X						X	
Kevin Cummings Illinois Natural History Survey, Champaign, Illinois	USA		X		X	X							
Gustavo Darrigran Museo de La Plata	Argentina	X	X		X							X	
Ivaylo Dedov Institute of Biodiversity and Ecosystem Research, Sofia	Bulgaria		X	X	X	X							
Zoltán Fehér Hungarian Natural History Museum, Budapest	Hungary		X	X	X	X		X					
Junn Kitt Foon Australian Museum, Sydney	Australia / Malaysia			X	X	X							
António Frias Martins Universidade dos Açores, Ponta Delgada	Portugal (Azores)	X		X	X	X							
Gerardo Garcia Chester Zoo	UK			X					X				
Olivier Gargominy Muséum national d'Histoire naturelle, Paris	France			X	X	X							
Daniel Geiger Santa Barbara Museum of Natural History, California	USA	X			X	X							

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Official Members (continued)													
Jürgen Geist Technische Universität München, Freising	Germany		X		X	X			X				
Dilian Georgiev University of Plovdiv	Bulgaria		X	X	X	X							
Justin Gerlach, University of Cambridge	UK/Seychelles			X	X	X							
Mohammed Ghamizi Muséum d'Histoire Naturelle de Marrakech, Marrakech	Morocco		X	X	X	X		X	X				
Ronaldo Gomes de Sousa University of Minho, Braga	Portugal		X		X	X		X	X	X		X	
Benjamin Gomez-Moliner Universidad de Pais Vasco, Vitoria	Spain			X	X	X							
Daniel Graf University of Wisconsin, Wisconsin	USA		X		X	X			X				
Klaus Groh Büro Groh, Bad Dürkheim	Germany	X	X	X	X	X							
Diego Gutierrez Gregoric Museo de La Plata	Argentina		X		X	X			X				
Michael G. Hadfield University of Hawaii, Honolulu, Hawaii	USA			X									
Jason Hall-Spencer University of Plymouth	UK	X						X					
Kenneth A. Hayes Bishop Museum, Honolulu, Hawaii	USA		X	X	X	X							
Dai Herbert National Museum of Wales, Cardiff	UK / South Africa	X		X	X	X							
Auke-Florian Hiemstra Naturalis Biodiversity Center, Leiden	Netherlands	X				X							X
Isabel Hyman Australian Museum, Sydney	Australia			X	X	X			X				
Mayu Inada Ministry of the Environment, Chichijima	Japan			X		X			X				
Paul Johnson Alabama Aquatic Biodiversity Center, Marion, Alabama	USA		X		X				X				
Umit Kepabci Mehmet Akif Ersoy University, Burdur	Turkey		X	X	X	X							
Michael Klunzinger North Lakes, Queensland	Australia		X		X								
Frank Köhler Australian Museum, Sydney	Australia		X	X	X	X							
Andrew Kough John G. Shedd Aquarium, Chicago	USA	X				X			X				X
Charles Lange National Museums of Kenya, Nairobi	Kenya		X	X	X								
Dwayne Lepitzki Wildlife Systems Research, Banff	Canada		X		X	X		X					

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Official members (continued)													
Katrin Linse British Antarctic Survey, Cambridge	UK			X	X								
Jon Mageroy Norwegian Institute for Nature Research	Norway		X		X			X	X				
Igor Miyahira Universidade Federal do Estado do Rio de Janeiro	Brasil		X		X	X						X	
Marco Neiber Universität Hamburg	Germany		X	X	X	X							
Jeff Nekola Masaryk University, Brno	Czech Republic / USA			X		X							
Eike Neubert Naturhistorisches Museum, Bern	Switzerland			X	X	X							
Christine Ngereza National Museums of Tanzania, Dar es Salaam	Tanzania			X	X	X							
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Ayu Nurinsiyah Museum Zoologicum Bogoriense, Bogor	Indonesia			X	X	X							
Mac Elikem Nutsaokor Kwame Nkrumah University of Science and Technology, Kumasi	Ghana			X	X	X							
Kristiina Ovaska Royal British Columbia Museum and Biolinx Environmental Research Ltd., Victoria	Canada			X	X	X		X	X				
Barna Páll-Gergely Centre for Agricultural Research, Budapest	Hungary			X	X	X							
Somsak Panha Chulalongkorn University, Bangkok	Thailand			X	X	X							
Martina Panisi Associação BIOPOLIS, Porto	Portugal			X	X	X			X				
Christine Parent University of Idaho, Moscow, Idaho	USA/Galapagos			X	X	X							
Paul Pearce-Kelly Zoological Society of London	UK			X		X			X				X
Kathryn Perez University of Texas Rio Grande Valley, Edinburgh, Texas	USA		X	X	X	X		X					
Howard Peters University of York	UK	X			X								X
John Pfeiffer Smithsonian National Museum of Natural History, Washington, DC	USA		X		X	X				X			
Winston F. Ponder Australian Museum, Sydney	Australia												
Vincent Prié Muséum national d'Histoire naturelle, Paris	France		X		X	X		X		X	X		

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Official members (continued)													
Nicolas Puillandre Muséum National d'Histoire Naturelle, Paris	France	X			X								
Canella Radea National and Kapodistrian University of Athens	Greece		X		X	X							
Nicoletta Riccardi Institute of Ecosystem Study, Verbania Pallanza	Italy		X		X	X		X	X		X		
Ira Richling Staatliches Museum für Naturkunde Stuttgart	Germany		X	X	X	X				X			
Rodrigo Salvador Museum of New Zealand Te Papa Tongarewa, Wellington	New Zealand / Brasil		X	X	X	X			X				
Sonia B. dos Santos Universidade do Estado do Rio de Janeiro, Rio de Janeiro	Brasil		X			X							
Menno Schuilthuizen Naturalis Biodiversity Center, Leiden	Netherlands			X		X				X			
Mary B. Seddon Okehampton	UK	X	X	X	X	X	X				X		
Julia Sigwart Senckenberg Research Institute and Natural History Museum, Frankfurt am Main	Germany	X			X	X					X		
Ioan Sîrbu Lucian Blaga University of Sibiu	Romania		X		X	X		X				X	
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Dinarte Teixeria Instituto das Florestas e Conservação da Natureza, Madeira	Portugal (Madeira)			X	X	X	X						
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Kostas Triantis National and Kapodistrian University of Athens	Greece			X	X	X							
Do Van Tu Institute of Ecology and Biological Resources, Hanoi	Viet Nam		X		X	X							
Dirk Van Damme Destelbergen	Belgium		X		X	X							
Jackie Van Goethem Royal Belgian Institute of Natural Sciences, Brussels	Belgium	X		X		X							

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Official members (continued)													
Ilya Vikhrev N. Laverov Federal Center for Integrated Arctic Research, Arkhangelsk	Russian Federation		X		X	X				X			
Maxim Vinarksi Saint Petersburg State University	Russian Federation		X		X	X				X			
Ted von Proschwitz Göteborg Natural History Museum	Sweden		X	X	X	X							
Thomas von Rintelen Museum für Naturkunde, Berlin	Germany		X		X	X							
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Tadeusz Zajac Institute of Nature Conservation, Krakow	Poland		X		X	X			X				
Alexandra Zieritz University of Nottingham	UK		X		X	X			X				
Other contributors													
Jonathan Ablett, Natural History Museum, London	UK	X		X									
Takahiro Asami Shinshu University, Matsumoto	Japan			X									
Ruud Bank, University of Groningen	Netherlands		X	X									
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Philippe Bouchet Muséum national d'Histoire naturelle	France	X	X	X									
Bram Breure Naturalis Biodiversity Center, Leiden	Netherlands			X									
Gilianne Brodie University of the South Pacific	Fiji			X	X								
David Clarke Zoological Society of London	UK			X					X				
Robert Cameron University of Sheffield	UK			X	X	X							
Jay Cordeiro Boston	USA		X		X								
Willy De Mattia Natural History Museum Vienna	Austria			X	X								
Mark Etherbirdge Environment and Natural Resources	Bermuda			X					X				
Hiroshi Fukuda Okayama University	Japan	X											
Terrence Gosliner California Academy of Sciences, San Francisco, California	USA	X											
Owen Griffiths BioCulture Mauritius	Mauritus			X	X								

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Other contributors (continued)													
Nova Hanson Memorial University of Newfoundland	Canada	X			X								
Joseph Heller Hebrew University, Jerusalem	Israel		X	X	X	X							
Jasna Lajtner University of Zagreb	Croatia		X		X	X							
Charles (Chuck) Lydeard Morehead State University, Morehead	USA		X	X									
Maria Cristina Dreher Mansur Museu de Ciências e Tecnolo, Porto Alegre	Brasil		X	X									
Ristiyanti M. Marwoto Research and Development Centre for Biology, Bogor	Indonesia		X	X									
Paula M. Mikkelsen Paleontological Research Institution, Ithaca	USA	X											
Hugh Morrison Australian Sea Shells P/L	Australia	X			X								X
Richard Neves Virginia Tech, Blacksburg, Virginia	USA		X						X				
Diarmaid Ó Foighil University of Michigan	USA		X	X	X					X			
Timothy A. Pearce Carnegie Museum, Pittsburg	USA		X	X									
Shane Penny Fisheries, Department of Industry, Tourism and Trade, Northern Territories	Australia	X	X										
Vladimir Pešić University of Montenegro	Montenegro		X	X	X								
Guido Poppe Conchology Inc, Cebu	Philipinnes	X			X								X
Barry Roth San Francisco, California	USA			X									
David Robinson USDA/APHIS/PPQ, Academy of Natural Sciences, Philadelphia	USA			X									
Rebecca J. Rundell State University of New York, Syracuse	USA			X									
John Stanisic Queensland Museum, South Brisbane	Australia			X									
Jaap J. Vermeulen National Botanic Garden, Singapore	Singapore			X									
Peter Ward University of Washington, Seattle	USA	X											
Anton (Ton) J. de Winter Nationaal Natuurhistorisch Museum, Leiden	Netherlands			X									
Min Wu Nanjing University	China			X									

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Xiaoping Wu Nanchang University	China		X										
Nicolas Zuël, Ebony Forest Ltd	Mauritius			X	X	X		X