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

TENTACLE

Editor – Robert H. Cowie
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EDITORIAL

The biggest ever edition of *Tentacle*! But apologies for its late arrival. The bigger *Tentacle* becomes the more work is needed to put it together. The two associate editors have of course been a great help, once again.

This issue includes some good news – reintroduction of *Partula* to field exclosures in Tahiti – but also ongoing bad news of declines and probable extinctions. The articles are dominated by contributions from South America and the Caribbean, which reflects real commitment to molluscs and their conservation in the region. But there is also a diversity of contributions dealing with Africa, India and Nepal, south-east Asia, Israel, Eastern and Western Europe, North America and of course the Pacific islands. I encourage more of you to submit contributions from other regions and countries rarely represented in the pages of *Tentacle* – I cannot believe that there are no mollusc conservation stories from these places that would be of interest to the readers of *Tentacle*.

Tentacle is an excellent place to publish your news stories – stories that would not normally be published in the peer-reviewed or technical literature. It is a place for news about progress on projects related to conservation and what you have accomplished during the past year or past few years. It is not a place for detailed new research results and in the future will not publish exceptionally long, detailed and dry annotated lists of species recorded in field surveys. Those kinds of results should be published in more formal scholarly journals – they can be summarised in *Tentacle*, mentioning particularly significant species or events, especially if they include attractive illustrations. The key is that *Tentacle* is a newsletter – a publication that people will want to read and enjoy from start to finish. I hope you enjoy this issue.

Robert H. Cowie

In this issue: click on page

TENTACLE – PUBLICATION GUIDELINES AND INFORMATION

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 lives of the editorial team a lot easier!

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

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

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

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

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

Selander, R.K., Kaufman, D.W. & Ralin, R.S. 1974. Self-fertilization in the terrestrial snail *Rumina decollata*. *The Veliger* 16: 265-270.

South, A. 1992. *Terrestrial slugs: biology, ecology, and control*. Chapman and Hall, London. x + 428 p.

Cowie, R.H. & Robinson, D.G. 2003. Pathways of introduction of nonindigenous land and freshwater snails and slugs. In: *Invasive species. Vectors and management strategies* (ed. Ruiz, G.M. & Carlton, J.T.), p. 93-122. Island Press, Washington.

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

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

Membership of the Mollusc Specialist Group is by invitation. However, everyone is welcome to submit articles to *Tentacle* and to promote its distribution as widely as possible. Since I announce the publication of each new issue to all who are on my *Tentacle* e-mail distribution list, please keep me updated with your current e-mail address so that you do not drop off the list. I also announce the availability of each issue on the MOLLUSCA listserver (for details, see p. 57 of this issue of *Tentacle*) and the Unitas Malacologica members e-mail list.

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

NEWS

Giant clams provide multiple benefits to coral reef ecosystems

From: Oryx 49(2): 191, April 2015

The 13 species of giant clams of the Indo-Pacific coral reefs, the world's largest molluscs, have significant ecological value in coral reefs, performing multiple functions. A variety of predators and scavengers feed on their tissues, and the zooxanthellae, faeces and gametes they discharge provide food for opportunistic feeders. Their shells serve as nurseries and refuges for young fish, and provide a substrate for colonization by epibionts. The clams help to build the reef structure, increasing its topographic heterogeneity, and act as reservoirs of symbiotic zooxanthellae, which are essential for a healthy reef. Their calcium carbonate shell also provides material that is eventually incorporated into the reef framework. The clams, which are a vital indicator of coral reef health, face significant threats from overfishing, and it is hoped that a greater understanding of their ecological value will make them a focus for conservation attention.
Sources: Biological Conservation 181: 111-123 (2015); New Scientist (2014)

Abalone poaching linked to drug gangs

From: Oryx 49(1): 6, January 2015

Extensive poaching of perlemoen abalone has been linked to growing drug addiction in coastal communities in South Africa, according to a report produced by TRAFFIC and funded by USAID. Illegal trade in this sea snail, from Africa to Asia, is controlled by crime syndicates. Divers harvesting the abalone are paid in drugs instead of cash, fuelling social problems in impoverished communities. South African abalone is considered a delicacy in East Asia, where it is expensive, and most of it ends up in Hong Kong. Although annual quotas have been set for harvesting of the snails, these have been exceeded by more than ten times in the past decade. The species is particularly vulnerable to over-exploitation because it inhabits shallow water, is slow moving and slow growing and is late to reproduce. The TRAFFIC report will provide a basis for future interventions to address the poaching crisis and improve enforcement.

GOING, GOING . . . NARROWLY ENDEMIC SNAILS IN SOUTHEAST ASIA AT IMMINENT RISK OF EXTINCTION AS A RESULT OF QUARRYING FOR CEMENT

By Tony Whitten

Isolated limestone hills are well known for the remarkable micro-endemism among many of the animals living on them, or in their caves. Species can be found in just one cave or on just one hill, and nowhere else. What has not been done recently is to engage the companies that are quarrying some of these hills for the manufacture of cement. The larger cement companies do give some attention to biodiversity, but a trawl through their websites shows that this attention is focused almost entirely on the rehabilitation or restoration of sites, typically the creation of wetlands from the pits left after the hill has disappeared into brown sacks.

There was press coverage in late 2014 when a new species of snail, *Charopa lafargei*, was named for Lafarge, the multinational cement company that is quarrying the only hill where it (and seven other species of invertebrates and plants) is known. Flora & Fauna International and IUCN are engaging with the Lafarge staff in Paris and Kuala Lumpur and there are signs that a means of achieving rational management of the site might be found. The Lafarge policies read well, but their implementation on the ground for complex biodiversity sites seems to be a challenge.

There was also attention given in a recent Red List to another Malaysian snail species that is now categorized as Extinct because of the cement quarrying, which totally eliminated the only known site.

Also in Malaysia are limestone hills that are being quarried by the international Malaysian conglomerate YTL (the owners of Wessex Water in the UK). One of these, Tenggek Hill, is the only known site for three species of unusual snails: the elephant trunk snail (*Hypselostoma elephas*), the Tenggek braided snail (*Plectostoma tenggekensis*) and the towered braided snail (*P. turriforme*), which is also known from the nearby Sagu Hill. But Sagu Hill is also being converted into a pit by YTL. These three species have recently been categorized on the IUCN Red List as Critically Endangered. The only natural habitat remaining for them on Tenggek Hill is two tufts of forest on the top. Tenggek and Sagu Hills are also the only known localities for the attractive herb *Paraboea bakeri*, and the fern *Calciphilopteris alleniae* is known from Tenggek Hill and just four other sites (all in Peninsular Malaysia). IUCN wrote to the YTL CEO in Kuala Lumpur asking for the company's assurance that they will avoid the imminent extinction of these species, and offering assistance with conservation planning. A year later there is still no response.

Meanwhile in Vietnam the Swiss cement giant Holcim (which has recently merged with Lafarge) has quarries in a group of isolated limestone hills in the far south, close to Cambodia. Neighboring hills are being quarried by much smaller Vietnamese and Chinese companies. Early in 2016 a Red List assessment of the dozens of narrowly endemic snails, cave invertebrates and plants from those hills will be conducted in the new Cambridge Conservation Campus. This is likely to lead to the identification of the world's greatest concentration of Critically Endangered species. IUCN has been engaging with the company for some years but real progress on the ground has yet to be seen.

Finally, in Cambodia, the Ministry of Environment is considering bringing together the major cement companies after a short YouTube video showed a limestone hill being quarried by a Thai company without appropriate assessment of biological impacts.

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MALACOWIKI, THE WIKI OF THE IBERIAN MOLLUSCS

By J. Sebastián Torres Alba & Miguel Carrillo Pacheco

Malacowiki (Fig. 1) was created back in 2009 to collaboratively put together resources of the many molluscan species that inhabit mainland Spain and Portugal plus the Balearic Islands and the Macaronesian archipelagos (Canary Islands, Madeira, Azores, Cabo Verde and Selvagens).

We have been adding entries to the list of terrestrial species and creating dedicated species pages since then. All snail pages follow the same template (description, habitat, distribution, bibliography, etc.), have pictures of the shell and display a distribution map (e.g. Fig. 2). Optionally, each page may have an embedded footage of the species if there is a video on the malacowiki youtube channel.

There are nearly 90 species listed and a similar number of videos. The number of taxa will keep growing every year; we intend to add hundreds in the future.

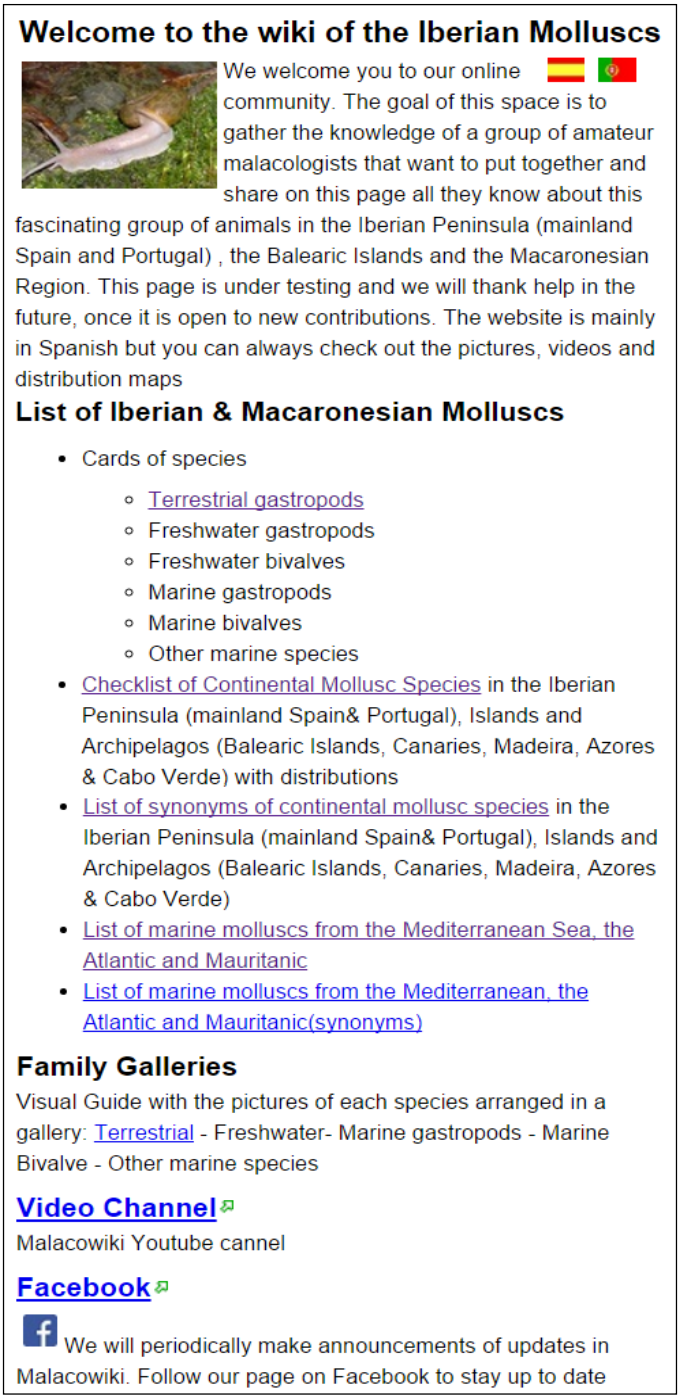

Fig. 1. Malacowiki homepage.

The goal of this web site is to disseminate widely knowledge of species that is quite often accessible to academic circles but difficult for the general public to reach. Many of the species of the regions under consideration are endemic, restricted to small areas, and others are experiencing serious declines in numbers and distributions.

The site contributes data and distribution maps that demonstrate the vast diversity of Iberian and Macaronesian molluscs, a treasure that we must preserve for future generations.

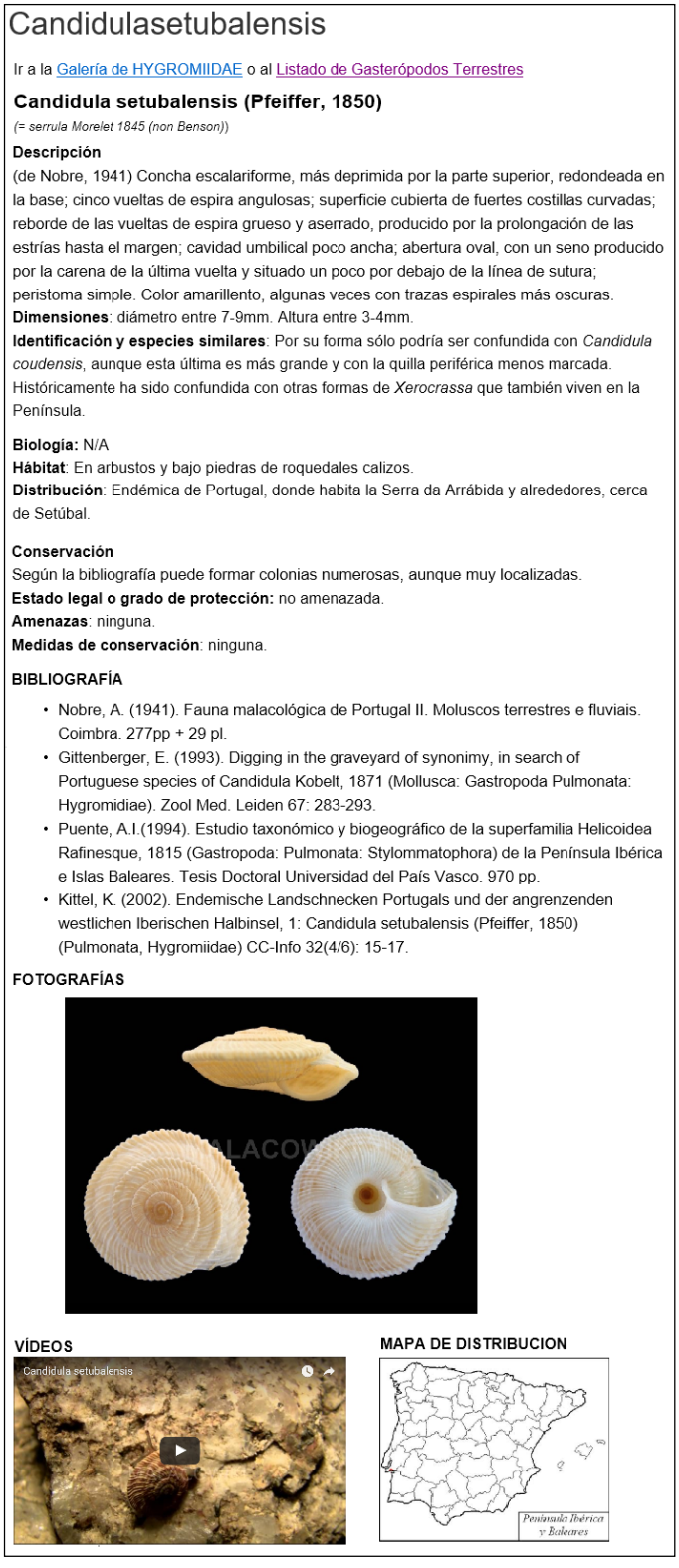

Fig. 2. Example species page (*Candidula setubalensis*).

There are specific sections in each species page for legal protection status and conservation measures adopted or recommended. Unfortunately, it is often the case that the laws lag behind the actual conservation needs and the Malacowiki team wants to do its part in raising awareness of the need to

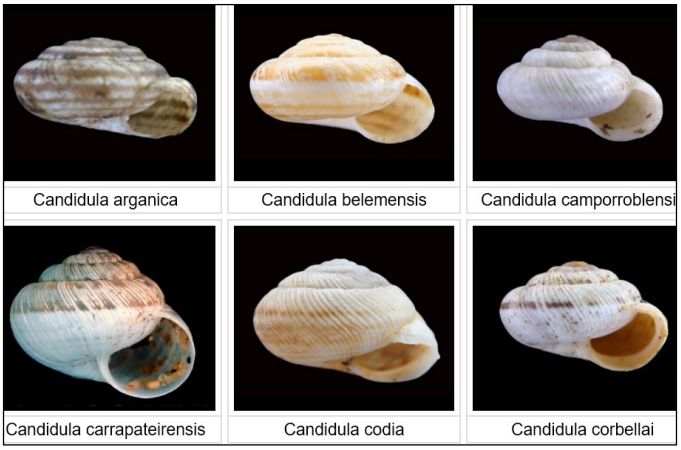

Fig. 3. Partial view of the Hygromiidae gallery page.

protect a pleiad of most remarkable species, some of which are endangered to different degrees, even critically.

Malacowiki is mainly written in Spanish but the pictures, family galleries (see a sample of a gallery in Fig. 3) and videos should be useful for anyone interested in the malacofauna of these regions. There are also four checklists linked from the homepage (Fig. 1) that will be of use for those new to the fauna of the Iberian Peninsula and related archipelagos.

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CONSERVATION STATUS OF *COLONICONCHA PRIMA* (GASTROPODA, PLEURODONTIDAE)

By Altagracia Espinosa J. & Ruth H. Bastardo

Coloniconcha prima Pilsbry, 1933 is an endemic terrestrial mollusc, considered to be the only semi-slug on the island of Hispaniola. This species occurs in cloud forest in the eastern portion of the Sierra de Bahoruco, in the southwestern part of the Dominican Republic, and in the contiguous Massif de la Selle on the Haitian side of the border. Both locations are part of the southern palaeo-island of Hispaniola. There is an isolated population at Sierra Martín García in the Dominican Republic (Breure, 2010).

Little is known of the natural history, biology and conservation status of this monotypic genus. However, scattered observations in Barahona province, Sierra de Bahoruco (2002-2009), as well as a recent project on the terrestrial invertebrate fauna of Dominican cloud forests (2010-2015, except for 2014) have brought some insight to the ecology, biology and population and conservation status of *C. prima*.

Some of this information was obtained from Loma Remigio, a locality in the protected Monumento Natural Miguel Domingo Fuertes. Stations were established in *Prestoea montana* (manaclares) palm forest, with samples obtained from plots and transects over a year (June 2010 and October 2011). Surrounding areas were inspected during both the day and the night, allowing new populations of *C. prima* to be identified.

The eastern area of Bahoruco was covered by a broadleaf cloud forest exhibiting high endemism, which is in part due to its historic origin, isolation and environmental conditions. Three types of original vegetation have been described, some remnants of which are still found at various altitudes: 1) manaclares, 2) forest dominated by *Magnolia hamori* and 3) *Schefflera tremula* forests. These are interspersed with secondary vegetation or areas degraded by human activity (Guerrero, 1993). A great portion of the original forest coverage has been removed to plant coffee under the shade of amapola (*Erythrina poeppigiana*) and native trees like guama (*Inga vera*); because of their humidity and shade, these habitats have been recolonized and often are valued for their contribution to wildlife conservation. Other uses like ranching and cultivating short cycle crops have resulted in loss of the forest and its degradation as a habitat for molluscs (Fig. 1).

Fig. 1. Area destroyed for agriculture in the manaclares forest.

Coloniconcha prima occurs in open areas like roadsides and sunny trails in cloud forest remnants. It is also found in areas with a high human impact where secondary vegetation and abandoned crops grow. For example, at Loma Remigio, out of 133 specimens observed only nine were within the manaclar, with the rest seen in adjacent areas, on the pathway to Cortico River and at the border between the forest and open areas. Of the observed individuals 37 were resting and 96 were moving on foliage, branches and stems.

The average temperature at the station closest to the town of Polo was 22 °C, with an average annual precipitation of 1,950 mm (Martínez Batlle *et al*., 2013). In the areas sampled between 2010 and 2011, the temperature measured was between 17 and 21 °C, and relative humidity between 80.1 and 87.1 %. *Coloniconcha prima* was found at altitudes of 1,040-1,416 m above sea level (highest elevation in the area is 1,603 m at Pie de Palo hill (Breure, 2010; Martínez *et al*., 2013).

This species is considered to be a generalist because of the great variety of plants used for feeding and resting, as well as the use of very different habitats. The flora of the eastern area of Bahoruco presents a high diversity of autochthonous species, and *C. prima* uses a great variety of vascular plants, both native and introduced, and crops, for feeding and resting: 47 species in 46 genera and 37 families. The highest frequency of feeding observed was on *Urera baccifera*, *Lepianthes*

Fig. 2. *Coloniconcha prima* crossing from one *Thelypteris* sp. frond to another.

umbellata, *Eupatorium odoratum*, *Brugmansia candida*, *Thelypteris* sp., *Odontosoria uncinella*, *Urena lobata*, *Gliricidia sepium*, *Lobelia robusta*, *Inga vera*, *Boehmeria ramiflora* and *Stachytarpheta cayenensis* (Fig. 2). *Coloniconcha prima* also feeds on withered or decayed flowers and leaves.

Habitats for this species were coffee crops, montane forest, trees, shrubs and other plants (Breure, 2010). Coffee crops are common at high elevation (above 800 m), being a substitute for natural forests in Bahoruco. This species is associated with the native flora growing at the boundaries bewtween coffee crops and forest. The only cultivated plant we found used by *C. prima* for feeding was chayote (*Sechium edule*); however, we have not seen any populations in coffee plantations. Other substrates like rock crevices, dry branches and wooden poles were also used. In 2013, at Monteada Nueva, six adults were found inside the crevices of scattered rocks in an open area where little vegetation now exists, but that was covered with a dense forest decades ago. At El Manaclar (2015, 1,239 m above sea level) we witnessed behavioural patterns previously unknown for this species, with active individuals at ground level and numerous adults resting on a fence pole (Fig. 3).

Fig. 3. Aggregation of *C. prima* on a fence post fence at El Manaclar.

We have records from seven months including low and high rainfall seasons (January, March, April, June, August, October and December), in which we observed eggs, juveniles, subadults and adults; the climatic conditions, with little seasonal variation, could favour several reproductive events per year. The overall number of individuals observed varied from one location to the other. In several counts at the end of January 2015, at El Manaclar, in an area of cloud forest highly altered by agriculture and ranching, 449 individuals (282 juveniles) were observed; this is the largest population of *C. prima* found to date, and perhaps a recovery process is occurring there, as other mollusc species also have large populations. One specimen with eggs in a dirt nest was found under a rock; the eggs were taken to the laboratory where they hatched. Also in April (Loma Remigio, 2010) newly hatched individuals were found on a fertile frond of the fern *Blechnum fragile*, looking like drops of water (Fig. 4).

Fig. 4. Freshly hatched juveniles, Loma Remigio (2010).

We used to consider the populations from Loma Remigio as the largest and healthiest. However, the discovery of new populations at El Manaclar and on the way up to Monteada Nueva (2015) (both at the edge of the highway) have proven a pleasant surprise, because of the numbers of individuals found in different states of development. In recent decades (around 20 years), the loss of forest coverage in the zone around Cachote (Loma Remigio), Cortico and Monteada Nueva has been estimated at 20 % (7.2 km^2) and the regenerating forests have grown sparsely (Martínez Batlle, 2013). Continuous perturbations might not permit recovery of populations where only isolated individuals have been found (El Gajo del Toro, Cortico).

Construction and maintenance of roads as access routes to crops, agricultural activities, ranching, the renewed illegal extraction of trees to produce charcoal, fires of anthropogenic origin, the replacement of former shaded coffee crops and the return of short cycle crops like beets (*Beta vulgaris* L.) (e.g. Fig. 5) are current threats to the survival and conservation of this species, which still does not have any legal protection.

Fig. 5. Areas used for ranching (left) and for beet crops (right).

The field work and observations undertaken during 2010-2015 were funded by the Ministry of Superior Education, Science and Technology (MESCyT) through FONDOCyT No. 2009-102 to Ruth H. Bastardo "Regarding the Mollusc and Arthropod Fauna of the cloud Forest" and FONDOCyT No. 2014-1A2-136 to Rosa Rodríguez Peña "Population Genetics and pollination of *Vaccinium* (Ericaceae)". We thank Lucy Martinez-Guerrero for translating the manuscript and América Sánchez, Candy Ramírez and Samy Genaro for lab and fieldwork assistance.

Breure, A.S.H. 2010. The rediscovery of a semi-slug: *Coloniconcha prima* Pilsbry, 1933 (Gastropoda, Pleurodontidae) from Hispaniola. *Basteria* 74(4-6): 78-86.

Guerrero A., A.E. 1993. *Magnolia hamori*, la flora y la vegetación asociadas, en la parte oriental de la Sierra de Bahoruco, República Dominicana. *Moscosoa* 7: 127-152.

Martínez Batlle, J.R., Cámara Artigas, R., Santos Grullón, I., Herrera Hernández, D., Medina Castillo, E.V. & Laurencio Girón, G. 2013. Geomorfología y geobotánica de Monteada Nueva, Cortico y Cachote, Sierra de Bahoruco, República Dominicana: superficies corrosivas, pedimentos y bosques nublados amenazados en karst de montaña media tropical. *Anuario de Investigaciones Científicas* 2(1): 18-27.

Pilsbry, H.A. 1933. Santo Domingan land mollusks collected by Daniel C. Pease, 1932, and by A.A. Olsson, 1916. *Proceedings of the Academy of Natural Sciences* 85: 121-162, pl. 6-11.

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RESTRICTED-RANGE SPECIES IN THE COASTAL ZONE OF HOLGUÍN, CUBA: CHECKLIST AND NEW RECORDS OF PRIORITY SPECIES FOR CONSERVATION

By Alejandro Fernández, Steffen Franke & Alexis Suárez

Restricted-range species are a priority for biodiversity conservation. Their small area of occurrence makes them intrinsically vulnerable to threats, in particular if they are constrained to islands. The Cuban land snail fauna, with more than 96 % of the species being endemic (Espinosa & Ortea, 1999), must therefore be considered an important hotspot for biodiversity conservation. At the local scale, for conservation of biodiversity, species and subspecies that occur in only very few localities are of high importance to local and regional governments and their agencies involved in sustainable development. In Cuba, environmental laws are robust.

However, fewer natural wildlife habitat areas remain each year. Moreover, the habitat that remains has often been degraded and bears little resemblance to the original wild areas. Habitat loss, due to destruction, fragmentation or degradation, is the primary threat to the survival of wildlife. In 1990 rapid development of sun and beach tourism in Holguín province began and has continued. The coastal landscapes have changed and this habitat disturbance has evidently had an impact on terrestrial molluscs (Fernández *et al*., 2015a). In the last 15 years several localities of interest for tourist development and nature conservation in the coastal zone of Holguín province have been studied.

Known local endemic species should be of major significance as a conservation focus, but the key information on these species is limited. This article lists the restricted-range land snail species of the coastal zone of Holguín, providing comments and new records. The area studied is between the coastline and about 4 km inland, limited by the first three terrace levels and adjacent hills. The taxonomy follows Espinosa & Ortea (1999). The field work was carried out in 2013-2015 at the following locations (Fig. 1):

1. Mayarí municipality: Saetia key, Delta del Río Mayarí; Guatemala, Felton, Levisa, Cabonico, 15-25 September, 22-24 November 2013.
2. Antilla municipality: Peninsula El Ramón de Antilla, November 19-29 2013, 12-16 March and 15-18 May 2014.
3. Rafael Freyre municipality: Cayo Bariay (key) to Naranjo bay, 10-15 and 26 March 2014.
4. Gibara municipality: Punta de Mangle to Playa Los Bajos, 15-18 February, 12-15 September, 15-18 October 2014, 6-8 March, 25-28 June, 20-23 July 2015.
5. Banes municipality: Guardalavaca beach, Samá bay to Río Seco bay, 9-14 July 2015; Morales beach, Punta de Mulas, Cabo Lucrecia and Ensenada Río Seco, 15-21 December 2014.
6. Moa: Yaguaneque to Río Jaguani, 9-12 January 2015.
7. Frank País: Cananova-Guajaca, Cayo Mambí, 8-10 April 2015.

Fig. 1. Coastal zone of Holguin province: sampling areas 1-7. Source of map: Google Maps, 2016.

Fifty-one restricted-range species of terrestrial molluscs are listed from the Holguín coastal zone. Of these 21 species have allopatric subspecies, all restricted to small geographic areas with one or a few localities (only those present in the Holguín coastal zone are listed below). All are endemic to Holguín

province. The largest number of species are in the families Potamiidae and Cerionidae.

Twenty-two species are new records for the area. More research is still needed, including visiting the type localities of described species and subspecies.

Kowledge of the restricted-range species of Holguín's coastal zone will be useful for further conservation planning and management by local stakeholders, local government, educational institutions, museums, and other institutions with responsibilities for protecting biodiversity. We recommend specific safeguards for the conservation of extinction-prone species, such as these restricted land snails of the coastal zone of Holguín province, as all restricted-range species are intrinsically vulnerable to both natural threats and threats from human activities.

This work is part of the complex process of environmental education centered on local communities and we are planning some actions for protection of restricted terrestrial molluscs.

Restricted-range gastropods of the coastal zone of Holguín province

CYCLONERITIMORPHA
Family HELICINIDAE
1. *Helicina holguinensis* Clench & Aguayo, 1953. La Calera, San Germán, type locality (Espinosa & Ortea, 1999). **New record**: Cabo Lucrecia, on trees and bushes.
2. Helicina poeyi Pfeiffer, 1859
Helicina poeyi gibarensis Aguayo, 1953. Punta del Fuerte, Gibara, sub-fossil (Espinosa & Ortea, 1999). No evidence of live specimens.
3. *Alcadia euglypta* Clench & Aguayo, 1950. Cerro Cariblanco and other localities around Holguín and Gibara (Espinosa & Ortea, 1999). **New records**: Cerro Las Tinajitas, Cerro Colorado.
4. *Emoda blanesi* Clench & Aguayo in Aguayo, 1953. Around Banes and Antilla cities (Espinosa & Ortea, 1999). **New records**: Cerro de Yaguajay, Cerro Los Muertos, Punta Alta, other places between Samá and Naranjo bays, Ensenada de Júcaro and other places on Peninsula El Ramón.
5. *Eutrochatella* (*Microviana*) *spinopoma* Aguayo, 1943. Previously only known from two localities in the former province of Oriente (Espinosa & Ortea, 1999); recorded between Playa Pesquero Nuevo and Playa Caleticas (Richling *et al*., 2007). May be restricted to coastal karstic habitats. **New records**: Ensenada de Júcaro, Antilla.
LITTORINIMORPHA
Family POMATIIDAE
6. *Chondropoma laetum* ("Gutierrez" in Poey, 1858). Four subspecies, all from Gibara municipality, two in the coastal zone (Espinosa & Ortea, 1999):
C. l. appendiculatum Torre & Bartsch, 1938. Loma La Vigía, Gibara (Espinosa & Ortea, 1999). **New record**: Abra de Gibara.
C. l. breviarus Aguayo, 1953. Caletones, type locality (Aguayo, 1953; Espinosa & Ortea, 1999). **New record**: Los Cocos, Eolic Park in Gibara, Holguín.
7. *Chondropoma aguayoi* Torre *&* Bartsch, 1938. Silla de Gibara (Espinosa & Ortea, 1999). Occurrence confirmed but rare.
8. *Chondropoma solidulum* ("Gundlach" in Pfeiffer, 1860). Subspecies:
C. s. banesense Aguayo, 1944. Cayo de la Raya, Banes (Espinosa & Ortea, 1999).
C. s. isabelae Aguayo, 1943. Finca Godinez, Punta de Mulas, Banes (Espinosa & Ortea, 1999). **New record**: Cabo Lucrecia lighthouse, Ensenada Río Seco, Banes.
C. s. lucreciae Aguayo, 1943. Cabo Lucrecia lighthouse, type locality (Espinosa & Ortea, 1999). **New Record**: Rio Seco, Banes.
C. s. melanaxis Aguayo, 1943. Cañón, Banes bay (Espinosa & Ortea, 1999). **New records**: Morales beach to Banes bay, Punta de Piedra to El Ramón beach, Antilla.
C. s. tanamense Torre & Bartsch, 1938. Sagua de Tánamo (Espinosa & Ortea, 1999).
C. s. vitaense Torre & Bartsch, 1938. Costa Oeste de la Bahía de Vita (Espinosa & Ortea, 1999), Pesquero Nuevo (Fernández *et al*., 2015a).
9. *Chondropoma virgineum* Aguayo, 1953. Two subspecies (Espinosa & Ortea, 1999).
C. v. virgineum Aguayo, 1953. Cayo de la Virgen bahía de Nipe (Espinosa & Ortea, 1999).
10. *Chondropoma alberti* Clench & Aguayo, 1948. Cabo Lucrecia, Banes, type locality (Espinosa & Ortea, 1999), occurrence confirmed.
11. *Chondropoma ernesti* (Pfeiffer, 1862). Subspecies:
C. e. quinonesi Aguayo, 1943. Cerro Yaguajay, Banes, type locality (Espinosa & Ortea, 1999). **New record**: Cerro Los Muertos, Banes municipality, near Guardalava beach, Chorro de Maita.
C. e. hortensiae Aguayo, 1943. Samá, Banes (Espinosa & Ortea, 1999).
12. *Chondropoma confertum* (Poey, 1852) in Espinosa & Ortea (1999). Subspecies:
C. c. alleni Torre & Bartsch, 1938. Sagua de Tánamo (Espinosa & Ortea, 1999). Corinthya, Barrederas, Cananova on Sagua de Tánamo, Frank País municipality. **New record**: Yaguanque, Moa.
C. c. nipense Torre & Bartsch, 1938. Bahia de Nipe, Antilla, Felton, Cayo del Rey (Espinosa & Ortea, 1999; Fernández *et al*., 2015b).
C. c. perplexum Torre & Bartsch, 1938. Gibara (Espinosa & Ortea, 1999), El Yayal and Cerros de Maniabón (Fernández, 2009). **New records**: Naranjo bay, Rafael Freyre municipality; Peninsula El Ramón de Antilla, Antilla municipality; Cayo Saetia, Mayarí.
13. *Limadora garciana* (Aguayo, 1932). One subspecies:
L. g. sillaensis (Torre & Bartsch 1941). Silla de Gibara (Espinosa & Ortea, 1999), Pesquero Nuevo (Fernández *et al*., 2015a).
14. *Wrightudora banensis* Aguayo, 1944. Punta Gorda, Cabo Lucrecia, Banes, type locality (Espinosa & Ortea, 1999). **New Records**: Punta El Ramón de Antilla, Ramón beach near Lucrecia lighthouse, Banes.
15. *Wrightudora enode* ("Gundlach" in Pfeiffer, 1860). Subspecies:
W. e. enode ("Gundlach" in Pfeiffer, 1860). Gibara, Holguín province. **New records**: Laguna Blanca, Los Cocos, La Escobancha, localities between Gibara city and Caletones beach.
16. *Wrightudora gibarana* Aguayo, 1943. Loma de La Vigía, Gibara (Espinosa & Ortea, 1999). **New records**: Curva la Campana and Rancho Bravo, Gibara.
STYLOMMATOPHORA
Family UROCOPTIDAE
17. *Idiostemma alfredoi* Franke & Fernández, 2007. Cerro de Yaguajay, cerro Los Muertos (Franke & Fernández, 2007; Espinosa & Ortea, 2009). **New records**: Punta Alta Retrete Abajo, Banes. Extinct populations: Limoncito, Camazán (Baguános); Pilón Hill, Los Tibes; Lindero Cruz Hill (Holguín) (pers. obs., A. Fernández, 2009).
18. *Macroceramus interrogationis* Torre & Bartsch, 1972 (in Torre & Bartsch, 2008). Subspecies:
M. i. lituratus Torre & Bartsch, 1972 (in Torre & Bartsch, 2008). La Silla, Santa Lucia, and from Gibara (Torre & Bartsch, 2008). Los Cocos (Franke & Fernández, 2004; as *M. pictus*). **New records**: Laguna Blanca, Gibara, the Bioparque Rocazul, Bahia de Naranjo, Rafael Freyre municipality.
19. *Macroceramus pictus "*Gundlach" in Pfeiffer 1859. Subspecies:
M. p. reticulatus Torre & Bartsch, 1972 (in Torre & Bartsch, 2008). La Silla, Santa Lucia, Rafael Feryre municipality.

20. *Spiroceramus barbouri* Aguayo, 1958. Curva de la Campana, Gibara, type locality (Espinosa & Ortea, 1999), Rancho Bravo (Fernández & Franke, 2008).
21. *Microceramus minor* (Arango in Pfeiffer, 1866). Bahía de Tánamo, Sagua de Tánamo, Frank País municipality (Espinosa & Ortea, 1999). Not seen in 20th or 21st centuries.
Family CERIONIDAE
22. *Cerion aguayoi* Torre & Clench, 1932. Two subspecies from Holguín (Espinosa & Ortea, 1999).
C. a. aguayoi Torre & Clench, 1932. Camino de Caletones, 6 km west of Gibara (Espinosa & Ortea, 1999). New records: at the same locality, Gibara lighthouse and Los Cocos, Eolic Park.
C. a. bequeaerti Torre & Clench, 1932. Faro Lucrecia lighthouse, type locality (Espinosa & Ortea, 1999). Punta de El Manglito, 4.2 km east of lighthouse to near Playa de El Muerto around 3 km west of the lighthouse. In the contact zone there are hybrids of *C. torrei moralesi* X *C. aguayoi*, and between these and *C. banesense*. Hybridization has been seen in Cuban cerionids (Galler & Gould, 1979).
23. *Cerion alberti* Clench & Aguayo, 1949. Punta del Puerto, Banes bay, Peninsula El Ramón de Antilla (Espinosa & Ortea, 1999). El Muelle, to about 100 m west of the lighthouse, next to Punta Caracolillo, in the jurisdiction of Antilla, entrance to Banes bay (Suárez *et al*., 2011).
24. *Cerion alleni* Torre, 1929. Four subspecies (Espinosa & Ortea, 1999):
C. a. alleni "Torre" in Pilsbry, 1929. Antillas (Espinosa & Ortea, 1999).
C. a. madama Sánchez Roig, 1951. Madama Key, Arroyo Blanco bay, Mayarí (Espinosa & Ortea, 1999).
C. a. migueleti Sánchez Roig, 1951. Miguel Key, Boca de Yaguaneque, Sagua de Tánamo (Espinosa & Ortea, 1999).
C. a. sanchezi Clench & Aguayo, 1953. Lengua de Pájaro, Levisa bay, Mayarí (Espinosa & Ortea, 1999).
25. *Cerion banesense* Clench & Aguayo, 1949. East side of Sama bay, Banes (Espinosa & Ortea, 1999). **New records**: Ensenada Rio Seco to near El Muerto Beach, also Rio Seco to Samá bay, Banes.
26. *Cerion blanesi* Clench & Aguayo, 1951. Two endemic subspecies (Espinosa & Ortea, 1999):
C. b. blanesi Clench & Aguayo, 1951. Los Cocos, east side of Gibara bay (Espinosa & Ortea, 1999). **New records**: Guardalavaca beach (Banes) to Los Cocos (Gibara).
C. b. bariayi Aguayo & Jaume, 1957. Miramar, to east of Bariay key (Espinosa & Ortea, 1999). Abundant.
27. *Cerion crassiusculum* Torre in Pilsbry & Vanatta, 1899. Subspecies:
C. c. smithi Blanes in Pilsbry, 1902. Sagua de Tánamo (Espinosa & Ortea, 1999). **New record**: Cananova beach, Frank País municipality.
28. *Cerion dimidiatum* (Pfeiffer, 1847). Gibara (Espinosa & Ortea, 1999). Los Cocos and Gibara lighthouse.
29. *Cerion disforme* Clench & Aguayo, 1946. Punta de Manolito, El Ramón de Antilla. Two parapatric subspecies (Espinosa & Ortea, 1999):
C. d. disforme Clench & Aguayo, 1946. Punta de Manolito, El Ramón de Antilla (Espinosa & Ortea, 1999).
C. d. nodalis Clench & Aguayo, 1953. Former Oriente province, (Espinosa & Ortea, 1999). Punta Manolito, El Arenal.
30. *Cerion feltoni* Sánchez Roig, 1951. Felton, Mayarí (Espinosa & Ortea, 1999).
31. *Cerion geophilum* Clench & Aguayo, 1949: Punta de Piedra-Playa Morales, Banes (Espinosa & Ortea, 1999). Hybrids (*Cerion torrei moralesi* X *Cerion geophilum*) in the western part of Morales beach.
32. *Cerion hessei* Clench & Aguayo, 1949. Balcón de Damas, Playa Guardalavaca, Banes (Espinosa & Ortea, 1999).
33. *Cerion humberti* Clench & Aguayo, 1949. Ensenada de Jucaro, Banes bay (Espinosa & Ortea, 1999). **New records**: Carmona beach coastal lagoon as far as the coast, Antilla, entrance to Banes bay near the lighthouse, on Punta Caracolillo and other sites.
34. *Cerion josephi* Clench & Aguayo, 1949. Subspecies (Espinosa & Ortea, 1999):
C. j. josephi Clench & Aguayo, 1949. Western part of Caletones beach, Uvita beach, Gibara (Espinosa & Ortea, 1999).
35. *Cerion microdon* Pilsbry & Vanatta, 1896. Two subspecies:
C. m. microdon Pilsbry & Vanatta, 1896. Gibara (Espinosa & Ortea, 1999).
C. m. pygmaeum Pilsbry & Vanatta, 1896. Gibara (Espinosa & Ortea, 1999).
36. *Cerion nipense* Aguayo, 1953. Nipe (Espinosa & Ortea, 1999).
37. *Cerion pauciculptum* Clench & Aguayo, 1952. Punta de Música, Samá bay, Banes (Espinosa & Ortea, 1999).
38. *Cerion prestoni* Sánchez Roig, 1951. Preston, Nipe bay (Espinosa & Ortea, 1999).
39. *Cerion saetiae* Sánchez Roig, 1948. Playa del Cristo, Saetía, Nipe bay (Espinosa & Ortea, 1999). Playita de Fidel, on Saetia key and Baracutey beach, Antilla (Fernández *et al*., 2015c).
40. *Cerion scalarinum* ("Gundlach" in Pfeiffer, 1860). Two subspecies (Espinosa & Ortea, 1999):
C. s. scalarinum ("Gundlach" in Pfeiffer, 1860). Gibara (Espinosa & Ortea, 1999). West of Gibara city to before the Gibara lighthouse.
C. s. sueyrasi "Blanes" in Pilsbry & Vanatta, 1898. Vita, Samá, La Caletica, Punta de Manglito, El Ramón de Antillas and other localities in Banes and Antillas (Espinosa & Ortea, 1999). West side of Samá bay.
41. *Cerion torrei* "Blanes" in Pilsbry & Vanatta, 1898. Three subspecies (Espinosa & Ortea, 1999):
C. t. torrei "Blanes" in Pilsbry & Vanatta, 1898. Puerto de Vita (Espinosa & Ortea, 1999). **New record**: Bariay key, Rafael Freyre municipality.
C. t. moralesi Clench & Aguayo, 1951. Playa Morales, 11 km southeast of Banes city (Espinosa & Ortea, 1999). **New record**: Los Cocos, Gibara.
C. t. ornatum Pilsbry & Vanatta, 1898. Puerto de Vita, Rafael Freyre municipality (Espinosa & Ortea, 1999). Estero de Pequero Nuevo (Fernández *et al*., 2015a).
42. *Cerion vulneratum* (Küster, 1855). Subspecies (Espinosa & Ortea, 1999):
C. v. vulneratum (Küster, 1855). Caletones beach, Gibara (Espinosa & Ortea, 1999).
C. v. feriai Clench & Aguayo, 1953. Cayo Largo (or de Los Muertos), Naranjo bay, Rafael Freyre municipality (Espinosa & Ortea, 1999). We have never seen living specimens.
C. v. lepidium Clench & Aguayo, 1951. Lagoon of Punta de Mulas, Banes (Espinosa & Ortea, 1999). Lagoon of Punta de Mulas to 8.2 km east of the Lucrecia lighthouse (Fernández, 2015).
Family OLEACINIDAE
43. *Melaniella quinonesi* Aguayo & Jaume, 1954. Quarry on Cabo Lucrecia close to the lighthouse, Banes, type locality (Espinosa & Ortea, 1999). Some specimens found there.
Famiy CAMAENIDAE
44. *Zachrysia gibarana* Pilsbry, 1928. Gibara (Espinosa & Ortea, 1999). Found in various places in northeastern Cuba; identity of some specimens, including at La Máquina on Punta de Maisí (González, 2008), requires further study. Gibara city.
Family CEPOLIDAE
45. *Coryda nigropicta* ("Arango" in Poey, 1867). Sagua de Tánamo (Espinosa & Ortea, 1999). Cantera de Mella (Fernández *et al*., 2015b). **New record**: Yaguajay Hill, near Guardalavaca beach.
46. *Cysticopsis luzi* ("Arango" in Poey, 1868). Sagua de Tánamo (Espinosa & Ortea, 1999). Not found.
47. *Hemitrochus alleni* Aguayo & Jaume. Cayo Mambi, Sagua de Tánamo (Espinosa & Ortea, 1999). From Corinthya beach to Barrederas and Cayo Mambi, Frank País municipality.

48. *Hemitrochus hendersoni* Aguayo & Jaume. Miramar, Bariay key, Rafael Freyre municipality (Espinosa & Ortea, 1999).
49. *Hemitrochus garciana* Clench & Aguayo, 1953: Gibara (Espinosa & Ortea, 1999). Gibara, east of Caletones beach.
50. *Hemitrochus rufoapicata* (Poey, 1858). Gibara (Espinosa & Ortea, 1999).

Family XANTHONYCHIDAE

51. *Polymita sulphurosa* (Morelet, 1849). Two subspecies (Espinosa & Ortea, 1999; Maceira *et al*., 2005). **New record**: El Quince, Moa. This should be considered for conservation as a protected area.

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Espinosa, J. & Ortea, J. 1999. Moluscos terrestres del archipiélago cubano. *Avicennia.* Supplement 2: 1-137.

Espinosa, J. & Ortea, J. 2009. *Moluscos terrestres de Cuba*. Vaasa. Finland. 191 p.

Fernández, A. 2009. Moluscos terrestres en diez cerros calcáreos del Grupo Orográfico Maniabón, provincia Holguín. *Anuario de Investigaciones Ambientales del CISAT-CITMA*. CD ISBN 978-959-291-008-6.

Fernández, A. 2015. Diversidad de especies del género *Cerion* (Mollusca) en Holguín: implicaciones conservacionistas en zona costera de desarrollo inversionista del turismo. *Boletín de la Sociedad Cubana de Geología. Filial Holguín* 1: 10-14.

Fernández, A. & Franke, S. 2008. Geographic distribution of *Microceramus angulosus, Microceramus orientalis* and *Spiroceramus* sp. (Mollusca: Gastropoda: Urocoptidae) for Holguín, Cuba: new records and their habitats. *Of Sea and Shore* 28: 6 p.

Fernández, A., Suárez, A. & Franke, S. 2015a. New records of rock dwelling molluscs at risk from tourist developments on coastal zone of Pesquero Nuevo, Holguín, Cuba. *Tentacle* 23: 13-15.

Fernández, A., Franke, S., Espinosa, J., Reyes, E., Sigarreta, S., Matos, A. & Rodríguez, Y. 2015b. Moluscos terretres (Mollusca: Gastropoda) en Sierra de Nipe y alturas adyacentes, Cuba. *Solenodon* 12: 38-56.

Fernández, A., Franke, S., Suárez, A. & Hernández, I. 2015c. Registros nuevos, abundancia y morfometría de *Cerion saetiae* (Mollusca: Pulmonata) en la provincia Holguín. *Solenodon* 12: 28-32.

Franke, S. & Fernández, A. 2004. Data about a local population of *Macroceramus pictus* (Mollusca: Urocoptidae) in Gibara, Cuba and a brief comment on ecology and systematic. *Of Sea and Shore* 26(2): 94-98.

Franke, S. & Fernández, A. 2007. A new land snail of the genus *Idiostemma* Pilsbry et Vanatta 1898 (Gastropoda: Urocoptidae) from eastern Cuba *Schriften zur Malakozoologie* 23: 79-86.

González, A. 2008. *Cuba, el paraíso de los moluscos terrestres*. Editores GRETA, Spain. 306 p.

Maceira, D., Reyes-Tur, B., Fernández, A. & Lauranzón, B. 2005. Estado de poblaciones de las especies del género *Polymita* Beck, 1837. Unpublished report. Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), Santiago de Cuba. 53 p.

Richling, I., Franke, S., Fernández, A. & Sigarreta S. 2007. New data on the micro-land snails *Eutrochatella* (*Microviana*) *spinopoma* Aguayo 1943 and *Eutrochatella* (*Microviana*) *holguinensis* Aguayo 1932 (Neritopsina: Helicinidae) in the province of Holguín, eastern Cuba. *Schriften zur Malakozoologie* 23: 19-24.

Suárez, A., Fernández, A. & Hernández, I. 2012. Nuevos datos sobre la distribución, abundancia y el hábitat de *Cerion alberti* (Mollusca: Cerionidae), en Antilla, Holguín, Cuba. *Ecovida* 3(1).

Torre, C. de la & Bartsch, P. 2008. *Los moluscos terrestres cubanos de la familia Urocoptidae*. Editorial Científico-Técnica y Ruth Casa Editorial, La Habana. [xxxvii] + 730 + [28] p.

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CONSERVATION DATA ON *CERION MUMIA HONDANUM* (MOLLUSCA: PULMONATA: CERIONIDAE) FROM BAHÍA HONDA, PINAR DEL RIO, CUBA

By Alexis Suárez Torres, Iriel Hernández & Alejandro Fernández

Of the 600 species of cerionids described, there are 147 in the Cuban malacofauna (Espinosa & Ortea, 2009). The *mumia* complex, in the genus *Cerion* Röding, 1798, comprises *Cerion mumia mumia* (Bruguière, 1792), *C. m. cabrerai* Aguayo & Sánchez Roig, 1953, *C. m. chrysalis* (Férussac, 1837), *C. m. cuspidatum* Aguayo & Sánchez Roig, 1953, *C. m. fastigatum* (Maynard, 1896), *C. m. hondanum* Pilsbry, 1902, *C. m. noriae* Aguayo & Sánchez Roig, 1953 and *C. m. wrighti* Aguayo & Sánchez Roig, 1953. Very little is known of the ecology or natural history of these subspecies; *C. m. chrysalis* is the best studied (Suárez, 2013, 2015).

Field work in April 2011 took place in a coastal area at San Pedro beach, Bahía Honda, Pinar del Río (Fig. 1). This is habitat for *C. m. hondanum* (Fig. 2), a Cuban endemic subspecies.

In general, at Bahía Honda, a monodominant *Rhizophora mangle* (red mangrove) strip exists, varyng in height between 8 and 11 m. This strip is behind a mixed forest of *Avicennia germinans*, with some *Laguncularia racemosa* (see Menéndez & Guzmán, 2010), with patches of grass or sandy shore vegetation.

Over a distance of 3 km between 23º00'N 83º01'W and 23º00'N 83º02'W, *C. m. hondanum* were observed alive. In these places, the vegetation alternates between grass and

Fig. 1. View of the coastal zone from Bahía Honda, Pinar del río, Cuba, where the population of *Cerion mumia hondanum* is established.

Fig. 2. *Cerion mumia hondanum* on a tree branch at Bahia Honda.

mangrove swamp growing directly on the earth to sandy shore vegetation. For this work the vegetation was divded into four subzones: 1, herb; 2, mangrove swamp; 3, sea grape area; and 4, sandy shore vegetation.

Between 10 and 20 m from the shore line, several sampling plots of 1 m^2 were established, and living *C. m. hondanum* counted (subzone 1: 13 plots; subzone 2: 14 plots; subzone 3: 6 plots; subzone 4: 5 plots).

In subzone 1, the plots were in the herb area fully exposed to solar radiation. The density estimated here was 1.9 individuals per m^2. Seven individuals were recorded in two of the plots, in the rest the numbers were lower.

Subzone 2, where the red mangrove grows, was a shady environment with plants growing to 6 m in height. Here, snails were observed on the ground and also on trunks and branches. The density recorded here was 2.1 individuals per m^2. The maximum number of idividuals recorded in a plot was 4, seen in one plot only.

Subzone 3 was a small area covered with sea grape trees, with plants growing up to 1.5 m in height. The sun's rays were filtered by the vegetation canopy; snails were in the branches and under fallen leaves. Eight individuals were recorded in one plot; in the rest of the plots, the numbers exceeded 10 individuals, indicating a high population density and, in fact, a great aggregation. The overall density in this subzone was 33.8 individuals per m^2.

Subzone 4 was an open space with a narrow band of *Ipomoea pes-caprae* growing in the sand. Here the snails were on the ground and on leaves. In one plot just a single individual was found, and in the rest more than ten. The overall density was 38.0 individuals per m^2.

At the Bahía Honda locality, both the herb and mangrove areas are established on the soil, whereas the sea grape tree and *Ipomoea pes-caprae* grow on the sand. The soil characteristics could be the determining factor in the differences in the health of the different cerionid populations, associated with reproduction. The soil is harder and more compact than the sand, and the vegetation that grows there may contribute to the resistance of the soil through decomposition of litter. This may affect egg laying, hatching and emergence of juveniles. Until now the scientific literature does not describe how cerionids lay their eggs, but we have observed many individuals of several *Cerion* species, on wet days, opening a small hole in the sand, introducing their body, and later withdrawing and covering the hole with the removed sand. On one occasion, after a specimen of *C. m. chrysalis* finished this behaviour, the first author dug into the space and found eggs. These were soft and translucent.

In the four subzones, the dispersion was heterogeneous. Only 20 % of the herb subzone, and 7.1 % of the mangrove swamp subzone supported the highest densities, with fewer than 10 individuals per m^2, while in the rest of plots there were fewer than 3 individuals per m^2; they were categorized as locally common in both subzones under Woodruff's (1978) proposed scales, as modified by Suárez *et al.* (2012). In the sea grape area and in the sandy vegetation, 83.3 % and 80 % respectively of the sampled plots contained more than 10 individuals per m^2; in these areas the population was categorized as locally very common.

According to Hamilton (1971), aggregation offers an advantage in diluting predation risk. On the other hand, animals aggregate when and where resources and conditions favour their reproduction and survival (Begon *et al.*, 2006).

This is not the first record of cerionids associated with mangrove swamps, although Espinosa & Ortea (2009) stated that cerionids have never been found on these plants. In the original description of *Cerion gundlachi* Pfeiffer, 1852, the author mentions the association with mangroves, making clear that the species of mangrove is *Avicennia* sp. (Pfeiffer, 1852). Another case is *C. pastelilloensis* Sánchez Roig, 1951, but the author does not specify the species of mangrove (Sánchez Roig, 1951). Consequently, this is the first record of *Cerion* associated with *Rhizophora mangle*.

The plasticity that characterizes the molluscs of this genus has permitted them to establish in different habitats, and perhaps this character may be the genesis of so much diversity in the genus.

Cerion coutini Sánchez Roig, 1951, the population of which is localized in a little area at Cayo de Tako Bay, Baracoa, Guantánamo, may have used the coastal vegetation that existed in the locality before it was converted by people through planting of coconut palms, some 500 years ago. In this case the snails had to adapt to this new substrate (Suárez & Hernández, 2013).

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Begon, M., Townsend, C.R. & Harper, J.L. 2006. *Ecology. From individuals to ecosystems*. Blackwell, Oxford.

Espinosa, J & Ortea, J. 2009. *Moluscos terrestres de Cuba*. Vaasa, Finland. 191 p.
Hamilton, W.D. 1971. Geometry for the selfish herd. *Journal of Theoretical Biology* 31(2): 295-311.
Menéndez, L. & Guzmán J.M. 2010. Los ecosistemas forestales costeros. Su importancia económica, social y ambiental. In: *Memorias de SIMFOR*, 2010. 19 p.
Pfeiffer, L. 1852. Descriptions of sixty-six new land shells, from the collection of H. Cuming, Esq. *Proceedings of the Zoological Society of London* 20: 56-70.
Sánchez Roig, M. 1951. Nuevos Moluscos terrestres Cubanos. *Revista de la Sociedad Malacológica "Carlos de la Torre"* 7(3): 95-120.
Suárez, A. 2013. Dieta de *Cerion mumia chrysalis* (Gastropoda: Pulmonata: Cerionidae). *Solenodon* 11: 103-108.
Suárez, A. 2015. Ciclo reproductivo de *Cerion mumia chrysalis* (Pulmonata: Stylommatophora: Cerionidae). *Solenodon* 12: 21-27.
Suárez, A. & N. Hernández. 2013. *Cerion coutini* (Pulmonata, Cerionidae) at Tako Bay Key, Baracoa, Guantánamo, Cuba. *Tentacle* 21: 5-7.
Suárez, A, Hernández, I. & Fernández, A. 2012. Abundancia, sustrato y estrato de *Cerion peracutum peracutum* (Mollusca: Pulmonata) en Guanabo, La Habana, Cuba. *Solenodon* 10: 32-37.
Woodruff, D.S. 1978. Evolution and adaptive radiation of *Cerion*: a remarkable diverse group of West Indian land snail. *Malacologia* 17(2): 223-239.

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CONSERVATION STATUS OF *PINERIA TEREBRA* POEY, 1851 (GASTROPODA: UROCOPTIDAE) FROM ISLA DE LA JUVENTUD, CUBA

By Jane Herrera Uria

Cuba has a rich terrestrial malacofauna with >1,300 species, of which about 95 % are endemic (Espinosa & Ortea, 1999). Urocoptidae comprise 41 % of Cuban land snails, with 47 genera and 572 species (Torre & Bartsch, 2008).

Pineria (Fig. 1) is an endemic genus of terrestrial molluscs from the Isla de la Juventud. It contains two species: *Pineria beathiana* Poey, 1851 and *P. terebra* Poey, 1851, the latter with two subspecies (Figs. 2, 3): *P. t. terebra* and *P. t. colombiana* from north of Sierra de las Casas and south of Sierra Colombo, respectively. At present, these are the only known localities for these snails. Information on the natural history of *P. terebra* is very scarce. The last record of its occurrence dates from a PhD thesis (Correoso, 1995).

Within the Cuban archipelago, the Isla de la Juventud (Fig. 4) is considered one of the most important sites for endemism, because about 30 % of its terrestrial mollusc species are local endemics (Espinosa & Ortea, 1999). The Isla de la Juventud,

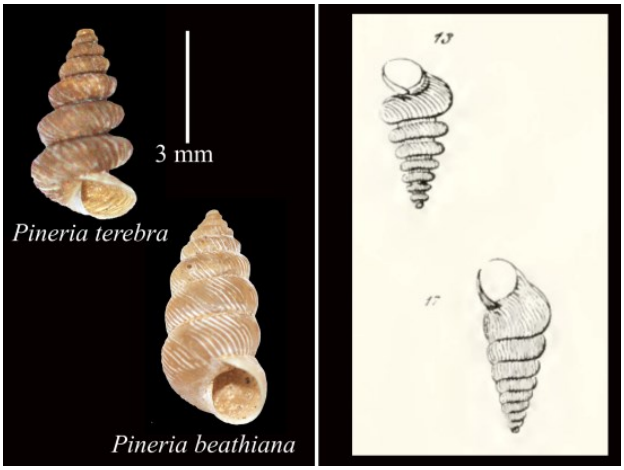

Fig. 1. Left–shells of *Pineria beathiana* and *P. terebra*; right–illustrations of the same two species from Poey (1851) (right).

Fig. 2. *Pineria terebra terebra* from the eastern hillside to the north of Sierra de las Casas, Isla de la Juventud, Cuba.

Fig. 3. Juvenile of *Pineria terebra colombiana*, south of Sierra Colombo, Isla de la Juventud, Cuba.

formerly known as the Isle of Pines, is a Caribbean island separated from Cuba by approximately 94 km, and with an area of 2,200 km².

Sierra de las Casas (261 m asl, Fig. 5) is the second highest point on the island (after Sierra de Caballos, 295 m above sea level). Its eastern foothills face the largest human settlement on the island, which results in the Sierra de las Casas suffering direct environmental impacts from frequent fires in dumps and in the forest. Likewise, Sierra Colombo (130 m above sea level, Fig. 6) sustains similar impacts as well as mining for marble exploitation. These are the major threats to *Pineria terebra*.

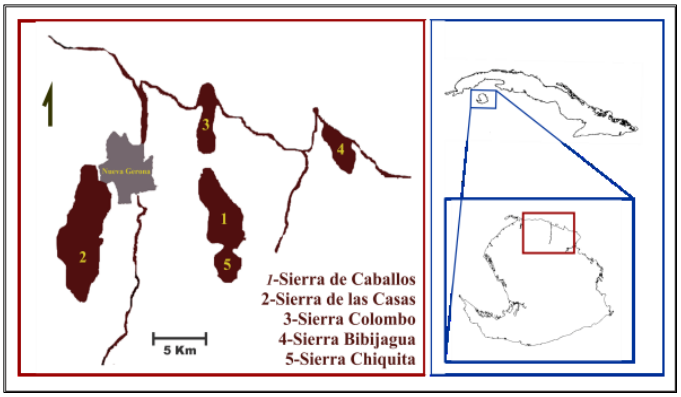

Fig. 4. Mountain ranges in the north of the Isla de la Juventud, Cuba.

During my fieldwork in the northeastern part of the Isla de la Juventud (2014-2015), I confirmed the continued existence of *Pineria terebra*. I found both subspecies and photographed the shells. These snails depend on limestone and that is why microlocation is so important for them. I measured the habitat areas as 20 m² for *P. t. terebra* and 6 m² for *P. t. colombiana*; but habitat loss occurs because of frequent forest fires (Fig. 7).

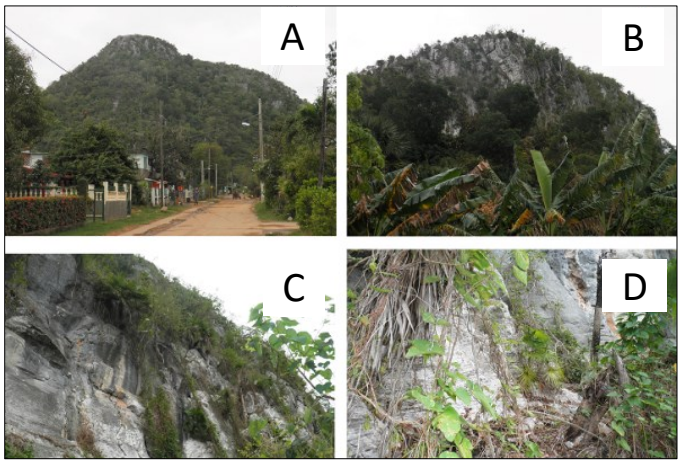

Fig. 5. A–Pueblo Nuevo town; B–eastern hillside north of Sierra de las Casas; C, D–type locality and habitat of *Pineria t. terebra*.

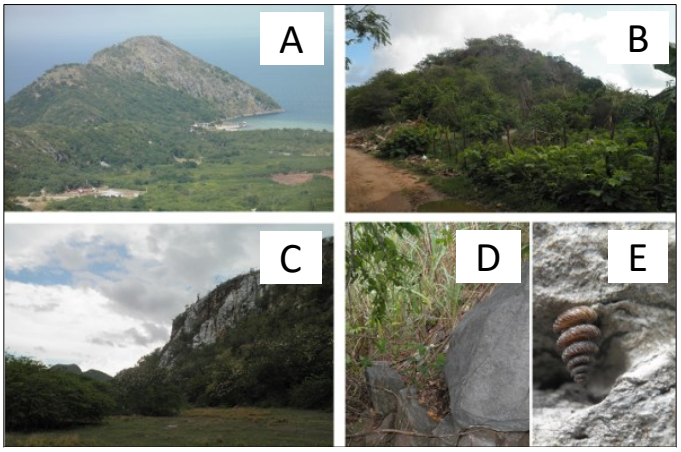

Fig. 6. A–view of Sierra Colombo; B–type locality of *Pineria terebra colombiana*; C–southeastern side of Sierra Colombo; D–specific habitat of *P. t. colombiana*; E–*P. t. colombiana* on rocks.

Fig. 7. Dead land snails killed by forest fire.

Vales *et al*. (1998) claimed that the majority of Cuban land snails are threatened; but so far *Pineria terebra* has not been evaluated by the IUCN. This contribution is the first alert regarding this species.

I thank The Rufford Foundation for providing financial support for expeditions (Ref. 15700-1). I thank Gilberto Silva Taboada for his reviews of all my papers. Also, I want to express my gratitude to a very special person, who gave me a lot of support for this field work.

Correoso, R.M 1995. *Caracterización de la malacofauna de la Isla de la Juventud.* Investigación terminada. Tesis de investigador. Inédita. Ministerio de ciencia tecnología y medio ambiente, Antigua Academia de Ciencias de Cuba, Isla de la Juventud.

Espinosa, J. & Ortea, J. 1999. Moluscos terrestres del archipiélago cubano. *Avicennia* Supplement 2: 1 -137.

Poey, F. 1851. *Memorias sobre la Historia Natural de la Isla de Cuba*. Tomo 1. Barcina, Habana. 463 p., 34 pl.

Torre, C. de la & Bartsch, P. 2008. *Los moluscos terrestres cubanos de la familia Urocoptidae*. Editorial Científico-Técnica. [xxxvii] + 730 + [28] p.

Vales, M., Álvarez, A., Montes, L. & Ávila, A. 1998. *Estudio Nacional sobre la Diversidad Biológica en la República de Cuba*. CESYTA, Madrid. 480 p.

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CONSERVATION OF *VERTIGO MOULINSIANA* AND *V. ANGUSTIOR* (GASTROPODA, PULMONATA, VERTIGINIDAE) IN THE NATURAL PROTECTED AREA OF LAKE BANYOLES (CATALONIA, SPAIN)

By Mª José Madeira, Benjamín J. Gómez-Moliner, Miquel Campos, Quim Pou-Rovira & Emili Bassols

Vertigo moulinsiana and *V. angustior* are two of the four species in to the genus *Vertigo* (Gastropoda: Vertiginidae) included in the Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, otherwise known as the "Habitats Directive". Both species are also included in the List of Wild Species under Special

Protection (LESRPE) (Royal Decree 139/2011) of Spain, where these species have been reported from a few locations during the last century. Hydrogeological conditions and microhabitats are different for the two species. Both species are very sensitive to changes in drainage conditions and to fragmentation of their habitat, these being the main causes of the significant declines in their populations in recent decades. Inclusion of these species in the Habitats Directive has stimulated a significant amount of work on them in certain parts of Europe, including the Iberian Peninsula (Robles, 1991; Martínez-Ortí, 1999, 2011; Gómez-Moliner *et al*., 2001, 2010; Martínez-Ortí & Robles, 2003; Martínez-Ortí *et al*., 2010, 2013).

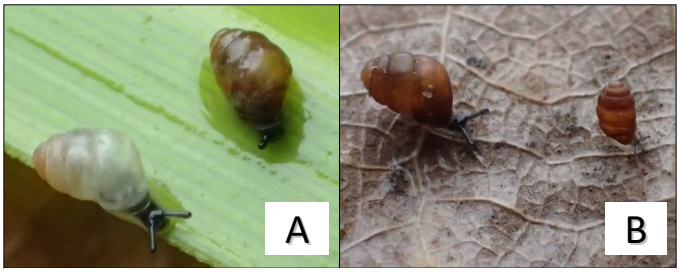

Fig 1. *Vertigo* from Lake Banyoles. A–two specimens of *V. moulinsiana*, one collected from a population with a high proportion of albino shells; B–*V. moulinsiana* (left) and *V. angustior* (right).

According to current data, Lake Banyoles, in the northeast region of Catalonia, can be considered the best place in the Iberian Peninsula for conservation of *V. moulinsiana* and *V. angustior* (Fig. 1). Since 2014, a LIFE Nature project "LIFE Potamo Fauna" (LIFE12 NAT/ES/001091) has been carried out at the Banyoles lake system, including monitoring and recovery actions, with the aim of recovery and long-term conservation of these two *Vertigo* species in their habitat. The main objective of this project for these species is the "Expansion and consolidation of the populations of *Vertigo moulinsiana* and *V. angustior* in the Natura 2000 site Estany de Banyoles (ES5120008) via translocations from within the site". For that, the following specific objectives are being developed to 1) provide an accurate distribution of both species across the lake and ponds, 2) determine their abundance, population structure and habitat requirements, 3) asses sampling methods for each species, 4) establish measures to ensure the conservation and management of both species and 5) develop a protocol for monitoring each species for 2014-2017. Management actions included in this project for 2014-2017 are 1) develop a monitoring protocol for both species in this lake system, taking into account the specific environmental characteristics of the northeastern Iberian Peninsula and testing different collecting methods for the Banyoles habitat characteristics, 2) perform population estimates of both species in the lake system, 3) design and prepare new wetlands for establishment of new populations, 4) translocate *V. angustior* and *V. moulinsiana* to the new recovered wetlands and 5) monitor translocated populations over four years to evaluate their establishment.

At present there is no standardized methodology for monitoring and recovering natural populations of either species in the Iberian Peninsula. Therefore, the development of a package of protocols and methods for this purpose will be of great interest in defining the guidelines for future monitoring and management of these two species of European Community interest. For *V. moulinsiana* and *V. angustior* this will be the first major project in the Iberian Peninsula focused on their conservation and management, and it will allow consolidation of the main Iberian populations, assuring significant representation of both species in Europe.

Gómez-Moliner, B.J., Moreno, D., Rolán, E., Araujo, R. & Álvarez, R.M. 2001. *Protección de moluscos en el catálogo nacional de especies amenazadas. Reseñas Malacológicas XI.* Sociedad Española de Malacología, Madrid. 286 p.

Gómez-Moliner, B.J., Madeira, M.J., Razkin, O. & Chueca, L.J. 2010. Delimitación del área ocupada por las especies de moluscos terrestres recogidas en la Directiva Hábitats (*V. moulinsiana* y *V. angustior*) dentro de la zona lacustre del Estany de Banyoles. Unpublished report submmitted to Consorci del Estany de Banyoles. 32 p.

Martínez-Ortí, A. 1999. Los moluscos terrestres testáceos de la Comunidad Valenciana. Tesis Doctoral. Universitat de València. [ix] + xxxviii +743 + [1] p., 31 pl.

Martínez-Ortí, A. 2011. Informe sobre el descubrimiento de poblaciones de dos moluscos gasterópodos protegidos: *Vertigo moulinsiana* y *Vertigo angustior* (familia Vertiginidae). Report. Museu Valencià d'Història Natural, València. 9 p.

Martínez-Ortí, A., López-Alabau, A. &. Arco, M.C. 2010. Nuevos hallazgos del vertigínido *Vertigo angustior* Jeffreys, 1830 (Gastropoda, Pulmonata) en la península ibérica. *Noticiario de la Sociedad Española de Malacologia* 54: 50-54.

Martínez-Ortí, A., Pérez, A., López-Alabau, A. & Arco, M.C. 2013. Nuevos hallazgos de poblaciones de *Vertigo moulinsiana* (Dupuy, 1849) (Pulmonata: Vertiginidae) en las provincias de Castellón Cuenca y Teruel (España). *Noticiario de la Sociedad Española de Malacologia* 59: 60-63.

Martínez-Ortí, A. & Robles, F. 2003. *Moluscos continentales de la Comunidad Valenciana*. *Colección Biodiversidad 11*. Generalitat Valenciana, Conselleria de Territori i Habitatge, València. 259 p.

Robles, F. 1991. Gasterópodos terrestres de la provincia de Valencia. Revisión bibliográfica y lista de especies. *Iberus* 9(1-2): 467-481.

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A POSSIBLE LAND SNAIL DIVERSITY HOTSPOT IN BAHIA STATE, BRASIL

By Daniel C. Cavallari, Rodrigo B. Salvador & Luiz R.L. Simone

The state of Bahia is home to many land snail species (e.g. Simone, 2006), including several endemics distributed over its vast 567,000 km² territory. At the family level, the helicinids, orthalicoids, megalobulimids, pleurodontids, streptaxids, strophocheilids, subulinids and systrophiids stand out in terms

Figs. 1-7. Some of the new species recently described from Bahia state, Brasil. 1–*Oxychona maculata*, Bulimulidae (shell height, H 17.9 mm); 2–*Solaropsis alcobacensis*, Pleurodontidae (shell width, W 33.2 mm); 3–*Cyclodontina tapuia*¸ Odontostomidae (H 22.9 mm); 4–*Leiostracus fetidus*, Bulimulidae (H 21.2 mm); 5–*Kora corallina*, Bulimulidae (H 43.4 mm); 6–*Kora nigra* (H 30.1 mm); 7–*Kora* sp. nov. (H 37.7 mm).

of diversity. Orthalicoidea is the most diverse group of snails in Brasil, encompassing about 40 % of the known fauna (Simone, 2006). Its presence in Bahia is remarkable, mainly represented by the genera *Auris*, *Bahiensis*, *Bulimulus*, *Cyclodontina*, *Drymaeus*, *Leiostracus* and *Rhinus*. Some genera have surprisingly unusual shell shapes, such as *Anostoma*, *Cochlorina* and *Oxychona*; others have apertures with natural tooth-like palisades against predation, such as *Auris* and *Ringincella*; and still others have shells of intense colour and beauty, such as *Leiostracus*.

All this diversity had already been noticed by the European and North American naturalists who studied the fauna of Bahia in the nineteenth century, such as Spix, d'Orbigny, Beck, Moricand and Pfeiffer, among others. Despite all these researchers having described several land snail species, recent studies have shown that there is still a great diversity to be discovered in Bahia. A good example of the results of a taxonomic study of a small sample of terrestrial gastropods from the municipality of Santa Maria da Vitória is the new orthalicoid genus *Kora* (Simone, 2012a). It is notable for its beautiful, fusiform shell, bearing an expanded lip, which did not fit into any known genus. The type species, *K. corallina* (Fig. 5), was named in memory of the great Brasilian poet Cora Coralina. In the same study, three other species were described: *Anostoma tessa*, *Megalobulimus amandus* and *Spixia coltrorum*. Three new species were later (Simone, 2015) described in the genus *Kora*, namely *K. nigra* (Fig. 6), *K. terrea* and *K. iracema*. The latter two were transferred to the genus *Drymaeus* by Salvador & Simone (2016), who also described a new species of *Kora* (Fig. 7).

Specimens from similar samplings carried out in other locations in the state have yielded other new species (Salvador & Cavallari, 2014; Salvador & Simone, 2014, 2015a; Porto *et al*., 2015): *Cyclodontina tapuia* (Fig. 3), *Leiostracus fetidus* (Fig. 4), *Oxychona michelinae* and *Solaropsis alcobacensis* (Fig. 2). Moreover, some interesting troglofaunal samples were collected by the team of Dr. Maria E. Bichuette (UFSCar) in Bahia and the new caenogastropod genera *Spiripockia* and *Habeas* were erected for four species (Simone, 2012b, 2013): *S. punctata*, *H. corpus*, *H. data* and *H. priscus*. Finally, new species can also be found in old collections. The incorporation of part of the collection belonging to the renowned physician and researcher Jorge Faria Vaz into the Museu de Zoologia da Universidade de São Paulo (MZSP; see Cavallari & Simone, 2015) also resulted in finding a new orthalicoid species (Salvador & Cavallari, 2013): *Oxychona maculata* (Fig. 1).

The diversity of terrestrial molluscs in Bahia seems to be really exceptional and can be linked to the fact that the state includes the boundaries of three Brasilian biomes: the Cerrado, the Caatinga and the Atlantic Rainforest. The recent discovery of several new species in Bahia from relatively small samples and restricted localities, shows the limited nature of the knowledge of the northeastern Brasilian molluscan fauna. Such high diversity needs special attention, both for the preservation of the likely endemic areas as well as in-depth studies of basic biology and evolution of unusual adaptations to semi-arid or cave environments. Moreover,

many land snail species are imperiled or at risk of becoming extinct even before being known to science (see Salvador & Simone, 2015b for a Brasilian example). This reinforces the necessity of further study and the establishment of effective conservation policies. In this regard, special attention is needed for the Caatinga and Cerrado environments, which are rarely targets of environmental and conservation activities.

Cavallari, D.C. & Simone, L.R.L. 2015. Incorporation of the Jorge Vaz Collection into the Museu de Zoologia da Universidade de São Paulo. *Strombus* 22: 29-36.

Porto, R., Rocha Filho, J.R., Johnsson, R. & Neves, E. 2015. New species of *Oxychona* (Bulimulidae) from Michelin ecological reserve (Bahia state, northeastern Brazil). *Journal of Conchology* 42(3): 1-6.

Salvador, R.B. & Cavallari, D.C. 2013. A new *Oxychona* species (Gastropoda: Pulmonata: Orthalicidae) from Bahia state, Brazil. *Journal of Conchology* 41: 315-318.

Salvador, R.B. & Cavallari, D.C. 2014. A new species of *Leiostracus* from Bahia, Brazil (Gastropoda, Pulmonata, Orthalicidae). *Iheringia, Série Zoologia* 104(1): 39-42.

Salvador, R.B. & Simone, L.R.L. 2014. New species of *Cyclodontina* from Bahia, Brazil (Gastropoda, Pulmonata, Odontostomidae). *Iheringia, Série Zoologia* 104(4): 484-487.

Salvador, R.B. & Simone, L.R.L. 2015a. Taxonomical study on a sample of land snails from Alcobaça (Bahia, Brazil), with description of a new species. *Stuttgarter Beiträge zur Naturkunde A, Neue Serie* 8: 1-7.

Salvador, R.B. & Simone, L.R.L. 2015b. The discovery and possible extinction of a *Leiostracus* land snail in southeastern Brasil. *Tentacle* 23: 7-8.

Salvador, R.B. & Simone, L.R.L. 2016. A new species of *Kora* from Bahia, Brazil (Gastropoda: Pulmonata: Orthalicoidea), with an emended diagnosis of the genus. *Stuttgarter Beiträge zur Naturkunde A, Neue Serie* 9: in press.

Simone, L.R.L. 2006. *Land and freshwater molluscs of Brazil*. EGB, Fapesp, São Paulo. 390 p.

Simone, L.R.L. 2012a. Taxonomical study on a sample of pulmonates from Santa Maria da Vitória, Bahia, Brazil, with description of a new genus and four new species (Mollusca: Orthalicidae and Megalobulimidae). *Papéis Avulsos de Zoologia* 52(36): 431-439.

Simone, L.R.L. 2012b. A new genus and species of cavernicolous Pomatiopsidae (Mollusca, Caenogastropoda) in Bahia, Brazil. *Papéis Avulsos de Zoologia* 52(40): 515-524.

Simone, L.R.L. 2013. *Habeas*, a new genus of Diplommatinidae from Central Bahia, Brazil (Caenogastropoda), with description of three new species. *Journal of Conchology* 41(4): 519-525.

Simone, L.R.L. 2015. Three new species of *Kora* (Pulmonata, Orthalicidae) from Bahia and Minas Gerais, Brazil. *Journal of Conchology* 42(1): 51-56.

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MOLLUSCS INTERCEPTED AT THE BORDERS OF ISRAEL IN 2014 (ADDITIONAL RECORDS) AND 2015

By Svetlana Vaisman & Henk K. Mienis

Although the whole phylum Mollusca is protected by law in Israel, most molluscs are still endangered by numerous events such as pollution, habitat destruction and competition from alien species. During the ongoing urbanisation of large parts of Israel all three of these negative impacts often influence each other and in such areas usually only 10-20 of the native land snail speciess are still present, although often only in small scattered populations. All other snails and slugs in such places are alien species.

In our previous report (Vaisman & Mienis, 2015) we have already given some information on the replacement of autochthonous species by allochthonous species in gardens and parks in Israel: “For example, if a student is asked to bring snails and/or slugs living in their parents’ or neighbours’ garden to school, 80-90 % are of foreign origin”. As a matter of fact 22 % of all the terrestrial mollusc taxa occurring in Israel are currently of foreign origin. Most of these alien snails are still confined to areas that are irrigated during the dry season, more or less from the beginning of April to the end of September. But the list of alien species that manage to survive in natural non-irrigated areas is also growing slowly but steadily. Therefore, it is important to curb the constant influx of additional allochthonous species. The Plant Protection and Inspection Services (PPIS) of the Ministry of Agriculture, stationed at the borders of Israel, is the only organisation that can curb the ongoing arrival of still more foreign snails and slugs. Although their main function is to prevent the import of agricultural pests they also try to prevent the introduction of possible alien fauna and flora that may endanger or alter the biodiversity of Israel. Thus, the actions of PPIS are important in the conservation of the native mollusc fauna of Israel.

Inspectors of the PPIS stationed at the international Ben Gurion Airport near Lod, the Mediterranean harbours of Haifa and Ashdod and the border crossing with Gaza, Palestinian Authority, near Kerem Shalom, in 2014 provided three samples not dealt with in our report dealing with interceptions in 2014 (Vaisman & Mienis, 2015) and 13 samples in 2015. All the intercepted snails and slugs were terrestrial species.

The material was handed over to Mrs. Svetlana Vaisman of the mollusc identification unit of the PPIS in Bet Dagan. She brought the samples to Mr. Henk K. Mienis for final verification and permanent storage in the mollusc collection of the Steinhardt Museum of Natural History and the National Research Center of Tel Aviv University.

The 16 samples treated in this report (Tables 1 and 2) arrived from six countries: the Netherlands (7), France (4), Turkey (2), Palestine (1), Spain (1) and the USA (1). These samples contained at least nine taxa of terrestrial snails (5) or slugs (4). Three samples could only be identified at the generic level because of poor preservation: two samples of *Deroceras* (slug) and one of *Xeropicta* (snail).

Table 1. Additional molluscs intercepted at the borders of Israel in 2014.

Date	Species intercepted (number of specimens)	Origin	Shipment
7 September	*Deroceras* sp. (1)	Netherlands	green cabbage
23 November	*Deroceras laeve* (1)	Netherlands	potted orchids
9 December	*Oxyloma elegans* (1)	France	apples

Table 2. Molluscs intercepted at the borders of Israel in 2015.

Date	Species intercepted (number of specimens)	Origin	Shipment
11 January	*Oxyloma elegans* (8)	France	apples
18 January	*Deroceras laeve* (1)	Netherlands	potted spindle trees
27 January	*Oxyloma elegans* (2)	France	apples
2 February	*Oxyloma elegans* (1)	France	apples
15 February	*Cornu a. aspersum* (1)	Spain	apples
26 March	*Lehmannia valentiana* (1)	USA	railway sleepers
23 June	*Xeropicta* species (1)	Turkey	squash
30 June	*Deroceras* species (1)	Turkey	squash
24 September	*Zonitoides nitidus* (1)	Netherlands	potted orchids
24 September	*Deroceras reticulatum* (1)	Netherlands	green cabbage
7 December	*Deroceras invadens* (2) *Deroceras reticulatum* (1)	Netherlands	green cabbage
9 December	*Microxeromagna lowei* (1)	Palestine	green cabbage
10 December	*Zonitoides arboreus* (2)	Netherlands	potted orchids

Imported apples (mainly of the race Pink Lady) have remained one of the main carriers of alien snails. Of interest is the fact that apples arriving from France this time only carried *Oxyloma elegans* (Succineidae) in the pedicel notch, while apples from Spain were contaminated with *Cornu aspersum aspersum*. The latter is much smaller than *C. aspersum megalostomum*, which arrived long ago in Israel from other eastern Mediterranean or North African countries. It is now commonly encountered in most urbanised areas in Israel and one of the few alien species invading natural areas.

Shipments of green cabbage (*Brassica oleracea* var. *capitata*) from the Netherlands were accompanied by three species of *Deroceras.* It was the first time that *D. invadens* had been intercepted on imported merchandise, although it was already known from several nurseries in Israel (Mienis *et al.*, 2014; Mienis & Rittner, 2015). The shipment of 23,100 kg of green cabbage from the Netherlands containing both *D. reticulatum* and *D. invadens* was sent back.

A specimen of *Microxeromagna lowei* was found on green cabbage imported from the Gaza Strip, Palestine. This species is commonly encountered in the Mediterranean coastal region of Israel, but was not previously known from Palestine (Mienis, 2015).

We thank the inspectors of the Plant Protection and Inspection Services of the Ministry of Agriculture for supplying us with the specimens discussed.

Mienis, H.K. 2015. A preliminary review of the land snails recorded from the Gaza Strip, Palestine. *Triton* 32: 25-31.

Mienis, H.K. & Rittner, O. 2015. Malacological fieldwork in Israel. In: *The Steinhardt Museum of Natural History. Israel National Center for Biodiversity Studies. Annual Report 2013/2014*, p. 70-87. Tel Aviv University, Tel Aviv.

Mienis, H.K., Mienis, D., Vaisman, S. & Rittner, O. 2014. Two exotic gastropods: *Aegopinella nitidula* and *Deroceras invadens*, recently discovered in Israel. *Triton* 29: 21-25.

Vaisman, S. & Mienis, H.K. 2015. Molluscs intercepted at the borders of Israel in 2014. *Tentacle* 23: 12-13.

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IMPACTS OF ANTHROPOGENIC CLIMATE CHANGE ON FRESHWATER MOLLUSCS IN KAILALI, WESTERN NEPAL

By Prem B. Budha

Freshwater ecosystems are the most endangered ecosystems in the world and are vulnerable to human activities and environmental change (Dudgeon *et al*., 2006). Many drivers such as airborne pollution, deforestation, industrial point source pollution, dams, river channelization/diversions, overharvesting of resources, introduction of invasive species, ground water extraction, roads and flood control infrastructure affect freshwaters (Carpenter *et al.*, 2011). Impacts on biodiversity brought about by climate change are difficult to measure from climate data alone because change can result from the interaction of a number of pressures.

There are more than 6,000 rivers and rivulets and 5,358 natural lakes in Nepal (Bhuju *et al*., 2010), which are important habitats for various freshwater gastropods and bivalves across their range from less than 100 m to about 5,000 m elevation. Kailali is one of the richest districts with some of the highest numbers of natural lakes. Recent study of topographical maps of Nepal identified only 114 lakes in Kailali district, but many small lakes remain unknown and are not marked on official topographical maps. This study identified 106 lakes and surveyed 73 lakes within eight Village Development Committees (VDCs) of Kailali (Fig. 1) including the Ghodaghodi Lake Complex, one of nine Ramsar sites in Nepal. Most of the lakes are under the management of private entities or Community Fishery Management Committees, except for two lakes of the Ghodaghodi complex, Ghodaghodi and Nakrod.

Valid species of freshwater molluscs globally number about 4,000 gastropods (Strong *et al*., 2008) and 1,026 bivalves (Bogan, 2008). A rough estimate of the number of freshwater mollusc species of Nepal includes 61 gastropods and 30 bivalves. However, they are poorly studied in western Nepal with only 11 species reported from Ghodaghodi lakes (Subba, 2003; Glöer & Bössneck, 2015). About 20 species of freshwater molluscs are consumed by various ethnic

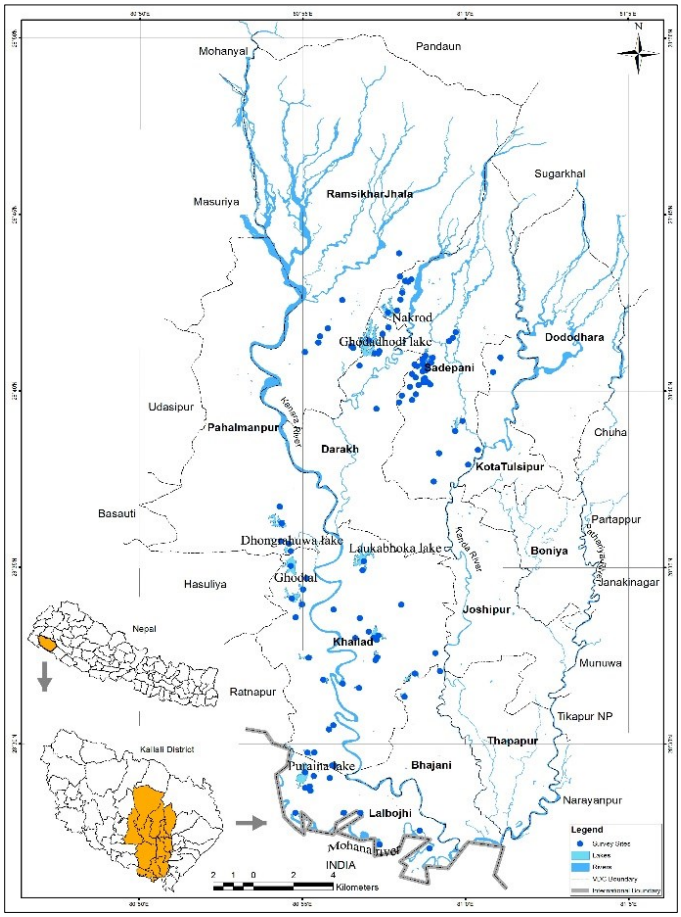

Fig. 1. Distribution of lakes in the study area.

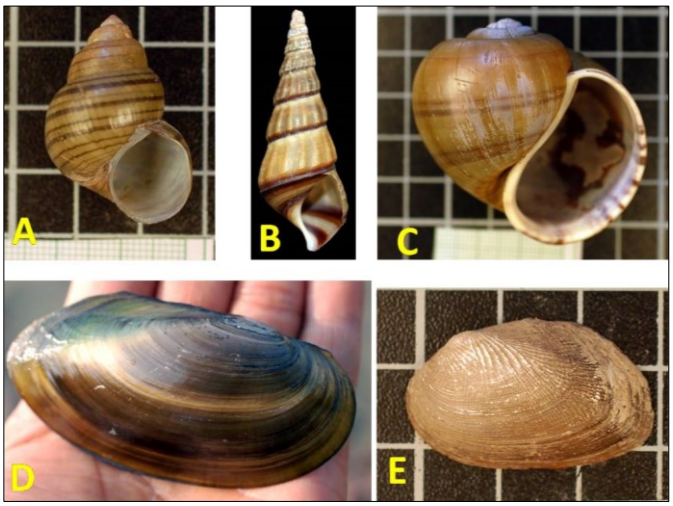

Fig. 2. Edible molluscs of Nepal. A–*Bellamya bengalensis*, B–*Brotia costula*, C–*Pila globosa*, D–*Lamellidens jenkinsianus*, E–*Parreysia* sp. (Photos: Prem Budha)

communities in Nepal (Subba, 2012). Molluscs valued for food in Nepal are *Bellamya* spp., *Brotia costula*, *Pila globosa*, *Lamellidens* spp. and *Parreysia* spp. (Fig. 2).

Consumption of freshwater snails and mussels and their collection from nearby lakes, rivers, irrigation canals and paddy fields is a long-standing practice and tradition in Kailali (Figs. 3, 4).

Fig. 3. This Tharu woman collected snails and mussels from Mohana River far from her own village, Thapapur. (Photo: Prem Budha)

Fig. 4. Typical fishing and shellfish collection techniques of Tharu people, Kailali, with one of a few remaining individuals of *Lamellidens jenkinsianus.* (Photo: Prem Budha)

The wetlands of Tarai face tremendous pressures from encroachment, conversion, dredging, fishing, poisoning, eutrophication and overexploitation (Khatri, 2013). Lakes and ponds have become marshes ("ghols") or swamps because of siltation and plant succession in many places in Tarai (Jha, 2008).

This work presents the current status of freshwater molluscs briefly. In total, 14 species (11 gastropods, 3 bivalves) were identified in this study. Most of the 50 respondents interviewed in the study area have observed the decline of edible freshwater snails (*Bellamya* spp., *Pila globosa*) and mussels (*Lamellidens* spp., *Parreysia* spp.) (Fig. 4). Their views were verified by rapid assessment of 73 lakes that found just few individuals of large bivalves in only five lakes (Ghodaghodi, Nakrodi, Dhongrahuwa, Ghodtal and Laukabhoka). This is a result of habitat loss and improper management of lakes for fish farming as well as other natural and human-influenced disasters such as flooding, drought and siltation. Evidence of fish poisoning and direct application of pesticide (e.g. malathion) in one lake was observed. Two years

ago an unknown person poured poison into Puraina lake (there are about half a dozen lakes with this name) of Ramshikharjhala. This action killed everything in the lake and not a single individual of any mollusc or fish species was observed in this survey.

Poor management practices, such as intentionally drying lakes every year by pumping water out, destroy the natural habitat of freshwater molluscs. In addition, liming without monitoring water pH and adding salt, urea, mustard cake and rice hay to reduce acidification alter the natural substrates required for snails and mussels. A quick survey of the lakes reported the most common, occasional and rare edible species are *Bellamya bengalensis*, *Pila globosa* and *Lamellidens* spp., respectively. *Lamellidens* spp. have been lost completely from many lakes.

The impact of climate change plays a crucial role in destroying the freshwater habitats. The hot winds that were not known before 1950 in western Tarai (Sharma, 1979) are now common in every hot season. Twenty-six major events of floods, cloudbursts, glacial lake outburst floods, infrastructure failure outburst floods and landslides have been recorded between 1958 and 2013 (Paudel *et al*., 2013). Five winter droughts have been reported since 1966 (as monthly precipitation lower than 10 mm, i.e. in 1966/67, 2005/06, 2007/08, 2008/09, and 2009/10), four occurring after 2005 (Wang *et al*., 2013) alone. These kinds of climate change patterns have a direct impact on freshwater bodies. One large lake (Puraina lake in Bhajani-Trishakti Municipality-1), with an area of >100 ha, was flooded by the Mohana River in 2008. Now the lake has been encroached on by local farmers for cultivation and there is no sign of the natural lake. Some other small but permanent lakes (e.g. Thanda Chatiya, Kotatulsipur Village Development Committee-5) that were primarily used for drinking water for cattle and collecting edible molluscs have now been converted into grazing land. Fifteen to twenty years ago, a person could collect several buckets of snails and mussels in nearby water bodies. But people can hardly find such water bodies any more. Information on the impacts of climate change on freshwater biodiversity in Nepal is severely lacking. This study aims to develop baseline data for future monitoring of freshwater mollusc populations of economic importance.

This article is based on research supported by the Nepal Academy of Science and Technology under the Climate Change Research Grants Program, which is part of the Mainstreaming Climate Change Risk Management in Development project. It is a component of Nepal's Pilot Program for Climate Resilience and is executed by the Ministry of Science, Technology and Environment (Nepal), financed by Climate Investment Funds, administered by the ADB with technical assistance from ICEM, METCON and APTEC.

Bhuju, U.R., Khadka, M., Neupane, P.K. & Adhikari, R. 2010. A map based inventory of lakes of Nepal. *Nepal Journal of Science and Technology* 11: 173-180.

Bogan, A.E. 2008. Global diversity of freshwater mussels (Mollusca, Bivalvia) in freshwater. *Hydrobiologia* 595: 139-147.

Carpenter, S.R., Stanley, E.H. & Zanden, J.V. 2011. State of the world's freshwater ecosystems: physical, chemical, and biological changes. *Annual Review of Environment and Resources* 36: 75-99.

Dudgeon, D., Arthington, A.H., Gessner, M.O., Kawabata, Z.I., Knowler, D.J., Lévêque, C. & Sullivan, C.A. 2006. Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological Reviews* 81(2): 163-182.

Glöer, P. & Bössneck, U. 2013. Freshwater molluscs from Nepal and North India with the description of seven new species (Gastropoda: Bithyniidae, Lymnaeidae, Planorbidae). *Archive für Molluskenkunde* 142(1): 137-156.

Jha, S. 2008. Status and conservation of lowland Terai wetlands in Nepal. *Our Nature* 6: 67-77.

Khatri, T.B. 2013. Wetlands, biodiversity and climate change. *The Initiation* 5: 138-142.

Paudel, P., Regmee, S.B. & Upadhyay, S.N. 2013. Overview of June 2013 flood and landslides with focus on Darchula disaster. *Hydro Nepal* 13: 56-63.

Sharma, C.K. 1979. Partial drought conditions in Nepal / Les conditions de sécheresse partielle en Nepal. *Hydrological Sciences Bulletin* 24(3): 327-333.

Strong, E.E., Gargominy, O., Ponder, W.F. & Bouchet, P. 2008. Global diversity of gastropods (Gastropoda; Mollusca) in freshwater. *Hydrobiologia* 595: 149-166.

Subba, B.R. 2003. Molluscan checklist of Ghodaghodi Tal area, Kailali District. *Our Nature* 1: 1-2.

Subba, B.R. 2012. Impact of climate change on food value of molluscs in Nepal. *Nepalese Journal of Biosciences* 2: 98-108.

Wang, S.-Y., Yoon, J.-H., Gillies, R.R. & Cho, C. 2013. What caused the winter drought in western Nepal during recent years? *Journal of Climate* 26: 8241-8256.

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MEGALOBULIMUS PARANAGUENSIS AND *ACHATINA FULICA*: A GOOD MODEL FOR STUDIES OF THE CONSERVATION OF NATIVE FAUNA AND INTERACTIONS WITH ALIEN SPECIES

By Marcel Sabino Miranda & Iracy Lea Pecora

Megalobulimus paranaguensis (Pilsbry & Ihering, 1900) (Fig. 1A) is among the largest snails in Brasil. Little is known about its populations in Brasil, but it is probably threatened by habitat alteration and introduction of alien species. Recently, its occurence was reported on Ilha Porchat, in São Vicente, São Paulo State (Miranda *et al*., 2015). In this area, there is a population the giant African snails, *Achatina fulica* Bowdich, 1822 (Fig. 1B). Studies were conducted with both species, based at the Biosciences Institute of São Paulo State University Coastal Campus, to understand better the interactions between them and to provide useful information for management of the alien species and conservation of the native species.

Miranda *et al.* (2015) analysed the population structure of both species on Ilha Porchat, and interactions between them by spatial niche overlap analysis. *Megalobulimus paranaguensis*

Fig. 1. A–*Megalobulimus paranaguensis*; B–*Achatina fulica*.

showed a reduced life span when compared with a nearby population in Santos City, but no interactions were detected between it and *A. fulica* in the niche overlap analysis. In a laboratory study, Miranda & Pecora (in press) analysed the behavioural interactions between *M. paranaguensis* and *A. fulica* and showed that *A. fulica* becomes more active than usual in the presence of *M. paranaguensis*, but that there is no effect on *M. paranaguensis*. The conclusions of both studies are that the main factor possibly affecting *M. paranaguensis* is environmental modification and the efforts to control *A. fulica*. The authors also suggested that efforts to conserve *M. paranaguensis* should be intensified and should focus on education regarding the importance and current status of terrestrial molluscs.

To disseminate knowledge about the species, an environmental education project was conducted in the region's elementary schools (Pecora & Miranda, 2014). This project used live specimens, shells, eggs and information on both species and the environmental problems involving them. There was great interest from the students both in the specific subject and in the overall environmental problems. The project also helps to strengthen the bonds between IB/CLP and the surrounding community. In addition, a nursery of *M. paranaguensis* was created in IB/CLP-UNESP. At present there are 59 individuals and there have been 46 births (Pecora *et al*., 2015). The next steps for the nursery are the establishment of the F2 generation and reintroduction into the natural environment.

These species are relatively easy to keep in a controlled environment for observation, which allows various types of studies, including studies of reproductive and foraging behaviour. Keeping the two species in captivity also allows us access to animals for use in environmental education and behavioural testing, contributing to a better understanding of the interactions between these species and of their basic biology. This is important for developing actions in support of population growth in *M. paranaguensis* and effective control efforts against populations of alien species.

Miranda, M.S. & Pecora, I.L. 2016. Conservation implications of behavioural interactions between the Giant African Snail and a Native Brazilian species. *Ethology, Ecology & Evolution* in press.

Miranda, M.S., Fontenelle, J.H. & Pecora, I.L. 2015. Population structure of a native and an alien species of snail in an urban area of the Atlantic Rainforest. *Journal of Natural History* 49(1/2): 19-35.

Pecora, I.L. & Miranda, M.S. 2014. Salvando e aprendendo com *Megalobulimus*. *Revista Ciência em Extensão* 10(1): 72-82.

Pecora, I.L., Correia, L.V.B. & Miranda, M.S. 2015. Salvando e aprendendo com *Megalobulimus*: uma análise da evolução do projeto e das pesquisas envolvidas. In: *Anais do 8° Congresso de Extensão da UNESP*, 6 p. UNESP, São Paulo.

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RESEARCH AND CONSERVATION OF MOLLUSCS IN SANTA CATARINA STATE, CENTRAL SOUTHERN BRASIL, AFTER 20 YEARS OF SYSTEMATIC ACTIVITIES

By A. Ignacio Agudo-Padrón

After 20 years of systematic research and monitoring, since 1996, the inventory of molluscs in the small central southern Brasilian state of Santa Catarina comprises a confirmed total of 891 species and subspecies. Of these, 671 are marine taxa, including 11 Polyplacophora, 400 Gastropoda, 10 Scaphopoda, 226 Bivalvia (4 non-native) and 24 Cephalopoda (Agudo-Padrón, 2015); 220 are non-marine taxa, of which 150 are terrestrial, including 16 non-native and 26 endemic gastropods, 70 are freshwater, including 30 bivalves (3 non-native) and 40 gastropods (5 non-native), and 2 are amphibious gastropods (Agudo-Padrón, 2014).

Traditionally, research on molluscs in Santa Catarina state has focused almost entirely on development of commercial cultivation of marine species (non-natives and natives). Other general aspects of their biology are practically ignored and/or relegated to the background.

Regional indifference to other molluscs is clearly reflected in 1) the total lack of curators and of very few regional representative institutional mollusc collections in the state, with these in dubious, precarious and restricted conditions, and 2) lack of incentives and/or academic motivation, for example for development of expert researchers and research programmes in this field of regional zoology, other than in the mariculture sector. These factors, consequently, are directly reflected in the lack of knowledge of the current conservation situation.

Finally, however, there are researchers with an interest in developing some more specific and focused studies of the local malacofauna (Fig. 1), particularly in the specific geographic and ecological region of the Itajaí Valley (Fig. 2), the largest river basin of the Atlantic slope in Santa Catarina (Colley, 2015).

Research into the conservation status of mollusc biodiversity in the state of Santa Catarina is necessary in view of the rapid

Fig. 1. Some native micro-gastropods of the forest soil in Serra da Leoa, Rodeio Municipal District (Middle Itajaí Valley), Santa Catarina state. Clockwise from top left: *Zilchogyra clara* (Thiele, 1927) (Charopidae), *Lamellaxis* (*Leptopeas*) *mizius* Marcus & Marcus, 1968 (Subulinidae), *Tamayoa* cf. *banghaasi* (Boettger in Thiele, 1927) (Systrophiidae) and *Adelopoma brasiliense* Morretes, 1953 (Diplommatinidae). (Photos: Ana Elisa Zermiani and Luís Adriano Fúnez, FURB/Blumenau, SC)

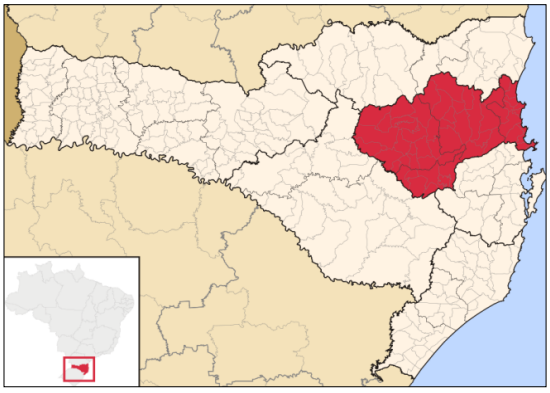

Fig. 2. The Itajaí River Basin Valley region (red) in Santa Catarina state. Inset: location of Santa Catarina in Brasil.

changes taking place to the natural environment as a result of human activities and the parallel rapid process of invasion by alien species. In depth studies of the basic population biology and reproductive cycles of the molluscs are urgently needed, in addition to middle- and long-term ecological research.

For more complete and detailed information, please contact the author of this report.

Agudo-Padrón, A.I. 2014. Inventario sistemático de los moluscos continentales ocurrentes en el Estado de Santa Catarina, Brasil. Inventário sistemático dos moluscos continentais ocorrentes no Estado de Santa Catarina, Brasil. *Bioma* 21: 6-23.

Agudo-Padrón, A.I. 2015. Inventario sistemático revisado y actualizado de los moluscos marinos ocurrentes en el Estado de Santa Catarina, Brasil. *Revista Brasileira de Gestão Ambiental e Sustentabilidade* 2: 59-75.

Colley, E. 2015. Macroecologia dos gastrópodes terrestres em um trecho de floresta atlântica do sul do Brasil. *Resumos XXIV Encontro Brasileiro de Malacologia/ EBRAM*: 42.

A. Ignacio Agudo-Padrón, Project "Avulsos Malacológicos – AM", P.O. Box 010, 88010-970 Centro, Florianópolis, Santa Catarina - SC, Brasil. ignacioagudo@gmail.com
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CONSERVATION OF ENDEMIC MOLLUSCS IN THE SOUTHERNMOST REGION OF BRASIL: FIRST CONFIRMED RECORD OF THE ALIEN SNAIL *ACHATINA FULICA* IN THE PAMPAS BIOME

By A. Ignacio Agudo-Padrón

The Pampas biome is the last terrestrial ecological frontier of the Brasilian territory. Located in Rio Grande do Sul state, southernmost Brasil, this fragile and restricted environment (also known as "Southern Fields") is shared with the neighbouring countries of Uruguay and Argentina (Fig. 1).

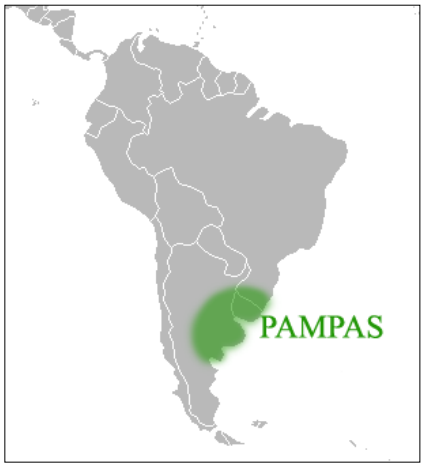

Fig. 1. Location of the Pampas biome in South America.

This habitat of rare species of endemic land molluscs, among them the very little known or studied native giant snail *Megalobulimus proclivis* (Martens, 1888) (Fig. 2), has suffered severe, diverse and intensive soil use from extensive human interventions. This is reflected in the impacts on the local malacofaunal diversity (Agudo-Padrón, 2015).

In addition to these factors, there has been a parallel and alarming spread of diverse invading alien molluscs. For the greater Porto Alegre metropolitan region, for example, a total of 70 molluscs are known today, including 46 gastropods (26 freshwater). Of these, 14 (20 %) are alien species: 1 freshwater and 10 terrestrial Gastropoda and 3 freshwater Bivalvia.

In July 2015, another alien gastropod became part of this regional statistic: the occurrence of the giant African snail *Achatina fulica* Bowdich, 1822 was confirmed by us for the first time in the greater Porto Alegre area, part of the Pampas biome environment. This adds to the known geographic distribution of non-marine molluscs in Rio Grande do Sul state

and southernmost Brasil in general (Agudo-Padrón, 2015). It generally takes advantage of the empty space left by native snails that have been displaced by human activities and occurs sympatrically with other alien molluscs that are already dominant invaders in the region, such as the European edible snail *Cornu aspersum* (Müller, 1774) (Fig. 3).

Fig. 2. The rare native giant snail *Megalobulimus proclivis* (Martens, 1888).

Fig. 3. Giant African snail *Achatina fulica* Bowdich, 1822 found in sympatry with the European invader *Cornu aspersum* (Müller, 1774), in the industrial district of Cachoeirinha, Rio Grande do Sul state.

This brief report covers the first geographical record of the giant African snail *Achatina fulica* Bowdich, 1822 in Brasil in the greater Porto Alegre region. There it coexists in sympatry with the traditional regional dominant European invader species *Cornu aspersum* (Müller, 1774) and other alien species. It is currently found in urban areas, particularly the industrial district of Cachoeirinha city and municipality, which is naturally part of the Pampas biome, supporting the biogeographic model of potential distribution in South America formulated for this species (Barrero *et al*., 2009).

For more complete and detailed information, please contact the author of this report.

Agudo-Padrón, A.I. 2015. The precarious official conservation status of molluscs in the states of Santa Catarina and Rio Grande do Sul, southern Brasil. *Tentacle* 23: 19-20.

Borrero, F.J., Breure, A.S.H., Christensen, C.C., Correoso, M. & Mogollón Avila, V. 2009. Into the Andes: three new introductions of *Lissachatina fulica* (Gastropoda, Achatinidae) and its potential distribution in South America. *Tentacle* 17: 6-8.

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FRESHWATER MOLLUSC DECLINES, LOCAL EXTINCTIONS AND INTRODUCTIONS IN FIVE NORTHERN CALIFORNIA STREAMS.

By Edward J. Johannes & Stephanie A. Clark

In 1991 a train derailment caused the release of a large quantity of herbicide (the Cantara spill) into the upper Sacramento River in northern California almost entirely extirpating the molluscs in the river above Shasta Lake. From 1992 to 1996 Deixis Consultants conducted extensive surveys for aquatic molluscs as part of an overall environmental assessment of the impacts of the spill on the aquatic ecosystem (Frest & Johannes, 1993, 1994, 1995, 1997). Deixis also conducted surveys of the adjacent Klamath River, Eagle Lake and Willow Creek (Honey Lake) drainages in the late 1990s to early 2000s. In 2012 and 2013, the authors had the opportunity to revisit and conduct equivalent surveys of a number of previously sampled sites in the Sacramento River, Klamath River, Willow Creek (Honey Lake) and Eagle Lake basins. We also sampled a few sites within the Scott River drainage that had not been previously surveyed by Deixis. The results of our surveys show declines, local extinctions and new occurrences of introduced species in five northern California streams (Willow Creek, Pit, Shasta, Scott and Klamath rivers) (Fig. 1; Table 1).

In our most recent surveys we found three species of introduced freshwater molluscs (none seen in the 2012 sites covered here). Two of them, *Radix auricularia* and *Corbicula fluminea*, had been found in the earlier surveys, while *Potamopyrgus antipodarum* had not (Table 1). *Radix auricularia* had been found in previous surveys at three of the revisited sites (Willow Creek, Klamath and Shasta Rivers) but we only found living specimens in the Klamath River at the

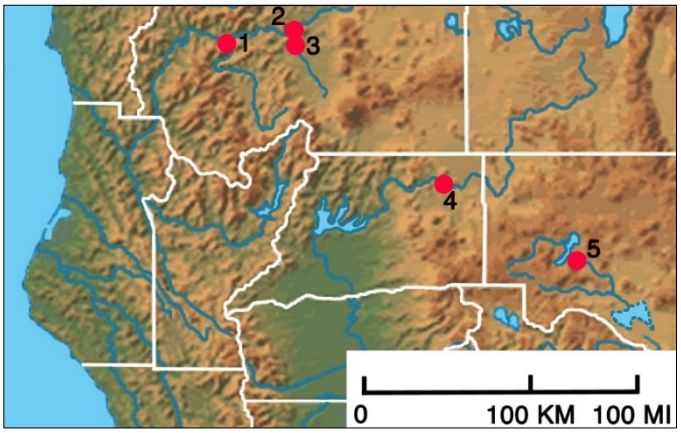

Fig. 1. Site locations in northern California. 1–Scott River; 2–Klamath River; 3–Shasta River; 4–Pit River; 5–Willow Creek.

Randolph E. Collier Rest Area just downstream of the Interstate 5 (I-5) bridge crossing. However, we found *R. auricularia* at a number of other sites not discussed here in northern California and southern Oregon and it appears to be rapidly expanding its range throughout the western USA (personal observations of the authors). During the extensive surveys conducted by Deixis from 1993 to 1996, no populations of *Corbicula fluminea* were found in the upper Sacramento River system except in Shasta Lake in 1992. It was first reported in the Pit River in 2001 (USGS, 2015). Since then it has spread extensively in the Pit River system (pers. comm. Maria Ellis, 2013). *Corbicula* also appears to be expanding its range into a new river system as we record it for the first time from the Klamath River at the rest area. The first report of *Potamopyrgus antipodarum* in the upper Sacramento system was in the Pit Arm of Shasta Lake in 2007 (USGS, 2015). In 2013 we found *Potamopyrgus* for the first time in the Pit River above Shasta Lake at a fishing access under the State Route (SR) 299 bridge. *Potamopyrgus* was first noted at a lower Klamath River boat ramp in 2008 and in 2013 by us at the Randolph E. Collier Rest Area in the upper middle Klamath River (USGS, 2015).

We also noted a decline in the overall abundance and diversity of freshwater molluscs at four of the previously sampled sites (Table 1). Two species found in 2002, *Fluminicola* n. sp. 1 (Klamath pebblesnail), a Federal Survey and Manage species designated under the Northwest Forest Plan (Fig. 2; USDA & USDI, 1994), and *Juga shastaensis*, were not seen in the Klamath River at the Randolph Collier Rest Area in 2013. *Vorticifex effusa* and *Lanx alta*, two other cold-water sensitive species, continue to exist there but in very much reduced numbers. In the lower Shasta River about 2 km upstream of its junction with the Klamath River, we observed a significant decline in the molluscan fauna. Compared with the 1993 survey, in 2013 we found only four of the eleven formerly recorded species still living; of the others we only found long dead specimens in flood debris along the banks of the river (Table 1). Another site where we saw a significant decline in abundance and diversity from earlier surveys was at Willow Creek in the Honey Lake drainage (Great Basin), about 3.5 km south of Murrers Upper Meadow (spring source of the creek). In 2012 we found only three of the nine previously recorded

Fig. 2. *Fluminicola* n. sp. 1 (Klamath pebblesnail), a Federal Survey & Manage species. Occurrence in the Klamath drainage basin shown in red. Shell height: photo 8.6 mm; drawing 8.4 mm. (Photo: T. Frest © Deixis Consultants; drawing: E. Johannes © Deixis Consultants)

species still living. In 2001, this site had a healthy population of *Anodonta nuttalliana* but we only found a few fragmentary valves. The once large population of *Juga acutifilosa* has also suffered a major decline, as we found hundreds of dead shells and only a small number of living individuals compared with previous samplings. An undescribed *Fluminicola* collected during the earlier survey from this site we found to be absent, but it still occurs in springs upstream, as does *Juga acutifilosa*.

In 2013, we sampled the Scott River near its junction with the Klamath River and saw only *Physella* along the river margin. But in a groundwater influenced, bedrock lined, side channel under the SR 96 bridge, we found a remnant mollusc fauna that included *Juga shastaensis*, *Margaritifera falcata* and *Anodonta nuttalliana*, as well as *Lanx alta*, *Gyraulus parvus*, *Planorbella tenuis*, *Haitia mexicana* and *Gonidea angulata*. Upstream of this site the river and tributaries were substantially reduced or dry from a combination of a number of factors including water diversions, extensive groundwater extraction for irrigation and a prolonged drought (Fig. 3).

The cause of the observed declines in the Pit and Klamath River sites is not as clear-cut as in the Scott River. We have learned subsequently that the Shasta River, like the Scott

Fig. 3. The dry Scott River in 2014. Note vehicle tracks in the riverbed and fields being irrigated. (Photo: Klamath RiverKeeper).

Table 1. Comparison of the mollusc fauna collected over a decade apart at four northern California streams.

Scientific Name	Klamath River		Shasta River		Pit River		Willow Creek	
	2002	2013	1993	2013	2001	2013	2001	2012
Fluminicola n. sp. 1[1]	x							
Fluminicola n. sp.							x	d
Fluminicola seminalis					x	x		
Potamopyrgus antipodarum[2]		x				x		
Juga acutifilosa							x	x
Juga occata					x	x		
Juga shastaensis	x		x	d				
Vorticifex effusa	x	x	x	d	x	x	x	d
Gyraulus parvus	x	x	x	d	x	x	x	
Planorbella tenuis			x	d			x	x
Galba parva					x	x		
Lymnaea stagnalis							x	x
Lanx alta	x	x	x	d				
Lanx patelloides					x	x		
Radix auricularia[2]	x	x	x	d			x	d
Haitia mexicana	x	x						
Physella gyrina	x	x	x	x	x	x	x	
Pisidium spp.			x	x				
Pisidium lilljeborgii	x	x	x	x				
Pisidium nitidum	x	x	x	x				
Pisidium ultramontanum					x	x		
Sphaerium patella	x	x						
Sphaerium striatinum	x	x						
Anodonta nuttalliana					x	x	x	d
Gonidea angulata	x	x	x	d	x	x		
Corbicula fluminea[2]		x				x		
Total Native (live)	**12**	**10**	**10**	**4**	**10**	**10**	**8**	**3**
Total Introduced (live)	**1**	**3**	**1**	**0**	**0**	**2**	**1**	**0**

[1] Klamath pebblesnail, federal Survey & Manage species (USDA & USDI, 1994); [2] introduced species; x live; d dead shells only

River, had reached an all-time low flow in 2009. It was dewatered by a combination of drought and over-allocation of agricultural water diversions. As a result, the mollusc fauna has declined sharply. The reduction in flows and the increase in nutrients from agricultural and urban runoff in the drainage have clearly impacted the water quality and aquatic ecosystem of the Klamath River. At Willow Creek, an additional factor affecting this site is cattle grazing.

The Klamath River drainage had one of the most productive salmon fisheries on the west coast of the USA. In recent years there has been a concerted effort to restore the salmon runs by State and Federal agencies, but despite this, irrigators have continued unimpeded leading to substantial reduction of flows in the Scott River and more recently the Shasta River. Our 2012 and 2013 surveys have demonstraated the current dire condition of molluscs in the Klamath drainage and elsewhere in northern California. Recoveries for some species (e.g. *Lanx alta* and *Juga shastaensis*) in the Shasta River are unlikely, as currently no upstream populations are known. *Fluminicola* n. sp. 1 is an endemic species found in a small portion of the Klamath River system, occurring most abundantly in the Upper Klamath Lake (UKL) basin, Oregon (Fig. 2). But even here it is threatened by groundwater withdrawal. By 2014 the pre-2001 groundwater levels in the UKL basin had declined by about 6.1-7.6 m (Gannett & Breen, 2015). One of us (SC) has seen evidence of the impact from groundwater withdrawal in this basin at Big Springs, which was almost dewatered in 2013. This is one of the larger springs in the UKL basin and is used as a water source by the city of Bonanza. Three springsnail species (*Pyrgulopsis* n. sp. 2 and *Fluminicola* n. spp. 8 and 42) were found in this spring (Frest & Johannes, 1998). Impacts of groundwater withdrawal on other springs or streams in the UKL region are unknown. Despite obvious threats to *Fluminicola* n. sp. 1, this species along with other molluscs was recently rejected for listing under the Endangered Species Act (USFWS, 2012; Johannes, 2013). The demise of the *Anodonta nuttalliana* population in Willow Creek and *Gonidea angulata* in the Shasta River continues a decline seen in unionid populations in California (Howard *et al*., 2015).

Our brief surveys have shown that there is a strong need to monitor the status of freshwater mollusc populations in the western USA. This is especially true now as the region has been enduring a prolonged drought and reduced snow pack while at the same time experiencing an unsustainable increase in groundwater extraction and water diversions.

We thank Richard Lis, California Department of Fish and Wildlife, Redding, for accompanying us in the field in 2013, Maria Ellis, Spring Rivers Ecological Sciences LLC, Cassell, for specimens from and discussions on molluscs in the Pit River and Kerul Dyer, Klamath Riverkeeper, Somes Bar, for photos of the Scott River.

Frest, T.J. & Johannes, E.J. 1993. Freshwater molluscs of the Upper Sacramento System, California, with particular reference to the Cantara Spill. 1992 yearly report to California Department of Fish and Game, Redding, California. iv + 101 p., appendices.

Frest, T.J. & Johannes, E.J. 1994. Freshwater molluscs of the Upper Sacramento System, California, with particular reference to the Cantara Spill. 1993 yearly report to California Department of Fish and Game, Redding, California. ii + 57 p., appendices.

Frest, T.J. & Johannes, E.J. 1995. Freshwater molluscs of the Upper Sacramento System, California, with particular reference to the Cantara Spill. 1994 yearly report to California Department of Fish and Game, Redding, California. Deixis Consultants. iii + 88 p., appendices.

Frest, T.J. & Johannes, E.J. 1997. Upper Sacramento System freshwater mollusks monitoring, California. 1996 yearly report to Cantara Trustee Council, Redding, California. Deixis Consultants. iii + 39 p., appendices.

Frest, T.J. & Johannes, E.J. 1998. Freshwater mollusks of the Upper Klamath Drainage, Oregon. 1998 yearly report to Oregon Natural Heritage Program, Portland, Oregon, and Klamath Project, U.S. Department of the Interior, Bureau of Reclamation, Klamath Falls, Oregon. Deixis Consultants. vii + 200 p., appendices.

Gannett, M.W. & Breen, K.H. 2015. Groundwater levels, trends, and relations to pumping in the Bureau of Reclamation Klamath Project, Oregon and California. *U.S. Geological Survey Open-File Report* 2015-1145. iv + 19 p.

Howard, J.K., Furnish, J.L., Brim Box, J. & Jepsen, S. 2015. The decline of native freshwater mussels (Bivalvia: Unionoida) in

California as determined from historical and current surveys. *California Fish and Game* 101: 8-23.
Johannes, E.J. 2013. U.S. Fish and Wildlife Service rejects 14 of 26 Pacific Northwest snails and slugs proposed for listing and sets a dangerous precedent. *Tentacle* 21: 23-26.
USDA & USDI. 1994. *Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the Northern Spotted Owl. Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the Northern Spotted Owl.* U.S. Forest Service, Portland, Oregon. ii + 74, viii + 144 p.
USFWS. 2012. Endangered and threatened wildlife and plants; 12-month finding on a petition to list 14 aquatic mollusks as endangered or threatened; proposed rule. *Federal Register* 77: 57922-57948.
USGS. 2015. NAS-Nonindigenous Aquatic Species.

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MOLLUSCS ASSESSED BY COSEWIC IN 2015

By Dwayne A.W. Lepitzki & Joseph P. Carney

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is the independent body of conservation experts that assesses the conservation status of species using IUCN criteria and recommends listing and legal protection under the Canadian Species at Risk Act (see *Tentacle* 21 for details). The Act requires at-risk species to be reassessed every 10 years. In 2015 one mollusc species was downlisted to a lower at-risk category while another was assessed for the first time.

The rainbow mussel (*Villosa iris*) (Fig. 1), a freshwater mussel confined in Canada to southern Ontario, was originally assessed as Endangered in April 2006 but was reassessed and downlisted to Special Concern in November 2015. In the intervening years since the previous assessment additional searches have revealed large numbers of this species in previously unknown locations, especially in the headwaters of some larger rivers. Previously, these areas were not known to contain suitable habitat for these mussels. Six of the seven Canadian subpopulations show signs of recent recruitment but small subpopulations in the Ausable River and Lake St. Clair are continuing to decline. Historical subpopulations in the Detroit and Niagara rivers, shared with the United States, were lost due to invasion by dreissenids (zebra mussel *Dreissena polymorpha* and quagga mussel *D. rostriformis bugensis*). While these headwaters are upstream of the dreissenid invasion, they are still prone to the effects of household, urban and agricultural pollution and potentially, to a new threat, an invasive fish, the round goby (*Neogobius melanostomus*). While healthy subpopulations of this species have been discovered, rainbow mussels are still considered to be of conservation concern because of these ongoing threats.

Fig. 1. A live rainbow mussel (*Villosa iris*) from the Thames River, Ontario. (Photo: Fisheries and Oceans Canada)

The new species added to the COSEWIC list is the proud globelet (*Patera pennsylvanica*). In Canada, this large terrestrial snail (shell diameter up to 2 cm) is known only from a wooded urban park near Windsor, Ontario. Freshly dead snails were initially found in this park in 1992 and 1996 (Fig. 2) but by 2013, only dead, weathered shells were collected. While the causes of decline or possible disappearance of the species may never be known, human intrusions and disturbances from recreational activities, ecosystem modifications from invasive plants and animals, the surrounding urbanization, pollution from local and regional sources and climate change may all have been involved. It also appears that another native land snail, the whitelip snail (*Neohelix albolabris*), disappeared from the same area at the same time.

Including these two species in 2015, the total number of at-risk molluscs assessed by COSEWIC increased to 36. One is Extinct, two are Extirpated, 20 are Endangered, four are Threatened and nine are of Special Concern. Two additional

Fig. 2. Proud globelet (*Patera pennsylvanica)* shell collected by Michael J. Oldham near Windsor, Ontario, Canada, on 19 April 1996 (CMNML 096170). (Photo: Robert Forsyth)

molluscs have been assessed as Not at Risk and another five as Data Deficient by COSWIC.

More information on COSEWIC can be found at http://www.cosewic.gc.ca. Status reports will be available on the SARA Public Registry.

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REQUIEM FOR *MELANOPSIS PARREYSSII* OR THE ANATOMY OF A NEW EXTINCTION IN ROMANIA

By Ioan Sîrbu & Ana Maria Benedek

In north-western Romania several small thermal spring-fed lakes and creeks suported, until recently, rare, endemic or relict species, including freshwater gastropods. Although the habitats were scattered and reduced, and exposed during the turbulent history of the area to severe human impact, they still supported remarkable communities. However, this has changed, especially during the last two decades, characterized by huge political and economic changes, but also by disrespect for the law and common sense.

As stated by Sîrbu & Benedek (2009), until 2005 the relict, endangered and extremely rare species *Theodoxus prevostianus* (C. Pfeiffer, 1828) could still be found in two short mesothermal rivulets in north-western Romania, close to the village of Răbăgani. There it lived with other remarkable species, notably a melanistic form of the relict *Microcolpia daudebartii acicularis* (Férussac, 1823). Although a nature reserve was declared in the area, nothing was really done to maintain the habitats and the communities they sheltered. In one of these creeks, *Theodoxus prevostianus* has disappeared because of a slow process triggered by water-drainage, concrete works and pollution. In the second habitat (and the last in Romania), its fate was decided by an opportunistic and illegal event. Sîrbu & Benedek (2009), wrote that "in June 2006 the firm S.C. D.R. Mayer Impex S.R.L. began capturing the Tina cea Rea mesothermal rivulet and digging in order to create fishponds for breeding sturgeon. The company had permission from the local town hall that owned the land, but none of the other legally required permits." No environmental or other legal permit was held by this firm, and the rest of the story is briefly described by the above authors. Therefore *Theodoxus transversalis* was declared extinct in Romania. In December 2015 we have found that another firm built a sturgeon farm in the same area (Fig. 1), capturing the thermal waters from what was the last remaining habitat.

Microcolpia daudebartii acicularis is still present in one of the former habitats, but is extremely endangered because the land was retroceded to a villager who does not consider it to be part of the nature reserve and has offered it for sale to exploit the rest of the former thermal creek. Considering thermal waters

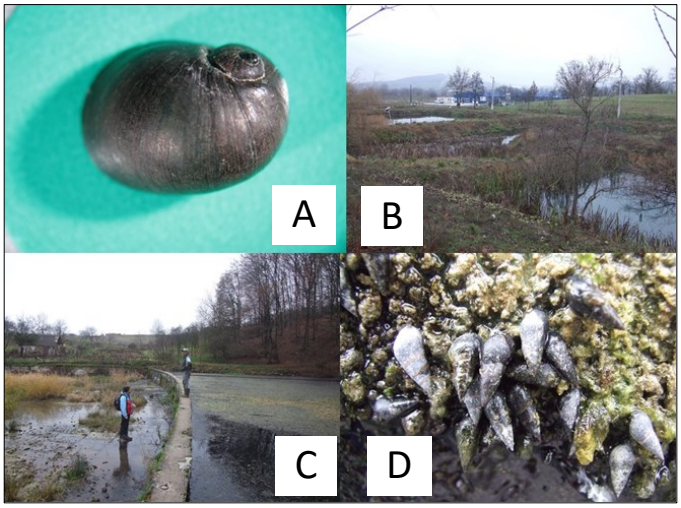

Fig. 1. In north-western Romania, in two former meso-thermal water rivulets: *Theodoxus transversalis* (A) lived up to 2005. It became extinct because of illegal fish-ponds built in its former range (B), or water capture and habitat changes in the former nature reserve areas (C), that are now private property. A local, relict and isolated population of *Microcolpia daudebartii acicularis*, the last remnant of the former community, is still striving to survive (D). (Photos B, C and D taken in December 2015).

as personal goods and using these resources only for commercial benefit is an extremely narrow way to consider the value of these rare and unique habitats. Declaring nature reserves or other protected areas, and undertaking nothing afterwards in order to preserve them, is also useless. What took thousands of years to evolve, has vanished in a few years. The inability of authorities to prevent, stop or restore the nature preserve is obvious.

The story of another thermal lake and its inhabitants was the theme of a recent note (Sîrbu *et al*., 2013) that drew attention to a unique habitat, Pețea Lake (Fig. 2) and its communities, including one endemic gastropod, that are on the brink of extinction. Also in Bihor county, close to Oradea, lies the Mai

Fig. 2. The nature reserve and Site of Community Interest Pețea Lake about a decade ago. Inset: *Melanopsis parreyssii* was a local endemic species inhabiting the lake until recently.

Baths (also known as Băile Episcopiei, Püspökfürdő, in Hungarian, or Bischofsbad, in German). Here a rich geothermal aquifer sustained until recently a lake and a rivulet declared a nature reserve and a Natura 2000 Site of Community Importance. There were lakes and creeks fed by thermal springs, forming the only habitat in Europe where the Egyptian white water-lily (*Nymphaea lotus thermalis* Tuzson, 1907) naturally grew, and two local endemic species used to occur, the fish *Scardinius racovitzai* Müller, 1958 and the snail *Melanopsis parreyssii* (Philippi, 1847). Because of the interest for and use of the geothermal waters in these area, increasing with the human population and its needs, the springs began to clog and the natural thermal lakes were reduced, up to the point where the only natural but shrinking lake that remained was Pețea (also known as the Ochiul Mare Lake on the Pețea rivulet). The demand for thermal resource use has increased exponentially during the last few years, with an exceptional increase in local buildings and tourist facilities. Sîrbu *et al*. (2013) stated that a great reduction of the thermal springs' flow and of the lake's water level and surface area ocurred in a short period of time, up to December 2011 when the spring of the Pețea Lake ceased activity.

Considering all these facts, Fehér (2013) listed *Melanopsis parreyssii* as Critically Endangered (B1ab[iii,v]+2ab[iii,v], v.3.1), a status still listed in the IUCN Red List of Threatened Species, version 2015-4. Sadly this status is now outdated.

All imaginable efforts were made by the dedicated specialists from the Crișurilor Country Museum in Oradea (Muzeul Țării Crișurilor, in Romanian) and their supporters. Specimens of endemic species were sent to leading experts and institutions from various countries in a last attempt to save these unique taxa. Water was (and still is) pumped to the lake from one of the drillings in the vicinity, in an extreme, artificial hope of curing the sick habitat with the cause of its disease. Illegal drillings were searched for and pressure was exerted in order to limit aquifer use. Scientific, conservation and management projects were developed and accomplished, some even as recently as in 2015, gathering experts and authorities, in order to find a solution. Most efforts were hindered, found little support or had little effect, but solutions were and are still searched for.

As was stated by Sîrbu *et al*. (2013), "all possible assistance, at the whole range of scales and fields of knowledge will be crucial to save these taxa, including the endemic snail *Melanopsis parreyssii* and its habitat, the thermal Peţea or Ochiul Mare Lake, and to save this heritage for further generations. There is Sisyphean work to be done in order to try, *in extremis*, to keep as much as possible of the former habitat and its unique species."

In the last two years the outcome for the three endemic species was different. In 2015, a few individuals of the plant species *Nymphaea lotus thermalis* still lived in the remnants of the lake, downstream in the thermal creek, and there is still some hope of maintaining the species *in situ*. It was also accommodated in several botanical gardens in other countries. Regarding the endemic fish species, to the best of our knowledge (A.A. Nagy, I. Imecs, pers. comm.), *Scardinius racovitzai* is no longer present in its natural habitat but there are hundreds of reproducing individuals, artificially maintained and reared, in Romania, Austria and Hungary. But the endemic gastropod *Melanopsis parreyssii* had a bitter fate. As A. Gagiu told us, most probably the end for this species was close in 2014, yet hope was still there. In 2015, we searched the remnants of the lake, as well as the whole surrounding area during July (Fig. 3), August (Fig. 4) and December (Fig. 5), but with no result.

Fig. 3. Pețea Lake in July 2015, reduced to a small pond because of thermal aquifer overexploitation. Inset: only empty shells of *Melanopsis parreyssii* can be found; the species became extinct during the last two years.

In the shrinking remnants of the former lake almost all known species of freshwater molluscs have disappeared, except for one, the invasive bivalve *Sinanodonta woodiana* (Lea, 1834), proving once again its high resilience and capacity to survive.

Only empty shells of *Melanopsis parreyssii* were found and the final act was to declare this species Extinct in the Wild.

Fig. 4. Pețea Lake in August 2015. The lake is still shrinking, although thermal water is (or is supposed to be) pumped through a hose coming from a neighbouring drill. Inset: the single mollusc species that managed to survive is the invasive bivalve *Sinanodonta woodiana.*

Fig. 5. In December 2015 only a ghost of the former lake is still present, evoking the insatiable human appetite for resources and its effects on nature.

Through the dedication of A. Gagiu, several individuals were sent to Hungary. According to T. Müller (pers. comm.), reproduction succeeded in the beginning, but after a while the population suffered high mortality. Groups of survivors were sent to other specialists, but with less success. There may be a few survivors, but with a highly uncertain fate. Even in the improbable event that some individuals will be able to survive, considering how the former lakes look now, returning them is probably impossible. During recent decades there were also other attempts to breed this species in natural or artificial thermal waters from Romania and Hungary, but with no success.

We had the misfortune to witness the extinction of two species, *Theodoxus prevostianus* (at the national level) and *Melanopsis parreyssii*, in less than a decade. Both cases have been triggered by the same urge to overexploit resources. Human greed comes first of all. Fish farms could be built elsewhere in the former case, and limiting drilling for thermal water should not be impossible. Alternative resources are readily available. Obviously, the small ranges and habitats, as well as the limited tolerance of the species to thermal conditions, have favoured the outcome. But effective protection of these tiny, special, sometimes unique habitats, is a challenge and tests the limits for conservationists. Hopefully something can be learned from these events.

We thank Mr. Adrian Gagiu for all the dedication, information and help as well as his colleagues from the Țării Crișurilor Museum in Oradea, Romania. The last field studies were mainly supported by Mr. Constantin Vezeanu, to whom we owe our sincere thanks.

Fehér, Z. 2013. *Melanopsis parreyssii*. The IUCN Red List of Threatened Species. Accessed 30 December 2015.

Sîrbu, I. & Benedek A.M. 2009. The extinction of *Theodoxus prevostianus* (C. Pfeiffer, 1828) (Mollusca: Gastropoda: Neritidae) in Romania. *Tentacle* 17: 19-21.

Sîrbu, I., Gagiu, A. & Benedek, A.M. 2013. On the brink of extinction: fate of the Peţea thermal lake (Romania) and its endemic species. *Tentacle* 21: 34-37.

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THE SECOND INTERNATIONAL MEETING ON BIOLOGY AND CONSERVATION OF FRESHWATER BIVALVES. BUFFALO, USA, 4-8 OCTOBER 2015

By Manuel Lopes-Lima, Alexander Karatayev, Lyubov Burlakova, Knut Mehler & Ronaldo Sousa

Freshwater bivalves have been highly threatened by human activities and recently their global decline has captured both conservation and social attention. For these reasons there has been an exponential growth of freshwater bivalve research, both in the fields of basic biology, ecology and physiology and also in applied conservation such as habitat restoration and propagation. However, these studies need to be integrated and the details accessible to all ecologists, conservation biologists and freshwater malacologists. This integration needs also to include managers, policy makers and other stakeholders to find and apply the best measures to conserve these animals and their natural habitats. The Freshwater Mollusk Conservation Society has played this role in North America, promoting research and awareness but also organizing periodic meetings and workshops. In other parts of the world, research efforts vary and integration and knowledge exchange are urgently needed. Trying to fill this gap a group of researchers coordinated by Manuel Lopes-Lima from the University of Porto aimed to organize a series of periodic meetings that would promote the interchange of ideas and data on an international level. In this context, the first International Meeting on Biology and Conservation of Freshwater Bivalves was organized in September 2012 in Bragança, Portugal, with a high level of success and participation of more than 100 researchers and conservationists from 22 countries. Since then, this international group of scientists has continued to meet periodically as part of other international meetings (e.g. the symposium on freshwater bivalve conservation at the World Congress of Malacology in the Azores, Portugal, in 2013, and the Congress of the European Malacological Societies in Cambridge, UK, in 2014). These efforts have been recognised by the IUCN, through the formal establishment of a working subgroup on freshwater bivalves that aims to promote the conservation of these taxa at a global scale. Already under the wing of this subgroup, the second International Meeting on Biology and Conservation of Freshwater Bivalves was magnificently hosted by Alexander Karatayev, Lyubov Burlakova and Knut Mehler from the Great Lakes Center of Buffalo State College on 4-8 October 2015 in Buffalo, USA.

The meeting brought together over 80 scientists from 19 countries and five continents (Europe, North America, South America, Asia and Australia) (Fig. 1). The 56 oral communications and 26 posters presented by senior and young

Fig. 1. Group photo of the meeting.

scientists covered diverse topics including biogeography, genetics, impacts of invasive species, physiology, systematics and taxonomy, parasitology, fish-host relationships and conservation and threats to species and ecosystems. Following this success, a third International Meeting on Biology and Conservation of Freshwater Molluscs is already being planned for 2018. This upcoming event is being discussed as a possible joint effort with the IUCN/SSC Mollusc Specialist Group and the Freshwater Mollusk Conservation Society and will also include freshwater gastropods.

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ARE MAJOR WATER IMPOUNDMENTS CONTRIBUTING TO FRESHWATER MOLLUSC KNOWLEDGE AND CONSERVATION IN BRASIL?

By Monica Ammon Fernandez & Silvana Carvalho Thiengo

The key energy source for Brasil is hydroelectric power and the increasing number of dams being built throughout the country is a problematic issue because the reservoirs not only create conditions suitable for the establishment of the mollusc transmitters of disease parasites but also lead to increased permanent human settlement and tourism (Leme, 2007; Lima & Batista, 2010). In the Serra da Mesa reservoir (UHE [Usina Hidrelétrica] Serra da Mesa), state of Goiás, Thiengo *et al.* (2005), based on surveys undertaken from 1997 to 2004, reported the spread of the schistosomiasis vector *Biomphalaria straminea* (Dunker, 1848) and the alien snail *Melanoides tuberculata* (Müller, 1774), as well as the decline of the native species *Gundlachia ticaga* (Marcus & Marcus, 1962) and *Aylacostoma tenuilabris* (Reeve, 1860). The Serra da Mesa reservoir is on the Tocantins river and covers an area of 1,784 km^2 and is bodered by eight municipalities (Barro Alto, Campinaçu, Campinorte, Colinas do Sul, Minaçu, Niquelândia, Santa Rita do Novo Destino and Uruaçu). The possibility of the spread of schistosomiasis in the area, a non-endemic region in Brasil, due the occurrence of the vector snails was reported by Fernandez & Thiengo (2002, 2010), who observed different degrees of susceptibility of *B. straminea* from two reservoirs when submitted to experimental infection by *Schistosoma mansoni* Sambon, 1907. Therefore, epidemiological surveillance, including freshwater mollusc surveys combined with parasitological examination was performed every two or three months until February 2015 (Fig. 1).

Fig. 1. Serra da Mesa reservoir, Goiás State.

Of the 28 species recorded in the UHE Serra da Mesa region by Thiengo *et al.* (2005), three are noteworthy when one analyses their occurrence throughout the period (1997-2015): *Biomphalaria occidentalis* Paraense,1981 (Fig. 2A), *B. intermedia* (Paraense & Deslandes, 1962) (Fig. 2B) and *Physa marmorata* Guilding, 1828 (Fig. 2C). The first was only observed in the municipality of Uruaçu (over 50 specimens) in November 1998 (two years after filling the reservoir began), on three tributaries of the Tocantins River: Mula River, Macacos River and Passa Três River. Subsequently, only six specimens of *B. occidentalis* were found in another tributary of the Tocantins River (Almas River): March 2001 (two specimens), November 2003 (one) and August 2011 (three). This decrease in distribution and abundance reflects the difficulty this species has to adapt to the lentic environment formed by the construction of the dam. Similarly, Fernandez *et al*. (2014) reported the occurrence of *B. occidentalis* in the

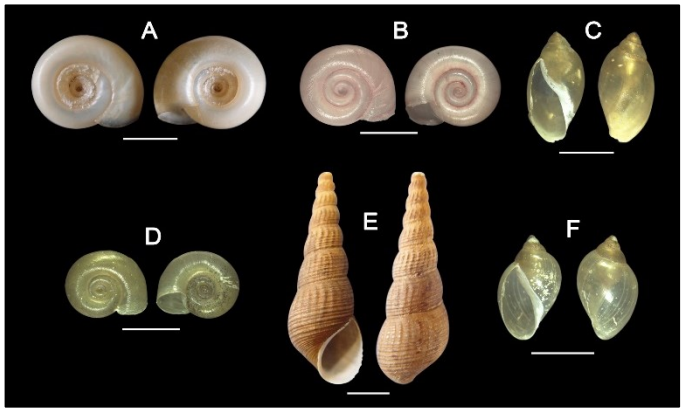

Fig. 2. Freshwater molluscs of the Serra da Mesa area, Goiás state. A–*Biomphalaria occidentalis*; B–*Biomphalaria intermedia*; C–*Physa marmorata*; D–*Biomphalaria straminea*; E–*Melanoides tuberculata*; F–*Physa acuta.* Scale bars: 5 mm.

reservoir of the Manso hydroelectric power plant (APM [Aproveitamento Múltiplo] Manso) in 2002 but did not find it subsequently, even after ten extensive searches between April 2009 and October 2010.

Biomphalaria intermedia was found in streams in the municipalities of Minaçu and Niquelândia, in the localities of Cana Brava and Tupiraçaba, respectively (Thiengo *et al*., 2005). These were the first records of *B. intermedia* in the state of Goiás. The type locality is the municipality of Valparaíso in the state of São Paulo and it was previously known to occur in the states of Minas Gerais, Mato Grosso do Sul and Pernambuco (Paraense, 1975; Fernandez *et al*., 2009). Studies based on morphological and molecular analyses of samples from Minaçu, confirmed this record (Fernandez *et al*., 2009). According to these authors, in January 2001 the farm where the snails were collected was expropriated for the construction of Cana Brava hydroelectric plant (UHE Cana Brava) and the habitat was submerged by flooding, forming a reservoir with an area of 139 km^2. Searches in the reservoir area near the site of the previous report (Fig. 3) were carried out between May 2012 and January 2014 (every three months) but only specimens of *B. straminea* (Fig. 2D) and *M. tuberculata* (Fig. 2E) were found. As for the locality with *B. intermedia* recorded in Niquelândia, no search was performed in the following years as it was not part of the area directly impacted by the construction of UHE Cana Brava and UHE Serra da Mesa.

A population decline of *Physa marmorata* was observed in the Tocantins River after formation of the Serra da Mesa reservoir and the introduction of the alien congeneric species *Physa acuta* Draparnaud, 1805 (Fig. 2F). This was discussed during the workshop for evaluation of non-marine molluscs threatened with extinction in Brasil, held in São Paulo in September 2014 at the National Academy of Biodiversity. The specialists assessed 17 species, placing them in three IUCN categories: critically endangered (five species); endangered (seven) and vulnerable (five) (Santos *et al*., 2015). However, sufficient abundance data were only available for one of these, *Physa marmorata*, for the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), the governement agency responsible for listing, to formally place it (as vulnerable: VU, A4ce) on the list of threatened non-marine species in Brasil. Its numbers had declined following the introduction of *Physa acuta* to the Serra da Mesa reservoir. Regarding the final outcome of that workshop, Guidorizi (2015) emphasized that the application of the IUCN assessment method for invertebrates is quite difficult because of the lack of sufficient information on, for example population density and abundance and basic biology, and the difficulty of quantifying the impact of alien species.

Although there has been a diversification of energy sources in recent years, 81.7 % of energy production in Brasil comes from the water, with the construction of hydroelectric plants in several Brasilian water basins (Bronzatti & Neto, 2008). In the Tocantins River basin where our studies were carried out, there are 12 plants in operation or projected between the states of Goiás and Pará (Thiengo & Fernandez, 2008). The Amazon basin has the largest hydroelectric potential of the country,

Fig. 3. Searches in the Cana Brava reservoir near the site of previous report of occurrence of *Biomphalaria intermedia*.

estimated at 258,420 megawatts, but only 24 % of that potential has been harnessed (Tundisi, 2014). This is of conservation concern, as many of the species that may be impacted have not yet been described and little biological information is available for others. In addition, the reservoirs are vulnerable to the introduction of alien species; for example *Melanoides tuberculata* was introduced to the APM Manso (Fernandez *et al*., 2014) after February 2009 and became the most abundant species from April 2009 to October 2010. Changes due to pollution and modifications of trophic chains can influence local biodiversity, as reported by Dornfeld *et al*. (2004), who observed in Salto Grande reservoir, state of São Paulo, the almost complete exclusion of molluscs except for the alien *M. tuberculata*. These results demonstrate the importance of environmental and population studies of the fauna prior to development of hydroelectric projects, not just in Brasil but worldwide, in order to enrich knowledge of the species and facilitate their preservation.

In spite of environmental impact assessments having become a requirement for all hydroelectric projects in Brasil since 1986, there are few publications on the occurrence, appearance or disappearance of species as a result of environmental changes. Most of the information from these ecological studies comes from reports supported by hydroeletric power companies, which send them to government environmental agencies in order to get the appropriate licenses to start construction of the dam and subsequent power generation. Assessment of these reports usually takes a long time, which makes it more difficult to access the information in a timely manner.

We believe that studies on the fauna and flora in such impacted areas should be performed continuously through collaboration between the power companies and research institutes, regardless of specific governmental environmental requirements, with an aim of providing data on the biodiversity that can be used to enhance strategies for species conservation. This article, like most studies of this nature undertaken by our team, was made possible through financial support of the power companies. However, in spite of providing opportunities to know the species inhabiting the

impacted areas and surroundings, considering the threats to the integrity and functioning of freshwater ecosystems and the impacts of water impoundments that have ocurred in recent years, a critical assessment of the current situation in Brasil reveals that the cost-benefit relation has not favoured mollusc conservation at all.

We are grateful to all the collectors who collaborated in the field trips, especially Moises de Souza Oliveira and Ariovaldo Gomes Coelho. This work was sponsored by Fundação Oswaldo Cruz, Eletrobras Furnas, Consórcio Intermunicipal Serra da Mesa and Tractebel Energia.

Bronzatti, F.L. & Neto, A.I. 2008. Matrizes energéticas no Brasil: cenário 2010-2030. In: *XXVIII Encontro Nacional de Engenharia de Produção*, Rio de Janeiro, 15 p.

Dornfeld, C.B., Pamplin, P.A.Z., Espíndola, E.L.G., Alves, R.G. & Rocha, O. 2004. Composição, distribuição e mudanças temporais da fauna de invertebrados bentônicos do reservatório de Salto Grande (Americana, SP). In: *Reservatório de Salto Grande (Americana, SP): caracterização, impactos e propostas de manejo* (org. Espindola, E.L.G., Leite, M.A. & Dornfeld, C.B.), p. 221-238. Editora Rima, São Carlos.

Fernandez, M.A. & Thiengo, S.C. 2002. Susceptibility of *Biomphalaria straminea* (Dunker, 1848) from Serra da Mesa dam, Goiás, Brazil to infection with three strains of *Schistosoma mansoni* Sambon, 1907. *Memorias do Instituto Oswaldo Cruz* 97 (suppl I): 59-60.

Fernandez, M.A., Caldeira, R.L. & Thiengo, S.C. 2009. *Biomphalaria intermedia* no Norte de Goiás, Brasil. *Anais do XXI Encontro Brasileiro de Malacologia*, Rio de Janeiro, 19 a 24 julho, p. 373.

Fernandez, M.A. & Thiengo, S.C. 2010. Susceptibility of *Biomphalaria straminea* from Peixe Angical dam, Tocantins, Brazil to infection with three strains of *Schistosoma mansoni*. *Memorias do Instituto Oswaldo Cruz* 105(4): 488-491.

Fernandez, M.A., Mattos, A.C., da Silva, E.F., Santos, S.B. & Thiengo, S.C. 2014. A malacological survey in the Manso Power Plant, State of Mato Grosso, Brazil: new records of freshwater snails, including transmitters of schistosomiasis and exotic species. *Revista da Sociedade Brasileira de Medicina Tropical* 47(4): 498-506.

Guidorizi, C.E. 2015. Uso dos critérios e categorias IUCN para a avaliação do risco de extinção dos moluscos brasileiros. *Anais do XXIV Encontro Brasileiro de Malacologia*, Rio de Janeiro, 14 a 18 setembro, p. 262.

Leme, F.B.M. 2007. As represas como lugares turísticos: novas significações e valorizações de uma paisagem sem memória. *Cultur: Revista de Cultura e Turismo* 1: 65-85.

Lima, S.F.S & Batista, G.T. 2010. Impacto da Represa Hidrelétrica de Paraibuna, SP, Brasil. *Revista Ambiente & Água* 5(3): 208-221.

Paraense, W.L. 1975. Estado atual da sistemática dos planorbídeos brasileiros. *Arquivos do Museu Nacional* 55: 105-128.

Santos, S.B., Miyahira, I.C., Salgado, N.C., Heydrich, I., Pena, M.S., Colley, E., Fernandez, M.A., Thiengo, S.C., Gomes, S.R., Silva, M.J.M., Gonçalves, I.C.B., Lacerda, L.E.M., Tallarico, L.F. & Martins, D.S. 2015. Observations on the review of the list of endangered non-marine molluscs of Brasil. *Tentacle* 23: 26-28.

Thiengo, S.C. & Fernandez, M.A. 2008. Moluscos límnicos em reservatórios de usinas hidrelétricas no Brasil: aspectos biológicos e epidemiológicos. In: Schistosoma mansoni *& esquistossomose – uma visão multidisciplinar* (org. Carvalho, O.S., Coelho, P.M.Z. & Lenzi, H.L.), p. 435-457. Editora Fiocruz, Rio de Janeiro.

Thiengo, S.C., Santos, S.B. & Fernandez, M.A. 2005. Malacofauna límnica da área de influência do lago da usina hidrelétrica de Serra da Mesa, Goiás, Brasil. I. Estudo qualitativo. *Revista Brasileira de Zoologia* 22: 867-874.

Tundisi, J.G. 2014. *Recursos hídricos no Brasil: problemas, desafios e estratégias para o futuro*. Academia Brasileira de Ciências, Rio de Janeiro. xiv + 75 p.

Monica Ammon Fernandez & Silvana Carvalho Thiengo, Fundação Oswaldo Cruz, Instituto Oswaldo Cruz, Laboratório de Malacologia, Av Brazil 4365, Manguinhos, CEP 21040-900, Rio de Janeiro, RJ, Brasil. ammon@ioc.fiocruz.br sthiengo@ioc.fiocruz.br

LIFE HISTORY AND REPRODUCTIVE AND THERMAL BIOLOGY OF *ASOLENE PLATAE*, AN APPLE SNAIL FROM THE RÍO DE LA PLATA BASIN (ARGENTINA)

By María José Tiecher, Silvana Burela & Pablo R. Martín

The Neotropical apple snails that lay subaquatic, gelatinous egg masses (species of *Asolene*, *Felipponea* and *Marisa*) have received less scientific interest than those apple snails that lay masses of calcareous shelled eggs above the waterline (genus *Pomacea*). Basic and applied research has concentrated so far on two species of *Pomacea* that have become important pests of aquatic crops (mainly rice) as well as drivers of ecosystemic changes in invaded wetlands (Horgan *et al*., 2014; Hayes *et al*., 2015). Up to now, conservation oriented research and conservation efforts have been aimed only at the Florida apple snail, *Pomacea paludosa*, which is the staple food of an endangered raptor, the snail kite (Martín *et al*., 2015).

Like most members of the genus, *Asolene platae* is characterized by striking shell banding (Fig. 1), which is reflected in the name “zebra apple snail” given by aquarium hobbyists to some species of the genus. Although the distribution of *A. platae* is now restricted to the Río de la Plata

Fig. 1. Specimens of *Asolene platae* reared in the Laboratorio de Ecología (INBIOSUR); the snail at the bottom of the photograph is a female that is laying an egg mass. (Photo: M.J. Tiecher)

Fig. 2. Couple of *Asolene platae* in copulation in the Laboratorio de Ecología (INBIOSUR); the male is at the top of the photograph and the female's foot is adhered to the aquarium wall. (Photo: S. Burela)

basin, it may be susceptible to translocation by human action to other regions, as specimens captured from natural populations are reared as aquarium pets (Tiecher *et al*., 2015). As part of a broader research program that commenced five years ago on the natural history, invasion and conservation biology of Argentinean apple snails (Martín *et al*., 2013), we undertook a study of the life cycle and the reproductive and thermal biology of *A. platae* (formerly referred to as *Asolene pulchella*; Tiecher *et al*., 2014; Martín *et al*., 2013).

Our studies on experimental cohorts under laboratory conditions (25 ºC and a photoperiod of 14/10 hours of light/dark) showed that these apple snails live up to four years and that they reach sexual maturity quite late: at an average age of 52 weeks in males and 88 weeks in females (Tiecher *et al*., in press). Growth is slow but continuous during their lifespan, the snails reaching 80 % of their maximum size (which is 25 mm) after one year. On average only 37 % of the hatchlings survive more than eight weeks but most of the snails that get beyond this phase reach sexual maturity (Fig. 2). Fecundity is quite low (1,430 eggs per female) and the hatching success of the egg masses is only 77 %. We have observed a high level of cannibalism on egg masses, which are frequently eaten by the mother during the same night they are laid. Although the hatchlings of *A. platae* look like miniature adults (Fig. 3), they are able to breathe air and eat plant material only after several weeks (Tiecher *et al*., 2014). On the whole, considering activity, mortality and growth, the optimum temperature range for *A. platae* is 25-30 °C; temperatures above 35 °C increase mortality, whereas below 20 °C activity and growth almost stop (Tiecher *et al*., 2015). The information obtained on life history and thermal biology suggests that the life cycle in the wild in their temperate range would be multiannual and iteroparous, with the snails maturing at 2-3 years and reproducing during three successive summers at most.

Fig. 3. Hatchling of *Asolene platae* born at the Laboratorio de Ecología (INBIOSUR). (Photo: S. Burela)

Most aspects of the life history of *A. platae* (slow growth, late maturity, low survival and viability) and the narrow range of optimum temperatures indicate a lower invasive potential than that of the most renowned invasive apple snails (*Pomacea canaliculata*, *Pomacea maculata* and *Marisa cornuarietis*). On the other hand, these same traits seem to suggest a low resilience in *A. platae* populations and hence a higher vulnerability to diverse impacts than most wildlife managers would expect from an apple snail.

The conservation status of *A. platae* has not been assessed by IUCN but *A. pulchella*, a junior synonym of the former, has been considered as of Least Concern bcause of its "wide distribution from Argentina to Bolivia, and the absence of any threats to its global distribution" (IUCN, 2015). Nonetheless, the Río de la Plata basin is one of the most heavily populated and modified regions in South America and there are many impacts on rivers and streams that threaten biodiversity (contamination, invasive bivalves and snails and alteration of hydrological regimes by hydroelectric dams; Martín *et al*., 2013, 2015). A further clarification of the conservation status of *A. platae* would depend on a sounder taxonomic definition of all species of *Asolene* and on more direct data on its present distribution and population trends.

Our research on *A. platae* and other species of apple snails is funded by grants from the Universidad Nacional del Sur (UNS, PGI24/B185) and the Agencia Nacional de Promoción Científica y Tecnológica (ANPCyT, PICT 2012-1956), and through doctoral and postdoctoral scholarships granted to María José Tiecher by the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET).

Hayes, K.A., Burks, R.L., Castro-Vazquez, A., Darby, P.C., Heras, H., Martín, P.R., Qiu, J.-W., Thiengo, S.C., Vega, I.A., Wada, T., Yusa, Y., Burela, S., Cadierno, M.P., Cueto, J.A., Dellagnola, F.A., Dreon, M.S., Frassa, M.V., Giraud-Billoud, M., Godoy, M.S., Ituarte, S., Koch, E., Matsukura, K., Pasquevich, M.Y., Rodriguez, C., Saveanu, L., Seuffert, M.E., Strong, E.E., Sun, J., Tamburi, N.E., Tiecher, M.J., Turner, R.L., Valentine-Darby, P.L. & Cowie, R.H. 2015. Insights from an integrated view of the biology of apple snails (Caenogastropoda: Ampullariidae). *Malacologia* 58: 245-302.

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

IUCN. 2015. *IUCN Red List of Threatened Species*. Version 2014.3. Accesed 29 November 2015.

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

Martín, P.R., Burela, S. & Gurovich, F.M. 2015. Ongoing research into the natural history and ecology of an endemic and little known apple snail from the Alto Paraná and Iguazú Rivers (Argentina). *Tentacle* 23: 3-6.

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

Tiecher, M.J., Seuffert, M.E. & Martín, P.R. 2015. Thermal biology of the South American apple snail *Asolene platae* (Caenogastropoda: Ampullariidae). *Malacologia* 58: 233-243.
Tiecher, M.J., Burela, S. & Martín, P.R. In press. Life cycle of the South American apple snail *Asolene platae* (Caenogastropoda: Ampullariidae) under laboratory conditions. *Journal of Molluscan Studies*.

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A PRELIMINARY ASSESMENT OF LAND SNAIL DIVERSITY IN THE CHAGGA HOME GARDENS OF KILIMANJARO, TANZANIA

By Christine Ngereza

The Chagga home gardens on Mt. Kilimanjaro in northern Tanzania are often cited as an example of model land use. These gardens, which by oral traditions began in the 12th century, are among the five main ecosystems of Mt. Kilimanjaro (Lambrechts *et al*., 2002) and are estimated to cover 120,000 ha. The gardens have multilayered vegetation structure similar to a tropical montane forest with trees, shrubs, lianas, epiphytes and herbs (Fig. 1). Most of the tree species, lianas and epiphytes are remnants of the former forest cover. Apparently, the old age of these gardens and the vertical stratification of vegetation, which provide a gradient in light and relative humidity, combined to create different niches enabling various species groups to exploit them. However, few biodiversity inventories have been made in these gardens. The gardens maintain a high biodiversity with over 500 plant species including 400 non-cultivated species (Hemp, 2006). About 49 bird species are found in these gardens and it is estimated that 52 species, about a quarter of the entire Saltatoria fauna (bush-crickets, crickets and grasshoppers) of Kilimanjaro, are found in the home gardens (Hemp, 2005).

Land snails remain relatively little studied in the diverse habitats of Tanzania. Published information reports about 450

Fig. 1. A Chagga home garden on Mount Kilimanjaro. (Photo: Sara Costa)

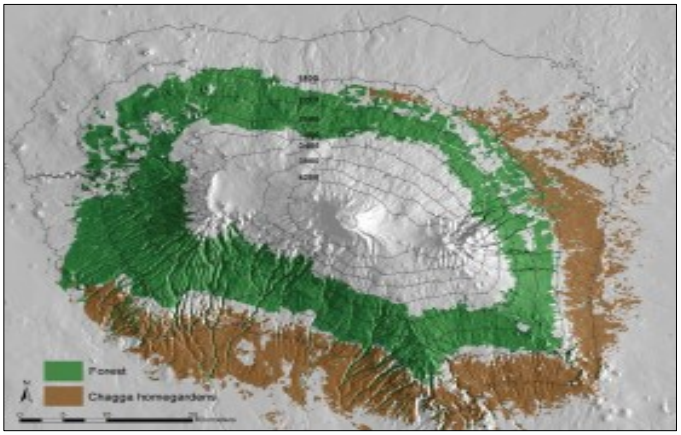

Fig. 2. Distribution of the Chagga home gardens on Mt. Kilimanjaro. (Source: Hemp & Hemp, 2008)

species, with the majority restricted to forest habitats (Emberton *et al*., 1997; Tattersfield, 1998; Seddon *et al*., 2005; Verdcourt, 2006). Published information available on the Kilimanjaro land snail fauna is based on the work of collectors rather than planned surveys, mostly derived from the 1905-1906 Swedish zoological expedition (Verdcourt, 2006). The present survey aimed to shed more light on the importance of these Chagga home gardens in the conservation of biodiversity as well as to serve as an introduction to further detailed studies on patterns of distribution, diversity and endemism of land snails in these gardens as well as in many other Kilimanjaro ecosystems.

The study site is the southern slopes of Kilimanjaro, the highest (5,895 m) mountain in Africa, in the northeastern part of Tanzania (3°4'S 37°22'E). The Chagga home gardens are on the southern and eastern slopes mainly between 900 and 1,800 m above sea level, in the climatically most favorable elevations of these slopes (Fig. 2). Kilimanjaro has a bimodal rainfall pattern of "short rains" from October to December and "long rains" from March to May. The average annual rainfall ranges from 1,000 to 1,700 mm with marked variation depending on elevation, exposure and aspect. Thus Kilimanjaro gets more rainfall on the south-eastern and eastern sides (where the Chagga home gardens are). The average size of a home garden is 0.68 ha with a range of 0.2 to 1.2 ha. The forest-like structural arrangement of plants in these gardens mainly consists of shade trees and the major cash crops coffee (*Coffea arabica*) and banana grown for food and sale. In order to meet their shade requirements, these agricultural crops are well intermixed in a complex arrangement with a higher canopy of indigenous or planted multipurpose trees. There is also a middle canopy of fruit and multipurpose trees/shrubs; the lower ground cover consists of food crops, medicinal plants and annual fodder plants (Fig. 1) (Soini, 2005).

The study was carried out in four randomly selected home gardens, one along each of the four main Kilimanjaro climbing routes, i.e. the Machame, Umbwe, Mweka and Marangu routes. Snails were sampled at the beginning of the long rains in March 2012 and during the short rains in November 2012. Sampling was done using a combination of

Fig.3. Snail sampling.

direct-search and litter-sieving methods (Fig. 3). Each plot was searched for 30 m. About 2 l of surface litter and soil were taken from each plot, dried (if necessary), sieved and then searched for snails.

During the study, 636 individuals were found, belonging to 10 families: Streptaxidae (9 species), Urocyclidae (8), Subulinidae (3), Bradybaenidae (2), Achatinidae (2), Endodontidae (2), Maizanidae (2), Ferussaciidae (1), Enidae (1) and Helicarionidae (1). The 31 species of land snails recorded in this study represent 43 % of the snail species reported from Mount Kilimanjaro (Verdcourt, 2006) (Table 1).

Table 1. The snails and slugs recorded from four Chagga home gardens in 2012, with endemic species asterisked.

Bradybaenidae
Haplohelix rufofusca (von Martens)*
Vicarihelix sp.
Urocyclidae
Polytoxon robustum (Simroth)
Leptichnus fischeri (Simroth)
Atoxon sp.
Trochozonites sp.
Thapsia radiata (d'Ailly)*
Thapsia kibotonoensis (d'Ailly)*
Chlamydarion volkensi (Thiele)*
Trochonanina (*Montanobloyetia*) *simulans* subsp. *simulans* (von Martens)*
Achatinidae
Limicolaria sjoestedti (d'Aily)*
Achatina zanzibarica kilimae (Dautzenberg)
Subulinidae
Curvella kretschmeri (von Martens)*
Subulina sp.
Pseudopeas sp.
Endodontidae
Punctum kilimanjaricum (Verdcourt)*
Trachycystis lamelosa (Pfeifer)
Maizanidae
Maizania volkensi (von Martens)
Maizania hildebrandti subsp. *kibotonoensis* (d'Ailly)
Ferussaciidae
Cecilioides sp.
Enidae
Conulinus daubenbergeri (Dautzenberg)
Helicarionidae
Kaliella sp. (Pfeifer)
Streptaxidae
Gonaxis (*Macrogonaxis*) *ennoides* (von Martens)
Streprostele (*Raffraya*) *kilimanjaroensis* (Blume)*
Gulella olkokolae (Adam)
Gulella tudes (von Martens)
Gulella percivali (Preston)
Gulella lacuna (Preston)
Gulella handeiensis (Verdcourt)
Gulella sp. B
Gulella sp. D

Table 2. Number of individuals, species and familes of land snails in four Chagga home gardens in 2012, with numbers of species endemic to Kilimanjaro.

Garden	Individuals	Species	Families	Endemics
Machame	387 (61 %)	18 (35 %)	10 (37 %)	9 (36 %)
Marangu	151 (24 %)	14 (27 %)	7 (26 %)	6 (21 %)
Mweka	72 (1 %)	13 (25 %)	5 (19 %)	8 (29 %)
Umbwe	26 (4 %)	7 (13 %)	5 (19 %)	4 (14 %)

Fig. 4. An *Atoxon* sp. slug new to science found in Machame and Mweka home gardens.

Fig.5. Caught in the the act, *Gonaxis ennoides* feeding on *Trochonanina* (*Montanobloyetia*) *simulans* in the Marangu home garden.

Among the recorded species, nine are endemic to Kilimanjaro (Table 1).

The highest snail species richness ocurred in the Machame home garden, followed by Marangu, Mweka and Umbwe (Table 2). The number of species per plot in the Machame, Marangu and Mweka gardens is typical of a small area in East African wet forest, i.e. 10-15 species (Seddon *et al*., 2005).

The findings of the present study underline the importance of Chagga home gardens, which are highly disturbed habitats, as important sanctuaries for Kilimanjaro land snails, including endemics. The mixture of vegetation provides microhabitat and microclimate conditions capable of supporting a diversity of land snails. This is the first effort to explore the land snail fauna in Chagga home gardens. The present list of snail species is not conclusive and exhaustive, but is a reference for future, more extensive study, which will update the check list.

Emberton, K.C., Pearce, T.A., Kasigwa, P.F., Tattersfield, P. & Habibu, Z. 1997. High diversity and regional endemism in land snails of eastern Tanzania. *Biodiversity and Conservation* 6: 1123-1136.

Hemp, C. & Hemp, A. 2008. The Chagga home gardens on Kilimanjaro. *IHDP Update* 2: 12-17.

Hemp, A. 2006. The banana forests of Kilimanjaro: biodiversity and conservation of the Chagga homegardens. *Biodiversity and Conservation* 15: 1193-1217.

Hemp, C . 2005. The Chagga home gardens – relict areas for endemic Saltatoria species (Insecta: Orthoptera) on Mount Kilimanjaro. *Biological Conservation* 125: 203-209.

Lambrechts, C., Woodley, B., Hemp, A., Hemp, C. & Nyitti, P. 2002. *Aerial survey of the threats to Mt. Kilimanjaro forests*. United Nations Development Programm, Dar es Salaam. 33 p., 14 maps.

Seddon, M.B., Tattersfield, P., Herbert, D.G., Rowson, B., Lange, C.N., Ngereza, C., Warui, C.M. & Allen, J.A. 2005. Diversity of

African forest mollusc faunas: what we have learned since Solem (1984). *Records of the Western Australian Museum* Supplement 68: 103-113.
Soini, E., 2005. Changing livelihood on the slopes of Mt. Kilimanjaro, Tanzania: challenges and opportunities in the Chagga home garden system. *Agroforestry Systems* 64(2): 157-167.
Tattersfield, P. 1998. Patterns of diversity and endemism in East African land snails , and the implications for conservation. *Journal of Conchology* Special Publication 2: 77-86.
Verdcourt, B. 2006. A revised list of the non-marine Mollusca of East Africa: Kenya, Uganda and Tanzania, excluding Lake Malawi. B. Verdourt, Maidenhead. 75 p.

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THREATENED LAND SNAILS *VERTIGO MOULINSIANA* AND *PUPILLA PRATENSIS* ARE RECENTLY EXTINCT IN CRIMEA

By Igor Balashov

Desmoulin's whorl snail, *Vertigo moulinsiana* (Dupuy, 1849) is one of the most protected mollusc species in Europe: it is included in Annex II of the Habitats Directive, the IUCN Red List, the European Red List and numerous regional and national red lists (Cameron *et al*., 2003; Cuttelod *et al*., 2011). This minute snail mainly inhabits undisturbed calcareous fens sporadically distributed across Europe, in the Caucasus, Asia Minor and the Atlas Mountains (Cameron *et al*., 2003; Sysoev & Schileyko, 2009; Welter-Schultes, 2012). Its conservation status is considered Vulnerable (Cuttelod *et al*., 2011). Declines are mainly due to anthropogenic transformation of natural water bodies and wetlands that causes changes in the natural hydrological regime of its habitats (Cameron *et al*., 2003).

In Ukraine this species was found for the first time, in 2008, in a single very small (less than 0.01 km^2) fen on the northern slope of the Crimean Mountains (Balashov & Palatov, 2011). This fen (Fig. 1) was about 2 km north of Ternovka village (Balaklava district of Sevastopol), in the Pyataya Balka tract, in a large ravine along a small stream, near a few springs and two small ponds, among the oriental hornbeam forest (44°35'55"N 33°45'36"E, elevation 400 m). Among the plants in the fen were *Carex* spp., *Petasites hybridus*, *Equisetum telmateia*, *Eupatorium cannabinum*, *Typha latifolia*, *Epilobium* spp., *Stachys palustris*, *Chaiturus marrubiastrum*, *Sambucus herbacea*, etc.

Vertigo moulinsiana was one of 32 species of terrestrial molluscs found together in the Pyataya Balka; for the complete list see Balashov (2013). Among these other species, most notable was *Pupilla pratensis* (Clessin, 1871). As for *V. moulinsiana* it was the first record of this species from Ukraine (Fig. 2). It was not recognized at first, as until 2009 *P. pratensis* was mostly considered as an ecomorph of *P. muscorum* (Linnaeus, 1758). Molecular revision separated *P. pratensis* from *P. muscorum* as a Central European species associated with fens (Proschwitz *et al*., 2009). Therefore, I

Fig. 1. Habitat of *Vertigo moulinsiana* and *Pupilla pratensis* in the Crimea, 2009.

have published data on the Crimean *P. pratensis* in a subsequent paper (Balashov, 2013). It has been suggested that this species is threatened for the same reasons as *V. moulinsiana* is (Horsák *et al*., 2010a, 2011; Balashov, 2013). However, most recent molecular studies suggests that *P. pratensis* is probably conspecific with *P. alpicola* (Charpentier, 1837) (Nekola *et al*., 2015), a species from the mountains of Central Europe and the Altai (Horsák *et al*., 2010a, b, 2011; Welter-Schultes, 2012). This species is considered not threatened globally (Cuttelod *et al*., 2011). However, this does not reflect the local conservation status of *P. pratensis*/*alpicola* in Ukraine, since there were previously no records of this species (Balashov & Gural-Sverlova, 2012).

The conservation status of *V. moulinsiana* and *P. pratensis* in Ukraine was considered clearly as Critically Endangered by the B1ab(i-iv) and B2ab(i-iv) criteria (IUCN, 2001), as this habitat was not protected and was much disturbed by recreation (Balashov & Palatov, 2011; Balashov, 2013). In 2011-2012 I fulfilled all the required procedures for these

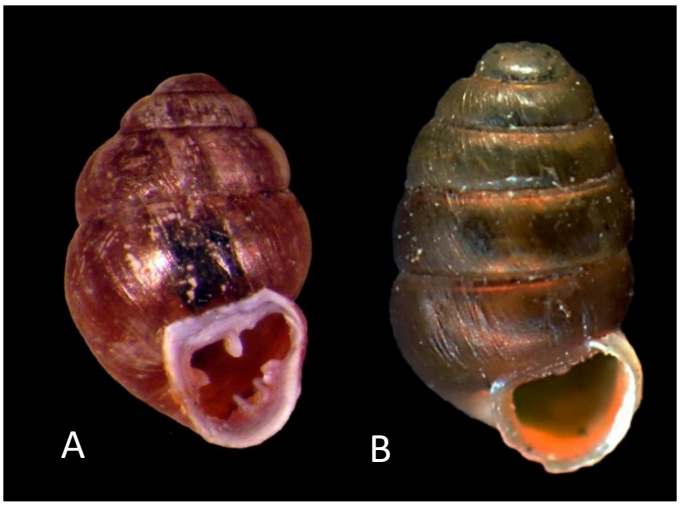

Fig. 2. A–*Vertigo moulinsiana* (2.5 x 1.6 mm); B–*Pupilla pratensis* (2.9 x 1.8 mm); from the Crimea (after Balashov, 2013).

species to be protected in Ukraine and for them to be included in the official Red Book of Ukraine (Balashov, 2012a, 2013). However, listing has been much delayed for bureaucratic reasons, and despite the Commission for the Red Book of Ukraine having approved my proposal, it seems that the official status will be not published before the next edition of the Red Book, scheduled to be produced in 2019. The listing gives none of the necessary background for creating a protected area in Pyataya Balka. In April 2015 these species were included in the Red Book of Crimea by the unrecognized "government" of Crimea (based on my much earlier submission). But it has now been revealed that these species were already extinct in the Crimea by that time.

Despite relatively large numbers of *V. moulinsiana* being recorded in Pyataya Balka in 2008-2010, only a single specimen of *P. pratensis* (Fig. 2) was found there, on a leaf of *Petasites hybridus*. This specimen was not quite typical of either *P. pratensis* or *P. alpicola* because of its unusual shell shape (Balashov, 2013). It is possible, therefore, that this specimen represents a separate subspecies or even a species. The closest *P. alpicola* s.l. sites are more than 600 km away in Romania (Welter-Schultes, 2012) and the closest *P. pratensis* sites are more than 800 km from the Crimean sites on the plains between Central and Eastern Europe (Balashov, unpublished).

In May 2015 my intention was to collect more specimens of this Crimean *Pupilla* for molecular clarification of its taxonomic status. However, during new visits to Pyataya Balka it was hard to recognize the area because of the huge anthropogenic transformation. It was sadly revealed that the fen had been completely destroyed by building of a large dam (Fig. 3A), which created a cascade of large ponds covering most of the now destroyed fen (Fig. 3B). Another part had become bare dry soil. All springs in the area were regulated and covered by cemented rocks (Fig. 4). Places suitable for recreation were organized on the banks of the ponds, with small buildings, some of which were in the process of being built during my visit. Thus this habitat of *V. moulinsiana*, *P. pratensis* and many more species was completely destroyed and became permanently untenable for them. There seems to be no chance of survival for these two snail species in this area so both of them should be considered extinct in Crimea.

Extinction probably happened in 2014, as construction activities were still ongoing when I visited, with workers still there. However, before that I had only visited this place in 2010 and cannot be sure what was going on between then and my later visit.

Fig. 3. Destroyed habitat of *Vertigo moulinsiana* and *Pupilla pratensis* in the Crimea, 2015. A–dam; B–pond.

Fig. 4. Regulated spring, 2015. Some *Vertigo moulinsiana* were collected exactly here in 2010.

Due to the political crisis in Crimea the North Crimean Canal (main source of the fresh water in the peninsula) was cut off from mainland Ukraine in 2014, leading to a freshwater deficit in Crimea. For this reason the politics of the new unrecognized Crimean "government" is to maximally use all available fresh water sources on the peninsula. While visiting Crimea in 2015 I also observed another place with a new cascade of ponds arranged in the same way as at Pyataya Balka, but this time even in a protected area. Therefore this political crisis perhaps was a cause of the snails' extinction and could lead to further decline of the Crimean wildlife.

Unfortunately, discovery of additional new locations with *V. moulinsiana* and *P. pratensis* in the Crimea is unlikely, especially in the case of the first species. Molluscs of the Crimean mountains have been intensively studied by numerous collectors since the first half of the 19th century, such that almost the entire species composition of land molluscs of the Crimea was well known by the first half of the 20th century (Puzanov, 1928). Species that were recorded from the Crimea more recently were identified mainly via anatomical characters that were not used by the earlier researchers (Hausdorf, 1994; Gural-Sverlova et al., 2009; Balashov, 2012b, 2014; Balashov & Baidashnikov, 2012, 2013; Balashov & Gural-Sverlova, 2012). However, *V. moulinsiana* can be readily distinguished by its shell, such that it is especially remarkable that it was not recorded until 2008. Moreover, Crimea, including its mountains, is a generally dry area; wet habitats are rare. Even most of the common mollusc species of wetlands of almost the entire Palearctic, such as *Carychium minimum* Müller, 1774, *Vertigo antivertigo* (Draparnaud, 1801), *Zonitoides nitidus* (Müller, 1774), *Succinea putris* (Linnaeus, 1758), etc, are very rare in Crimea. Most Crimean wetlands were transformed a long time ago and there is great concern for the exceptional ones that still remain, because of the current political circumstances on the peninsula.

The extinction of *V. moulinsiana* and *P. pratensis* in Crimea decreases their recent ranges. The nearest locality to the Crimea locality for *V. moulinsiana* is in Moldova (Balashov *et al*., 2013) and for *P. pratensis* is in north-western Ukraine or Romania (if it is considered conspecific with *P. alpicola*), more than 450 km and 800 km (600 km for *P. alpicola*) respectively.

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Balashov, I.A. 2012a. Conservation of terrestrial molluscs in Ukraine: state, problems, trends. *Naukovi zapysky Ternopilskogo universytetu. Serija: Biologija* 51(2): 24-32 [in Russian].

Balashov, I. 2012b. *Selenochlamys ysbryda* in the Crimean mountains, Ukraine: first record from its native range? *Journal of Conchology* 41(2): 141-144.
Balashov, I. 2013. The first finding of *Pupilla pratensis* for Ukraine in the Crimean mountains with remarks on its conservation status and differences from *Pupilla muscorum* (Stylommatophora, Pupillidae). *Ruthenica* 23(2): 181-185.
Balashov, I. 2014. *Taurinellushka babugana* gen. nov., sp. nov. (Stylommatophora: Pristilomatinae) from the Crimean Mountains (Ukraine) and revision of Crimean *Mediterranea* (Oxychilinae). *Journal of Conchology* 41(5): 575-584.
Balashov, I.A. & Baidashnikov, A.A. 2012. The first findings of a slug *Boettgerilla pallens* (Stylommatophora, Boettgerillidae) in Crimea. *Ruthenica* 22(2): 111-114.
Balashov, I.A. & Baidashnikov, A.A. 2013. Terrestrial molluscs in sparse Greek juniper forests of the Crimean Mountains. *Zoologicheskii Zhurnal* 92(3): 257-263 [in Russian].
Balashov, I.A., Son, M.O., Coadă, V. & Welter-Schultes, F. 2013. An updated annotated checklist of the molluscs of the Republic of Moldova. *Folia Malacologica* 21(3): 175-181.
Balashov, I. & Gural-Sverlova, N. 2012. An annotated checklist of the terrestrial molluscs of Ukraine. *Journal of Conchology* 41(1): 91-109.
Balashov, I.A. & Palatov, D.M. 2011. First record of *Vertigo moulinsiana* (Gastropoda, Pulmonata) for Ukraine on the territory of the Crimea. *Vestnik Zoologii* 45(1): 11-17 [in Russian].
Cameron, R.A.D., Colville, B., Falkner, G., Holyoak, G., Hornung, E., Killeen, I., Moorkens, E., Pokryszko, B.M., von Proschwitz, T., Tattersfield, P. & Valovirta, I. 2003. Species accounts for snails of the genus *Vertigo* listed in Annex II of the Habitats Directive: *V. angustior*, *V. genesii*, *V. geyeri* and *V. moulinsiana* (Gastropoda, Pulmonata: Vertiginidae). *Heldia* 5: 151-170.
Cuttelod, A., Seddon, M. & Neubert, E. 2011. *European Red List of non-marine molluscs*. Publications Office of the European Union, Luxembourg. x + 97 p.
Gural-Sverlova, N.V., Balashov, I.A. & Gural, R.I. 2009. Recent distribution of terrestrial mollusks of the family Agriolimacidae on the territory of Ukraine. *Ruthenica* 19(2): 53-61 [in Russian].
Hausdorf, B. 1994. Additive typogenesis in *Thoanteus* (Gastropoda: Bulminidae). *Zoological Journal of the Linnean Society* 112(3): 353-361.
Horsák, M., Škodová, J., Myšák, J., Čejka, T., Ložek, V. & Hlaváč, J.Č. 2010a. *Pupilla pratensis* (Gastropoda: Pupillidae) in the Czech Republic and Slovakia and its distinction from *P. muscorum* and *P. alpicola* based on multidimensional analysis of shell measurements. *Biologia* 65(6): 1012-1018.
Horsák, M., Chytrý, M., Pokryszko, B.M., Danihelka, J., Ermakov, N., Hájek, M., Hájková, P., Kintrová, K., Koči, M., Kubešová, S., Lustyk, P., Otýpková, Z., Pelánková, B. & Valachovic, M. 2010b. Habitats of relict terrestrial snails in southern Siberia: lessons for the reconstruction of palaeoenvironments of full-glacial Europe. *Journal of Biogeography* 37: 1450-1462.
Horsák, M., Schenková, V. & Myšák, J. 2011. The second site of *Pupilla alpicola* (Charpentier, 1837) and the first recent record of *Pupilla pratensis* (Clessin, 1871) in Poland. *Folia Malacologica* 20(1): 21-26.
IUCN. 2001. *IUCN Red List Categories and Criteria: Version 3.1.* IUCN, Gland. 30 p.
Lowe, S., Browne, M., Boudjelas, S., De Poorter, M. 2000. *100 of the World's worst invasive alien species. A selection from the Global Invasive Species Database.* Invasive Species Specialist Group (ISSG), Auckland. 12 p.
Nekola, J.C., Coles, B.F. & Horsák, M. 2015. Species assignment in *Pupilla* (Gastropoda: Pulmonata: Pupillidae): integration of DNA-sequence data and conchology. *Journal of Molluscan Studies* 81(2): 196-216.
Proschwitz, T. von, Schander, C., Jueg, U. & Thorkildsen, S. 2009. Morphology, ecology and DNA-barcoding distinguish *Pupilla pratensis* (Clessin, 1871) from *Pupilla muscorum* (Linnaeus, 1758) (Pulmonata: Pupillidae). *Journal of Molluscan Studies* 75(4): 315-322.
Puzanov, I. 1928. Die malakogeografische Glierderung der Krim und der Ursprung ihrer molluskenfauna. *Zoologische Jahrbücher* 54(2): 315-343.
Sysoev, A. & Schileyko, A. 2009. *Land snails and slugs of Russia and adjacent countries. Pensoft Series Faunistica 87*. Pensoft Publishers, Sofia-Moscow. 455 p.
Welter-Schultes, F.W. 2012. *European non-marine molluscs, a guide for species identification*. Planet Poster Editions, Göttingen. 679 p.

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IS THE CARPATHIAN LAND SNAIL *PLATYLA JANKOWSKIANA* EXTINCT?

By Igor Balashov, Veronika Skvortsova, Zoia Shvydka, Yulia Filatova, Anna Homenko, Oleksii Marushchak, Dariia Shyriaieva, Yaroslav Andrianov, Viacheslav Yeromin & Olexiy Vasyliuk

The land snail *Platyla jankowskiana* (Jackiewicz, 1979) (Caenogastropoda, Aciculidae) is a minute species (shell 2.5 x 0.8 mm) that lives in the leaf litter of beech forests. It was described and is only known from the three shells that were collected by A. Jankowski in 1926 and 1933 from a single valley in the eastern Carpathians (currently Ukraine). It was never found again and before our attempt in 2015 there were no focused attempts to search for it. In 2010 it was listed as Vulnerable under criterion D2 in the IUCN European Red List (Cuttelod *et al*., 2011).

The identity of this species was never disputed. Type specimens were checked during the last major revision of this group (Boeters *et al*., 1989). It was included as a good species in all recent reviews that mentioned or dealt with this region in western Ukraine (Sysoev & Schileyko, 2009; Balashov & Gural-Sverlova, 2012; Welter-Schultes, 2012).

The type locality of *P. jankowskiana* was not indicated very precisely; it was stated that the snails were collected in "Żeńca valley", near Tatariv village (Ivano-Frankisvk region of Ukraine), in beech forest on the upper terrace, altitude 600 m (Jackiewicz, 1979). It was especially mentioned that snails were collected on the rocky slope with old beech trees.
The name of the valley was wrongly transcribed from Polish, "dolina Żeńca" literally means "valley of Żeńec" (masculine, not feminine). Therefore the correct name of this river and its valley is Żeńec (Zheniec). There is no doubt that exactly this valley was mentioned, as its lower part is adjacent to Tatariv village and there are no other rivers with similar names nearby. However the altitude of 600 m is not possible for this valley. Tatariv village is located at this altitude but the valley is higher (especially the areas with beech forest). Perhaps it was an approximate value and the data are incorrect for this reason.

The length of Zheniec valley is about 5 km. It has broad slopes that extend 1-2 km in altitude from 650 to 1200 m. Therefore, the area that can be attributed to the type locality of *P. jankowskiana* is about 10 km^2. However, most parts of the valley's slopes are covered by pine forests. The beech forests, especially those with old trees, are insular, small and not numerous here (Fig. 1). Perhaps the situation was different when the type specimens were collected. This valley is attractive to tourists, especially because of the large waterfall in its upper part. Along most of the length of the Zheniec river there is recently developed infrastructure: cottages, restaurants, giftshops, the personal residence of the former President of Ukraine, etc, despite this being a protected area (Carpathian National Nature Park). Thus the bottom of the valley and the lower parts of some slopes are much transformed. In the forests on the slopes of the valley there is some forestry activity: old trees and dead wood are removed in some areas. Thole valley is under significant recreational impact.

Fig. 1. The team searching for *Platyla jankowskiana* in the Zheniec valley. Inset: old beech tree in one of the plots.

Our purpose during the expedition in August 2015 was to find *P. jankowskiana* and to assess its conservation status. Studies were carried out over eight days (21-28 August 2015) and ten collectors were involved, mainly students (Fig. 1). We chose 20 plots with beech (Fig. 1) and pine-beech forests in all parts of the Zheniec valley, at various altitudes (700-1200 m) and in the most diverse habitats. These 20 plots were intensively studied in the field for 1 h each. All molluscs were collected and 5 l of leaf litter were also collected from each plot to be carefully investigated later. Some additional plots were briefly studied. Several thousands of specimens belonging to 44 species were collected. They included at least 1,000 specimens of *Carychium tridentatum* (Risso, 1826), which is similar in size, shape and colour to *P. jankowskiana*, and 49 specimens of the closely related *Acicula parcelineata* (Clessin, 1911), which can be clearly distinguished from *P. jankowskiana* only by shell microsculpture (Fig. 2). Specimens of *A. parcelineata* were found in 14 of the 20 plots, but no *P. jankowskiana* was found.

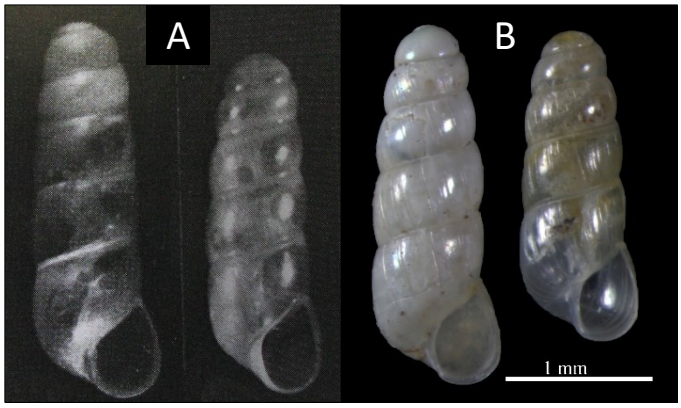

Fig. 2. A–type specimens of *Platyla jankowskiana*, height of shells 2.6 and 2.5 mm; from Boeters *et al*. (1989); B–shells of *Acicula parcelineata* from the Zheniec valley.

There could be four explanations for us not finding *P. jankowskiana*, as follows.

1. Perhaps it is extinct. It is possible that it was associated with the ancient primary beech forests that declined in this area during the 20th century. Some species of Aciculidae are associated with well preserved beech forests, for example the closely related *Platyla perpusilla* (Reinhardt, 1880) is known in Ukraine only from one locality in the Kuziy massif of the Carpathian Biosphere Reserve (Gural-Sverlova & Gural, 2009), which is one of the best preserved beech forests in Ukraine. Perhaps *P. jankowskiana* has similar preferences, but within its range no such preserved ancient beech forests remain.

2. Perhaps the initial information on the origin of the type specimens of *P. jankowskiana* was wrong. There are no direct reasons to suspect this but it is still possible, as all three specimens were collected by just one person and the species was described by someone else 50 years later.

3. Perhaps the three shells that were described as *P. jankowskiana* are abnormal *A. parcelineata*, lacking the microsculpture that should be present in this species. These two species are very similar in the shape and size of the shell. We measured seven shell parameters (height and width of the shell, of its aperture and of the visible part of the third whorl, and the height of the last whorl) of two type specimens of *P. jankowskiana* from the published photos (Boeters *et al*., 1989) and in all available specimens of *A. parcelineata* from the Ukrainian Carpathians (62, including 49 from the present locality, 22 of them adult). All these measured characters overlap in the two species. However, the two measured specimens of *P. jankowskiana* are larger than average adult shells of *A. parcelineata*, with most of the measurements of *P. jankowskiana* approximating the maximum values in *A. parcelineata*. Nonetheless, these species can only be clearly distinguished by the sculpture of the shell. The clear radial grooves on the shell surface in *Acicula* are considered to be very a important character, such that the absence of such sculpture in *Platyla* separates it from *Acicula* (Boeters *et al*., 1989). Perhaps in rare cases sculpture may be absent in *Acicula* because of mutation. But so far

there are no reports of specimens lacking sculpture in *Acicula*. Therefore there is no reason to consider *P. jankowskiana* and *A. parcelineata* as conspecific before it can be proven that sculpture-less specimens of *Acicula* can exist.

4. Perhaps our surveys were not sufficient to record this species and it still occurs here in the type locality. This possibility seems to be unlikely for us, as the surveys would normally be sufficient to record all species typically present. However, this explanation is probably still possible if this species is a relict that remains only in a very few small pockets of habitat.

Unfortunately, there seems to be no way to clearly resolve this case and to reject any of the above possibilities, unless additional specimens of *P. jankowskiana* should be found. Consequently, if *P. jankowskiana* is extinct, it seems to be almost impossible to prove this.

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Balashov, I. & Gural-Sverlova, N. 2012. An annotated checklist of the terrestrial molluscs of Ukraine. *Journal of Conchology* 41(1): 91-109.

Boeters, H.D., Gittenberger, E. & Subai, P. 1989. Die Aciculidae (Mollusca, Gastropoda, Prosobranchia). *Zoologische Verhandelingen* 252: 1-234.

Cuttelod, A., Seddon, M. & Neubert, E. 2011. *European Red List of non-marine molluscs.* Publications Office of the European Union, Luxembourg. x + 97 p.

Gural-Sverlova, N.V. & Gural, R.I. 2009. Interesting finding of gastropods (Aciculidae, Terrestribythinellidae) in the territory of the Ukrainian Carpathians. *Zoologicheskii Zhurnal* 88(7): 794-799 (in Russian).

Jackiewicz, M. 1979. *Acicula* (*Hyalacme*) *jankowskiana* sp. n. (Gastropoda, Prosobranchia) from east Carpathians. *Bulletin de la Société des Amis des Sciences et des Lettres de Poznan (Série D)* 19: 95-98.

Sysoev, A. & Schileyko, A. 2009. *Land snails and slugs of Russia and adjacent countries. Pensoft Series Faunistica 87*. Pensoft Publishers, Sofia-Moscow. 455 p.

Welter-Schultes, F.W. 2012. *European non-marine molluscs, a guide for species identification*. Planet Poster Editions, Göttingen. A3 + 675 + 78 [quick identification] p.

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DIVERSITY OF TERRESTRIAL MOLLUSCS IN URBAN AREAS AND SURROUNDING LANDSCAPES OF RIO DE JANEIRO STATE, BRASIL

By Paulo Rodrigues, Monica A. Fernandez, Silvana C. Thiengo, Norma C. Salgado & Suzete R. Gomes

The biological diversity of urban areas has been severely affected by the introduction of non-native species, which prey on native species, compete for limited resources and act as vectors for novel diseases and parasites to which native organisms can be particularly susceptible (Murphy, 1988). According to Herbert & Kilburn (2004) about 99 % of molluscan extinctions have been of non-marine species (68 % terrestrial and 31 % freshwater) as a consequence of such factors.

In Brasil, ecological and taxonomic studies on terrestrial molluscs are still scarce considering the presumed high biodiversity of its tropical regions especially. Among the reasons for this, is the huge geographic area and the lack of specialized taxonomists in the country. As a consequence, our knowledge of the diversity and distributions of terrestrial molluscs in Brasil is still poor and mostly based on old data.

In this article, we report the diversity of terrestrial molluscs occurring in urban areas and surrounding landscapes of Rio de Janeiro state. Molluscs were collected in 2015 from sixteen municipalities of Rio de Janeiro state: Cachoeira de Macacu, Duque de Caxias, Guapimirim, Itaboraí, Itaguaí, Japeri, Mesquita, Nilópolis, Nova Iguaçu, Paracambi, Rio de Janeiro, Rio Bonito, São João de Meriti, Seropédica, São Gonçalo and Tanguá (Fig. 1). Three sites were visited in each municipality, including wastelands and private gardens in urban areas, as well as surrounding areas, less urbanized areas. The specimens collected were transported to the Laboratório de Malacologia of the Institute Oswaldo Cruz, Rio de Janeiro, where the live individuals were analyzed and fixed in 70-90 % alcohol. Shells were kept dry. Specimens were dissected under a stereomicroscope to analyze morphological and conchological characteristics, and identified based on specialized literature (Salgado & Coelho, 2003; Thomé *et al*., 2006; Simone, 2006).

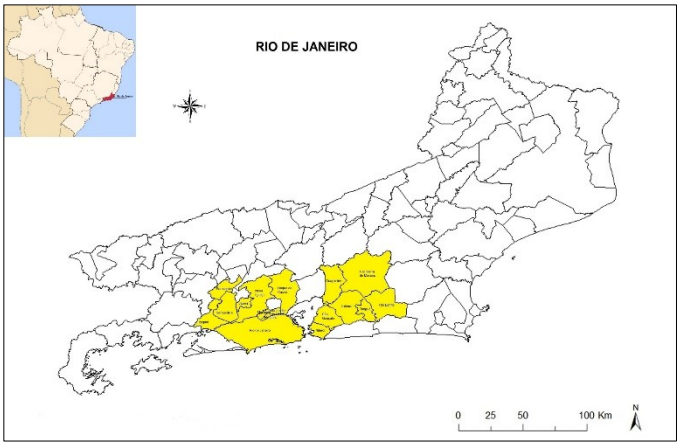

Fig. 1. Map indicating the sampled municipalities in Rio de Janeiro state.

Samples of the species from each municipality will be deposited in the mollusc collection of the Institute Oswaldo Cruz (CMIOC).Seven gastropod families were represented: Achatinidae, *Achatina fulica* Bowdich, 1822; Agriolimacidae, *Deroceras laeve* (Müller, 1774); Bradybaenidae, *Bradybaena similaris* (Rang, 1831); Bulimulidae, *Bulimulus tenuissimus* (Férussac, 1832); Streptaxidae, *Streptartemon cookeanus* (Baker, 1914); Subulinidae, *Subulina octona* (Bruguière, 1789) and *Leptinaria unilamellata* (d'Orbigny, 1835); Veronicellidae, *Sarasinula linguaeformis* (Semper, 1885) and *Sarasinula plebeia* (Fischer, 1868) (Fig. 2).

Fig. 2. Live specimens of A–*Achatina fulica* (Rio de Janeiro); B–*Deroceras leave* (Paracambi); C–*Bradybaena similaris* (Rio de Janeiro); D–*Bulimulus tenuissimus* (Rio de Janeiro); E–*Streptartemon cookeanus* (Rio de Janeiro); F–*Subulina octona* (Rio de Janeiro); G–*Leptinaria unillamelata* (Duque de Caxias); H–*Sarasinula linguaeformis* (Cachoeira de Macacu).

As expected, considering previous studies (Thiengo *et al*., 2007; Zanol *et al*., 2010), *A. fulica* was found in all municipalities and was also the most abundant species. It is listed among 100 of the World's worst invasive alien species (Lowe *et al*., 2000) and currently is present in almost all Brasilian States (Thiengo & Fernandez, 2013). After *A. fulica*, *S. linguaeformis* was the most widespread species, being found in 14 municipalities, in contrast to *S. plebeia*, which was found only in Rio de Janeiro city. Both veronicellid species are widespread in the Antilles and South America (Thomé, 1989; Thomé *et al*., 1997), and *S. plebeia* is also widspread in Central America and on Pacific slands (Thomé, 1989; Gomes & Thomé, 2004). The three other most widespread species were *B. tenuissimis* (11 municipalities), *B. similaris* (10 municipalities) and *S. octona* (10 municipalities). The type locality of *B. tenuissimus* is Rio de Janeiro but it is widespread in Brasil (Simone, 2006). *Bradybaena similaris* and *Subulina octona* are now worldwide species, originally from Asia and the Caribbean and tropical America, respectively (Brodie & Barker, 2011). *Leptinaria unilamellata* and *Streptartemon cookeanus* were found more rarely; the former is common in the West Indies and Central and South America (Araújo, 1982; Robinson *et al*., 2009), while the latter is reported from northern and northeastern Brasil (Simone, 2006). *Streptartemon cookeanus* is a carnivorous species and was seen feeding on *Subulina octona* in the field, and both species of subulinids were found together at some collecting sites. *Deroceras leave* was collected only in Paracambi. It is a Holarctic species that has been introduced to tropical, subtropical and temperate environments worldwide (Robinson *et al*., 2009). The second most abundant species, after *A. fulica*, was *B. similaris*, followed by *S. linguaeformis*. It is important to highlight that almost all species found in this study have been reported as intermediate hosts of *A. cantonensis* and/or *A. costaricensis* in Brasil (Araújo, 1982; Ohlweiler *et al*., 2010; Oliveira *et al*., 2015) and that eosinophilic meningitis caused by *A. cantonensis* is considered an emergent zoonosis in Brasil (Morassutti *et al*., 2014).

In Brasil it is still a priority to increase our knowledge of the distribution of terrestrial molluscs, including more inventory-type field research as reported here. This is the way to gain knowledge of our native diversity as well as of the alien species that present threats to the native species and to people. Most of the species we found are alien invasive species that are known for having synanthropic habits. We also draw attention to the fact that the conservation of natural habitats, including in urban areas, is essential in order to gain knowledge of and to preserve as much as possible of the local diversity that still persists despite the pressures of urban environments. We note that other projects being undertaken at the Laboratório de Malacologia have shown that native and more rare mollusc species, such as some species in the genera *Megalobulimus*, *Phyllocaulis*, *Drymaeus* and *Leiostracus*, can also be found in urban areas in Rio de Janeiro state, reinforcing the importance of continuous study of these areas.

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Araújo, J.L.B. 1982. *Alguns moluscos terrestres como hospedeiros intermediários de parasitos de animais domésticos, no Brasil: estudos sobre anatomia, sistemática e paarticipaçã em helmintos*. Tese de Doutorado. Decanato de Pesquisa e Pós-Graduação. Universidade Federal Rural do Rio de Janeiro, Rio de Janeiro. ix + 104 p.

Brodie, G. & Barker, G. 2011. Introduced land snails in the Fiji Islands: are there risks involved? In: *Island invasives: eradication and management* (ed. Veitch, C.R., Clout, M.N & Towns, D.R.), p. 32-36. IUCN, Gland.

Gomes, S.R. & Thomé, J.W. 2004. Diversity and distribution of the Veronicellidae (Gastropoda: Soleolifera) in the Oriental and Australian biogeographical regions. *Memoirs of the Queensland Museum* 49(2): 589-601.

Herbert, D. & Kilburn, D. 2004. *Field guide to the land snails and slugs of eastern South Africa*. Natal Museum, Pietermaritzburg. 336 p.

Lowe, S., Browne, M., Boudjelas, S., De Poorter, M. 2000. *100 of the World's worst invasive alien species. A selection from the Global Invasive Species Database*. Invasive Species Specialist Group (ISSG), Auckland. 12 p.

Morassutti, A.L., Thiengo, S.C., Fernandez, M. Sawanyawisuth, K. & Graeff-Teixeira. 2014. Eosinhphilic meningitis caused by *Angiostrongylus cantonensis*: an emergent disease in Brazil. *Memórias do Instituto Oswaldo Cruz* 109(4): 399-407.

Murphy, D.D. 1988. Challenges to biological diversity in urban areas. In: *Biodiversity* (ed. Wilson, E.O.), p. 71-76. National Academy Press, Washington.

Ohlweiler, F.P., Takahashi, F.Y., Guimarães, M.C.A, Gomes, S.R. & Kawano, T. 2010. *Manual de gastrópodes límnicos e terrestres do Estado de São Paulo associados às helmintoses*. Redes Editora, Porto Alegre. 223 p.

Oliveira, A.P.M., Gentile, R., Maldonado, A., Torres, E.J. & Thiengo, S.C. 2015. *Angiostrongylus cantonensis* infection in molluscs in the municipality of São Gonçalo, a metropolitan area of Rio de Janeiro, Brazil: role of the invasive species *Achatina fulica* in parasite transmission dynamics. *Memórias do Instituto Oswaldo Cruz* 110(6): 739-744.

Robinson, D.G., Hovestadt, A., Fields, A. & Breure, A.S.H. 2009. The land Mollusca of Dominica (lesser Antilles), with notes on some enigmatic or rare species. *Zoologische Mededelingen* 83: 615-650.

Salgado, N.C. & Coelho, A.C.S. 2003. Moluscos terrestres do Brasil (Gastrópodes operculados ou não, exclusive Veronicellidae, Milacidae e Limacidae). *Revista de Biología Tropical* 51: 149-189.

Simone, L.R.L. 2006. *Land and freshwater Molluscs of Brazil*. EGB/FAPESP, São Paulo. 390 p.

Thiengo, S.C., Faraco, F.A., Salgado, N.C., Cowie, R.H. & Fernandez, M.A. 2007. Rapid spread of an invasive snail in South America: the giant African snail, *Achatina fulica*, in Brazil. *Biological Invasions* 9: 693–702.

Thiengo, S.C. & Fernandez, M.A. 2013. Gastrópodes neotropicais continentais de importância médica. In: *Dinâmica das doenças infecciosas e parasitárias* (ed. Coura, J.R.), p. 131-140. Guanabara Koogan, Rio de Janeiro.

Thomé, J.W., Gomes, S.R. & Picanço, J.B. 2006. *Guia ilustrado: os caracóis e as lesmas dos nossos bosques e jardins*. USEB, Pelotas. 124 p.

Thomé, J.W., Santos, P.H. & Pedott, L. 1997. Annotated list of Veronicellidae from the collections of the Academy of Natural Sciences of Philadelphia and the National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA (Mollusca: Gastropoda: Soleolifera). *Proceedings of the Biological Society of Washington* 110(4): 520-536.

Thomé, J.W. 1989. Annotated and illustrated preliminary list of Veronicellidae (Mollusca: Gastropoda) of the Antilles, and Central and North America. *Journal of Medical and Applied Malacology* 1: 11-28.

Zanol, J., Fernandez, M.A. & Oliveira, A.P.M. 2010. O caramujo exótico invasor *Achatina fulica* (Stylommatophora, Mollusca) no Estado do Rio de Janeiro (Brasil): situação atual. *Biota Neotropica* 10(3): 447-451.

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IDENTIFYING HOTSPOTS OF NON-MARINE MOLLUSC DISTRIBUTION IN THE WESTERN GHATS, INDIA

By Aravind N.A. & Roshmi Rekha Sarma

The Earth is losing biological diversity at an alarming rate and hence efforts towards its conservation are of paramount importance. However, limited resources call for identifying regions of priority for focused and effective conservation and management (Margules & Pressey, 2000; Sutherland, 2001). Resource constraints are pronounced in tropical regions with rich biodiversity, which are where most developing countries are located. Despite the fact that invertebrates make up a large proportion of biodiversity across the world, global conservation planning is usually biased towards large and charismatic species (Myers *et al*., 2000; Uma Shaanker *et al*., 2004).

One invertebrate group that is largely neglected is molluscs. Non-marine molluscs are facing extinction from loss of habitat, overexploitation, introduction of invasive species, etc. Due to their poor dispersal ability and small ranges (Solem, 1984; Cameron, 1999), this group is especially vulnerable to extinction. According to the IUCN Red List (version 2015-4), 307 non-marine molluscs have gone extinct. Further, a recent study estimated that 7 % of all land snail species have already been lost (Régnier *et al*., 2015). Hence, the identification of regions of high species richness and endemism is essential for prioritization. The prioritization effort in the Western Ghats of India has largely been focused on either vertebrates or endemic plants, and lower organisms have been totally neglected, as in other parts of the world. As part of a larger study, we have tried to identify the regions of high species richness and endemism (hotspots) for non-marine molluscs in the Western Ghats.

The Western Ghats is one of 34 hotspots of biological diversity in the world and one of the four in India. This hotspot runs parallel to the west cost of India from 8°N to 21°N for 1,600 km, covering an area of 160,000 km^2. The Western Ghats harbour 270 species of land snails (Fig. 1) and 60 species of freshwater molluscs with 80 % and 40 % endemicity respectively (Aravind *et al*., 2011; Raheem *et al*., 2014). We compiled the information on the distribution of non-marine molluscs of the Western Ghats based on field studies and published literature. These data were geocoded using Google Earth. In total, there were 844 records for land snails and 896 for freshwater molluscs (Fig. 2). We mapped the distribution of non-marine molluscs using QGIS, and circular neighbourhood analysis was done in DIVA-GIS v.7.5 with 0.1 degrees (~11 km^2) as the pixel size.

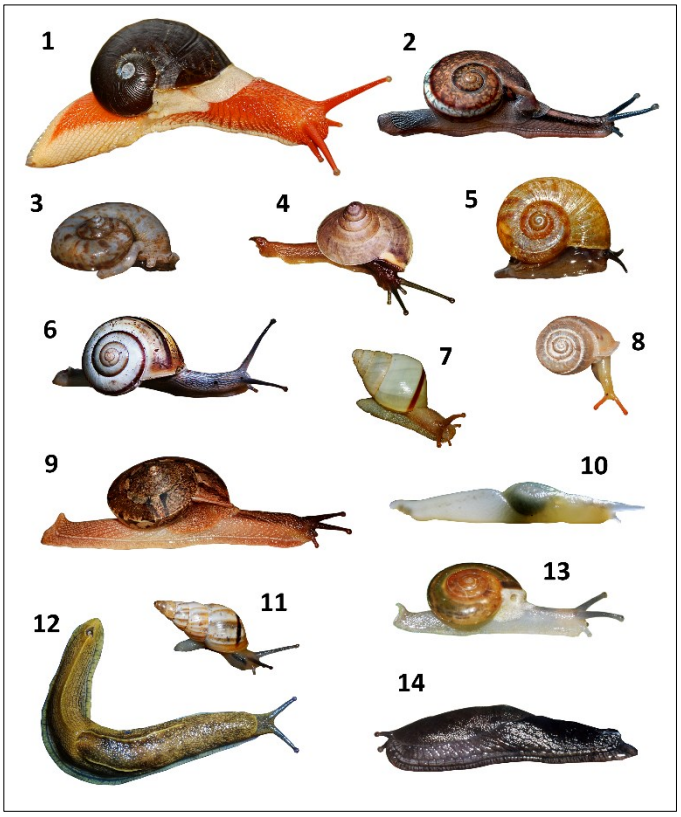

Fig. 1. Some land snails of the Western Ghats (images not to scale). 1–*Indrella ampulla*; 2–*Ariophanta bistrialis*; 3–*Pearsonia travancorica*; 4–*Euplecta* sp.; 5–*Theobaldius* sp.; 6–*Chloritis propinqua*; 7–*Beddomea calcadensis*; 8–*Perrottetia* sp.; 9–*Euplecta travancorica*; 10–*Satiella* sp.; 11–*Rachis punctatus*; 12–*Mariaella dussumieri*; 13–*Macrochlymus* sp.; 14–*Mariaella beddomei*.

The circular neighbourhood analysis based on point location data for land snails shows that the areas to the north and south of the Palghat Gap (Fig. 2) have highest species richness in the Western Ghats (Fig. 3). The species richness ranges from 114 to 141 in this region. Immediately north of the Palghat Gap is the next area of high species richness with 80 to 113 land snail species (Fig. 3). The northern part of the central Western Ghats and the northern Western Ghats (north of 16°N) has low to very low species richness. It is interesting to see that Kerala and the Western Ghats part of Tamil Nadu have the highest richness. This is mainly a result of relatively better sampling that was conducted during the British era as compared to other regions of the Ghats.

For freshwater molluscs, the hotspot of species richness is in the central Western Ghats (between 12°N and 16°N) and part of the northern Western Ghats. Contrary to land snails, freshwater molluscs are better sampled in the central and northern Western Ghats. Thus, the pattern observed is highly biased due to sampling efforts for both the groups. A significant proportion of the hotspot of richness is outside the Protected Area (PA) network (Fig. 3).

The Western Ghats hotspot also has the highest human population density of any hotspot in the world (Cincotta *et al*., 2000). It has only 48 PAs covering only 13 % (23,085 km^2) of

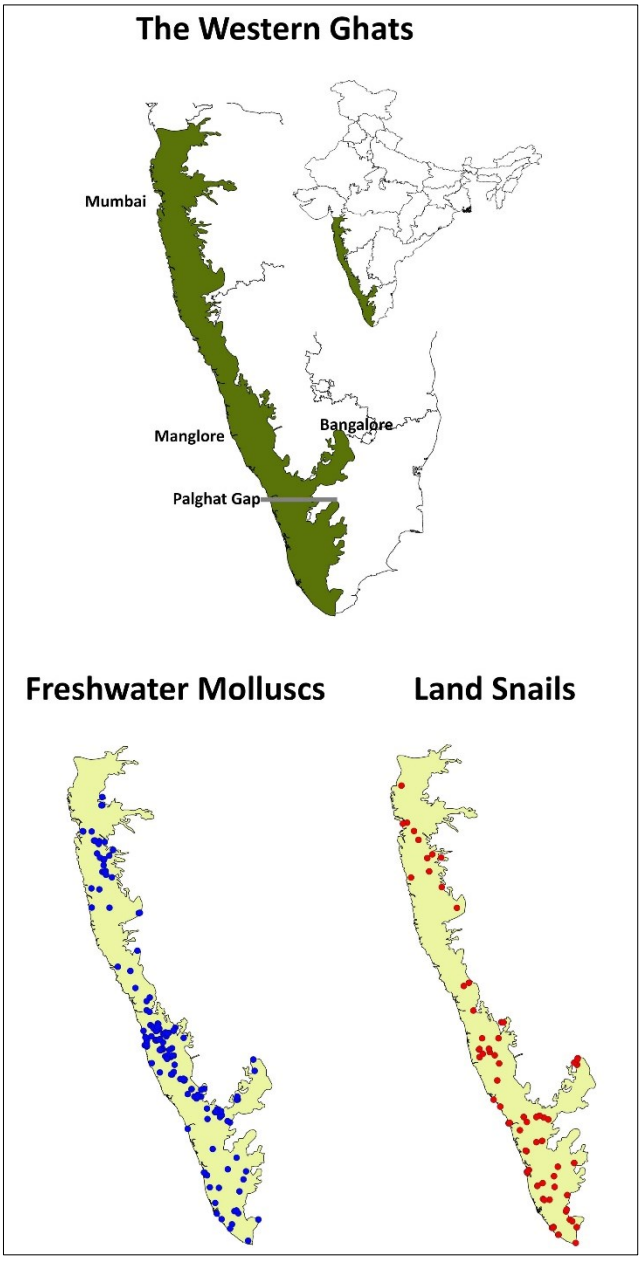

Fig. 2. Location of the Western Ghats and the distribution points for land and freshwater molluscs.

the geographical area of the Ghats. PAs in India are generally designated for large and charismatic animals, as in other parts of the world (Uma Shaanker *et al*., 2004).

The Western Ghats have undergone changes in land use resulting from a variety of anthropogenic activities ranging from establishment of commercial plantations for crops, including tea, coffee, teak and rubber, to infrastructure developmental such as construction of dams, roads and rail networks. Increased population has also resulted in the loss ofcritical habitats because of encroachment. For example, Kerala, the state in which the southern Western Ghats are located, lost 19.5 % of its evergreen forests between 1973 and 1995 (Jha *et al*., 2000). Under such scenarios, identifying remaining good forested areas and prioritizing those areas will

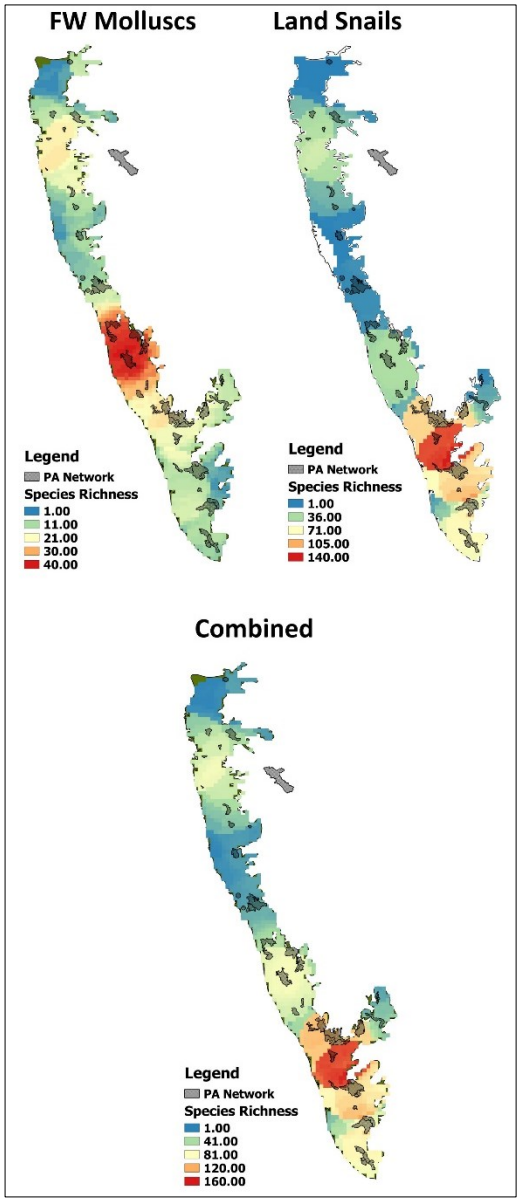

Fig. 3: Hotspot of species richness for land and freshwater molluscs of the Western Ghats.

become even more important for conservation of less charismatic species such as molluscs.

The major caveat with the present study is that the distribution data are not comprehensive. However, despite these limitations, some general conclusions can be drawn. Endemism in non-marine molluscs is higher (~ 80 %) than in other taxa in the Western Ghats and there are many very restricted, narrow range endemics. Existing knowledge has enabled us to identify the hotspots for both land snails and freshwater molluscs. Based on the available evidence, the southern Western Ghats (south of 12°N) are more diverse than areas further north. This pattern is also true for some other groups such as fishes (Dahanukar *et al*., 2004), endemic plants (Ramesh & Pascal, 1996) and odonates (Subramanian & Shivaramakrishnan, 2002). However, for amphibians and aquatic insects, latitudes between 12°N and 14°N are richest (Daniels, 1992; Subramanian, 2004).

In general, invertebrates such as molluscs have been neglected compared to vertebrates despite their far greater numbers. Yet they can be more reliable indicators of hotspots of high diversity and endemism (Moritz *et al*., 2001) at much smaller scales than vertebrates. Thus, efficient conservation planning requires awareness of their distributions and patterns of endemism (Aravind *et al*., 2005).

Given the high cryptic diversity and highly local patterns of endemism in non-marine molluscs and the lack of knowledge of species distributions, it is difficult to design an optimal PA network. The use of a large number of small PAs covering a wide range of habitats and altitudes for conservation of molluscs shouild be considered, as suggested by Cameron (1998), in the Western Ghats. These small areas might not harbour large animals, but given the small home range of molluscs, it might serve as a better model for conservation in highly human dominated landscapes such as the Western Ghats.

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Aravind, N.A., Rajashekhar, K.P. & Madhyastha, N.A. 2005. Species diversity, endemism and distribution of land snails of the Western Ghats, India. *Records of Western Australian Museum* Supplement 68: 31-38.

Aravind, N.A., Madhyastha, N.A., Rajendra, G.M. & Dey, A. 2011. The status and distribution of freshwater molluscs of the Western Ghats. In: *The status and distribution of freshwater biodiversity in the Western Ghats, India* (comp. Molur, S., Smith, K.G., Daniel, B.A. & Darwall, W.R.T.), p. 59-72. IUCN, Cambridge and Gland, Switzerland; Zoo Outreach Organisation, Coimbatore.

Cameron R.A.D. 1998. Dilemmas of rarity: biogeographical insights and conservation priorities for land Mollusca. *Journal of Conchology* Special Publication 2: 51-60.

Cameron, R.A.D. 1999. Biodiversity and extinctions in modern land snail faunas. *Contributions to the Zoogeogaphy and Ecology of the Eastern Mediterranean Region* 1: 21-26.

Cincotta, R.P., Wisnewski, J. & Engelman, R. 2000. Human population in the biodiversity hotspots. *Nature* 404: 990-992.

Dahanukar, N., Rupesh R. & Bhat, A. 2004. Distribution, endemism and threat status of freshwater fishes in the Western Ghats of India. *Journal of Biogeography* 31: 123-136.

Daniels, R.J.R. 1992 Geographical distribution of patterns of amphibians in the Western Ghats, India. *Journal of Biogeography* 9: 521-529.

Jha, C.S., Dutt, C.B.S. & Bawa, K.S. 2000. Deforestation and land use changes in Western Ghats, India. *Current Science* 79: 231-237.

Margules, C.R. & Pressey, R.L. 2000. Systematic conservation planning. *Nature* 405: 243-253.

Moritz, C., Richardson, K.S., Ferrier, S., Monteith, G.B., Stanisic, J., Williams, S.E. & Whiffin, T. 2001. Biogeographical concordance and efficiency of taxon indicators for establishing conservation priority in a tropical rainforest biota. *Proceedings of the Royal Society of London* B 268: 1875-1881.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., Da Fonseca, G.A. & Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.

Raheem, D.C., Taylor, H., Ablett, J., Preece, R.C., Aravind, N.A. & Naggs, F. 2014. A systematic revision of the land snails of the Western Ghats of India. *Tropical Natural History* Supplement 4: 1-298.

Ramesh, B.R. & Pascal, J.P. 1996. Distribution of endemic arborescent evergreen species in the Western Ghats. In: *The Proceedings of the Symposium on Rare, Endangered and Endemic Plants of the Western Ghats. Kerala Forest Department, special Publication No. III* (ed. Karunakaran, C.K.), p. 20-29. Kerala Forest Department, Thiruvananthapuram.

Régnier, C., Achaz, G., Lambert, A., Cowie, R.H., Bouchet, R. & Fontaine, B. 2015. Mass extinction in poorly known taxa. *Proceedings of National Academy of Sciences of the United States of America* 112: 7761-7766.

Solem, A. 1984. A world model of land snail diversity and abundance. In: *World-wide snails: biogeographical studies on non-marine Mollusca* (ed. Solem A. & van Bruggen, A.C.), p. 6-22. E.J. Brill/Dr W. Backhuys, Leiden.

Subramanian, K.A. 2004. Community composition and biomonitoring potential of hill stream insects of the Western Ghats. *Sahyadri E-news* 5.

Subramanian, K.A & Shivaramakrishnan, K.G. 2002. Conservation of odonate fauna in the Western Ghats - a biogeographic perspective. In: *Vistas of Entomological Research for the New Millennium* (ed. Sanjayan, K.P., Mahalingam, V. & Muralirangan, M.C.), p. 11-22. GS Gill Research Institute, Chennai.

Sutherland, W.J. 2001. *The conservation handbook. Research, management and policy*. Blackwell Science, Oxford.

Uma Shaanker, R., Aravind, N.A. & Ganeshaiah, K.N. 2004. Forest Management for Conservation. In: *Encyclopedia of Forest Science* (ed. Burley, J., Evans, J. & J.A. Youngquist), p. 215-223. Academic Press.

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WHAT DETERMINES LONG TERM SUCCESS IN ASSISTED COLONIZATION OF LAND SNAILS? INSIGHTS FROM A 19TH CENTURY EXPERIMENT

By Aydin Örstan and Timothy A. Pearce

A recent article in *The Economist* (Anonymous, 2015) declared that "In future the question will no longer be how to preserve species in particular places but how to move them around to ensure their survival". Assisted colonization may indeed become the only survival option left for many species facing extinction as a result of habitat loss or climate change. However, biologists have not reached a consensus yet on the conservation value of intentional introductions of species to places outside their native ranges (e.g. Ricciardi & Simberloff, 2009). We are interested in the potential use of assisted colonization to save threatened species of land snails (Örstan, 2009; Pearce & Paustian, 2013). Humans have been moving land snails around intentionally and unintentionally for thousands of years. We believe some of these existing introductions are good opportunities to gain more information about the determinants of long-term survival of introduced colonies and the likelihood of unintended ecological consequences. Without such information, haphazard and misguided introductions may end in wasted or disastrous efforts. As a start, we offer our findings from an ongoing colonization experiment that was initiated in the 1850s.

William G. Binney introduced the European land snail *Cepaea nemoralis* (Linnaeus, 1758), originally from near Sheffield, England, into the garden of his home in Burlington, New Jersey, USA, in 1857 (Gould & Binney, 1870). The snails did well and dispersed throughout the town. Perhaps because Binney was so pleased with the outcome of his experiment, he repeated it with a US species. *Xolotrema fosteri* (Baker, 1932), recorded by Binney as *Triodopsis appressa* (Say, 1821), was introduced once again to his garden in the 1860s using specimens from Illinois (Pilsbry, 1940: 832). Its native range is mostly in Illinois and Missouri (Hubricht, 1985).

In the early decades of the 20th century, Henry A. Pilsbry searched for both species in and around Burlington. He found *C. nemoralis* abundantly in some gardens and in several cemeteries in the city, but none in the surrounding country (Pilsbry, 1939: 10). By his account, *X. fosteri* had been more successful: "They are now abundant in suitable places all over the town, and in 1909 I found them at least 8 miles down the river, at Plum Point, above Riverton, and in several intervening places along the Delaware River; also found at Torresdale, on the Pennsylvania side (1911)" (Pilsbry, 1940: 832).

A survey in the summers of 2013 and 2014 in Burlington that included some localities where Pilsbry had collected more than 100 years earlier found six live snails and six empty shells of *C. nemoralis*. These results suggest that both the range and the population of *C. nemoralis* in the city have declined drastically since the 1930s and that the species could be extirpated in the near future (Örstan & Cameron, 2015).

The same survey also found *X. fosteri* in Burlington with an equally sparse population (Fig. 1). However, unlike the range of *C. nemoralis*, which is restricted to the city, that of *X. fosteri* still extends beyond Burlington. Since 1998 it has been found south of Burlington in New Castle and Sussex Counties of Delaware and further south in Somerset County of Maryland and as far north as Westchester County of New York (Pearce, unpublished records). While Pilsbry (1940) noted finding this species 8 miles (13 km) down the Delaware River from Burlington, these newer records report it 200 km down that river and into Delaware Bay, suggesting the possibility of dispersal by water. However, the species is also found along Chesapeake Bay, downstream from the Susquehanna River drainage to the west of the Delaware River and the record from Westchester County is not downriver from Burlington; these populations must have been founded by some other method besides water dispersal. When combined with the older records, the entire eastern North American range of *X. fosteri* becomes impressive (Fig. 2). In the absence of information on other introductions of *X. fosteri*, we assume that the ancestors of all the past and present colonies in Fig. 1 were the snails from Binney's garden.

In the light of these findings, we offer some comments that could be relevant to the assisted colonization efforts for land snails.

Short-term survival of a colony, even over several decades, does not guarantee long-term permanence. *Cepaea nemoralis* did very well in Burlington for at least 80 years before ending

Fig. 1. Records of *Xolotrema fosteri* in eastern North America based on the collections of T.A. Pearce and C.F. Sturm (circles) and the online catalogue of the Academy of Natural Sciences of Drexel University, Philadelphia (squares). Red arrow marks the location of Burlington. Inset: one of the five shells of *X. fosteri* found in Burlington in 2013 and 2014 (width 16.3 mm). (Background image: Google Earth)

up with its currently restricted and declining population. But we cannot attribute the decline of the population definitely to the species being non-native; population crashes, albeit over shorter periods, have been observed in introduced colonies of *C. nemoralis* even within its native range (e.g. Wolda, 1963).

Smaller and inconspicuous species (*X. fosteri*) may attract less attention from humans than do larger and showier ones (*C. nemoralis*) and thus the former may be less likely to face extermination attempts by gardeners, farmers and the like. But there is a caveat. The smaller a species is, the harder it may be to detect it during searches and, therefore, the more difficult it would be to monitor its colonies. Moreover, smaller more inconspicuous species might also escape intentional transport by humans, although Binney himself chose to transport both.

Some introduced species may gradually extend their ranges far beyond the initial introduction locality, just as *X. fosteri* did. The wider the range of a species the less likely it may go extinct; however, the unintended and uncontrolled spread of a species may not always be a desirable outcome.

Finally, deliberate introductions to urban areas should be avoided in assisted colonization efforts, because compared to rural locations, urban habitats may be shorter lived and more prone to interference by humans regardless of the presence of snails.

We hope our preliminary thoughts will inspire others to carry out similar studies.

Anonymous. 2015. A modern ark. *The Economist* 28 November.

Gould, A.A. & Binney, W.G. 1870. *Report on the Invertebrata of Massachusetts, published agreeably to an order of the legislature. Second edition, comprising the Mollusca*. Wright and Potter, Boston. vi + 524 p., 26 pls.

Hubricht, L. 1985. The distributions of the native land mollusks of the eastern United States. *Fieldiana* 24: i-viii, 1-191.

Örstan, A. 2009. Will assisted colonization be a viable option to save terrestrial gastropods threatened by climate change? *Tentacle* 17: 14-16.

Örstan, A. & Cameron, R.A.D. *Cepaea nemoralis* in Burlington, New Jersey, USA: its possible origin and state 157 years after its introduction. *Journal of Conchology* 42: 193-198.

Pearce, T.A. & Paustian, M.E. 2013. Are temperate land snails susceptible to climate change through reduced altitudinal ranges? A Pennsylvania example. *American Malacological Bulletin* 31(2): 213-224.

Pilsbry, H.A. 1939-1940. Land Mollusca of North America (North of Mexico), Vol. 1, Parts 1-2. *Academy of Natural Sciences of Philadelphia, Monograph* 3: 1-994.

Ricciardi, A. & Simberloff, D. 2009. Assisted colonization is not a viable conservation strategy. *Trends in Ecology & Evolution* 24: 248-253.

Wolda, H. 1963. Natural populations of the polymorphic landsnail *Cepaea nemoralis* (L.). *Archives Néerlandaises de Zoologie* 15(4): 381-471.

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PACIFIC ISLAND LAND SNAILS

Partula return to Tahiti after 30 years of conservation efforts

By Trevor Coote and 19 others

July 2015 marked a major milestone in the long running *Partula* snail conservation initiative with the commencement of the reintroduction phase of the programme. This initial release focused on the Tahitian species *Partula nodosa*, *P. affinis* and *P. hyalina* using populations from the international conservation breeding programme.

On the morning of 24 July 2015 a small crate containing 430 individuals of three species of Tahitian *Partula* tree snails arrived at Fa'a'ā airport on Tahiti. It was collected from customs by the *Partula* Programme's in-country field biologist and two zoo community colleagues. After inspection by the government vet, the crate was taken to a quarantine room in the local Environment Department where the *Partula* were welcomed and serenaded by the department personnel (Fig. 1). This was to be the first

Fig. 1. *Partula* in quarantine.

attempted re-establishment of any endemic species into French Polynesia.

The import of all live animals into French Polynesia is forbidden and, in order to import the *Partula*, an exemption to the law had to be secured, which necessitated protracted administrative arrangements to be completed. During this time the release population was assembled from the breeding groups at Bristol, Chester, Edinburgh, Detroit, London, Marwell and St Louis Zoos and given a thorough pre-release health screening. No pathological threat was found during screening, the animals were deemed clean and a health certificate prepared for the local government to enable their release into nature.

Two conservation strategies were under scrutiny. First, a secure reserve. A reserve secured against the principal threat to the endemic species, the carnivorous snail *Euglandina rosea*, had been constructed and tested on Moorea in 1994. Lessons had been learned from that experiment but the basic problems of cost and maintenance remained. However, after the current reserve had been built in Te Faaiti Natural Park in 2012 and while it remained empty awaiting import authorisation for the snails, the concept was superseded by a second cheaper and less labour intensive strategy. Second, tree releases. It had been noted that certain relict populations of *Partula clara* were found in the overhanging branches of the ubiquitous Tahitian chestnut tree or *mape*. The theoretical possibility of *mape* trees acting as refuges from *Euglandina* arose, their dry, dusty bark acting as potential impediments to the progress of the predator. This was easily testable but even if the idea failed it was clear that it would be far more cost effective and manageable to release snails directly into trees, which could then be secured, if necessary.

Three species of *Partula* were involved in the release:

- *Partula affinis* (Red List status CR). There is only one known surviving population of this species on the peninsula of Tahiti, though its former distribution consisted of most of the wet, windward side of Tahiti Nui and the peninsula of Tahiti Iti. This was the target species for the reserve in Te Faaiti Valley (Fig. 2), within its former range.

Fig. 2. Te Faaiti reserve (top) and Papehue Valley tree release site (bottom).

- *Partula hyalina* (Red List status VU). This species is widely distributed on Tahiti but nowhere common. It was transported in the past by people to six other islands in the Austral and Cook Island groups. A small control population was planned for the reserve as it survives well elsewhere.
- *Partula nodosa* (Red List status EW). Although extinct in the wild for at least 30 years this species has prospered exceptionally well in the breeding programme. This was the target species for tree releases in Papehue Valley (Fig. 2) on Tahiti's dry leeward coast, and the valley of origin of the entire breeding programme stock. A few individuals were earmarked for the reserve as a control group.

Unfortunately, a large proportion of the *Partula affinis* and all but one of the *P. hyalina* died en route. This was almost certainly due to a temperature aberration in the live animal cargo hold and improvements are being made to the transportation containers to reduce any such risk in future shipments. This meant adjusting the numbers for release and principally to put more *P. nodosa* into the reserve to make up for the losses. The final release figures into the reserve are given in Table 1. All 150 adult *Partula nodosa* released into the *mape* trees in Papehue Valley were adults.

Table 1. *Partula* released into the reserve.

Released	Adults	Subadults	Juveniles	Newborns	Totals
P. hyalina	1	0	0	0	**1**
P. nodosa	60	0	0	10	**70**
P. affinis	27	3	4	14	**48**
Totals	**88**	**3**	**4**	**24**	**119**

The snails were kept in quarantine for 2-3 days to allow them to awake from aestivation and to assess what was available for release. The shells of all the adult *Partula* were marked with enamel paint for individual identification and for future recording of dispersal information, and the snails were then packed into pots and placed in a cooler box ready for transport to the release sites (Fig. 3). A few individual newborns were left in a tank in the quarantine room for department personnel to gain husbandry experience.

Two days before release a number of makeshift barriers (wire wool, copper wire, sand) were put in place to try and secure the reserve against *Euglandina rosea* as the electric barrier was not functioning. There was also concern about lack of shade.

The first release was into Papehue Valley. Pots containing damp sphagnum moss and 15 marked *Partula nodosa* adults were secured at varying heights in ten pre-selected trees to

Fig. 3. Marking the snails and packing them for release.

Fig. 4. Securing the pots of *Partula* in Papehue Valley.

allow the animals to recover and disperse in their own time (Fig. 4). There were two non-*mape* control sites. Fifteen hours later a number of snails had left the pots and had begun dispersing into the trees.

Release into the reserve was more complicated and much discussion was held as to the best method of release. In the end it was decided to repeat the method used in Papehue Valley. The numbers and species in the pots differed, though, and they had to be attached to plants and shrubs rather than trees. Ten people were involved, including *Partula* programme and Governmental agency colleagues and interested members of the local commuity, and all helped in securing pots (Fig. 5).

After three and a half months of intensive monitoring in Papehue Valley just 24 dead shells have been recovered out of 150 released animals. It is presumed that the majority of those no longer visible have dispersed into the trees and beyond. The first newborn was spotted after one month and more were seen subsequently. At one point tiny juveniles were seen in each of the ten sites. However, it was difficult to tell if they were *Partula nodosa* or *P. clara*, which persists in some of the trees. The latest situation is that the juveniles seen are now at a size

Fig. 5. Securing the pots of *Partula* in Te Faaiti reserve.

Fig. 6. Released *Partula nodosa*, Papehue Valley. Inset: Papehue-born *P. nodosa*.

(6-7 mm) at which the two species can easily be distinguished and 11 young *P. nodosa* were recorded during the last monitoring session with one of the original stock still visible close to the release pot (Fig. 6).

The *Partula* in the reserve have fared less well. Only one individual of *Partula hyalina* was available for release but that died soon after. Possibly all of the *P. affinis* released are now dead and most of the *P. nodosa*. Interestingly, not one *Euglandina rosea* has been found in the reserve since the initial release. However, the hot, dry conditions and lack of shade may be the principal factor contributing to the high mortality. The difficulty lay in balancing the need for shade with the protection of the integrity of the barrier and security fence from falling trees in the reserve interior. Only one live juvenile *P. nodosa* was seen during the last monitoring session though there may still be some others hidden under leaves. In 2016 further release will take place into Papehue Valley and Te Faaiti reserve, as well to Moorea and hopefully Raiatea. Initial results so far are mixed but encouraging in the tree releases.

This conservation progress has only been possible because of the long-term collaboration between the French Polynesian environmental agencies and the international zoo community together with IUCN's SSC Conservation Breeding and Mollusc Specialist Groups.

Some key, relevant partulid conservation publications:

Coote, T. 2012. Tahiti becomes the focus of *Partula* conservation. *Tentacle* 20: 28-30.

Coote, T. 2008. Revised Red List categories for Partulidae. In *2008 IUCN Red List of Threatened Species.* IUCN, Gland.

Coote, T., Clarke, D., Hickman, C.S., Murray, J. & Pearce-Kelly, P. 2004. Experimental release of endemic *Partula* species, extinct in the wild, into a protected area of natural habitat on Moorea. *Pacific Science* 58(3): 429-434.

Coote, T. & Loève, E. 2003. From 61 species to five: endemic tree snails of the Society Islands fall prey to an ill-judged biological control programme. *Oryx* 37: 91-96.

Coote, T., Merz, R. & Pearce-Kelly, P. 2005 (revised 2006, 2009, 2010, 2012, 2013, 2014, 2015). *Action Plan for the conservation of French Polynesia's endemic tree snails of the genera* Partula*,* Samoana*, &* Trochomorpha. Partulid Global Species Management Programme in association with La Service Direction de l'Environnement de la Polynésie française.

Mace, G., Pearce-Kelly, P. & Clarke, D. 1998 An integrated conservation programme for the tree snails of Polynesia (Partulidae): a review of captive and wild elements. *Journal of Conchology* Special Publication 2: 89-96.

Ó Foighil, D. 2009. Conservation status update on Society Island Partulidae. *Tentacle* 17: 30-35.

Pearce-Kelly, P., Brewer, R., Coote, T., McFarlane, D. & Noelle, M. 2010. Conservation in a snail shell: working together to save some of Polynesia's most remarkable species. In: *Building a future for wildlife: zoos and aquariums committed to biodiversity conservation* (ed. Dick, G. & Gusset, M.), p. 167-172. World Association of Zoos and Aquariums Executive Office, Gland.

Pearce-Kelly, P., Clarke, D., Walker, C. & Atkin, P. 1997. A conservation programme for the partulid tree snails of the Pacific region. *Memoirs of the Museum of Victoria* 56(2): 431-433.

Pearce-Kelly, P., Mace, G. & Clarke, D. 1995. The release of captive bred snails (*Partula taeniata*) into a semi-natural environment. *Biodiversity and Conservation* 4: 645-663.

Pearce-Kelly, P., Clarke, D. & Mace, G. 1994. Partula *'94: an action plan for the conservation of the family Partulidae*. Pacific Island Land Snail Group, Zoological Society of London, London.

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Sam Aberdeen, Zoological Society of London.
Ross Brown, Marwell Wildlife.
Mark Bushell, Bristol Zoological Society.
Paul Buzzard, Detroit Zoological Society.
Dave Clarke, Zoological Society of London.
Jo Elliott, Royal Zoological Society of Scotland.
David Field, Zoological Society of London.
Glenn Frei, St Louis Zoo.
Gerardo García, North of England Zoological Society.
Justin Gerlach, Terrestrial and Freshwater Invertebrate Red List Authority (IUCN/SSC).
Don McFarlane, Auckland Zoo.
Bob Merz, St Louis Zoo.
Paul Pearce-Kelly, Zoological Society of London.
Sarah Robinson, Royal Zoological Society of Scotland.
Claude Serra, Direction de l'environnement, Government of French Polynesia.
Ed Spevak, St Louis, Zoo.
Christoph Schwitzer, Bristol Zoological Society.
Scott Wilson, North of England Zoological Society.
Tim Woodfine, Marwell Wildlife.

Partula compressa: not extinct after all

By Justin Gerlach

The Pacific tree snails of the family Partulidae are well known to have suffered high levels of extinction, with 31 % of the species being extinct and a further 16 % extinct in the wild. This is due almost entirely to predation by the infamous misguided biological control introductions of *Euglandina rosea*.

During my ongoing revision of the taxonomy of partulids and investigation into their ecology and conservation I re-examined the specimens of the particularly enigmatic species *Partula compressa* (Fig. 1). This species was first described by Lovell Reeve in 1850, but in 1866 William Harper Pease described the same species as *P. stolida* based on specimens collected by Andrew Garrett from under ferns in Papenoo valley on Tahiti. Pease confused things further by misidentifying some Raiatean specimens as this species. Fifty years later, Henry E. Crampton searched for *P. compressa* but was unable to find it and suggested tentatively that it might be an aberrant form of *P. affinis*. Since then the species has been completely neglected.

Fig. 1. *Partula compressa*.

The type specimens show that *P. compressa* is a distinct but quite variable species; *P. stolida* is just a synonym. There are no Raiatean specimens, this record just being a simple misidentfication. *Partula compressa* seemed to have been restricted to Papenoo until I found specimens in the Bishop Museum collected on Mt. Aorai in 1925. One of these allowed the anatomy of the species to be determined.

More recent specimens have also turned up, starting with several old dead shells found by Trevor Coote on Mt. Aorai. It looked like these were the remnants of the populations eliminated by *E. rosea* in the 1980s. In examining preserved material in the Zoological Soceity of London from the *Partula* captive breeding programme I realized that one population, supposed to be *P. otaheitana*, had been misidentified and was in fact *P. compressa*. Unfortunately, this population did not survive long in captivity. The snails had been collected by Eric Loève in 1996 from a site that is very difficult to reach. Photographs of the same species were taken by Jean-Yves Meyer in the same locality in 2004. So it seems that not only is *P. compressa* an overlooked valid species, but a wild population probably still survives on Tahiti.

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Introduction to the Hawaii Snail Extinction Prevention Program (SEPP)

By David Sischo

In Hawaii snails are said to sing. While the source of this voice has been debated for years, Hawaiian folklore suggests the snails themselves were the source of sound. Consequently, in Hawaiian custom, snails were the voice of the forest, and they embodied the Polynesian oral tradition of passing on one's genealogy through singing, making them extremely important to the cultural practices of hula and chant (Aimee Sato, pers. comm.).

With over 750 described species in 10 families (Cowie *et al*., 1995), the Hawaiian Islands were host to spectacular molluscan diversity, and are a true scientific spectacle of evolution (Fig. 1). Unfortunately, the past century has witnessed continually accelerating range reductions and extinction of much of this incredible fauna. The historic threats posed by habitat degradation due to agricultural practices, commercial development, and over-collection, have been overtaken by direct loss via predation by non-native species Three species of rats prey on snails, along with the rosy wolf snail (*Euglandina rosea*) and more recently the Jackson's chameleon (*Chamaeleo jacksonii*) introduced through the pet trade (Hadfield, 1986; Hadfield *et al*., 1993; Cowie, 2001; Hadfield & Saufler, 2009; Holland *et al*. 2010).

Fortunately all is not lost. Efforts to understand and save declining Hawaiian land snail populations have been ongoing for years thanks to University of Hawaii and Bishop Museum researchers, as well as staff from other organizations, including the US Fish and Wildlife Service, the Hawaii Department of Land and Natural Resources, The Nature Conservancy and the Oahu Army Natural Resources Program. These efforts along with a renewed awareness of the cultural implications of losing such iconic species have coalesced with the formation of the Hawaii Snail Extinction Prevention Program (SEPP), a partnership between the US Fish and Wildlife Service and the Hawaii Department of Land and Natural Resources – Division of Forestry and Wildlife.

The SEPP was founded in 2012 with the goals of rapidly increasing the capacity for snail conservation in the islands by coordinating efforts across agencies, synching conservation objectives and techniques and ensuring that species that have received no management efforts do not fall through the cracks into oblivion.

Fig. 1. Some of the extant molluscan diversity targeted by the SEPP, with their IUCN Red List status. A–*Achatinella sowerbyana* (Critically Endangered). B–*Partulina variabilis* (Endangered). C– *Laminella sanguinea* (Critically Endangered). D–*Achatinella mustelina* (Critically Endangered). E–*Amastra spirizona* (Critically Endangered).

Table 1. Outline of SEPP strategy.

Strategy	Objectives
Assessment and prioritization: Understand threats and plan actions	Assess rare snail distribution, abundance and specific threats to populations via targeted surveys Prioritize species and conservation actions based on vulnerability to extinction
Extinction intervention: Implement immediate stopgap measures to prevent extinctions	Implement predator control to slow the rate of declines Use captive rearing to hold individuals and or produce offspring for eventual release into protected areas
Secure and recover: Protect, establish, and grow populations	Establish viable populations inside predator-proof exclosure structures via translocation from laboratory and wild populations Implement monitoring of priority species and populations using consistent – scientifically robust methods
Education and outreach: Increase awareness and public support	Increase public awareness and support for rare snail conservation Promote appropriate interactions between hikers and rare snails
Capacity and efficacy: Build program capacity and support necessary research for rare snail survival	Synchronize rare snail management objectives and techniques across entities Build program capacity and support with sufficient staffing, financial, and partnership resources to effectively implement rare snail conservation across the islands Support and conduct research that improves our knowledge and techniques for rare snail conservation

It is with much enthusiasm that I introduce our program to the broader molluscan conservation community. Here I briefly outline the strategy of the SEPP (Table 1) and highlight a few promising techniques we in Hawaii are using

Fig. 2. Cage structure protecting a population of the ground-dwelling snail *Amastra cylindrica* (Amastridae) (IUCN Red List: Critically Endangered).

to recover our most imperiled species. It is my sincere hope that sharing the progress we have made on the conservation front here in Hawaii will spur collaboration with others across the globe.

We are currently experimenting with the use of small cage structures to protect populations of ground dwelling snails from predators *in situ*. These boxes are open on the bottom and the walls are made of untreated wood that is partially buried in the ground. The box covers are made of 3.175 mm (1/8 inch) epoxy coated wire mesh (Fig. 2). This mesh size and durability prevents incursion by rats, *Euglandina rosea*, and chameleons, keeping the target species safe. Adults and juveniles are too large to leave the box but newborn snails are small enough to fit through the mesh. The box protects breeding adults, while the slow leak of newborn snails out of the box allows populations to persist despite the presence of the aforementioned predators. Initial use shows promising results.

Although more costly to build and maintain, over the past 20 years, walled exclosure structures with predator barriers have been the most effective tool in protecting rare and endangered snail species *in situ* from rats, *Euglandina rosea* and Jackson's chameleons. The most current exclosure structure design in use today was developed by the Oahu Army Natural Resources Program and includes a walled barrier around a large portion of habitat (Rohrer *et al*., 2012). The wall consists of a rolled hood at the top to exclude rats and chameleons, and three *Euglandina rosea* barriers attached to the exterior of the wall. The *E. rosea* barriers consist of a flared 15° angled flange, solar-powered electrical wires and an array of upside-down, cut copper wire mesh (Fig. 3). The combination of these three barriers has proven very effective at excluding *E. rosea*. Currently five of these structures are in use on the

Fig. 3. Two predator-proof exclosure structures protecting critically endangered snail species endemic to the island of Oahu.

island of Oahu, with more slated for construction on Oahu as well as on the islands of Maui and Lanai.

Estimating the size of snail populations can be difficult, with most researchers relying on traditional capture-mark-recapture (CMR) methods. These procedures have usually involved marking snails with paint, ink or gluing tags on shells with chemical adhesives. All of these marking techniques have the potential for injury to the snail from a paint or glue mishap, or inadvertently attracting predators (Turner *et al*., 2012).

We have been experimenting with the photo identification software Hotspotter, developed to identify individual animals from a photo database (Crall *et al*., 2013). The software provides a set of possible matches that the user can confirm or bypass. Every confirmation of a match builds the photo library of that individual. This method of CMR allows multiple researchers to collect data simultaneously, reduces field time, and benefits the snails by reducing handling and manipulation. SEPP has tested this software with three species of snails in the genus *Achatinella*, with much success. The technique may prove to be extremely valuable for monitoring imperiled snails, when reducing risks associated with handling is imperative.

Cowie, R.H., Evenhuis, N.L. & Christensen, C.C. 1995. *Catalog of the native land and freshwater molluscs of the Hawaiian Islands*. Backhuys, Leiden. vi + 248 p.

Cowie, R.H. 2001. Can snails ever be effective and safe biocontrol agents? *International Journal of Pest Management* 47: 23-40.

Crall, J.P, Stewart, C.V., Berger-Wolf, T.Y., Rubenstein, D.I. & Sundaresan, S.R. 2013. HotSpotter – patterned species instance recognition. In: *Proceedings of the 2013 IEEE Workshop on Applications of Computer Vision (WACV)*, p. 230-237.

Hadfield, M.G. 1986. Extinction in Hawaiian achatinelline snails. *Malacologia* 27: 67-81.

Hadfield, M.G., Miller, S.E. & Carwile, A.H. 1993. The decimation of endemic Hawai‘ian [*sic*] tree snails by alien predators. *American Zoologist* 33(6): 610-622.

Hadfield, M.G. & Saufler, J.E. 2009. The demographics of destruction: isolated populations of arboreal snails and sustained predation by rats on the island of Moloka’i 1982-2006. *Biological Invasions* 11: 1595-1609.

Holland, B.S., Montgomery, S.L. & Costello, V. 2010. A reptilian smoking gun: first record of invasive Jackson’s chameleon (*Chamaeleo jacksonii*) predation on native Hawaiian species. *Biodiversity and Conservation* 19: 1437-1441.

Rohrer, J., Costello, V., Tanino, J., Bialic-Murphy, L., Sprague, J. & Joe, S. 2012. Appendix 3-1. Draft Technical Report: Development of tree snail protection enclosures: from design to implementation. In: *2013 Status Report for the Makua and Oahu implementation Plans*, p. [1-33]. Oahu Army Natural Resources Program, Schofield Barracks, and Pacific Cooperative Studies Unit, University of Hawaii, Honolulu.

Turner, R.L., Carter, G.M., Castro, I.C. & Minor, M.A. 2012. Use of adhesives to attach devices to invertebrates: implications for depredation by ship rats (*Rattus rattus*). *New Zealand Journal of Zoology* 40(2): 93-101.

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MARINE MATTERS

Haliotis, tasty but troubled

By Howard Peters

Following on the heels of the first global assessment of a marine gastropod mollusc group for the IUCN Red List – the cone snails – the University of York, UK, is now beginning an assessment of all species of abalone (*Haliotis* spp.) worldwide. Although facing many similar challenges to cone snails, abalone, as a culinary delicacy, are also targeted by commercial and recreational fishers, further aggravated in some regions of the world by an extensive illegal trade controlled by organised criminal gangs. By its own definition, estimates of illegal catch size cannot be precise. Nevertheless, it has been estimated to represent over 65 % of the total global legal abalone catch, with more recent years showing only a modest decline resulting from improved enforcement and growth in aquaculture (Cook, 2014).

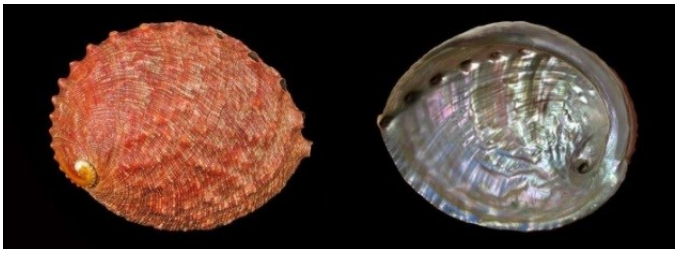

Fig. 1. *Haliotis sorenseni* (Bartsch, 1940). (Photo: Buzz Owen ©)

Overfishing for abalone is not a recent phenomenon. Even in prehistoric times, abalone populations were reduced to the point of local extinction. From shell middens dated to 258-2,830 BP on San Clemente Island, California, there is evidence that black abalone, *H. cracherodii* (Leach, 1814) were extirpated by the islanders, who subsequently ate turban snails, *Chlorostoma funebralis* (A. Adams, 1855) (Raab, 1992). More recently, white abalone, *H. sorenseni* (Bartsch, 1940) (Fig. 1), occurred in dense assemblages from north of Los Angeles to Punta Abreojos, Baja California. However, by 1978, only ten years after the nascent Californian fishery had started to expand, approximately 363,000 adults had been taken, leading to its total collapse and finally closure (Stierhoff *et al*., 2012). To the south, the Mexican abalone fishery followed a similar path (Shepherd *et al*., 1998).

Abalone are broadcast spawners but require close proximity of sexes for fertilisation (Riffell *et al*., 2004). In low density populations, typically resulting from stock depletions, they fall victim to the Allee Effect (Allee, 1931) as individuals struggle to find mates. In the case of white abalone this has resulted in recruitment failure, and despite fishery closure and protection under the US Endangered Species Act, scattered populations continue to decline and are threatened with extinction in the wild (Stierhoff *et al*., 2012). Reintroductions from aquaculture have had limited success and have been accompanied by the well-founded fear of releasing pathogens into the marine environment and loss of genetic diversity.

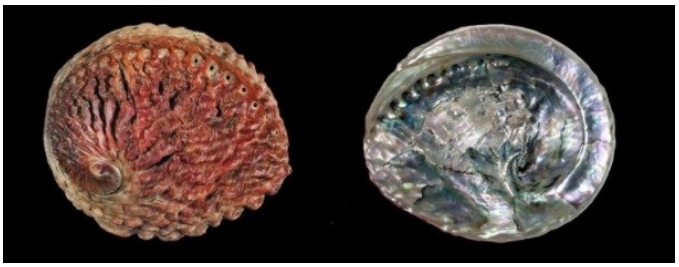

Fig. 2. *Haliotis midae* (Linnaeus, 1758) (Photo: Buzz Owen ©)

In South Africa, the endemic *H. midae* (Linnaeus, 1758) (Fig. 2), known locally as perlemoen, from the Dutch 'paarlemoer' for mother-of-pearl, progresses in the same direction. Fuelled by the demands of the traditional medicine market in eastern Asia, where abalone are considered to have aphrodisiac and fertility properties, illegal fishing organised by Chinese Mafia syndicates, combined with inadequate enforcement, have seen populations wiped out (Hauck & Sweijd, 1999; Plagányi *et al*., 2011). In 2008 it was estimated that the illegal catch at 860 tonnes was more than ten times the total allowable catch. This has been aggravated in some regions by the introduction of rock lobsters (*Parechinus angulosus*), resulting in the decline of sea urchins that protect juvenile abalone from predation (Plagányi *et al*., 2011).

In 2007 *H. midae* was listed by the Convention on International Trade in Endangered Species (CITES), but this was cancelled in 2010 by the South African government owing to inadequate resources to manage enforcement (Plagányi *et al*., 2011). Consequently there are no Haliotidae protected under CITES worldwide (see the Checklist of CITES species) and only two species on the IUCN Red List, namely the critically endangered black abalone, *H. cracherodii*, and the endangered pinto abalone, *H. kamtschatkana* (Jonas, 1845), both of Pacific North America. Surprisingly, given its high profile, the threatened *H. sorenseni* is only now to be fully assessed for the Red List.

The majority of research articles relating to abalone focus on the important commercial species, notably *H. midae* from South Africa, *H. iris* (Gmelin, 1791) from New Zealand, *H. tuberculata* (Linnaeus, 1758) from Europe, *H. laevigata* (Donovan, 1808) and *H. rubra* (Leach, 1814) from Australia and all *Haliotis* spp. from North America. With most species occurring in shallow water above 30 m (Geiger & Owen, 2012), abalone are at particular risk from anthropogenic pressures. However, especially for many non-commercial species, population stability and threats from disease, habitat loss, pollution and over-fishing go largely unreported. For all species, climate change and its effects on ocean temperature and chemistry will have an impact that has still to develop (Hall-Spencer, 2015). Nevertheless, through this comprehensive Red List assessment, understanding both the rates and causes of population change will enable action to be taken that offers protection to abalone for the benefit of biodiversity in general, and the fishers whose livelihoods depend on healthy abalone populations.

Allee, W.C. 1931. *Animal aggregations, a study in general sociology.* The University of Chicago Press, Chicago. 431 p.

Cook, P.A. 2014. The worldwide abalone industry. *Modern Economy* 5(13): 1181-1186.

Geiger, D.L. & Owen, B. 2012. *Abalone - Worldwide Haliotidae*. ConchBooks, Hackenheim. 361 p.

Hall-Spencer, J.M. 2015. Ocean acidification in a changing world. *Ocean Challenge* 21(1): 37-43.

Hauck, M. & Sweijd, N.A. 1999. A case study of abalone poaching in South Africa and its impact on fisheries management. *ICES Journal of Marine Science* 56: 1024-1032.

Plagányi, É., Butterworth, D. & Burgener, M. 2011. Illegal and unreported fishing on abalone—quantifying the extent using a fully integrated assessment model. *Fisheries Research* 107(1-3): 221-232.

Raab, L.M. 1992. An optimal foraging analysis on San Clemente Island, California. *Journal of Ethnobiology* 12(1): 63-80.

Riffell, J.A., Krug, P.J. & Zimmer, R.K. 2004. The ecological and evolutionary consequences of sperm chemoattraction. *Proceedings of the National Academy of Sciences of the United States of America* 101(13): 4501-4506.

Shepherd, S.A., Turrubiates-Morales, J.R. & Hall, K. 1998. Decline of the abalone fishery at La Natividad, Mexico: overfishing or climate change? *Journal of Shellfish Research* 17(3): 839-846.

Stierhoff, K.L., Neuman, M. & Butler, J.L. 2012. On the road to extinction? Population declines of the endangered white abalone, *Haliotis sorenseni*. *Biological Conservation* 152: 46-52.

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RECENT PUBLICATIONS RELEVANT TO MOLLUSC CONSERVATION

Walkerana becomes Freshwater Mollusk Biology and Conservation

Walkerana returned to publication in 2012 as the on-line journal of the Freshwater Mollusk Conservation Society, based in North America. In 2015, it changed its name to *Freshwater Mollusk Biology and Conservation*, publishing one issue (volume 18, number 1) consisting of one paper, on the mussels of Texas, USA. All issues are now available on-line with open access.

Journal of Threatened Taxa

The latest issue (Vol. 8, No. 1, January 2016) of the *Journal of Threatened Taxa* is available on-line now.

AMS Imperiled Species Newsletter

Keep up to date on threatened and endangered molluscs with the American Malacological Society's Imperiled Species Newsletter from Jay Cordeiro, Chair of the AMS Conservation Committee. It is available on the AMS conservation webpage. The most recent issue is for January 2016, reporting on events in 2015.

Climate Change and Molluscan Ecophysiology – AMS Symposium – American Malacological Bulletin

Marko, P.B., Carrington, E., Rosa, R., Giomi, F., Troschinski, S., Melzner, F. & Seibel, B.A. (ed.). 2015. Symposium on "Climate change and molluscan ecophysiology" at the 79th Annual Meeting of the American Malacological Society. *American Malacological Bulletin* 33(1): 121-173.

This symposium publication includes the following four papers.

Dunphy, B.J., Watts, E. & Ragg, N.L.C. Identifying thermally-stressed adult green-lipped mussels (*Perna canaliculus* Gmelin, 1791) via metabolomic profiling. p. 127-135.

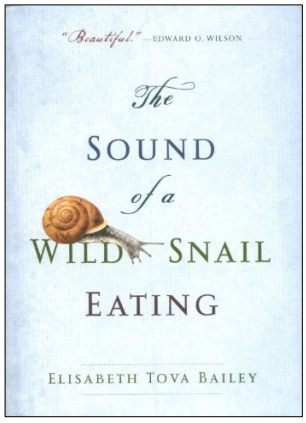
Fly, E.K., Hilbish, T.J., Wethey, D.S. & Rognstad, R.L. Physiology and biogeography: the response of European mussels (*Mytilus* spp.) to climate change. p. 136-149. [open access]

Matzelle, A.J., Sarà, G., Montalto, V., Zippay, M., Trussell, G.C. & Helmuth, B. A bioenergetics framework for integrating the effects of multiple stressors: opening a 'black box' in climate change research. p. 150-160.

Seibel, B.A. Environmental physiology of the jumbo squid, *Dosidicus gigas* (d'Orbigny, 1835) (Cephalopoda: Ommastrephidae): implications for changing climate. p. 161-173.

The Sound of a Wild Snail Eating

Elisabeth Tova Bailey, 2010. Algonquin Books of Chapel Hill, Chapel Hill, North Carolina, USA. ISBN 978-1-56512-606-0. US$18.95.



This delightful book was reviewed in *Tentacle* 19 (2011). Originally published in the USA, other editions and translations are now available in Australia and New Zealand, Austria, Germany and Switzerland, the United Kingdom, France, China, South Korea, Taiwan and Japan. It has received accolades globally. Seriously, if you have not obtained a copy, go and get one. It is even easier now as the audiobook edition is available as a Kindle or hard CD. Check out the author's website.

Other publications of interest

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

Bick, C.S., Ó Foighil, D. & Coote, T. 2016 [on line 24 October 2014]. Differential survival among Tahitian tree snails during a mass extinction event: persistence of the rare and fecund. *Oryx* 50(1): 169-175.

Bick, C.S., Ó Foighil, D. & Coote, T. 2016 [on line 30 January 2015]. Differential survival among Tahitian tree snails during a mass extinction event: persistence of the rare and fecund –ERRATUM. *Oryx* 50(1): 185.

Cao, Y., Stodola, A., Douglass, S., Shasteen, D, Cummings, K. & Holtrop, A. 2015. Modelling and mapping the distribution, diversity and abundance of freshwater mussels (Family Unionidae) in wadeable streams of Illinois, U.S.A. *Freshwater Biology* 60: 1379-1397.

Dong, Y., Huang, X. & Reid, D.G. 2015. Rediscovery of one of the very few 'unequivocally extinct' species of marine molluscs: *Littorina flammea* (Philippi, 1847) lost, found – and lost again? *Journal of Molluscan Studies* 81: 313-321.

Ford, D.F. & Oliver, A.M. 2015. The known and potential hosts of Texas mussels: implications for future research and conservation efforts. *Freshwater Mollusk Biology and Conservation* 18: 1-14.

Harried, B., Fischer, K., Perez, K.E. & Sandland, G.J. 2015. Assessing infection patterns in Chinese mystery snails from Wisconsin, USA using field and laboratory approaches. *Aquatic Invasions* 10(2): 169-175.

Moore, A.C., Burch, J.B. & Duda, T.F., Jr. 2015. Recognition of a highly restricted freshwater snail lineage (Physidae: *Physella*) in southeastern Oregon: convergent evolution, historical context, and conservation considerations. *Conservation Genetics* 16(1): 113-123.

Nicolai, A., Rouland-Lefèvre, C., Ansart, A., Filser, J., Lenz, R., Pando, A. & Charrier, M. 2015. Inter-population differences and seasonal dynamic of the bacterial gut community in the endangered land snail *Helix pomatia* (Gastropoda: Helicidae). *Malacologia* 59(1): 177-190.

Ray, E.J. & Bergey, E.A. 2015. After the burn: factors affecting land snail survival in post-prescribed-burn woodlands. *Journal of Molluscan Studies* 81: 44-50.

Régnier, C., Achaz, G., Lambert, A., Cowie, R.H., Bouchet, P. & Fontaine, B. 2015. Mass extinction in poorly known taxa. *Proceedings of the National Academy of Sciences of the United States of America* 112(25): 7761-7766.

Régnier, C., Bouchet, P., Hayes, K.A., Yeung, N.W., Christensen, C.C., Chung, D.J.D., Fontaine, B. & Cowie, R.H. 2015. Extinction in a hyperdiverse endemic Hawaiian land snail family and implications for the underestimation of invertebrate extinction. *Conservation Biology* 29(6): 1715-1723.

Rivera-Ingraham, G.A., Espinosa, F. & García-Gómez, J.C. 2015. Long-term monitoring of the critically endangered limpet *Patella ferruginea* Gmelin, 1791: new ecological insights and first demographic results. *Journal of Molluscan Studies* 81(1): 124-130.

Roe, K.J. & Boyer, S.L. 2015. A comparison of genetic diversity between sympatric populations of the endangered Winged-Mapleleaf (*Quadrula fragosa*) and the Pimpleback (*Amphinaias pustulosa*) in the St. Croix River, U.S.A. *American Malacological Bulletin* 33(1): 52-60.

Rudzīte, M., Rudzītis, M., Birzaks, J., Poppels, A. & Onkele, A. 2015. The freshwater pearl mussel *Margaritifera margaritifera* (Linnaeus, 1758) in Latvia - assessment of the survival possibilities. *Schriften Zur Malakozoologie* 28: 17-36.

Rundell, R.J. & Czekanski-Moir, J.E. 2015. A survey of the land snails of Kosrae (Caroline Islands, Micronesia) including the rediscovery of endemic *Delos oualanensis* (Pease, 1866) (Mollusca: Pulmonata: Rhytididae). *Malacologia* 59(1): 13-20.

Stephen, B.J. 2015. Species composition of Nebraska's freshwater gastropod fauna: a review of historical records. *American Malacological Bulletin* 33(1): 61-71.

Santos, R.M.B., Sanches Fernandes, L.F., Varandas, S.G.P., Pereira, M.G., Sousa, R., Teixeira, A., Lopes-Lima, M., Cortes, R.M.V. & Pacheco, F.A.L. 2015. Impacts of climate change and land-use scenarios on *Margaritifera margaritifera*, an environmental indicator and endangered species. *Science of the Total Environment* 511: 477-488.

Smith, D.R., McRae, W.E., Auigspurger, T., Ratcliffe, J.A., Nichols, R.B., Eads, C.B., Savidge, T. & Bogan, A.E. 2015. Developing a conservation strategy to maximize persistence of an endangered freshwater mussel species while considering management effectiveness and cost. *Freshwater Science* 34(4): 1324-1339.

Villemant, C., Daugeron, C., Gargominy, O., Isaia, M., Deharveng, L. & Judson, M.L.I. 2015. The Mercantour/Alpi Marittime All Taxa Biodiversity Inventory (ATBI): achievements and prospects. *Zoosystema* 37(4): 667-679.

Wang, Y.-N., Zhang, G.-R., Wei, K.-J. & Gardner, J.P.A. 2015. Reproductive traits of the threatened freshwater mussel *Solenaia oleivora* (Bivalvia: Unionidae) from the middle Yangtze River. *Journal of Molluscan Studies* 81(4): 522-526.

IUCN AND MOLLUSC SPECIALIST GROUP NEWS AND ANNOUNCEMENTS

www.iucn.org/

IUCN World Conservation Congress

Held once every four years, the IUCN World Conservation Congress brings together several thousand leaders and decision-makers from government, civil society, indigenous peoples, business and academia, with the goal of conserving the environment and harnessing the solutions nature offers to global challenges.

The Congress aims to improve how we manage our natural environment for human, social and economic development, but this cannot be achieved by conservationists alone. The IUCN Congress is the place to put aside differences and work together to create good environmental governance, engaging all parts of society to share both the responsibilities and the benefits of conservation.

The Congress is the place where IUCN's more than 1,300 Member organisations exercise their rights, influence the global conservation agenda and guide IUCN's work plan for the four years to follow.

The next Congress will take place 1-10 September 2016 in the Hawaii Convention Center, in the Hawaiian capital, Honolulu. It is being hosted by the State of Hawaii with the support of the Department of State of the USA.

IUCN Marine News - issue 12

The IUCN Global Marine and Polar Programme produces the *Marine News* e-newsletter. It includes news stories related to a diversity of marine-related topics such as climate change mitigation and adaptation, threatened marine species, energy and industry, marine protected areas, marine invasive species, fisheries and aquaculture, ocean governance and the Arctic. It also highlights recent marine expeditions and outstanding marine photographs. Issue 12, a special issue on climate change adaptation, was released in November 2015.

New cephalopod additions to the IUCN Red List

By Monkia Böhm & Louise Allcock

From the Kraken sea monster of legends to Paul the psychic octopus, cephalopods have captured our imagination through the ages. While we know that Ozy the octopus can open a jar in 54 seconds and that Paul had a knack for correctly predicting the outcome of Germany's World Cup matches, decidedly little is known about the conservation status of this enigmatic group. This is about to change. Since 2009, we have been carrying out IUCN Red List assessments for all the world's cephalopods. The assessment is due to be completed in 2016.

Here is what we know so far: 494 species have already been published on the IUCN Red List, including 242 squid species (orders Oegopsida, Bathyteuthida, Idiosepiida), eight bottletail squids, 118 cuttlefishes, 62 bobtail squids, 63 pelagic octopuses (Fig. 1) and *Spirula spirula.* Of these, only five have been listed in the threatened categories of Critically Endangered (one species), Endangered (two species) and Vulnerable (two species), with one other species listed as Near Threatened. What sounds like good news for the cephalopods probably is not: while 197 species are indeed listed as Least Concern, an overwhelming 291 species fall within the Data Deficient category. In many cases, species are known only

Fig. 1. Pelagic octopus *Stauroteuthis syrtensis* in a submarine canyon SW of Ireland. Photo copyright NUI Galway / Marine Institute, taken with ROV Holland I.

from the type material, and while these specimens may be of sufficient quality to assess the species' validity, they rarely tell us anything about its distribution (beyond type locality) or life history, characteristics that are fundamental in making Red List assessments.

All five threatened species belong to the cirrate octopuses. The most seriously threatened species we know about so far is O*pisthoteuthis chathamensis.* This species is found off the east coast of the North Island of New Zealand. Categorized as Critically Endangered, it has not been reported since 1999. The New Zealand endemics *Cirroctopus hochbergi* and *Opisthoteuthis mero* are both categorized as Endangered, although estimated population declines are based on limited data and more data on population sizes and trends are needed. *Opisthoteuthis calypso* and *O. massyae* are categorized as Vulnerable because of declines associated with deep-water fishing activities from southwest Ireland to Namibia.

The giant Australian cuttlefish, *Sepia apama*, is the only species of cuttlefish not in either the Least Concern or Data Deficient category. Intense fishing on reproductive aggregations has resulted in a dramatic population decline in the Spencer Gulf. Although this has had limited impact across the species' range, it is coupled with the potential for intense localized fishing elsewhere, albeit on smaller aggregations. Overall, the assessment classes this species as Near Threatened, although if the population in the upper Spencer Gulf is shown to be a separate species, then the species may require reassessment in a threatened category.

Overall, all 735 species of cephalopods will be published on the IUCN Red List by 2016, including distribution maps. This will make the IUCN Red List one of the most comprehensive sources on the status of these charismatic creatures, and open avenues for future research and conservation actions. For example, the large percentage of Data Deficient species emphasises the need for cephalopod research, particularly on taxonomy, distributional ranges, life history and ecology, population sizes and the effects and levels of fishing mortality. Of course, everybody can help to keep the assessments up-to-date and relevant to cephalopod conservation: feedback on assessments is always welcome! To find out more about the assessments, go to www.iucnredlist.org and search for your favourite (or just any) cephalopod.

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Final stage of the European Red List of terrestrial molluscs starts

By David Allen, Eike Neubert & Mary Seddon

European malacologists joined Eike Neubert (European Land Snail Red List Authority Coordinator) and Mary Seddon (Chair of the IUCN SSC Mollusc Specialist Group) for a Red List training course in Paris in October 2015 to initiate the second stage of the European Red List of Terrestrial Molluscs (Fig. 1). This new project, which is funded through the European Union LIFE Programme, will assess the extinction risk of the around 1,200 species of terrestrial slugs and snails that are native to continental Europe but which were not assessed in the first stage of the project in 2010-2011 (Cuttelod *et al*., 2011). The first project assessed 1,233 species from the following families: Aciculidae, Argniidae, Cochlicellidae, Cochlostomatidae, Elonidae, Enidae, Gastrocoptidae, Helicidae, Helicodontidae, Hygromidae, Lauriidae, Orculidae, Pupillidae, Trissexodontidae, Valloniidae and Vertiginidae. Based on these data, one in five terrestrial molluscs in Europe that had been assessed were found to be threatened.This preliminary level of threat for European terrestrial molluscs will be revised by including assessments of the species of the remaining families: Aciculidae, Agriolimacidae, Arionidae, Assimineidae, Boettgerillidae, Charopidae, Clausiliidae, Cochlicopidae, Discidae, Ellobiidae, Euconulidae, Ferussaciidae,

Fig. 1. Red List training course participants, including Eike Neubert, European landsnail Red List Authority Coordinator (far right), and Mary Seddon (Chair of the IUCN SSC Mollusc Specialist Group) (third from right).

Gastrodontidae, Helicodiscidae, Limacidae, Milacidae, Oleacinidae, Onchidiidae, Otinidae, Oxychilidae, Papillodermatidae, Parmacellidae, Pleurodiscidae, Pomatiidae, Pristilomatidae, Punctidae, Pyramidulidae, Spelaeoconchidae, Spelaeodiscidae, Sphincterochilidae, Streptaxidae, Subulinidae, Succineidae, Testacellidae, Trigonochlamydidae, Truncatellidae and Zonitidae. These families include almost 1,200 species. Combined with the data from the first round of assessments, a new and comprehensive view of the threat status of the landsnails of Europe will be possible.

Nearly 25 experts will be involved in producing draft assessments and distribution maps over the coming months, which will then be reviewed at an assessment review workshop to be held in November 2016, hosted by the Natural History Museum of Bern, Switzerland. The completed assessments will be submitted for publication on the IUCN Red List and the European Red List during 2017.

On completion, the work will be the first time that all native non-marine molluscs have been assessed for a continent, representing a huge achievement by the European malacological community, and providing a vital source of information on the distribution and habitats of European molluscs, and the threats they face.

Cuttelod, A., Seddon, M. & Neubert, E. 2011. *European Red List of Non-marine Molluscs*. Publications Office of the European Union, Luxembourg.

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MEETINGS 2016

This is not a comprehensive list of mollusc and conservation related meetings but includes those for which people have sent me details and those that I am generally aware of without doing a thorough search. – Ed.

World Congress of Malacology, 2016, Penang, Malaysia

The World Congress of Malacology (WCM) is the triennial event of Unitas Malacologica (UM) and Unitas Malacologia president Aileen Tan Shau-Hwai welcomes you to be part of it. Malaysia is proud to be hosting the congress for the very first time.

WCM2016 will be an opportunity for the international malacology community – academics, researchers, etc. – to present their work, exchange ideas and develop collaborations and networking with other countries.

The WCM2016 congress will be held on the beautiful island of Penang, Malaysia. Penang has been long regarded as the food capital of Malaysia and is known as the "Pearl of the Orient". Penang has been listed as a UNESCO World Heritage Site since 2008 for its heritage buildings, art and culture.

Dates: 18-24 July 2016.

For details see the Congress website.

Amercan Malacological Society andWestern Society of Malacologists combined 2016 meeting

The 49th meeting of the Western Society of Malacologists and the 82nd meeting of the American Malacological Society will take place jointly during 12-16 June 2016 at the School of Marine Sciences, Universidad Autónoma de Baja California, Ensenada, Baja California, Mexico. For additional information please contact Dr. Carlos Figueroa Beltrán – Universidad Autónoma de Baja California (WSM president) and Dr. Ángel Valdés - California State Polytechnic University (AMS President).

Deadlines are as follows:

- Early bird registration: 15 April 2016
- Abstract submission: 1 May 2016
- Late registration: 30 May 2016
- Hotel Coral y Marina reservations with conference discount: 12 April 2016

For additional details see the meeting website.

Mollusks in peril

A 2½ day forum titled "Mollusks in Peril" will be held 22-24 May 2016 at the Bailey-Matthews National Shell Museum on Sanibel Island, Florida. We will bring together some of the country's foremost experts on current large-scale threats to molluscan populations to discuss, through presentations and panels, the challenges facing the second most diverse group of animals on earth.

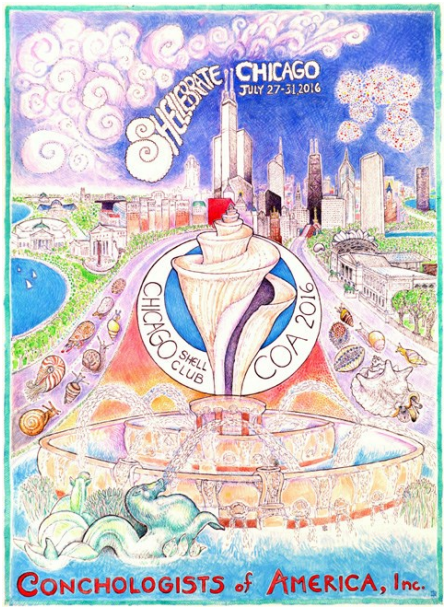
As our planet is subjected to unprecedented rates of human-induced environmental change, populations of mollusks inhabiting a wide range of habitats are being exposed to exceptional amounts of ecological stress. These stressors

include, but are not limited to, alterations caused by climate change and other large-scale environmental disturbances.

"Mollusks in Peril" will provide a forum for discussion of the possible ecological drivers of extinction risk, the synergies that enhance ecological stress, and the taxonomy, ontogeny, and geography of change in and risk to marine, freshwater, and terrestrial mollusks.

The forum's Scientific Advisory Committee invites researchers, students and all interested parties to join the forum to discuss the effects of large-scale change on mollusks. Please contact us at info@mollusksinperil.org for more information or to express your interest in the forum. Keep your eyes open, as soon the Museum will be releasing additional information on this unique gathering of minds.

Conchologists of America 2016 convention



The 2016 COA convention in Chicago will take place during 27-31 July. Information can be found at the COA conventions website.

INTERNET RESOURCES

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

Red List

The entire *IUCN Red List of Threatened Animals* can be searched at any of the following addresses, which all take you to the same website:
www.redlist.org www.redlist.net www.iucnredlist.org

Unitas Malacologica

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

Mollusca list

The MOLLUSCA listserver is intended as an informal forum for discussions of molluscan evolution, palaeontology, taxonomy and natural history. There are over 700 subscribers. From time to time it has something of interest related to conservation. To subscribe to the list send e-mail to
listproc@ucmp1.berkeley.edu
Then on the first line of the body of the message:
sub mollusca <your_name without the brackets>
Alternatively, send e-mail to
Majordomo@listlink.Berkeley.Edu
And on the first line of the message:
subscribe molluscalist <your_name without the brackets>
You will get a reply soon after saying that your name has been added. You will then receive anything that is posted to the list. MOLLUSCA is maintained and managed by David R. Lindberg of the University of California Museum of Paleontology, Berkeley, USA.

Mollia

The MOLLIA web site includes instructions to authors, subscription information and links to malacological journals. It also allows you to subscribe to the MOLLUSCA listserver (above) and to access the MOLLUSCA archives. MOLLIA, like MOLLUSCA, is maintained at the University of California Museum of Paleontology, Berkeley, USA.

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).

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.

Brasilian Society of Malacology

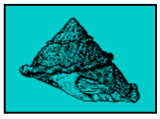
The Soceidade Brasileira de Malacologia (SBMa) welcomes malacological researchers, professionals and students, Brasilian and foreign, as well as aficionados of

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.

American Malacological Society

The homepage of the American Malacological Society carries a link to its conservation policy and to the AMS Conservation Committee Imperiled Species News. Student research grants are available.

Western Society of Malacologists



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

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.

Freshwater Mollusk Conservation Society

The Freshwater Mollusk Conservation Society (FMCS) is devoted to the advocacy for, public education about and conservation science of freshwater mollusks, 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* and has all issues of volume 1 on-line and available, which includes Jack Burch's Identification of *Eastern North American Land Snails* and two-part *North American Freshwater Snails*.

MUSSEL database project

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

IUCN Invasive Species Specialist Group

The ISSG website includes details of the Aliens-L listserver and the ISSG newsletter, *Aliens*.

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.

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.

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.

Tropical land snail project at the Natural History Museum, London

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

CLEMAM: Check List of European Marine Mollusca

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

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.

Samoan Snail Project

The Samoan Snail Project has 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.

Haus der Natur – Cismar

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

Field Museum land snails

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

Australian marine invertebrates

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

CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The majority of information relates to mammal and bird trade.

Other useful links

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

SSC MOLLUSC SPECIALIST GROUP

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

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