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

TENTACLE

UNITAS MALACOLOGICA

EDITORIAL

As I said a year ago in *Tentacle* issue 21, I would like to step down as editor of *Tentacle*, now after almost 20 years. A symptom of this is probably that both last year and this year I did not stick to my self-imposed deadline of getting it out in January, instead it is now March. A very small number of you suggested that you might be able to help out, perhaps by gathering articles from your region and doing some preliminary editing prior to sending the articles to me as an 'editor-in-chief'. But no one offered to take over as editor, so here I am again. The possibility of converting *Tentacle* into a blog was suggested and discussed briefly, but most of those with whom I discussed this seemed to like *Tentacle* just as it is now. Of course I am pleased that you like what I do, but I still feel that we mollusc people are just talking to ourselves and not getting the word out more broadly, which would require increasesd visibility on the internet. Who is going to take over and do that?

Now, I still fail to understand why it is so difficult to follow the guidelines for formatting your submissions to *Tentacle*. In the past I used to simply point you to the guidelines on the *Tentacle* website. Over the last few years I have made more and more strident requests (with bright red highlights) that you follow the formatting of *Tentacle* as closely as possible, putting this request prominently as the first article in the body of the issue. But I still spend hours formatting your articles and am increasingly frustrated by this. So now this plea is in my editorial on the first page! Last year I made a plea especially that you format your references very carefully, particularly regarding punctuation, italics, parentheses, spacing and so on – but few people take any notice. Regarding the text of your articles, some of you have followed the guidelines quite well, but none to the extent that I can simply cut and paste your submissions, including illustrations, into *Tentacle*. For example, *Tentacle* is printed in two columns, so please do not submit illustrations and tables that cannot fit in the width of a single column. Please please help me with this, unless you really want me to resign as editor!

Robert H. Cowie, Editor

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 these guidelines. Carefully following the guidelines will make my life a lot easier!

I usually make only editorial changes to submitted articles and I accept 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, 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. Because I accept most articles that are submitted, *Tentacle* might be seen 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. Despite many reminders, it still takes me many many hours formatting your submissions – please do it for me! Especially, please pay very careful attention to the format of references in the reference lists - I still spend 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:

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.

Barker, G.M. & Efford, M.G. 2004. Predatory gastropods as natural enemies of terrestrial gastropods and other invertebrates. In: *Natural Enemies of Terrestrial Molluscs* (ed. Barker, G.M.), p. 279-403. CABI Publishing, Wallingford.

Also note that all 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. 44 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).

NEWS

The return of the tree snail

From: Oryx 48(1): 11-12 (January 2014)

Partula tree snails were once widespread across the islands of French Polynesia but many species are now extinct and most of those that remain are Critically Endangered. Populations of the tiny snails, which grow to a maximum length of c. 2 cm, were decimated by the carnivorous wolf snail *Euglandina rosea*, which wsa introduced from Florida in the 1970s. However, following a successful 30- year collaboration between zoological institutions in Europe and North America and the French Polynesian Government, hundreds of *Partula* snails were reintroduced to a protected forest reserve in the Te Faaiti Valley on the island of Tahiti in October 2013. The reserve was cleared of invasive plants and animals in preparation for the arrival of three species of snails, one of which, *Partula affinis*, was thought to be extinct until 12 individuals were found in a single tree in 2012.

See also: ZSL London Zoo News and the Royal Zoological Society of Scotland News

BIOGEOGRAPHY OF THE LAND SNAILS OF THE CAUCASUS REGION

By Frank Walther, Pavel V. Kijashko, Laura Harutyunova, Levan Mumladze, Marco T. Neiber & Bernhard Hausdorf

The Caucasus region is one of the most important biodiversity hotspots in the world (Myers *et al*., 2000; Zazanashvili *et al*., 2004). We have started a project on the land snail fauna of the Caucasus region with the aim to update the taxonomy and to produce a distribution atlas as a basis for conservation planning and evolutionary and biogeographical studies. For practical reasons, we defined the Caucasus region as including Armenia, Azerbaijan, Georgia and the Caucasian territories of Russia, namely Krasnodar kray, Stavropol kray, Adygeya, Chechnya, Dagestan, Ingushetiya, Kabardino-Balkariya, Karachayevo-Cherkesiya and North Ossetia. This region covers approximately 430,000 km^2. The taxonomy of the land molluscs of the Caucasus region is moderately well studied (Likharev & Rammelmeier, 1952; Likharev, 1962; Riedel, 1966; Akramowski, 1976; Schileyko, 1978, 1984; Likharev & Wiktor, 1980; Egorov, 2008; Sysoev & Schileyko, 2009). However, the distribution of land snail species within this region is still insufficiently known, because only few published locality records are available for most of the species. Previous taxonomic revisions (Hausdorf, 1996, 2000, 2001, 2003) have shown that there is a considerable amount of unpublished material of Caucasian land molluscs deposited in research collections. Therefore, we compiled a register of the material in the collections with the most important holdings of Caucasian land snails, i.e. the Zoological Institute of the Russian Academy of Sciences, St. Petersburg (c. 9,500 samples), the Zoological Institute of the National Academy of Sciences of Armenia, Yerevan (6,000), the Zoological Museum of the Moscow Lomonosov State University, Moscow (c. 2,500), the Zoological Museum of the University Hamburg (3,850), the Naturmuseum Senckenberg, Frankfurt am Main (2,600), the Institute of Zoology of the Ilia State University, Tbilisi (c. 2,300), the Museum of Zoology of the Polish Academy of Sciences, Warsaw (750), and the Zoological Museum of the University, Zürich (550). We also compiled a list of the available literature on Caucasian land snails (currently 550 publications) and extracted the locality data contained therein. Finally, we collected and are going to collect additional material during expeditions to Georgia (2010-2013, L. Mumladze; 2011, L. Mumladze, M. Neiber & F. Walther; 2012, F. Walther), Russia (2012, P. Kijashko, M. Neiber & F. Walther) and Armenia (2014, planned). One aim of these expeditions was to collect insufficiently known species and to gather data on their distribution, ecology and conservation status. Overall sampling density was higher in the Lesser Caucasus than in the Greater Caucasus and decreased from west to east (Fig. 1). There is also a decrease of species diversity from west to east, which is probably not an artefact resulting from decreasing sampling density, but might be caused, at least in part, by the increasing aridity from west to east.

Our updated check-list of the land snails of the Caucasus region currently includes 318 species (Table 1), of which 66% are endemic. Almost one third of the endemic species have a distribution range smaller than 8,000 km^2. The check-list, interactive distribution maps and figures of most of the species can be found on the project homepage. The high degree of endemism results from some extensive radiations, especially of *Leiostyla* (Lauriidae), *Acrotoma* and the *Mucronaria* group (Clausiliidae), *Oxychilus* and *Schistophallus* (Oxychilidae), the predatory slug family Trigonochlamydidae (Fig. 2), *Gigantomilax* (Limacidae) and an endemic group of Hygromiidae, but also from some old relict groups like some lineages of the Phaedusinae (Clausiliidae). The presence of several relict groups indicates that the Caucasus region served as a long-term refugium (Pokryszko *et al*., 2011). To improve

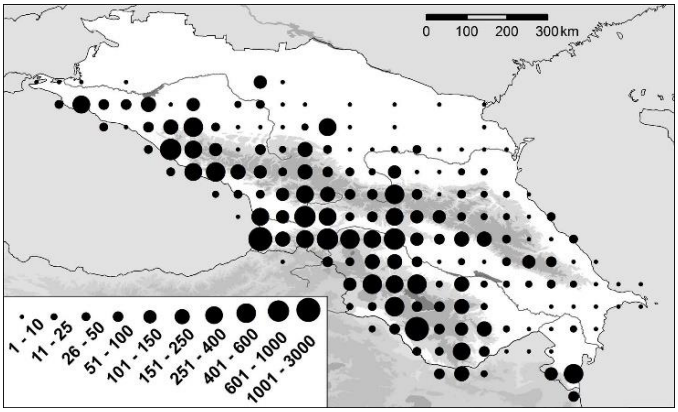

Fig. 1 Sampling density of land snails in the Caucasus region. Numbers include both samples in collections and literature records.

Table 1. Land snail species diversity and endemism in the Caucasus region.

Family	Number of species	Number of endemic species	Number of small range endemic species
Cyclophoridae	1	0	0
Aciculidae	2	2	0
Cochlostomatidae	1	1	0
Pomatiidae	2	1	0
Carychiidae	4	1	0
Succineidae	5	1	1
Cochlicopidae	3	0	0
Pupillidae	8	3	0
Chondrinidae	2	0	0
Lauriidae	13	12	6
Orculidae	8	3	2
Pyramidulidae	1	0	0
Valloniidae	8	0	0
Vertiginidae	13	1	0
Enidae	28	18	5
Clausiliidae	54	49	21
Ferussaciidae	2	1	0
Oleacinidae	1	1	0
Punctidae	2	0	0
Discidae	1	0	0
Gastrodontidae	1	0	0
Euconulidae	1	0	0
Oxychilidae	38	32	7
Pristilomatidae	6	4	2
Parmacellidae	1	0	0
Milacidae	1	1	0
Trigonochlamydidae	9	9	5
Limacidae	14	12	0
Agriolimacidae	12	7	0
Boettgerillidae	2	1	0
Vitrinidae	3	1	0
Arionidae	2	0	0
Helicidae	11	2	0
Camaenidae	1	0	0
Hygromiidae	57	48	18
Total	**318**	**211**	**67**

Fig. 2. *Boreolestes sylvestris* Kijashko, 1999, an enigmatic trigonochlamydid restricted to very few sites.

the understanding of the origin and biogeographic history of the land snail fauna of the Caucasus region, we are studying the phylogeny and phylogeography of some model groups, namely oxychilids, clausiliids, hygromiids, helicids and trigonochlamydids. Robust phylogenetic hypotheses are a prerequisite for the inference of biogeographic processes. For example, the Caucasian hygromiid genera *Caucasigena*, *Teberdinia*, *Dioscuria*, *Kokotschashvilia*, *Fruticocampylaea* and *Circassina* were assigned to two different subfamilies in the most recent classification (Schileyko, 2006), which is predominantly based on genital morphology. However, our preliminary analyses of mitochondrial (16S rDNA and *cox1*) and nuclear (28S rDNA and ITS2) markers indicate that these genera form a well-supported monophyletic group that is not closely related to either of the two Central European groups with which they are currently classified. This result highlights the importance of the Caucasus region as the centre of origin of a hitherto unrecognized radiation of Hygromiidae.

There are regional Red Lists for most administrative areas. However, only few of these lists (e.g. Kijashko & Tuniev in Zamotajlov, 2007; Harutyunova, 2010) contain detailed information on land snail species. This is primarily a problem of insufficient sampling and the lack of regional experts. Major threats to the malacofauna of the Caucasus region are deforestation and overgrazing of steppe and subalpine habitats. With ongoing development of the infrastructure this problem will increase and will reach areas that are now too

Fig. 3. Destruction of natural habitat as a result of construction for the 2014 Winter Olympic Games (photo taken August 2012).

remote to be affected by extensive anthropogenic pressure. Small range endemics are especially threatened by regional development projects. An example of severe anthropogenic impact was construction for the 2014 Winter Olympic Games in the valley of the Mzymta river (Fig. 3). The Mzymta gorge, especially a short canyon-like part of only 4 km, harbours at least four small range endemics and several other Caucasian endemics (Fig. 4).

For Georgia, how far existing nature reserves are sufficient to conserve the molluscan diversity has been assessed (Mumladze *et al*., 2014). We will extend this evaluation across the whole region. We also intend to assess the extinction risk of all species using the IUCN criteria.

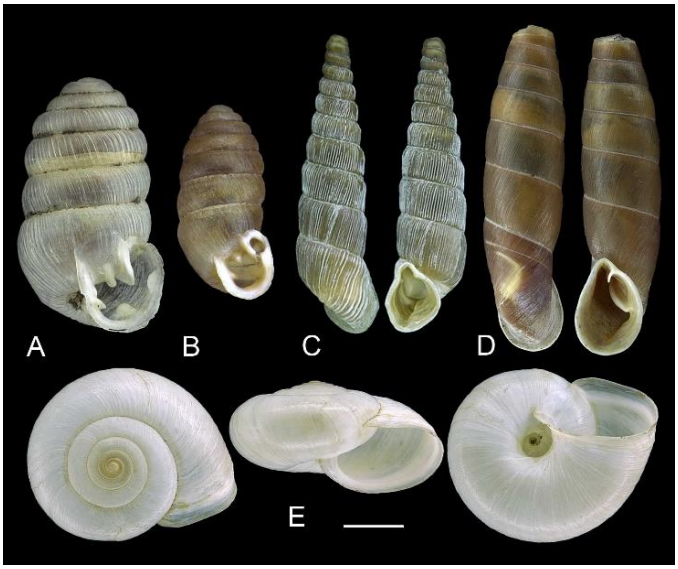

Fig. 4. Endangered endemics from the Mzymta gorge near Sochi (Russia). A, *Leiostyla vitrea* (Schileyko, 1988); B, *Leiostyla nemethi* Hausdorf, 1996; C, *Micropontica caucasica* (Schmidt, 1868); D, *Acrotoma tunievi* Suvorov, 2002; E, *Monacha claussi* Hausdorf, 2000. Scale bar 1.0 mm for *Leiostyla*, 2.5 mm for *Micropontica*, 5.0 mm for *Acrotoma* and *Monacha*.

We are grateful to the late E. Clauss (Quedlinburg) for indirectly initiating this project through his extensive collections in the Caucasus region, to R. Janssen (Frankfurt am Main), D. Mierzwa (Warsaw), B. Oberholzer (Zürich), B. Pokryszko (Wroclaw) and A.V. Sysoev (Moscow) for access to the collections curated by them or for sending us material on loan, and to the Volkswagen foundation for funding this project.

Akramowski, N.N. 1976. *Fauna Armyanskoy SSR. Mollyuski (Mollusca).* Akademiya Nauk armyanskoy SSR, Erevan. 268 p., 16 pl.

Egorov, R.V. 2008. *Treasure of Russian Shells, supplement 5. Illustrated catalogue of the recent terrestrial molluscs of Russia and adjacent regions*. Colus-Doverie, Moscow. 180 p.

Harutyunova, L. 2010. Gastropoda. In: *The Red Book of Animals of the Republic of Armenia. Invertebrates and Vertebrates* (ed. Aghasyan, A. & Kalashyan. M.), 2nd edition, p. 19-32. Zangak Press, Yerevan.

Hausdorf, B. 1996. Die Orculidae Asiens (Gastropoda: Stylommatophora). *Archiv für Molluskenkunde* 125: 1-86.

Hausdorf, B. 2000. The genus *Monacha* in the Western Caucasus (Gastropoda: Hygromiidae). *Journal of Natural History* 34: 1575-1594.
Hausdorf, B. 2001. A systematic revision of *Circassina* from the Western Caucasus Region (Gastropoda: Hygromiidae). *Journal of Molluscan Studies* 67: 425-446.
Hausdorf, B. 2003. Revision of the genus *Caucasocressa* from the Eastern Pontic Region (Gastropoda: Hygromiidae). *Journal of Natural History* 37: 2627-2646.
Likharev, I.M. 1962. *Klauziliidy (Clausiliidae). Fauna SSSR, Mollyuski, III (4) (= N. S. 83).* Akademiya Nauk SSSR, Moskva and Leningrad. 317 p.
Likharev, I.M. & Rammelmeier, E.S. 1952. *Nazemnye mollyuski fauny SSSR*. Opredelitel po faune SSSR, 43. Akademiya Nauk SSSR, Moskva and Leningrad. English translation 1962 in Israel Program for Scientific Translations, Monson, Jerusalem. 511 p.
Likharev, I.M. & Wiktor, A.J. 1980. *Slizni fauny SSSR i sopredelnych stran (Gastropoda terrestria nuda). Fauna SSSR, Mollyuski, III (5) (= N. S. 122).* Nauka, Leningrad. 437 p.
Mumladze, L., Cameron, R.A.D. & Pokryszko, B.M. 2014. Endemic land molluscs in Georgia (Caucasus): how well are they protected by existing reserves and national parks? *Journal of Molluscan Studies* 80: 67-73.
Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. & Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.
Pokryszko, B.M., Cameron, R.A.D., Mumladze, L. & Tarkhnishvili, D. 2011. Forest snail faunas from Georgian Transcaucasia: patterns of diversity in a Pleistocene refugium. *Biological Journal of the Linnean Society* 102: 239-250.
Riedel, A. 1966. Zonitidae (excl. Daudebardiinae) der Kaukasusländer (Gastropoda). *Annales Zoologici* 24: 1-303.
Schileyko, A. 1978. *Nazemnye mollyuski nadsemeystva Helicoidea. Fauna SSSR, Mollyuski, III (6) (= N. S. 117)*. Nauka, Leningrad. 384 p.
Schileyko, A.A. 1984. *Nazemnye mollyuski podotryada Pupillina fauny SSSR (Gastropoda, Pulmonata, Geophila). Fauna SSSR, Mollyuski, III (3) (= N. S. 130).* Nauka, Leningrad. 399 p.
Schileyko, A.A. 2006. Treatise on Recent terrestrial pulmonate molluscs. Part 14. Helicodontidae, Ciliellidae, Hygromiidae. *Ruthenica*, Supplement 2: 1907-2047.
Sysoev, A. & Schileyko, A. 2009. *Land Snails and Slugs of Adjacent Countries.* Pensoft, Sofia. 312+144 p.
Zamotajlov, A.S. (ed.). 2007. *Krasnaya kniga Krasnodarskogo kraya (zhivotnye)*. 2nd edition. Centr razvitiya PTR Krasnodarsky kraya, Krasnodar. 504 p.
Zazanashvili, N., Sanadiradze, G., Bukhnikashvili, A., Kandaurov, A. & Tarkhnishvili, D. 2004. Caucasus. In: *Hotspots revisited: Earth's biologically richest and most endangered terrestrial ecoregions* (ed. Mittermeier, R.A., Gil, P.G., Hoffmann, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoreux, J., da Fonseca, G.A.B.), p. 148–153. CEMEX, Mexico City.

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HABITAT LOSS AND WILDLIFE TRADE THREATEN THE SURVIVAL OF THE MONTANE CLOUD FOREST LAND SNAIL *PLATYMMA TWEEDIEI* IN CAMERON AND LOJING HIGHLANDS, PENINSULAR MALAYSIA

By Junn Kitt Foon

The largest native land snail in Peninsular Malaysia, *Platymma tweediei* Tomlin, 1938 (Ariophantidae) (Fig. 1) was first described from Telom Valley in the Cameron Highlands, which form part of the montane cloud forest biome of Peninsular Malaysia (Tomlin, 1938). Since then, the species has also been found in the cloud forests of Temenggor, 80 km to the north, and the Kelantan Mountains, 100 km north-northeast (Davison, 1995; Chew *et al*., 2008). Davison (1995) and Chew *et al*. (2008) reported that the species is restricted to cloud forests at least 1000 m above sea level. *Platymma tweediei* is naturally scarce in its habitat (Chew *et al*. 2008), which may be due to its restricted niche within cloud forests. It is still not known if the isolated records for *P. tweediei* represent either fragmented populations or are an artefact of insufficient survey of an otherwise contiguous population stretching across the northern section of the Titiwangsa Mountain Range in Peninsular Malaysia. Nevertheless,

Fig. 1. Umbilical (A) and lateral (B) views of *Platymma tweediei* in the Lojing Highlands. (Photo: Azrie Alliamat)

increasing habitat degradation, especially within the Cameron and Lojing Highlands coupled with a growing wildlife trade specifically targeting the species is a strong cause of concern for the long-term survival of vulnerable populations of the species.

To date, Malaysia has lost 23 % (621,000 hectares) of its cloud forests to agricultural incursions and commercial logging as well as infrastructure and tourism development (Fig. 2) (Peh *et al*., 2011). One of the regions experiencing major loss, Cameron Highlands, includes the type locality of *P. tweediei*. The Cameron Highlands lost 33 % of their forest to other land uses from 1947 to 1997 (Chan *et al.*, 2006). Specifically, the catchments of Upper Telom (type locality of *P. tweediei*) and Upper Bertam experienced a 44 % decrease in forest cover between 1947 and 2003 (Kumaran & Ainuddin 2006). Expanding agricultural and urban land use also result in localised increase of fertilisers, pesticides and pollutants, which may be harmful to native organisms such as land snails inhabiting forest remnants (Peh *et al.*, 2011; Barrow 2006; Salama *et al.* 2005). Another significant trend is the increasing 'heat island effect ' due to land clearing, which results in differences of 2-8 °C and 10-20 % humidity between forested and non-forested areas (Chan *et al.*, 2006). The 'heat island effect' has been shown to cause die-offs in populations of environmentally sensitive molluscs as their limited mobility restricts their ability to reach better habitats (Baur & Baur, 1993). Similar rapid agricultural and logging expansion is also currently underway at the neighbouring Lojing Highlands (Peh *et al.*, 2011; Hansen *et al.*, 2013).

Cloud forests elsewhere in the Titiwangsa Range fall within the boundaries of extractive, multi-purpose and mountain reserves (classified as IUCN categories V and VI) (Peh *et al.*, 2011) The building of roads across these forests, such as that of the East-West Highway in Temenggor and the Gua Musang Road in the Cameron and Lojing Highlands, further encourage commercial logging by increasing accessibility (Yeap *et al.*, 2009, Peh *et al.* 2011). Although being extractive reserves, the area between the Cameron-Lojing Highlands and Temenggor remains relatively inaccessible and hence an important habitat for the species. The only population of *P. tweediei* with adequate long-term protection (IUCN Category II) lies in Gunung Stong State Park at the north-eastern end of the Titiwangsa Range (Chew *et al.* 2008, Lau Chin Fong, pers. comm.).

Another worrying recent trend is the wildlife trade in *Platymma tweediei*. The number of hits through Google Search was surveyed on 2 February 2014 to estimate the growth of interest and intensity in wildlife trade and captivity of the species. I used the keywords '*Platymma tweediei*', '*Hemiplecta*' and '*Hemiplecta* Fire' for the survey, the latter being a popular name for the species in the trade. Publicly-available forum pages and webpages mentioning trade and captivity of the species were counted. The list of pages is available on line.

I found that interest in the trade and captivity of *P. tweediei* has increased almost twenty-fold over the last 6 years (Fig. 3). A total of 27 unique websites and forum pages mentioned

Fig. 2. Fragmentation of the cloud forest habitat of *Platymma tweediei* by agricultural expansion (A), logging (B) and urbanisation (C) in the Cameron and Lojing Highlands. (Photos: A and B, Junn Kitt Foon; C, Kok Shan See)

trade and captivity of *P. tweediei* between 2007 and 2013. Interest is primarily from Europe (Germany, Russia and the Czech Republic sharing 87 % of the websites; UK 7.5 %) but it is also popular within the country of origin, Malaysia (4.5 %) (Fig. 3). Given that this survey was restricted to publicly searchable websites at a single point in time, the scale of the trade offline could be bigger than mentioned here. This is further suggested by the first online record of the species in 2007, in which *P. tweediei* has been mentioned as having been in the European wildlife trade for several years whereas internet searches for *P. tweediei* by the author did not produce any results back in 2006.

All forums surveyed suggest *P. tweediei* has become popular among snail terrarium hobbyists because of its large size and bright red colouration. The general consensus in forums

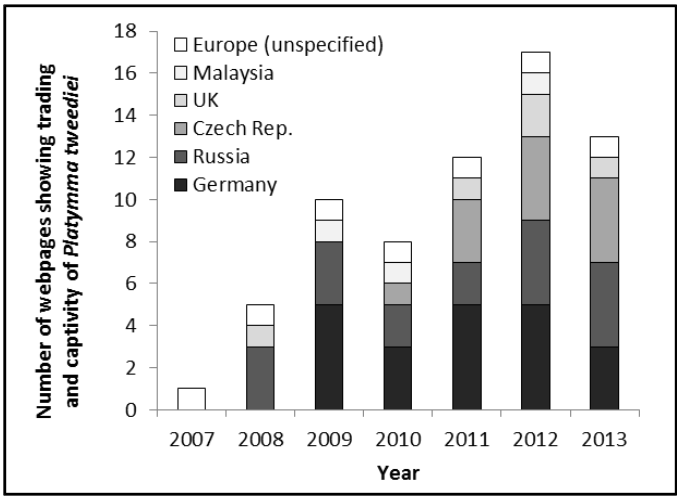

Fig. 3. Number of web and forum pages mentioning trading and captivity of *Platymma tweediei* from 2007 to 2013 classified according to destination countries of the market.

suggests that hobbyists are not able to raise *P. tweediei* successfully from hatchling to adulthood and hence a continuous supply of wild caught adult specimens is required for the hobby to continue. This is not surprising given that many cloud forest organisms including land snails are ecologically and altitudinally specialised, and therefore sensitive to environmental changes (e.g. Nadkarni & Longino 1990; Soh *et al.*, 2006; Liew *et al.*, 2009). The source locations for *P. tweediei* for the trade market remain unknown but in general forests along major roads are prone to overharvesting of wildlilfe because of the greater access afforded to poachers (Laurance *et al.*, 2009). The presence of captive *P. tweediei* displayed in one highly-accessible tourist attraction in the Cameron Highlands further suggests such a possibility (Sow Yan Chan, pers. comm.).

In view of the circumstances *Platymma tweediei* is facing, more detailed studies are urgently required to address the limited knowledge of the distributional patterns and ecological interactions of the species in order to gauge its vulnerability to habitat loss and exploitation. Relevant measures ensuring sustainable development should also be in place to minimise damage to the sensitive cloud forest habitat (Peh *et al.*, 2011). A thorough assessment of the extent to which *P. tweediei* is being traded should also be conducted to prevent over-exploitation of the species in the Cameron and Lojing Highlands.

I thank R.G. Clements and T.S. Liew for their comments in improving the paper, A. Alliamat for permitting the use of his photos, M.E.Y. Low for his help in acquiring some references as well as S.K. Tan and S.Y. Chan for discussion of the species in 2006. Photo by K.S. See was sourced from Wikimedia Commons under fair use purposes for research.

Barrow, C.J. 2006. Sustainable agriculture in the Cameron Highlands, Malaysia. In: *Cameron Highlands: Issues & Challenges in Sustainable Development* (ed. Chan, N.W.), p. 62-75. Universiti Sains Malaysia, Penang.

Baur, B. & Baur, A. 1993. Climatic warming due to thermal radiation from an urban area as possible cause for the local extinction of a land snail. *Journal of Applied Ecology* 30(2): 333-340.

Chan, N.W., Ghazali, S. & Md Nor, N. 2006. Climate change and heat island effects in Cameron Highlands. In: *Cameron Highlands: Issues & Challenges in Sustainable Development* (ed. Chan, N.W.), p. 35-55. Universiti Sains Malaysia, Penang.

Chew, M.Y., Yao T.L. & Kamaruddin S. 2008. *Platymma tweediei*, a rare gem endemic to the Central Mountains. *Conservation Malaysia* 8: 6-7.

Davison, G.W.H. 1995. The terrestrial molluscan fauna of Temengor Forest Reserve, Hulu Perak, Malaysia. *Malayan Nature Journal*, 48: 233-248.

Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O. & Townshend, J.R.G. 2013. High-resolution global maps of 21st-century forest cover change. *Science* 342(6160): 850-853.

Kumaran, S. & Ainuddin, A.N. 2006. Forests, water and climate of Cameron Highlands. In: *Cameron Highlands: Issues & Challenges in Sustainable Development* (ed. Chan, N.W.), p. 1-11. Universiti Sains Malaysia, Penang.

Laurance, W.F., Goosem, M. & Laurance, S.G.W. 2009. Impacts of roads and linear clearings on tropical forests. *Trends in Ecology and Evolution* 24(12): 659-669.

Liew, T.S., Schilthuizen, M. & bin Lakim, M. 2009. The determinants of land snail diversity along a tropical elevational gradient: insularity, geometry and niches. *Journal of Biogeography* 37(6): 1071-1078.

Nadkarni, N.M. & Longino, J.T. 1990. Invertebrates in canopy and ground organic matter in a neotropical montane forest, Costa Rica. *Biotropica* 22(3): 286-289.

Peh, K.S.H., Soh, M.C.K., Sodhi, N.S., Laurance, W.F., Ong, D.F. & Clements, R. 2011. Up in the clouds: is sustainable use of tropical montane cloud forests possible in Malaysia? *BioScience* 61(1): 27-38.

Soh, M.C.K., Sodhi, N.S. & Lim, S.L.H. 2006. High sensitivity of montane bird communities to habitat disturbance in Peninsular Malaysia. *Biological Conservation* 129: 149-166.

Salama, A.K., Osman, K.A., Saber, N.A. & Soliman, S.A. 2005, Oxidative stress induced by different pesticides in the land snails, *Helix aspersa*. *Pakistan Journal of Biological Sciences* 8(1): 92-96.

Tomlin, J.R. le B. 1938. A new Ariophantid from the Malay. *Proceedings of the Malacological Society of London* 23: 116-117, pl. 14A.

Yeap, C.A., Krishnasamy, K. & Loh, C.L. 2009. Belum-Temenggor forest complex: conserving one of Peninsular Malaysia's last great wild northern frontiers. In: *The Natural Heritage of Northern Peninsular Malaysia Conference* (ed. Chan, N.W.), p. 32-40. Universiti Sains Malaysia, Penang.

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IN SEARCH OF *CORILLA ANAX* (CORILLIDAE), RARE AND ENDEMIC LAND MOLLUSC OF THE WESTERN GHATS

By N.A. Aravind, Roshmi Rekha Sarma, Madhushree Munsi & Sandeep Sen

The Western Ghats of India, running parallel to the West Coast of India, is one of the 34 biodiversity hotspots of the world (Myers *et al.*, 2000) with amazing diversity and

Fig. 1. Shells of *Corilla anax* collected from Valparai, Tamil Nadu.

endemism of flora and fauna especially of vertebrates. However, diversity and endemism of invertebrates have not been studied except for certain charismatic taxa. This is particularly true for land snails of India, in general and in the Western Ghats in particular. The Indian land snail fauna is very diverse and to date 1,129 species have been reported from the country (Ramakrishna & Dey, 2010). There may be many more undescribed species, especially in the three biodiversity hotspots - the Western Ghats, part of the Himalayas and part of the Indo-Burma hotspot (which includes north-eastern Indian states). The Western Ghats biodiversity hotspot has 270 species representing 24 families and 58 genera (Aravind, 2005; Aravind *et al*., 2005) with 76 % endemicity. The ecology of many land snail species of the Western Ghats is still poorly known. Among many cryptic and interesting snail species is *Corilla anax* (Corillidae). The genus *Corilla* is represented by only one species in the Western Ghats (Fig. 1) and ten from Sri Lanka. The Natural History Museum, London, Royal Belgian Institute of Natural Sciences, Brussels and ATREE, Bangalore, are collaborating in an effort to understand the evolutionary relationships between corillids from the Western Ghats and Sri Lanka.

William Henry Benson, a pioneer in Indian malacology, described *Corilla anax* in 1865 (Benson, 1865). The type locality is 'Mavillicurray' in the Travancore Hills of Kerala state of western India. Benson's description says the 'Mavillikurray [sic] Hills are 2000 feet in height, to the east of the station of Cottyam'. Cottyam is currently known as Kottayam (9º 35′ N, 76º 31′ E) in Kerala, southwestern India (Fig. 2). Our recent extensive survey around the type locality has yielded no shells of *Corilla anax*. According to Gude (1914), *C. anax* is also found in 'Anamullay' (now Anamalais), which is in the present day Tamil Nadu state of

Fig. 2. Past and present distribution of *Corilla anax* in the Southern Western Ghats, India. The blue dot indicates the type locality and the red dots the current distribution. (Image source: Google Earth)

Fig. 3. Live sub-adult *Corilla anax* from Vazhachal forest, Kerala, Western Ghats, India. This is the only photograph of live *Corilla anax* from the Western Ghats. (Photo: NCF, Mysore)

southern India. A survey was conducted recently in this part of the Ghats, especially in the forest fragments amidst tea and coffee plantations in the Valparai of Anamalais region (Fig. 2). Our survey yielded a few fresh and old shells, but we failed to locate any live specimens. We were surprised when Shankar Raman of the Nature Conservation Foundation (NCF), an NGO working in Valparai, showed us a photograph of a small, live sub-adult of *C. anax* (Fig. 3), which he photographed at Vazhachal forest, adjacent to Valparai plateau in Kerala state. This is the first ever photograph of a live *C. anax* from India. Further extensive surveys in the adjoining less disturbed forests might yield good population information of *C. anax*. Currently, *C. anax* is known to occur on the western slopes and the hill top evergreen forests of the Western Ghats. Its altitudinal range is between 600-1,200 m asl. It prefers evergreen forest with thick canopy and thick litter cover. Ecological niche modeling using BIOCLIM and altitude data show that *C. anax* has very limited suitable area in the northern part of the southern Western Ghats. Most of this area, however, is under cardamom, tea and rubber plantations (Fig. 4).

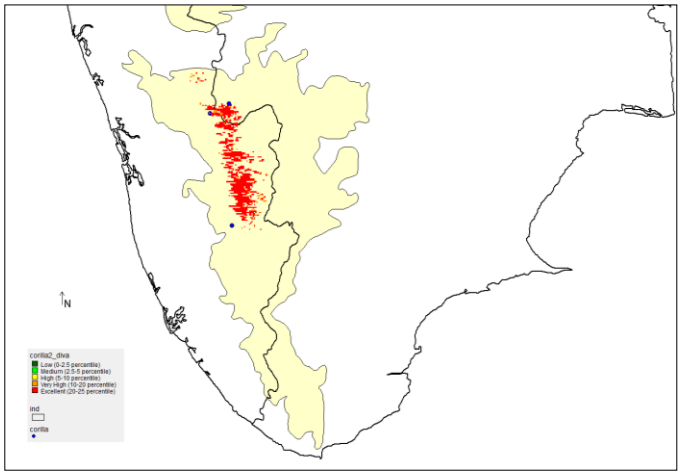

Fig. 4. Ecological niche modelling of the potential *Corilla anax* range in the Western Ghats.

The major threat to *C.anax* is deforestation. The forests around the type locality are almost completely lost and converted into rubber, tea and cardamom plantations. The remaining patches are highly disturbed. The majority of these transformations, especially in Kerala, have occurred in just the last century. According to Jha *et al*. (2000), between 1976 and 1995, Kerala lost 25 % of its evergreen forest to other vegetation types. *Corilla anax* prefers evergreen forests with good canopy cover and we presume that perhaps 100 years ago this species must have been widely distributed. The habitat has shrunk dramatically as a result of various development activities and plantation expansion reducing the suitable areas and thus leading to local extinction of populations.

Restoration efforts by NCF, with the help of Tata Coffee, of the fragments in Valparai where *C. anax* was found are underway. This effort might help to build local populations of *C. anax*. Further degradation of the fragments or forest patches should be curtailed. Given the low abundance of this species, it is imperative to conserve and connect the patches wherever possible to maintain genetic diversity. With the present distribution, population density and the level of threat this species is facing, we recommend that this species should be classified as 'Critically Endangered'.

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Aravind, N.A. 2005. *Ecology of land snails of the Western Ghats, India*. PhD thesis, Mangalore University.

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*, Suppl. 68: 31-38.

Benson, W.H. 1865. New land-shells from travancore, western and northern India. *Annals and Magazine of Natural History*, series 3, 15: 11-15.

Gude G.K. 1914. *The Fauna of British India, including Ceylon and Burma. Mollusca.—II. (Trochomorphidae-Janellidae)*. Taylor and Francis, London. xii + 520 + [2] p.

Jha, C.S., Dutt, C.B.S. & Bawa, K.S. 2000. Deforestation and land use changes in Western Ghats, India. *Current Science* 79: 231-238.

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

Ramakrishna, Mitra, S.C. & Dey, A. 2010. *Annotated Checklist of Indian Land Molluscs*. Zoological Survey of India, Kolkata, 359 p.

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NINE MOLLUSCS ASSESSED BY COSEWIC IN 2013

By Dwayne A.W. Lepitzki

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was busy again in 2013 (see *Tentacle* 21 for explanation of COSEWIC's mandate), assessing and re-assessing mollusc species that were previously assessed as being at risk of extinction or extirpation from Canada. In 2013 three mollusc species were assessed for the first time while six were re-assessed.

Cryptomastix devia (Puget Oregonian) was confirmed as Extirpated. In Canada this terrestrial snail is only known from three old records (1850-1905) from Vancouver Island and the Lower Fraser Valley of British Columbia (BC). Continuing extensive searches within the historical range have still failed to find this snail.

Allogona townsendiana (Oregon Forestsnail; Fig. 1) was confirmed as Endangered. This large land snail (up to about 3 cm in diameter) is endemic to western North America but in Canada it mainly occurs within the Lower Fraser Valley, BC. Habitat loss due to residential and commercial development continues to fragment and isolate the remaining snail populations trying to survive in the most densely human-populated and highly fragmented region in BC.

Fig. 1. *Allogona townsendiana* (Oregon Forestsnail). (Photo: Jennifer Heron)

Ptychobranchus fasciolaris (Kidneyshell) was confirmed as Endangered. This freshwater mussel had disappeared from 70 % of its historical range in Canada by 2001 and is currently confined to a few watersheds in southern Ontario with signs of reproduction occurring in only two of the four subpopulations. The invasion by dreissenid mussels, habitat loss from land use practices, pollution from agricultural, urban and road runoff sources and the recent invasion by the Round Goby (*Neogobius melanostomus*), a fish native to Eurasia, are all threats.

Toxolasma parvum (Lilliput) was newly assessed as Endangered. This freshwater mussel has been lost from 44 % of its historical range in Canada and is currently restricted to a few watersheds in southern Ontario. The invasion by the exotic Zebra and Quagga mussels (*Dreissena polymorpha* and *D. bugensis*) as well as pollution from a variety of sources, in addition to sedimentation, are the main causes of decline.

Obovaria subrotunda (Round Hickorynut), another freshwater mussel confined to southern Ontario, was confirmed as Endangered. It has experienced an estimated 99 % decline over the last 30 years for the same reasons as the other freshwater mussels in this region of Canada.

Obliquaria reflexa (Threehorn Wartyback; Fig. 2) was newly assessed as Threatened. While the situation does not appear as dire for this southern Ontario freshwater mussel as for the others, it too faces the same threats of pollution, sediment loading and invasive species.

Fig. 2. *Obliquaria reflexa* (Threehorn Wartyback). (Photo: Fisheries and Oceans Canada)

Staala gwaii (Haida Gwaii Slug; Fig. 3) is a new genus and species described in 2010, endemic to Haida Gwaii (formerly the Queen Charlotte Islands), off the coast of British Columbia, and was newly assessed as Special Concern. Its range was extended to include the Brooks Peninsula on northwestern Vancouver Island in 2012, another unglaciated refugium. Impacts from introduced deer on Haida Gwaii and climate change threaten to reduce the extent of the slug's preferred subalpine habitat.

Fig. 3. *Stalla gwaii* (Haida Gwaii Slug). (Photo: Kristiina Ovaska)

Hemphillia glandulosa (Warty Jumping-slug) was confirmed as Special Concern. In Canada this species has a restricted range and patchy distribution on southern Vancouver Island. Habitat loss and fragmentation, primarily from forestry practices, as well as residential and recreational developments are threats.

Lampsilis cariosa (Yellow Lampmussel), a freshwater mussel confined to single watersheds in both Nova Scotia and New Brunswick, was confirmed as Special Concern. Threats from non-native fishes and industrial pollution continue.

More information on COSEWIC can be found online. Finalized status reports for all these species except *Lampsilis cariosa* (Yellow Lampmussel) are now available on the SARA Public Registry. The most recent report on this species should be available after September 2014 but the previous report is currently on the registry.

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TOO MUCH OR NO WATER? HOW DO MOLLUSC COMMUNITIES COPE WITH EXTREME HABITAT FLUCTUATIONS IN THE LAST REMNANT OF THE LOWER DANUBE FLOOD AREA?

By Ioan Sîrbu, Ana Maria Benedek, Monica Sîrbu & Lorena Popescu

In the south-eastern part of Romania, along the lower Danube River, a few kilometers before it enters the Danube Delta Biosphere Reserve, a small part of the river's flood area has survived and is now preserved in the Small Wetland of Brăila Nature Park ('*Balta Mică a Brăilei*' in Romanian). Almost the entire lower Danube River valley, its flood areas, as well as the neighbouring wetlands were drained for economic reasons, especially for agriculture, during the second half of the 20th century. The nature park is considered the last remaining area with a natural flooding regime on the lower Danube, as well as the 'inland delta'. It covers about 245 km^2, i.e. 10 % of the former wetland, which once covered 2,413 km^2 (Fig. 1).

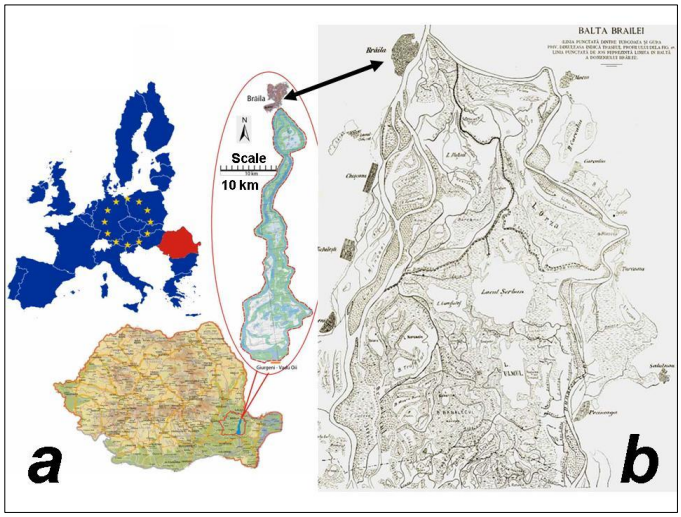

Fig. 1. a - location and present-day shape of the Small Wetland of Brăila Nature Park in Romania; b - the northern half of the former wetland of Brăila as it was recorded by Grigore Antipa in 1910; the black arrow shows the town of Brăila in both maps. Maps source: http://www.posmediu.ro/upload/pages/PNBmB(1).pdf

Fig. 2. The Danube's branches delimit and regularly flood seven islands along a sector of 62 km; in the photo the navigable Danube is bounded on the left by Fundu Mare Island and on the right by the boundary of the wetland protected area, bordered by a high and impenetrable dyke.

The park extends along a sector of 62 km of the Danube River (between km 175 at Brăila town and upstream to km 237). The Danube's arms form a network, delimiting and flooding seven islands of different dimensions (Fig. 2). First dykes were built during the early 1900s, aiming to protect local communities from the devastating floods, but the large scale, severe anthropogenic impact began in 1964, focusing on economic and political goals and disregarding preservation of nature and its ecological value. High dykes, draining and drying out of most wetlands have changed the landscape and restricted the former wetlands to a small proportion of its former extent. Intensive agriculture was started on the newly gained dry land (on more than 80 % of the former flood area) and, as a consequence of the aridization, irrigation systems had to be developed. At the same time, large areas were subject to deforestation, cutting of reed beds, surface digging and leveling and filling and clogging of former canals. All these changes have resulted in the climate and condition of the main part of the former wetland area becoming steppe-like. Another major impact resulted from the cutting of primary alluvial forests and their replacement by fast growing homogeneous Canadian poplar stands, leading to a further loss of genetic and ecological diversity. Later, these artificial cultures were invaded by different allochthonous species, the most common being the false indigo-bush (*Amorpha fruticosa*).

The remnant part of the wetlands, the present-day Small Wetland of Brăila, consists of a complex of different ecosystems subject to continuous fluctuation, especially because of the water regime. The inland network of lakes and canals was transformed into a vast fishery complex, exploited and managed exclusively for economic purposes. The high dykes bordering both sides of the Danube and its branches (the eastern and western limits of the present park) prevent the flooding of the bordering areas, but they also force the Danube's spring high-waters and floods to flow through the remnant part of the wetland, as if it were a broader river bed. This is linked to high water level changes, floods that cover almost the entire surface of the islands, forming a continuous water surface between the two dykes, leading to increased erosion, sedimentation, clogging of the former lakes and links between them, etc. Only the emergent forests mark the position of the former land. The high waters of spring and the beginning of summer are followed by lowering of the water, leading to complete drying up of lakes, ponds and marshes in most or all parts of the islands during the late summer and early autumn (Fig. 3). By the end of the summer the main parts of the islands are dry land, covered with terrestrial opportunistic and pioneering vegetation, with the exception of shallow remnant waters of some lakes and canals. Everything that manages to survive in this harsh environment has to cope with these fluctuating conditions.

After the political changes in Romania at the end of the 1980s, the remains of the former wetlands received attention from scientists, environmentalists and public administrators. The protection level increased during the following years: in 1994 part of this area was declared a regional reserve, in 1997 as a natural zoological reserve, gaining the status of a nature park in 2000, a RAMSAR site in 2001, and in 2007 it became both a site of community interest (ROSCI006) as well as of avifaunistic interest (ROSPA005), part of the European network 'Natura 2000'. The present and ongoing project aims to revise the former management plan for this area, in the context of becoming a Site of Community Importance (SCI) and Special Protection Area (SPA), by providing additional scientific insight regarding species of community and national interest, establishing an ecological database system, improving management actions and measures, etc. As part of these objectives, a malacological survey is also in progress, being the first intensive research on molluscs in the wetland.

Despite all the former research and management projects, little was known about the malacofauna of the Small Wetland of

Fig. 4. Searching for naiads (Unionidae) in the Danube branches; inset a - *Pseudanodonta complanata* with individuals of *Dreissena polymorpha* attached to its shell; b - only empty shells of *Unio crassus* have been found.

Brăila Nature Park. There were 21 mollusc species recorded from the area or its surroundings (Grossu, 1962; Grossu *et al.*, 1964; Negrea & Popescu-Marinescu, 1992); Negrea, 1994; Popa & Popa, 2006). Six of these species have not been found in our surveys. One of these is *Theodoxus transversalis* (C. Pfeiffer, 1828), a species of community interest, listed in Annexes II and IV of the EUHSD (92/43/EEC 1992), known as the Habitats Directive. This species is presumed to be extinct in Romania, since there have been no verified records during recent decades (Sîrbu & Benedek, 2005). It is a stenobiotic, oxy-rheophylic taxon requiring a certain quality of the aquatic environment, which has disappeared because of habitat destruction and pollution over the main part of its former range (Fehér *et al.*, 2012). Another missing species is *Unio crassus* (Philipson, 1788), also a species of community interest (Fig. 4), of which only empty shells have been found, probably washed down from an inhabited tributary of the Danube. Several decades ago it still lived in the Danube but has disappeared from the main part of the river. The number of species currently known to inhabit the area is 46, among which are 11 terrestrial gastropods, 10 bivalves and 25 freshwater gastropods, a poor diversity compared to other wetlands.

Because of the hydrological characteristics, terrestrial snails are represented by only a few species, mainly hygrophylous and eurybiotic, resistant elements. The most frequently encountered species (in more than one third of the surveyed terrestrial habitats) is *Zonitoides nitidus* (Müller, 1774), followed by *Trochulus sericeus* (Draparnaud, 1801), *Cepaea vindobonensis* (C. Pfeiffer, 1828) and *Oxyloma elegans* (Risso, 1826). In forests the main feature is the absence of the typical species adapted to such habitats. This reflects the artificial conditions of the plantations, and the lack of correlation between the ecological successions of plant and animal communities, the newly established forests being devoid of the typical forest species.

The freshwater gastropods belong to three ecological categories: 1) rheophylic, adapted to the conditions in the Danube River and its branches, 2) lentiphylic and macrophytophylic, found mainly during spring and the beginning of summer in the stagnant or slow flowing waters on the islands, and especially in the lakes, and 3) eurybiotic species, which inhabit a wide range of habitats, both in the flowing as well as stagnant waters.

In lakes, ponds or slow flowing, usually shallow waters on the flooded islands, rich in aquatic and hygrophylous vegetation, we found *Valvata cristata* Müller, 1774, *Acroloxus lacustris* (Linnaeus, 1758), *Physa fontinalis* (Linnaeus, 1758) - this species being strictly protected by Romanian legislation, *Ferrissia* (*Pettancylus*) *wautieri* (Mirolli, 1960), *Anisus calculiformis* (Sandberger, 1874), *Hippeutis complanatus* (Linnaeus, 1758), *Gyraulus* (*Gyraulus*) *albus* (Müller, 1774) and others. Characteristic of the flowing branches of the Danube are species such as *Theodoxus danubialis* (C. Pfeiffer, 1828), *Esperiana* (*Microcolpia*) *daudebartii acicularis* (Férussac, 1823), *Lithoglyphus naticoides* (C. Pfeiffer, 1828) and others. Species with a wide range of ecological tolerance can be found in almost all kinds of aquatic habitats, some of them being able to survive during the summer in small, warm and shallow waters on the islands. These are mainly some eurybiotic snails in the families Lymnaeidae and Planorbidae. The bivalves are scarcely found in the lakes and waters of the islands because of the summer droughts and drying up of most aquatic habitats. During the spring to early summer, only juvenile Unionidae, and especially young *Anodonta cygnaea* (Linnaeus, 1758) or *Musculium lacustre* (Müller, 1774) can be found in these temporary ecosystems, most of them dying after the water disappears. Most bivalves inhabit the Danube's branches, mainly in the vicinity of the river banks and not too far towards the middle river bed, where the current speed is high and sediments are not stable. A rich unionid community consisting mainly of *Unio tumidus* Philipsson, 1788 (most abundant and dominant) can be easily found especially during the low water levels in late summer and autumn. Here, the most sensitive lowland species (in relation to water and sediment quality), *Pseudanodonta complanata* (Rossmässler, 1835),

Fig. 3. Between flood and drought: extreme water level fluctuations shape the landscape, as well as mollusc community structure: a - September 2012 on Fundu Mare Island, Chiriloaia lake is totally dried up; b - the same place at the end of April 2013; c -Calia Island, Iezerul Morilor, September 2012; d – the same place in April, 2013.

which is strictly protected in Romania (Fig. 4), can also be found. Among the veneroids, the allochthonous species *Corbicula fluminea* (Müller, 1774) prevails along the whole Danube river and its arms, close to the sandy banks, but also in deep waters. On hard substrates such as logs, artificial materials and stones, but also on the valves of Unionidae and bigger snails, large groups of *Dreissena polymorpha* (Pallas, 1771) are frequent everywhere (but seldom in inland waters). *Dreissena bugensis* Andrusov, 1897, another allochthonous species, was also found in the summer of 2013.

Between the extreme habitat fluctuations, caused by the flow regime and the seasonal climatic dynamics, the mollusc communities have adapted in several ways. During the rainy season, extreme 'r-selection' is obvious in the island waters: huge numbers of offspring are produced, most of which do not survive during the warm and dry season, followed by an increasing survival curve during the rest of the year. A few tolerant species survive in the remnant shallow, warm and stagnant waters with little dissolved oxygen. Only the rheophylic, psammophylous species characteristic of the Danube River and its branches are less affected. They adapt to the changing water levels by active vertical migration. Both vertical and horizontal migration also enable the survival of some terrestrial and aquatic species on the islands. For instance, when the water level is rising, in the forested areas the terrestrial snails climb up the trees and remain there until the water level lowers. There is a continuous switch between aquatic and terrestrial habitats, and the molluscs gradually change their behaviour and community structure accordingly. The 46 species are forming dynamic meta-communities in a broad sense. The effects of periodic changes in the water level, human impact and other issues can be buffered and life conditions could be improved only by means of integrated, long-term, multivariate, sustainable, and, especially, active (i.e. implying continuous conscious effort) as well as adaptive management measures. Up to the present, several projects and plans have been accomplished, concerning these complex issues, but little has been done so far. The challenges of preserving the last remnant of the former lower Danube flood area and establishing a sound base for long-term research, monitoring, protection and development of this highly valuable area are still to be confronted.

Fehér, Z., Albrecht, C., Major, Á., Sereda, S. & Kríysik, V. 2012. Extremely low genetic diversity in the endangered striped nerite, *Theodoxus transversalis* (Mollusca, Gastropoda, Neritidae) – a result of ancestral or recent effects? *North-Western Journal of Zoology, Oradea, Romania* 8(2): 300-307.

Grossu, A.V. 1962. *Mollusca; Bivalvia.* Fauna R.S.R. 3(3). Editura Academiei, Bucureşti. x + 426 p.

Grossu, A.V., Călinescu, R., Bunescu, S. & Ştefănescu, I. 1964. Răspândirea geografică şi valorificarea Unionidelor din R.P.R., cu privire specială asupra Bălţii Brăila. *Analele Universităţii Bucureşti, Seria Geologie-Geografie* 13(2): 109-121.

Negrea, A. & Popescu-Marinescu, V. 1992. Gasteropodele din sectorul românesc al Dunării găsite până în prezent. *Hidrobiologia (Bucureşti)* 20: 75-110.

Negrea, A. 1994. Contribution á l'étude faunistique et biogéographique des Gastéropodes du secteur roumain du Danube. *Annales de Limnologie* 30(3): 179-195.

Popa, O.P. & Popa, L.O. 2006. *Sinanodonta woodiana* (Lea, 1834), *Corbicula fluminea* (O. F. Müller, 1774), *Dreissena bugensis* (Andrusov, 1897) (Mollusca: Bivalvia): alien invasive species in Romanian fauna. *Travaux du Muséum National d'Histoire Naturelle 'Grigore Antipa'* 49: 7-12.

Sîrbu, I. & Benedek, A.M. 2005. The genus *Theodoxus* Montfort, 1810 (Mollusca, Gastropoda, Neritidae) in the Romanian Inner Carpathian Basin. *Scientific Annals of the Danube Delta Institute for Research and Development, Tulcea-Romania* 11: 92-98.

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ACCIDENTAL INTRODUCTIONS OF FRESHWATER SNAILS IN AN INSULAR ENVIRONMENT: A CASE STUDY IN ILHA GRANDE, RIO DE JANEIRO, BRASIL

By Isabela Cristina B. Gonçalves, Igor C. Miyahira & Sonia B. dos Santos

Ilha Grande is the largest island of the state of Rio de Janeiro, municipality of Angra dos Reis in the southern region of the state. It is included in the Atlantic Forest Biome, one of the priority areas for biodiversity conservation, considered a hotspot (Myers *et al*., 2000; Mittermeier *et al*., 2004). The main threats to this biome are habitat destruction and the introduction of alien species. Ilha Grande is covered predominantly by tropical rain forest, with great diversity of environments, including montane, sub-montane and coastal plain forests, beaches, waterfalls, rivers and mangroves (Alho *et al.*, 2002; Callado *et al.*, 2009).

From 1903 Ilha Grande served as a prison-island, one of the reasons for its preservation according to old residents (Prado, 2003a, b). Following the prison closure in 1995, a lot of people moved to the island and Vila do Abraão (Abrãao Village) - 'the doorway to the island' - was the most affected by new building (Prado, 2003a,b) and deforestation (Alho *et al.*, 2002; Callado *et al.*, 2009) (Fig. 1).

There are 15 villages on Ilha Grande and the estimated population is about 4,883 people. However, on holidays and during the high season, especially in the summer, this number can be much higher (Prado, 2003a, b; Cadei *et al.*, 2009), because hundreds of tourists come to the island from Brasil and all over the world, resulting in a lot of environmental problems, including pollution, domestic sewage and alien species.

People, animals and all necessary goods are transported to the island by vessels (Fig. 2). It is interesting to note that tourists are considered invaders by local residents according to Prado (2003a).

Fig. 1. Abraão Village, Ilha Grande, showing urbanization of lowlands and deforestation. (Photo: S.B. Santos)

The present note is intended as one more alert to the risk of accidental introductions of freshwater molluscs to insular environments, evaluating the case of Ilha Grande, Rio de Janeiro, Brasil.

The Laboratory of Freshwater and Terrestrial Malacology of the State University of Rio de Janeiro has undertaken, since 2005, a long-term study in a stream in the most populous village on the island, Abraão Village, monitoring the freshwater molluscs. During this time, several introductions have been observed: *Melanoides tuberculata* (Müller, 1774) and *Biomphalaria tenagophila* (d'Orbigny, 1835) in 2005 (Santos *et al*., 2007); *Physa acuta* Draparnaud, 1805 in 2009 (Miyahira *et al*., 2010) and an extension of distribution of *M. tuberculata* and *P. acuta* in 2010 (Gonçalves *et al*., 2012). Some of these species have clearly been introduced more than once (Miyahira *et al*., 2010; Gonçalves *et al*., 2012).

In October 2012 we recorded one more species, never found previously, at least during our study: the succineid *Omalonyx*

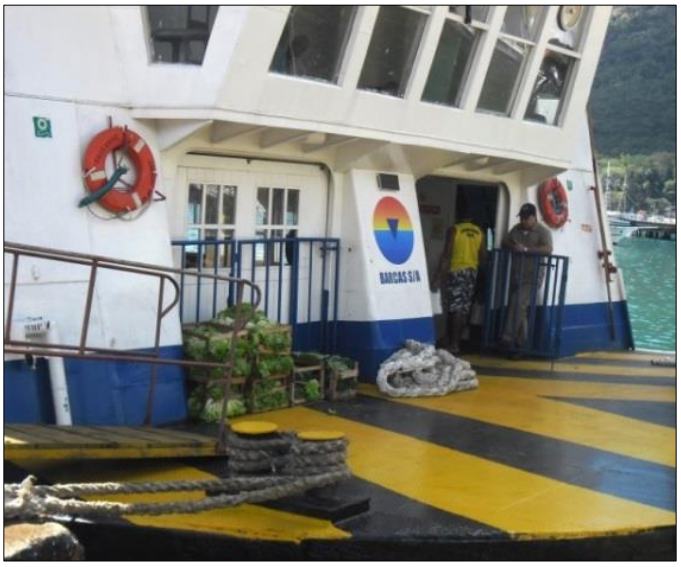

Fig. 2**.** Vessel arriving at Abraão Village, Ilha Grande, from the mainland. In front of the closed door are some boxes of lettuce and other vegetables. (Photo: I.C.B. Gonçalves)

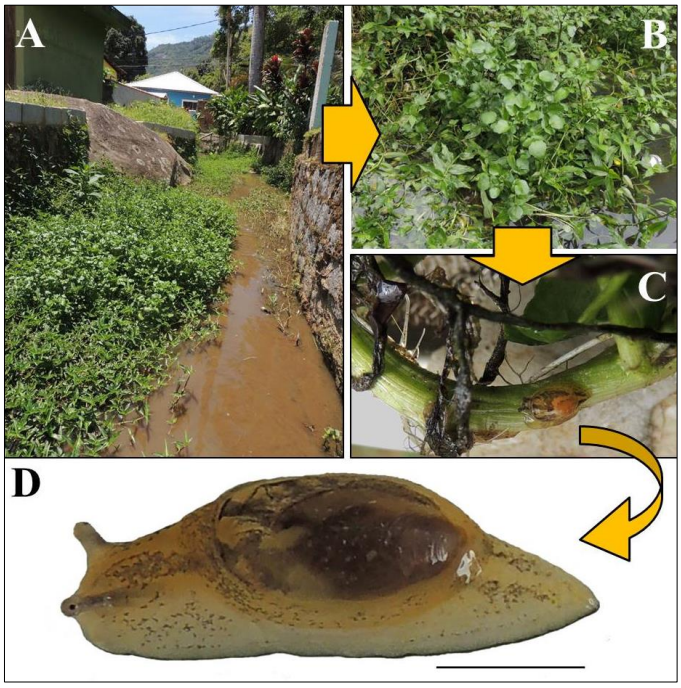

Fig. 3. A: general view of an area of the stream of Vila do Abraão showing the clusters of watercress (*Nasturtium officinale*); B: detail of watercress; C: a small specimen of *Omalonyx matheroni* attached to the stem of watercress; D: close-up of *O. matheroni*, scale bar: 0.5 cm. (Photos: I.C.B. Gonçalves)

matheroni (Potiez & Michaud, 1835). After this first record, other specimens were found in the following months, indicating that the population was apparently established. The discovery of *O. matheroni* coincided with the emergence of watercress (*Nasturtium officinale*) in the stream channel (Fig. 3), probably coming from kitchen waste, including vegetables, thrown into the stream by riverside dwellers. The specimens of *O. matheroni* were found attached to watercress stems (Fig. 3). It is possible that this species traveled from the nearby mainland to Ilha Grande attached to watercress transported in boxes of vegetables (Fig. 2). Watercress is also an alien vegetable, coming from Europe and Asia (McHugh *et al*., 1987). This scenario is similar to that of other introduced slugs in Brasil, such as *Deroceras laeve* (Müller, 1774) and *Limax maximus* Linnaeus, 1758 (Boffi, 1979; Ohlweiler *et al.*, 2010).

Although *B. tenagophila and P. acuta*, according to Santos *et al*. (2012), and *O. matheroni*, according to Arruda *et al*. (2009), are common species in the state of Rio de Janeiro, previous studies (Haas, 1953; Thiengo *et al*., 2004) did not find this species on Ilha Grande. *Physa acuta* and *M. tuberculata* are alien species in Brasil and widely distributed around the world (Paraense & Pointier, 2003; Simone, 2006; Ohlweiler *et al.*, 2010; Santos *et al*., 2012). Long-term continuous monitoring of the freshwater snails allowed us to note this recent new introduction.

The amphibious slugs of the genus *Omalonyx* are common in freshwater habitats (Parodiz, 1963) attached to aquatic plants or in the mud at the interface between water and air (Arruda *et al*., 2009; Montresor *et al*., 2012).

This record of another alien species on Ilha Grande calls attention to the vulnerability of islands to biological introductions in freshwater ecosystems, which may represent one more threat to the native fauna. The fragility of insular ecosystems has been pointed out by Cowie (2001) regarding Pacific Islands. On Ilha Grande, in the same stream, the increasing population of *M. tuberculata* caused a reduction of that of the native bivalve *Pisidium punctiferum* (Guppy, 1867) (Braga *et al*., 2012). So far, the population of *O. matheroni* remains very small, restricted to a small part of the stream. Monitoring is necessary in order to evaluate future impacts of this new introduction. However, the dispersal of this species to other island water bodies represents a threat to native species of molluscs as well as native aquatic plants. Olazarri (1979) reported *Omalonyx* species as pests in crops of watercress, and it may also damage native aquatic plants. There are also records of *Omalonyx* species causing damage to leaves of elephant grass, *Pennisetum purpureum* Schumach (Garcia *et al*., 2012).

As previously considered (Maciel *et al*., 1984; Santos *et al*., 2007; Nunes & Pereira, 2009; Gonçalves *et al*., 2012), there are several important aquatic ecosystems on the island, including lagoons of Praia do Sul and the rivers of Vila Dois Rios and Parnaioca. The arrival of these alien species could affect ecosystem functioning as well as cause a loss of biodiversity.

The long term study of this stream allowed us to track the successive introductions of freshwater molluscs. This provides an alert, since Ilha Grande has important environments that must be preserved. Based on this information, it is necessary to implement a regular inspection by the authorities of goods that arrive on Ilha Grande, as well as educational activities (Silva *et al*., 2008) in order to avoid other unintentional introductions and prevent further damage to the native fauna and flora of the island.

We thank Dr. Janine Arruda for identifying the slug. The study was conducted under Sisbio License 10812-1 and INEA License 18/2007 and supported by Faperj APQ1 E-26/110.402/2010 and APQ1 E-26/110.362/2012.

Alho, C.J.R., Schneider, M. & Vasconcellos, L.A. 2002. Degree of threat to the biological diversity in the Ilha Grande State Park (RJ) and guidelines for conservation. *Brazilian Journal of Biology* 62(3): 375-385.

Arruda, J.O, Pereira, D., Bergonci, P.E.A., dos Santos, C.P. & Mansur, M.C.D. 2009. Novos registros de *Omalonyx matheroni* (Pontiez [sic] & Michaud, 1835) (Mollusca, Gastropoda, Succineidae) para os Estados de São Paulo e Paraná, Brasil. *Biotemas* 22(2): 187-190.

Boffi, A.V. 1979. *Moluscos brasileiros de interesse médico e econômico*. Editora HUCITEC, São Paulo. 182 p.

Braga, R.M.R.B., Miyahira, I.C., Lacerda, L.E.M. & Santos, S.B. 2012. Population dynamics and morphometry of *Pisidium punctiferum* in Ilha Grande, Rio de Janeiro, Brazil. *XI International Congress on Medical and Applied Malacology. Crossing Boundaries: Integrative Approaches to Malacology*. Abstract Book, p. 158.

Cadei, M.S., Pereira, J.B.M. & Moura, N.C. 2009. Educação Ambiental. In: *O Ambiente da Ilha Grande* (ed. Bastos, M.& Callado, C.H.), p. 471-537. UERJ/CEADS, Rio de Janeiro.

Callado, C.H., Barros, A.A.M., Ribas, L.A., Albarello, N., Gagliardi, R. & Jascone, C.E.S. 2009. Flora e cobertura vegetal. In: *O Ambiente da Ilha Grande* (ed. Bastos, M.& Callado, C. H.), p. 91-161. UERJ/CEADS, Rio de Janeiro.

Cowie, R.H. 2001. Invertebrate invasions on Pacific Islands and the replacement of unique native faunas: a synthesis of the land and freshwater snails. *Biological Invasions* 3: 119-136.

Garcia, M.V.B., Arruda, J.O., Pimpão, D.M. & Garcia, T.B. 2012. Ocorrência e controle de lesmas do gênero *Omalonyx* (Gastropoda, Succineidae), pragas de capim-elefante *Pennisetum purpureum* (Poaceae) em Rio Preto da Eva, Amazonas. *Acta Amazonica* 42(2): 227-230.

Gonçalves, I.C.B., Miyahira, I.C. & Santos, S.B. 2012. Range extension of the alien freshwater snail *Melanoides tuberculata* in Ilha Grande, Angra dos Reis, Rio de Janeiro, Brasil. *Tentacle* 20: 11-13.

Haas, F. 1953. Mollusks from Ilha Grande, Rio de Janeiro, Brazil. *Fieldiana, Zoology* 34: 203-209.

Maciel, N.C., Araújo, D.S.D. & Magnanini, A. 1984. Reserva Biológica Estadual da Praia do Sul (llha Grande, Angra dos Reis, RJ): Contribuição para conhecimento da fauna e flora. Boletim FBCN 19: 126-148.

McHugh, J.J., Jr., Fukuda, S.K. & Takeda, K.Y. 1987. Hawaii watercress production. *Research Extension Series, Hawaii Institute of Tropical Agriculture and Human Resources* 88: 1-8.

Mittermeier, R.A., Robles-Gil, P., Hoffmann, M., Pilgrim, J.D., Brooks, T.M., Mittermeier, C.G., Lamoreux, J.L. & Fonseca, G. 2004. Hotspots revisited: earth's biologically richest and most endangered terrestrial ecoregions. CEMEX, Mexico City. 392 p.

Miyahira, I.C., Lacerda, L.E.M. & Santos, S.B. 2010. How many species are introduced every day? Some insights from a tropical insular stream in Brasil. *Tentacle* 18: 30-32.

Montresor, L., Teixeira, A., Paglia, A. & Vidigal, T. 2012. Reproduction of *Omalonyx matheroni* (Gastropoda: Succineidae) under laboratory conditions. *Revista de Biologia Tropical (International Journal of Tropical Biology)* 60(2): 553-566.

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

Nunes, J.D. & Pereira, C.Q. 2009. Hidrografia e hidrologia. In: *O Ambiente da Ilha Grande* (ed. Bastos, M.& Callado, C. H.), p. 65-74. UERJ/CEADS, Rio de Janeiro.

Ohlweiler, F.P., Takahashi, F.H., 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. 224 p.

Olazarri, J. 1979. Los moluscos plaga de los cultivos de 'berro' en Salto, Uruguay. *Comunicaciones de la Sociedad Malacológica del Uruguay* 5(36): 63-69.

Paraense, W.L. & Pointier, J.-P. 2003. *Physa acuta* Draparnaud, 1805 (Gastropoda: Physidae): a study of topotypic specimens. *Memórias do Instituto Oswaldo Cruz* 98: 513-517.

Parodiz, J.J. 1963. Observaciones anatomicas sobre *Omalonyx patera* Doer., com una nota biografica acerca de Adolfo Doering (1848-1926). *Sterkiana* 12: 1-7.

Prado, R.M. 2003a. As espécies exóticas somos nós: reflexão a propósito do ecoturismo na Ilha Grande. *Horizontes Antropológicos* 9(20): 205-224.

Prado, R.M. 2003b. Tensão no paraíso: aspectos da intensificação do turismo na Ilha Grande. *Caderno Virtual de turismo* 3(1): 1-9.

Santos, S.B., Miyahira, I.C. & Lacerda, L.E.M. 2007. First record of *Melanoides tuberculatus* (Müller, 1774) and *Biomphalaria tenagophila* (d'Orbigny, 1835) on Ilha Grande, Rio de Janeiro, Brazil. *Biota Neotropica* 7(3): 361-364.

Santos, S.B., Thiengo, S.C., Fernandez, M.A., Miyahira, I.C., Gonçalves, I.C.B., Ximenes, R.F., Mansur, M.C.D. & Pereira, D. 2012. Espécies de moluscos límnicos invasores no Brasil. In: *Moluscos Límnicos Invasores no Brasil: biologia prevenção,*

controle (ed. Mansur, M.C.D., Santos, C.P., Pereira, D., Paz, I.C.P., Zurita, M.L.L., Rodriguez, M.T.R., Neherke, M.V. & Bergonci, P.E.A), p. 25-49. Redes Editora, Porto Alegre.
Silva, P.S.C., Oliveira, J.L. & Santos, S.B. 2008. O caramujo africano *Achatina fulica* Bowdich, 1822 como indutor de ações educativas sobre espécies exóticas em escolas de ensino fundamental. *Anais da XIII Semana de Educação da UERJ*, p. 1-8.
Simone, L.R. 2006. *Land and freshwater molluscs of Brazil*. EGB, Fapesp., São Paulo. 390 p.
Thiengo, S.C., Mattos, A.C., Boaventura, M.F.F. & Fernandez, M.A. 2004. Freshwater Snails and schistosomiasis mansoni in the State of Rio de Janeiro, Brazil: IV - Sul Fluminense Mesoregion. *Memórias do Instituto Oswaldo Cruz* 99(3): 275-280.

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FIRST REPORT OF THE NEW ZEALAND MUDSNAIL (*POTAMOPYRGUS ANTIPODARUM*) ON THE ATLANTIC SLOPE OF THE USA

By Timothy A. Pearce & Robert Morgan

The New Zealand mud snail (NZM), *Potamopyrgus antipodarum* (Gray, 1853) (Fig. 1a), was discovered in October 2013 in Spring Creek, Centre County, Pennsylvania (40.891° N, 77.793° W). This discovery represents the first occurrence of this invasive snail on the Atlantic slope of the USA. The identity of NZM in Spring Creek was confirmed independently by Robert Dillon and by Robert Hershler.

During surveys by biologists from Pennsylvania Fish and Boat Commission Division of Environmental Services, NZM were found only in Spring Creek substrates and on human-made structures with direct contact to Spring Creek water (Fig. 1b). Its range from uppermost to lowermost occurrence was 4.8 km, or 9.8 km along the creek. NZM population densities in the most heavily infested areas were visually estimated to be approximately 1,000/m^2.

Each parthenogenic female can produce an average of 230 juveniles per year and the NZM is known to be able to pass alive through the digestive and excretory systems of several fish species (Vinson & Baker, 2008; Benson *et al*., 2012; Sea Grant Pennsylvania, 2013).

NZM is a conservation concern for other mollusc species because once established, it can negatively impact benthic communities in two principal ways: (1) it can reproduce rapidly to become the dominant invertebrate in an area, and (2) its extremely high consumption rate of the available primary production can decrease available food for other species (Alonso & Castro-Díez, 2008).

Fig. 1. Left, adult New Zealand mud snail; right, rock from Spring Creek, Pennsylvania, infested with New Zealand mud snails. (Photos: left, D. Gustafson; right, Pennsylvania Fish and Boat Commission)

Alonso, A. & Castro-Díez, P. 2008. What explains the invading success of the aquatic mud snail *Potamopyrgus antipodarum* (Hydrobiidae, Mollusca)? *Hydrobiologia* 614: 107-116.
Benson, A.J., Kipp, R.M., Larson, J. & Fusaro, A. 2012. *Potamopyrgus antipodarum*. USGS Nonindigenous Aquatic Species Database, Gainesville, Florida. Revision date: 11 June 2012.
Sea Grant Pennsylvania. 2013. New Zealand Mudsnail *Potamopyrgus antipodarum* [factsheet]. Updated October 2013.
Vinson, M.A. & Baker, M.A. 2008. Poor growth of rainbow trout fed New Zealand mud snails *Potamopyrgus antipodarum*. *North American Journal of Fisheries Management* 28: 701-709.

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IMPORTANCE OF PRESERVING FOREST REMNANTS IN URBAN AREAS FOR THE CONSERVATION OF NATIVE MOLLUSCS: A STUDY IN SOUTHERN BRASIL

By A. Ignacio Agudo-Padrón & Jefferson Souza da Luz

In this report we discuss briefly a rather neglected subject: the threatened conservation of non-marine molluscs in remaining urban forests.

Since May 2002 (Agudo, 2004, 2005), we have systematically monitored the richness and conservation status of the terrestrial and arboreal molluscs of the ‘Bosque Vereador Pedro Medeiros’. The Bosque is an urban public place (c. 10,500 m^2 in area) of contemplative leisure in the ‘Estreito’ (Strait) neighborhood of Florianópolis, Santa Catarina state, southern Brasil. It was originally a rural remnant, part of a 19th century coffee farm, and its preserved green area corresponds to Atlantic Forest in the secondary stage of

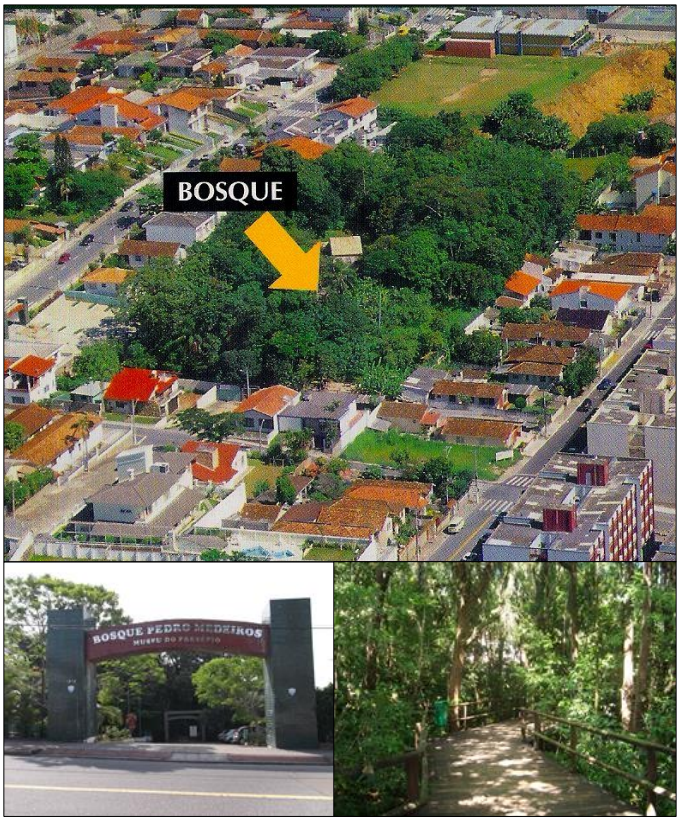

Fig. 1. General aspects of the Bosque Vereador Pedro Medeiros, Florianópolis.

regeneration. It is a small green island in the middle of urban development, criss-crossed by ecological trails (Fig. 1).

Although the Bosque has remained relatively intact, the low remnant mollusc diversity is a consequence, mainly, of human activities, with the associated environmental degradation, due to historical designation of the habitat for regional urban property expansion.

In total, 15 native gastropods survive in the Bosque, favoured by well maintained vegetation, a forest environment, humidity and shade. The species recorded are:

- Five slugs: *Angustipes erinaceus* (Colosi, 1921), *Phyllocaulis boraceiensis* Thomé, 1976 (Fig. 2), *Phyllocaulis soleiformis* (d'Orbigny, 1835), *Phyllocaulis tuberculosus* (Martens, 1868) (Fig. 2), *Phyllocaulis* cf. *variegatus* (Semper, 1885).
- Six ground-dwelling snails: *Succinea meridionalis* d'Orbigny, 1846, *Allopeas micra* (d'Orbigny, 1835), *Bulimulus tenuissimus* (d'Orbigny, 1835), *Gastrocopta solitaria* (Smith, 1890), *Habraconus* (= *Euconulus*) *martinezi* (Hidalgo, 1869), *Zilchogyra cleliae* Weyrauch, 1965.
- Four arboreal snails – *Helicina brasiliensis* Gray, 1824, *Drymaeus p. papyraceus* (Mawe, 1823) (Fig. 3), *Mesembrinus interpunctus* (Martens, 1887) (Fig. 4), *Simpulopsis decussata* Pfeiffer, 1856 (Fig. 4).

Unfortunately, this reduced, isolated and fragile habitat surrounded by typical urban development (Fig. 1) is being disrupted by nine synanthropic alien species, as follows:

- Three slugs: *Deroceras laeve* (Müller, 1774), *Limacus flavus* (Linnaeus, 1758), *Meghimatium pictum* (Stoliczka, 1873).
- Six snails: *Achatina* (*Lissachatina*) *fulica* Bowdich, 1822, *Subulina octona* (Bruguière, 1792), *Lamellaxis gracilis* (Hutton, 1834), *Bradybaena similaris* (Rang, 1831), *Cornu aspersum* (Müller, 1774), *Pupisoma discoricola* (Adams, 1845).

Fig. 2. Giant native slugs: *Phyllocaulis boraceiensis* (left) and *Phyllocaulis tuberculosus* (right).

Fig. 3. Native tree snail *Drymaeus p. papyraceus*.

Fig. 4. Native tree snails *Simpulopsis decussata* (left) and *Mesembrinus interpunctus* (right).

These alien species further compromise the persistence of the native species in this locality, most of which are already rare.

This work demonstrates the value and importance of preserving woodlands and forests (even if small remnants) for effective conservation of non-marine molluscs. For more complete and detailed information concerning the species recognized to date in this locality, including a bibliography and other publications, please contact the authors.

Agudo[-Padrón], A.I. 2004. Diagnóstico da biodiversidade como indicadora de qualidade ambiental em bairros da área urbana continental do Município de Florianópolis, Santa Catarina: situação no 'Bosque Vereador Pedro Medeiros', bairro do Estreito Florianópolis, SC. *UDESC/ FAED, IV Simpósio Geografia UDESC - Brasil: Geografia e Políticas Nacionais, 2004*, CD-ROM.

Agudo[-Padrón], A.I. 2005. Malacofauna ocorrente no Bosque Vereador Pedro Medeiros, bairro do Estreito, Florianópolis continental, Santa Catarina, região Sul do Brasil. *Resumos XIX Encontro Brasileiro de Malacologia - XIX EBRAM*: 266.

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RICHNESS, REGIONAL DISTRIBUTION AND CONSERVATION STATUS OF NON-MARINE MOLLUSCS IN SANTA CATARINA STATE, CENTRAL SOUTHERN BRASIL

By A. Ignacio Agudo-Padrón

After 18 years of research and disemination, the participants in 'Avulsos Malacológicos – AM' have recorded 219 species and subspecies of non-marine molluscs (189 gastropods - 147 terrestrial, 40 limnic/freshwater, 2 amphibious - and 30 freshwater bivalves), representing 97 genera and 37 families, in the state of Santa Catarina, southern Brasil (Fig. 1).

Of these, six gastropod species await final specific determination; 24 taxa (23 gastropods, 1 bivalve) still need confirmation in the field; 24 (3 bivalves, 21 gastropods) are alien; and 69 species (19 bivalves, 50 gastropods) are threatened to some degree with extinction.

For the purposes of recognition of the spatial distribution of these taxa, we divided the state into six regions (Fig. 2), based on their bio-ecological and geographical characteristics,

Fig. 1. Santa Catarina State, southern Brasil.

Fig. 2. The six regions of Santa Catarina State. 1 - Greater Florianópolis, 2 - Northern, 3 - Western, 4 - Highlands, 5 - Southern, 6 - Itajaí River Valley.

Fig. 3 (left). *Phyllocaulis boraceiensis* Thomé, 1976 (region 1).
Fig. 4 (right). *Megalobulimus paranaguensis* (Pilsbry & Ihering, 1900) (region 2).

Fig. 5 (left). *Pomacea megastoma* (Sowerby, 1825) (region 3).
Fig. 6 (right). *Strophocheilus pudicus* (Müller, 1774) (region 4).

Fig. 7. *Megalobulimus elongatus* (Bequaert, 1948) (region 5).
Fig. 8. *Macrodontes fasciatus* (Pfeiffer, 1869 (region 6).

according to Agudo-Padrón (2008: 149-150) and Agudo-Padrón *et al.* (2013: 14-31), and here illustrate a representative native species from each.

Region 1 – Greater Florianópolis (Fig. 3): 76 species (6 Bivalvia, 70 Gastropoda); 15 alien (1 Bivalvia, 14 Gastropoda); 12 under immediate threat of extinction (5 Bivalvia, 7 Gastropoda).

Region 2 – Northern (Fig. 4): 57 species (4 Bivalvia, 53 Gastropoda); 9 alien (2 Bivalvia, 7 Gastropoda); 13 under immediate threat of extinction (1 Bivalvia, 12 Gastropoda).

Region 3 – Western (Fig. 5): 91 species (23 Bivalvia, 68 Gastropoda); 14 alien (3 Bivalvia, 11 Gastropoda); 45 under immediate threat of extinction (13 Bivalvia, 32 Gastropoda).

Region 4 – Highlands (Fig. 6): 25 species (6 Bivalvia, 19 Gastropoda); 7 alien Gastropoda; 11 under immediate threat of extinction (5 Bivalvia, 6 Gastropoda).

Region 5 – Southern (Fig. 7): 52 species (8 Bivalvia, 44 Gastropoda); 8 alien (2 Bivalvia, 6 Gastropoda); 12 under immediate threat of extinction (5 Bivalvia, 7 Gastropoda).

Region 6 – Itajaí River Valley (Fig. 8): 79 species (8 Bivalvia, 71 Gastropoda); 15 alien (2 Bivalvia, 13 Gastropoda); 23

under immediate threat of extinction (5 Bivalvia, 18 Gastropoda).

Based on the above information, the Uruguay River Basin (region 3) stands out regionally as one of the hotspots of the world (it is the river basin with the greatest biodiversity of molluscs in Latin America), followed by the subtropical valley of the Itajaí-Açu River Basin (region 6) in the Atlantic slope forest domain of southern Brasil, the largest Atlantic drainage basin of the state.

The study of non-marine mollusc biodiversity in the state of Santa Catarina is urgent in view of the rapidly changing natural environments due to human activities and the rapid process of invasion by alien species.

For more complete and detailed information concerning the species recognized to date in Santa Catarina State, as well as a bibliography, please contact the author.

Agudo-Padrón, A.I. 2008. Listagem sistemática dos moluscos continentais ocorrentes no Estado de Santa Catarina, Brasil. *Comunicaciones de la Sociedad Malacológica del Uruguay* 9(91): 147-179.

Agudo-Padrón, A.I., Veado, R.W. ad-V. & Saalfeld, K. 2013. *Moluscos e Saúde Pública em Santa Catarina: subsídios para a formulação estadual de políticas preventivas sanitaristas*. Espaço Científico Livre Projetos Editoriais, Duque de Caxias. 134 p.

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REVIEW OF LIST OF NON-MARINE MOLLUSCS THREATENED IN BRASIL

By Sonia Barbosa dos Santos & Carlos Eduardo Guidorizzi de Carvalho

The Chico Mendes Institute for the Conservation of Biodiversity (ICMBio), headquartered in Brasilia, through its 'Coordination Assessment of the Status of Biodiversity Conservation – COABIO', is responsible for leading the process of analyzing and assessing the risk of extinction of species of the Brasilian fauna. The aim is to update the current list (Machado *et al*., 2008) of endangered species prepared by the Ministry of Environment. A concentrated effort to revise the lists of vertebrates and major groups of marine invertebrates, including molluscs, evaluated nearly 8,000 species over the course of more than 40 workshops and with the participation of more than 600 researchers representing the Brasilian scientific community. Now, a number of groups of non-marine invertebrates, including limnic and terrestrial molluscs are to be evaluated. Revision of the list of non-marine threatened invertebrates will be undertaken through consultation with experts and researchers who have relevant expertise, ensuring rigour and technical accuracy of the compiled information about each species listed. Briefly, the stages of the revision work are: 1) compilation of information about each species, including preparation of distribution maps; 2) a workshop, scheduled for September 2014, with the participation of experts, in which the information will be verified and discussed by all; and 3) assignment of a risk category to each species, following the IUCN methodology. The results will be published by the Ministry of Environment.

Machado, A.B.M., Drummond, G.M. & Paglia, A.P. (eds.) 2008. *Livro Vermelho da Fauna Brasileira Ameaçada de Extinção*. Volume 1. Ministério do Meio Ambiente e Fundação Biodiversitas, Brasília. 512 p.

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HOW TO PRESERVE POPULATIONS OF *VERTIGO ANGUSTIOR* AND *VERTIGO MOULINSIANA*: NEW INSIGHTS

By Zofia Książkiewicz

Vertigo moulinsiana (Dupuy, 1849) and *Vertigo angustior* (Jeffreys, 1830) are minute pulmonate snails (Fig. 1) that usually occur in treeless, moist habitats dominated by sedges. *Vertigo moulinsiana* is a so-called 'climbing' species and during hot days climbs up plants to attain the appropriate humidity level (Killeen, 2003; Tattersfield & McInnes, 2003). *Vertigo angustior* is a typical litter dweller (Hornung *et al*., 2003; Moorkens & Gaynor, 2003). The species spends its life among dead leaves of sedges and only in unusual cases (for example during humid and cool autumn days) can be found at the base of leaves of plants (Cameron *et al*., 2003; Książkiewicz, unpublished). Thus it is said that mowing has a negative influence, especially on *Vertigo moulinsiana* because it destroys the snails mechanically as well as devastating suitable microhabitats.

Fig. 1. Shells of *Vertigo moulinsiana* (left) and *Vertigo angustior* (right). (Photos: Zofia Książkiewicz)

Both species are threatened across the Europe and are listed in Annex II of the Habitats Directive. The main threat is disappearance of habitats due to human activities as well as natural succession that leads to increased shading and changes in microhabitat conditions just above the ground, reduction of litter humidity and alteration in plant species composition.

Since an environmental management scheme, financed by the European Union, was implemented in Poland in 2004, many farmers have decided to use moist sedge meadows extensively for supporting The Birds Directive (Council Directive

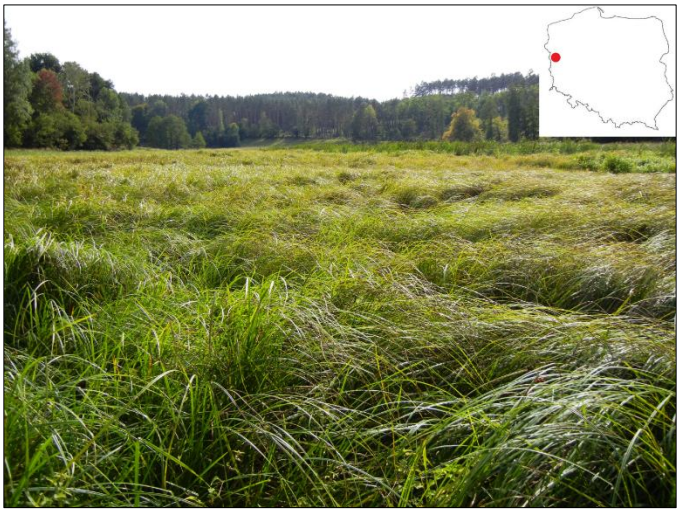

Fig. 2. The locality of *Vertigo angustior* and *Vertigo moulinsiana* in the Ilanka river valley; extensively used area, mowed every 3-5 years. (Photo: Zofia Ksiazkiewicz)

2009/147/EC on the conservation of wild birds). Agricultural subsidies were offered to farmers to encourage them to maintain meadows in desirable states, resulting in extensive mowing being commonly applied. Such land use is beneficial for conservation of rare bird species but is questionable for maintaining populations of snails.

In the Ilanka river valley sedge meadows are scattered along the valley and are linked by the river. In 2007 new localities of both *Vertigo* species were discovered in the area (Książkiewicz, 2008, 2009).

In July 2012 some of the extensively used areas (Fig. 2) were surveyed for snails and numerous populations of both vertiginids were discovered. Individuals were remarkably abundant in plots mowed three years before the surveys. Lower densities of species were found in unmowed plots in which reeds predominated. Such results are inconsistent with previous studies on mowing impact on the vertiginids, especially on *Vertigo moulinsiana* (Killeen, 2003; Zając, 2004). This observation may demonstrate that appropriate extensive land use can actually have a positive impact on both species. In this case, huge areas of the meadows are divided into plots mowed alternately every 3-5 years. Thus about 60-80 % of the area remains intact every year. Such a dynamic mosaic of plots mowed in consecutive years provides the refugia required by the snails, enabling them to spread out into the adjacent, freshly mowed plots. Additionally, mowing can increase soil moisture by reducing evapotranspiration, which can be an advantage especially for *Vertigo moulinsiana*. Such procedures also eradicate shrubs and lead to increased area available for the species. The great advantage of the study area is the connective force of the river, which is a great corridor for *Vertigo moulinsiana* and *Vertigo angustior* transportation (Falkner, 2003; Hornung *et al*., 2003; Myzyk, 2005). Thus the impoverished populations of the species can be supplied by individuals form other meadows in the same wetland system.

The observations presented in this paper need to be supported by more detailed and long-term research. The enormous densities of *Vertigo moulinsiana* could be related to the weather conditions: the year during which the field work took place was subject to particularly high rainfall and thus the ground water level as well as surface water was high, which creates favorable conditions for these species and caused populations to flourish. However, the presence of the species in mowed patches indicates that the populations are robust and can spread from refugia to adjacent patches and via the river corridor into freshly disturbed areas.

Cameron, R.A.D., Colville, B., Falkner, G., Holyoak, G.A., Hornung, E., Killeen, I.J., Moorkens, E.A., Pokryszko, B.M., 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*. *Heldia* 5: 151-170.

Falkner, G. 2003. The status of the four Annex II species of *Vertigo* in Bavaria. *Heldia* 5: 59-72.

Hornung, E., Majors, G., Fehér, Z. & Varga, A. 2003. An overview of the *Vertigo* species in Hungary: their distribution and habitat preferences. *Heldia* 5: 51-57.

Killeen, I.J. 2003. Ecology of Desmoulin's whorl snail *Vertigo moulinsiana*. *Conserving Natura 2000 Rivers, Ecology Series* 6: 1-25.

Książkiewicz, Z. 2008. The narrow-mouthed whorl snail *Vertigo angustior* (Pulmonata: Gastropoda: Vertiginidae) - distribution and habitat disturbance in northwestern Poland. *Tentacle* 16: 5-6.

Książkiewicz, Z. 2009. New localities of *Vertigo moulinsiana* (Dupuy, 1849) (Gastropoda: Pulmonata: Vertiginidae) in northwestern Poland. *Folia Malacologica* 17(4): 219-222.

Moorkens, E.A. & Gaynor, K. 2003. Studies on *Vertigo angustior* at a coastal site in western Ireland. *Heldia* 5: 125-134.

Myzyk, S. 2005. O biologii *Vertigo moulinsiana* (Dupuy 1849) (Gastropoda: Pulmonata: Vertiginidae). *Seminarium Malakologiczne Toruń-Ciechocinek. Materiały Konferencyjne*: 31-32.

Tattersfield, P. & McInnes, R. 2003. Hydrological requirements of *Vertigo moulinsiana* on three candidate Special Areas of Conservation in England (Gastropoda, Pulmonata: Vertiginidae). *Heldia* 5: 135-147.

Zając, K. 2004. *Vertigo moulinsiana* (Dupuy 1849). In: *Poradnik ochrony siedlisk i gatunków Natura 2000. Poradnik metodyczny. Bezkręgowce* (ed. Witkowski Z. & Adamski P.), p. 158-161. Ministerstwo Środowiska, Warszawa.

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MOLLUSCS INTERCEPTED AT THE BORDERS OF ISRAEL IN 2012 AND 2013

By Svetlana Vaisman & Henk K. Mienis

Inspectors of the Plant Protection and Inspection Services (PPIS) of the Ministry of Agriculture stationed at the entries into Israel, i.e. at the international airports near Lod and Elat, the harbours along the Mediterranean (Ashdod and Haifa) and Red Sea (Elat) coasts and the land border crossings with Jordan and Egypt, have intercepted molluscs on only six occasions during the past two years (2012-2013). This number of interceptions stands in strong contrast with those of 2009-2010 when molluscs were encountered on 14 occasions

(Vaisman & Mienis, 2011) and 2011 with nine interceptions (Vaisman & Mienis, 2012).

The intercepted material was handed over to Mrs. Svetlana Vaisman, who is dealing with all the mollusc related items at the PPIS. She transferred the samples to Mr. Henk K. Mienis of the Steinhardt National Collections of Natural History, Tel Aviv University, for identification and permanent storage in the mollusc collection.

Five samples consisted of terrestrial snails and slugs, which arrived from the Netherlands (3 samples), Scotland (1) and Turkey (1), while the sixth sample consisted of freshwater snails arriving from Thailand (Mienis *et al*., 2013). Six or possibly seven species were represented in the intercepted material (Table 1).

Table 1. Molluscs intercepted at the borders of Israel in 2012 and 2013.

Date	Species intercepted (number of specimens)	Origin	Shipment
2012			
3 May	*Deroceras reticulatum* (1)	Netherlands	*Echinodorus* cuttings
2013			
17 January	*Vitrina pellucida* (1)	Scotland	Various tree-trunks
17 January	*Deroceras reticulatum* (many)	Netherlands	Potted *Campanula*
16 May	*Filopaludina m. martensi* (4)	Thailand	Luggage (food)
	Pila polita (9)		
	Pomacea maculata (15)		
4 July	*Deroceras reticulatum* (2)	Netherlands	*Sedum* cuttings
2 September	*Xeropicta krynickii* (2)	Turkey	Dried *Salvia*
	Xeropicta species (1)		

Among these species is at least one, *Deroceras reticulatum*, with a known pest status in numerous European countries (Godan, 1983). Its establishment in Israel has to be prevented by all means. In addition it could also turn into a serious competitor of the two native species of *Deroceras* occurring in Israel: *D. berytensis* and *D. libanoticus*.

Three species were recorded for the first time: two species of land snails, *Vitrina pellucida* and *Xeropicta krynickii*, and one freshwater species, *Pila polita* (Fig. 1).

Vitrina pellucida is a Holarctic species and it is doubtful whether it is able to survive under natural conditions in Israel.

Xeropicta krynickii is confined more or less in its distribution to south-eastern Europe. Like *Xeropicta vestalis joppensis*, which occurs in Israel, it is a potential agricultural pest and a competitor of the native *Xeropicta* species living in areas characterized by a Mediterranean climate and vegetation.

The freshwater snail *Pila polita* is widely distributed in South-east Asia (Brandt, 1974). Of late, several other tropical freshwater species, including *Tarebia granifera* and *Pseudoplotia scabra*, have turned out to be rather successful in establishing flourishing populations in Israel (Ben-Ami, 2006; Mienis & Mienis, 2008; Mienis, 2012), so we may not rule out the possibility that *Pila polita* might also establish populations and become a severe competitor of most of the indigenous species. Even more serious could be the introduction of *Pomacea maculata* as it is one of two highly invasive species in South-east Asia. Also, introduced *Pila polita* and *Pomacea maculata* may carry metacercariae of the trematode *Echinistoma ilocanum*, a parasite still not known to occur in Israel.

Fig. 1. *Pila polita* intercepted at the borders of Israel. (Photo: Oz Rittner)

The low number of intercepted samples is without doubt due to a cutback in the number of inspectors working in the arrival hall of Israel's largest international airport: Ben-Gurion Airport near Lod. It is important to restore this work to the previous rate, i.e. the presence of at least one inspector 24 hours a day. The interception of alien species may play an important role in the conservation of the native mollusc fauna of Israel.

We thank the inspectors of the Plant Protection and Inspection Services of the Ministry of Agriculture (Ber Dagan, Israel) for supplying us with the material discussed. Likewise we thank Oz Rittner for his fine photograph of *Pila polita.*

Ben-Ami, F., 2006. First report of the invasive freshwater snail Tarebia granifera (Lamarck, 1816) (Gastropoda: Thiaridae) from Israel . *The Nautilus* 120: 156-161.

Brandt, R.A., 1974. The non-marine aquatic Mollusca of Thailand. *Archiv für Molluskenunde* 105: 1-423.

Godan, D. 1983. *Pest Slugs and Snails. Biology and Control*. Springer Verlag, Berlin, Heidelberg, New York. x + 445 pp.

Mienis, H.K., 2012. What is the correct generic name of the invasive tropical Thiarid species occurring in Israel and elsewhere that was described originally as *Buccinum scabrum* Müller, 1774? *Ellipsaria* 14(2): 14-16.

Mienis, H.K. & Mienis, D. 2008. *Thiara scabra*, a tropical snail, has invaded the Sea of Galilee, Israel. *Triton* 18: 35-36.

Mienis, H.K., Vaisman, S. & Rittner, O. 2013. Another failed attempt to smuggle freshwater snails from Thailand into Israel thanks to the work of the Plant Protection and Inspection Services at Ben-Gurion Airport. *Triton* 28: 29-32.

Vaisman, S. & Mienis, H.K. 2011. Molluscs intercepted at the borders of Israel in 2009 and 2010. *Tentacle* 19: 15-18.

Vaisman, S. & Mienis, H.K. 2012. Molluscs intercepted at the borders of Israel in 2011. *Tentacle* 20: 6-7.

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PIONEERING STUDIES ON TERRESTRIAL MOLLUSCS IN THE ATLANTIC FOREST OF ILHA GRANDE, RIO DE JANEIRO BY THE RAPELD METHODOLOGY

By Sonia Barbosa dos Santos, Jaqueline Lopes de Oliveira & Mariana Castro de Vasconcelos

RAPELD (Rapid Surveys in Long-term Ecological Research) is the Brasilian acronym joining RAP, as proposed by Conservation International, and PELD (Pesquisas Ecológicas de Longa Duração – Long Term Ecological Research). The RAPELD program is integrated into PPBio (Biodiversity Research Program), coordinated and funded by the Brasilian Ministry of Science and Technology (Cardoso & Carvalho. 2002).

The RAPELD methodology was first designed by Magnusson *et al*. (2005, 2013) for use in the Amazon region and subsequently adopted by PPBio with the goal of developing biodiversity monitoring programs that allow comparison of the same biological group among different Brasilian regions and of different groups in the same region (Magnusson *et al*., 2005).

The great advantage of using the RAPELD methodology is that it allows rapid inventories of the flora and fauna, standardization of data, integration of different studies (soil, topography, etc.), reduction of costs and rapid availability of data for publication in the form of scientific articles, books and species identification guides (Magnusson *et al*., 2005, 2013; Zuquim *et al*., 2007). Integrated studies performed by this methodology will provide more accurate information about biological communities, providing support for better management of Conservation Units (Bergallo, 2012).

Several RAPELD study sites are already established in almost all Brasilian biomes (PPBio, 2014), generating many publications, which mostly focus on plants, fungi, fish, amphibians, reptiles, birds, mammals and invertebrates, especially arthropods (Magnusson *et al*., 2013); however, none of them addresses land or freshwater snails.

Ilha Grande is an island in southeastern Brasil (Fig.1), where two RAPELD modules (Module East and Module West) were recently established (Fig. 1) (Bergallo, 2012; Ribeiro *et al*., 2012). Ten regularly spaced plots were marked out in each module. The plots do not have a regular shape, but have a 250 m central transect line that follows the elevational contour (Fig. 2). The Laboratory of Limnic and Terrestrial Malacology of the Universidade do Estado do Rio de Janeiro is begining to study the Module East of the Ilha Grande RAPELD site. We are using a collecting protocol based on Nunes & Santos (2012) and Nunes (2013). In each plot we collect litter down to the soil surface from ten regularly spaced quadrats of 25 × 75 cm, storing the samples in plastic bags for subsequent screening in the lab. We also perform a one person-hour timed search for arboreal and litter-dwelling snails.

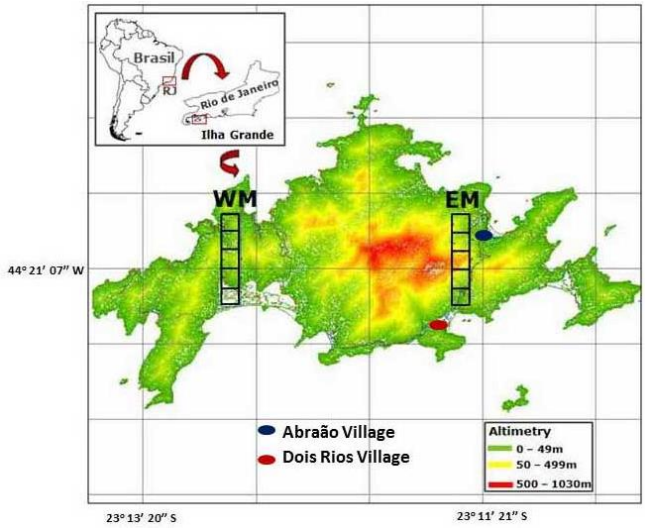

Fig. 1: Map of Ilha Grande, Angra dos Reis, Rio de Janeiro, Brasil, showing the position of RAPELD Module East (EM) and Module West (WM). Modified from Bergallo (2012).

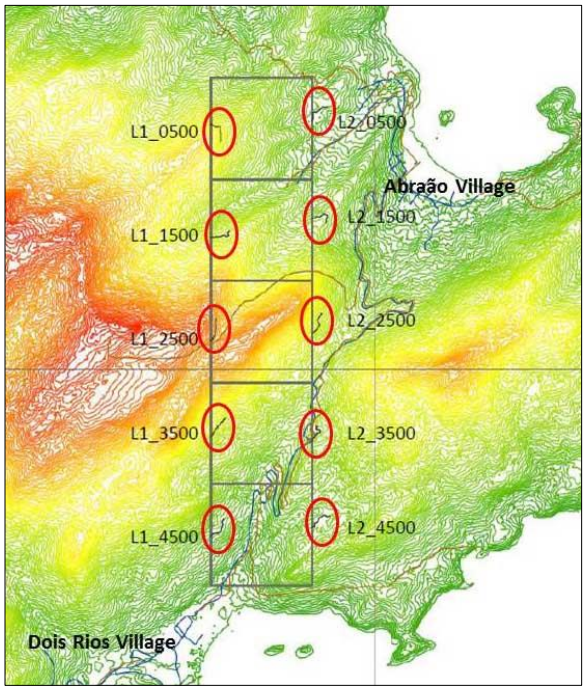

Fig. 2: Detail of Module East showing the location of each 250 m linear plot. Each plot is spaced 1,000 m from the next at the lines. Red circles identify each standardized numbered plot. L= virtual orientation line. Modified from Bergallo (2012).

The relevance of this research lies in expanding knowledge of the distribution of terrestrial snails on Ilha Grande, currently concentrated in the neighborhood of Dois Rios Village and Abraão Village (Santos *et al*., 2010), relating this distribution to various environmental factors and data from other research groups, and thereby increasing knowledge of the diversity of land snails in the Atlantic Forest in general.

The research is in its early stages and the results will constitute the Masters theses of the junior authors, to be defended in 2015. These are pioneering studies addressing

ecology and distribution of terrestrial molluscs in Brasil by using the RAPELD methodology. We hope that the results encourage other researchers to deploy the RAPELD methodology in other Conservation Units, in order to obtain integrated data that contribute to the conservation of terrestrial molluscs.

The study was conducted under Sisbio License 10812-1 and INEA License 18/2007 and supported by Faperj Pensa Rio E-26/110.284/2010; APQ1 E-26/110.402/2010 and APQ1 E-26/110.362/2012.

Bergallo, H.G. (coord). 2012. *Diversidade biológica na Ilha Grande: uma análise sintética dos processos e base para pesquisas de longa duração*. Acessed 15 March 2014.

Cardoso, F.H. & Carvalho, J.C. 2002. Decreto no. 4339 de 22 de agosto de 2002. Institui princípios e diretrizes para a implementação da Política Nacional da Biodiversidade. Diário Oficial da União, de 23.8.2002, seção 1, Imprensa Nacional.

Magnusson,W.E., Lima, A.P., Luizão, R., Luizão, F., Costa, F.R.C., de Castilho, C.V. & Kinupp, V.F. 2005. RAPELD: a modification of the Gentry method for biodiversity surveys in long-term ecological research sites. *Biota Neotropica* 5(2): 1-6.

Magnusson,W.E., Braga-Neto, R., Pezzini, F., Baccaro, F., Bergallo, H., Penha, J., Rodrigues, D., Verdade, L.M., Lima, A., Albernaz, A.L., Hero, J.-M., Lawson, B., Castilho, C., Drucker, D., Franklin, E., Mendonça, F., Costa, F., Galdino, G., Castley, G., Zuanon, J., Vale, J., Santos, J.L.C., Luizão, R., Cintra, R., Lisboa, A., Koblitz, R.V., Cunha, C.N. & Pontes, A.R.M. 2013. *Biodiversidade e monitoramento ambiental integrado*. Santo André, Áttema Editorial Assessoria e Design. 356 p.

Nunes, G.K.M. 2013. Diversidade, variação altitudinal e fatores ambientais que influenciam a distribuição da malacofauna terrestre em seis localidades da Ilha Grande, Angra dos Reis, Rio de Janeiro, Brasil. Tese de Doutorado. Universidade do Estado do Rio de Janeiro.

Nunes, G.K.M. & Santos, S.B. 2012. Environmental factors affecting the distribution of land snails in the Atlantic Rain Forest of Ilha Grande, Angra dos Reis, RJ, Brazil. *Brazilian Journal of Biology* 72(1): 79-86.

PPBio. 2014. Programa de Pesquisa em Biodiversidade. Localização dos Sítios de Coleta. Acessed 15 March 2014.

Ribeiro, G.P., Bergallo, H.G., Santos, A.W., Lopes, R.S. & Parma, R.G. 2012. Mapeamento digital na Ilha Grande em apoio a inventários rápidos RAPELD (Componente PELD- Pesquisas Ecológicas de Longa Duração). IV Simpósio Brasileiro de Ciências Geodésicas e Tecnologias da Geoinformação, Recife, 9p.

Santos, S.B., Rodrigues, C.L., Nunes, G.K.M., Barbosa, A.B., Lacerda, L.E.M., Miyahira, I.C., Viana, T.A., Oliveira, J.L., Fonseca, F.C., Silva, P.S.C. 2010. Estado do conhecimento da fauna de invertebrados não marinhos da Ilha Grande (Angra dos Reis, RJ). Oecologia Australis 14(2): 504-549.

Zuquim, G., Costa, F.R.C. & Prado, J. Sample effort reduction vs. information retention in inventories of pteridophytes in Central Amazonia. *Biota Neotropica* 7(3): 217-223.

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MOLLUSCS AND THEIR CONSERVATION PROBLEMS IN THE SAN MIGUEL DE PARADA FAUNAL REFUGE, EASTERN CUBA

By David Maceira, Carmen R. Tejeda, María del Carmen Fagilde Espinosa, Beatriz Lauranzón, Jorge Reyes, Luis O. Álvarez-Quintana & Alexis Pérez-Hernández

The San Miguel de Parada Faunal Refuge is located at Santiago de Cuba Bay in the municipality with the same name in eastern Cuba and covers an area of about 327.6 ha, of which 256.3 ha is on land and 71.3 ha is marine (Fig. 1). The mean monthly temperature is about 26.7 °C and the annual average is 27 °C. Annual rainfall is between 740 and 1,437 mm and average relative humidity is 68 % during the dry season and 77 % in the rainy season. The main habitats are mangrove forest, secondary forest and wetlands (Hechavarría & Bouza, 2010). The snail fauna of this protected area has not previously been studied.

On 11 December 2013 we inventoried and counted the tree snail species and individuals from 8:00 am to 10:00 am and ground dwelling molluscs from 10:30 am to 12:30 pm in the wetlands and secondary forest. We also surveyed El Cobre River, which crosses the protected area, as well as the seashore. All samples are deposited in the Malacological Collection of the Centro Oriental de Ecosistemas y Biodiversidad (BIOECO BSC-M).

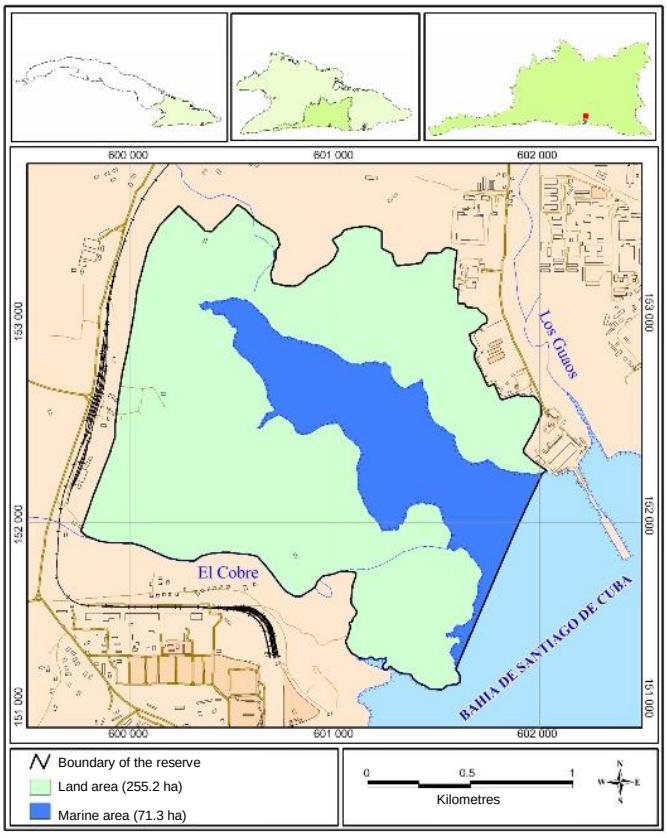

Fig. 1. Map of the San Miguel de Parada faunal reserve.


Fig. 2. No molluscs were found in these habitats. Left, secondary forest with *Leucaena leucocephala*; right, wetlands.

Fig. 3. *Veronicella cubensis*, the Cuban slug.

Four species of land snails were recorded in secondary forest of which just one is endemic to Cuba, two are introduced to Cuba and one is a Cuban mollusc now more widely distributed to many regions. No land molluscs were seen in the mangrove and wetlands (Fig. 2). All are pulmonates and all except one arboreal species are ground-dwelling. The recorded mollusc fauna is very poor and in very bad condition from the perspective of mollusc conservation in this protected area. The introduced *Praticolella griseola* lives on the invasive plant *Cordia obliqua* Willd. We also found the other three species around this plant as well as *Leucaena leucocephala* (Lam.). The Cuban slug (*Veronicella cubensis*), which has been introduced to other countries, was the most abundant species, with eight juveniles and 13 adults found under bricks around *Cordia obliqua* (Fig. 3). *Oleacina solidula* occurred in relatively high abundance, since as a predator it is usually difficult in eastern Cuba to find more that two individuals of this species living together.

No freshwater molluscs were found, neither live snails nor empty shells, possibly because intense rain over the previous days may have washed them out of the river. On the seashore (we did no SCUBA diving) we found only one species, *Batillaria minima*, in high abundance on the rocks (Fig. 4). This is a common marine snail in the Caribbean islands. Unfortunately the two more common sea snails living on the mangrove, *Crassostrea rhizophorae* (Guilding) and *Littoraria angulifera* (Lamarck), were not seen, although we suspect they are present but in very low abundance; they were last recorded in May 2004.

Threats to the conservation of marine molluscs include shore erosion, illegal fishing and mangrove cutting (Fig. 5). For the freshwater molluscs the El Cobre River edge is damaged, invasive plants are growing around it and because of erosion the soil is falling into the river so the water is muddy (Fig. 5). The threats to land molluscs inhabiting the wetland near to the mangrove include intense human activity that has resulted in destruction and fragmentation of the original habitat and the introduction of two species of terrestrial snails not


Fig. 5. Threats include erosion of the seashore (left) and impacts of invasive plants and river bank erosion along El Cobre River (right).

Fig. 6. The brackish lagoon, considered important for migratory birds.


Fig. 7. Additional threats. Damage caused to vegetation by Hurricane Sandy in October 2012 (left) and the invasive plant *Sansevieria hyacinthoides* (right).

characteristic of this ecosystem (*Subulina octona* and *Praticolella griseola*). In addition to this habitat loss and deforestation, other threats include illegal extraction of wood for craft, firewood and house building, introduction of invasive animals (rats, dogs, cats, chickens and pigs), droughts and natural and human-caused fires. This protected area, we consider, is most important for aquatic birds, many of which are migratory (Fig. 6). Also, on 25 October 2012 Hurricane Sandy caused great damage to the plant formations and molluscs living there. Almost all tree cover was lost, populations of the four species of mangroves were drastically reduced and damaged and large open spaces that are now being occupied by invasive species were created (Fig. 7).

In the refuge there are numerous invasive or potentially invasive plant species such as *Sansevieria hyacinthoides* (L.) Druce (Fig. 7). We list the most abundant of them, which are included in the list of 100 most harmful species in Cuba (Oviedo *et al*., 2012). The list includes *Azadirachta indica* A. Juss. (Nin tree), which despite being listed only as potentially invasive is well established and has a high rate of population regeneration. These effects become a serious threat to this protected area and conservation of its molluscs.

There are difficulties obtaining the necessary resources to develop an adequate technical infrastructure to support an ecological station for the development and maintenance of research. Communities of people resident in the reserve make

use of the natural value without sustainable development of the natural resources in their surroundings and a program of environmental education is still insufficient.

The research and monitoring program includes

- Reforesting the area with plants originally present in the wetland.
- Establishing a program of environmental education for the local human communities and a program to reduce rat presence in the area.
- Establishing a program to reintroduce the mangrove to protect the seashore.
- Replacing the invasive plants living in the area with the original plants of the wetland.
- Protecting the El Cobre river edge from erosion using original plants of the wetland.

Land mollusc species list

The number of snails of each species that were found alive per hour is given in parentheses.

Clase GASTROPODA
Subclass 'PROSOBRANCHIA'
Familia BATILLARIIDAE
Batillaria minima (Gmelin, 1791). Marine snail (> 100 specimens per m^2).

Subclass PULMONATA
Family VERONICELLIDAE
Veronicella cubensis (Pfeiffer, 1840). Widely distributed in many Caribbean islands and elsewhere (10.5).
Family SUBULINIDAE
Subulina octona (Bruguière, 1792). Ground-dwelling snail introduced to Cuba (4).
Family OLEACINIDAE
Oleacina solidula (Pfeiffer, 1840). Ground-dwelling snail endemic to Cuba and introduced to the Bahamas (2.5).
Familia POLYGYRIDAE
Praticolella griseola (Pfeiffer, 1841). Tree snail introduced to Cuba (3.5).

List of invasive plant species, with common names used in Cuba

Family BORAGINACEAE
Cordia obliqua Willd. (Uvita)
Family MIMOSACEAE
Leucaena leucocephala (Lam.) de Wit subsp. *leucocephala* (Ipil-ipil)
Prosopis juliflora (Sw.) DC (Cambrón)
Vachellia macracantha (Willd.) Seigler & Eivenger (Guatapaná)
Dichrostachys cinerea (L.) Wight & Arn (Marabú)
Family DRACAENACEAE
Sansevieria hyacinthoides (L.) Druce (Lengua de vaca)
Family OLEACEAE
Jasminum fluminense Vell. (Jazmín de oryza)

We thank Empresa de Flora y Fauna, Refugio de Fauna 'San Miguel de Parada' and Centro Oriental de Ecosistemas y Biodiversidad (BIOECO) for support of the fieldwork.

Hechavarría, G. & Bouza A.J.A. 2010. *Plan de manejo del refugio de Fauna San Miguel de Parada*. Empresa Nacional para la Protección de la Flora y la Fauna, Oficina territorial de Santiago de Cuba. 118 p.

Prieto, R.O., Oliver, P.H., Caluff, M.G., Regalado, L., Rodriguez, I.V., Fraga, J.M.P., Oviedo, I.B., Gutiérrez, P.A.G., Camacho, J.P., Schwesinger, L.H., González-Oliva, L., Guerra, L.C., Soroa, J.P., Terán, S.I.S., Cruz, R.E., Marrero, I.M.F., Angulo, R.R., Rodríguez, P.O., Mayedo, W.B., Gómez, M.V., Abad, N.S., Quiala, G.B., López, R.V., Torres, T.C., Mederos, J.M., Fernández, R.G., Acevedo, C., Piñeiro, J.L., Jiménez, M.R., Muñoz, I.M., González, Á.V., Leiva, A.T., Valdés J.A.H., Campo N.E.G., Silva, B.L.T., Echevarría M.T.G., García, A.M., Zorilla, M.I.C. & Cruz, M.T. 2012. Lista nacional de especies de plantas invasoras y potencialmente invasoras en la República de Cuba - 2011. *Bissea* 6(numéro especial 1): 22-96.

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Fig. 4. The marine snail *Batillaria minima*.

LAND SNAILS WITH STRANGE SHELLS: *OPISTHOSTOMA* IN SABAH, BORNEO, MALAYSIA

By Rina Uchida, Bakhtiar Effendi Yahya & Kiyonori Tomiyama

We surveyed the land snail fauna of 13 localities including three limestone outcrops in Sabah, Borneo, Malaysia, in 2010 (Fig. 1). Land snails were sampled by hand collecting and identified to species level when possible. In total, 39 species were recorded (Uchida *et al*., 2013). Species diversity in limestone areas was higher than in non-calcareous areas. The genus *Opisthostoma* is known for its very strange shells, and we were able to record a number of aspects of its ecology.

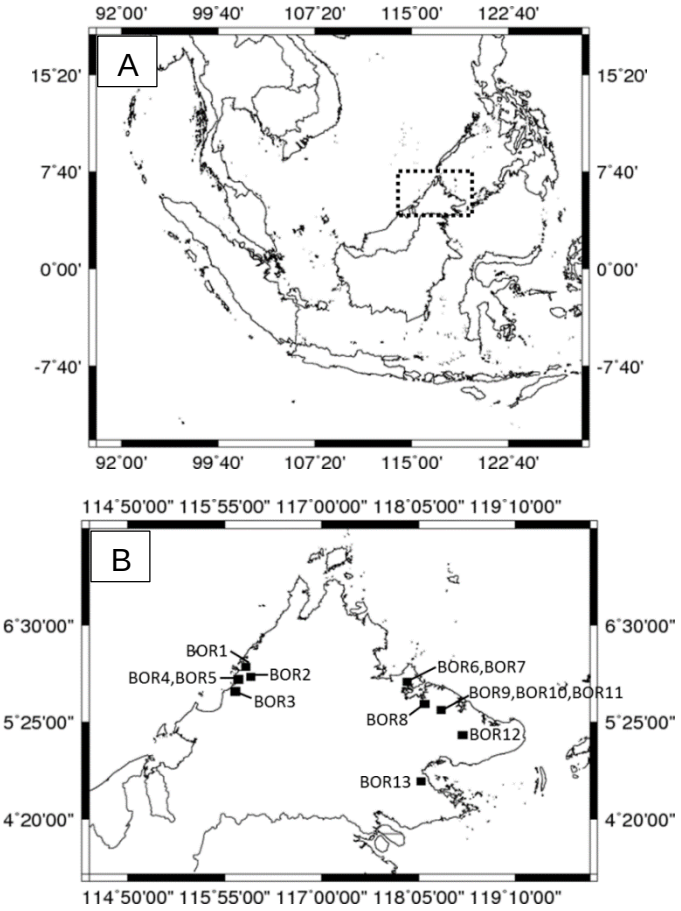

Fig.1. Maps of Sabah, with locations of the sampling sites. A, Sabah state is in the northern part of Borneo, Malaysia. B, the localities searched in this study: BOR1, UMS PEAK at Universiti Malaysia Sabah, BOR2: Kiansom Waterfall, BOR3: Hutan Lipur Kawang, BOR4: the mangrove forest in Kota Kinabalu Wetland Centre, BOR5: the parking area of Kota Kinabalu Wetland Centre, BOR6: the Universiti Malaysia Sabah facility in Sepilok, BOR7: the Rainforest Discovery Centre in Sepilok, BOR8: the Gomantong Caves limestone outcrop, BOR9: an oil palm plantation in Sukau, BOR10: a limestone outcrop called Hutan Simpan Buntai in Sukau, BOR11: the Universiti Malaysia Sabah facility in Sukau, BOR12: the Tabin Wildlife Reserve, BOR13: the Madai Caves limestone outcrop.

Snails of the genus *Opisthostoma* were found in all three limestone outcrops (Figs. 2, 3). However, each outcrop supported a different *Opisthostoma* species: *Opisthostoma concinnum* Fulton, 1901 from a limestone outcrop called Hutan Simpan Buntai in Sukau, *Opisthostoma mirabile* Smith, 1893 from the Gomantong Caves limestone outcrop, and *Opisthostoma lissopleuron lissopleuron* Vermeulen, 1994 from the Madai Caves limestone outcrop. The three limestone outcrops were separated by more than 20 km from one another. Our results suggest that *Opisthostoma* snails may be restricted to areas with limestone resulting in a high degree of local endemism (Schilthuizen *et al*., 2005). These results, however, do not mean that each outcrop harbours only the single *Opisthostoma* species that we found in the present surveys.

Opisthostoma usually occurs on the walls of the limestone outcrops. We often found many *Opisthostoma* on these walls.

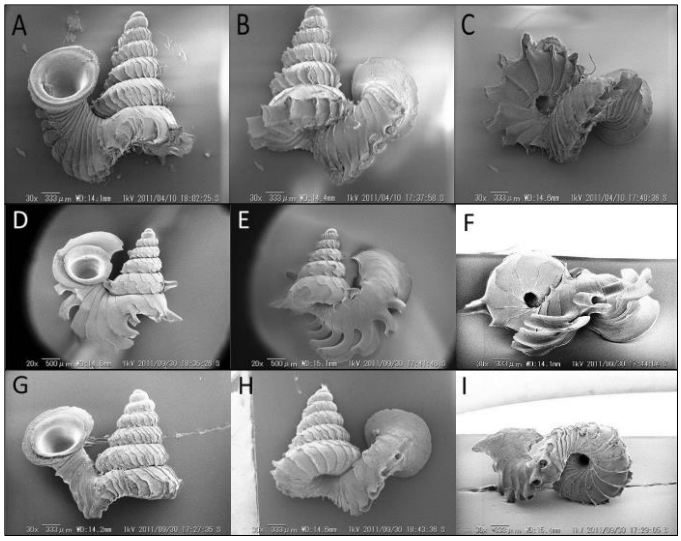

Fig. 2. Specimens of the genus *Opisthostoma* from three limestone outcrops in this study. A-C, *O. concinnum* from Hutan Simpan Buntai, Sukau (05°31'30.6"N, 118°13'17.5"); D-F, *O. mirabile* from Gomantong caves (05°31'52.1"N, 118°04'20.7"); G-I, *O. l. lissopleuron* from Madai caves (04°42'53.5"N, 118°09'20.4").

Fig. 3. *Opisthostoma* species in nature. A-B, *O. concinnum*; C, *O. mirabile*; D, *O. l. lissopleuron*.

When a snail sticks to a vertical surface, such as these walls, the weight of the shell becomes a load that has to hang from the soft body. It is possible that the strange shells of *Opisthostoma* may have evolved to reduce the burden caused by the hanging shell.

Limestone hills form malacofaunal reservoirs by supporting large populations and high levels of diversity and endemism. Limestone is a non-renewable resource but has been exploited or degraded in Sabah (Korsgaad *et al.*, 2000; Shilthuizen & Vermeulen, 2000; Shilthuizen *et al*., 2002, 2003, 2005, 2006a,b; Schilthuizen, 2006). Extinction of some site-endemic species has been recorded (e.g. Vermeulen, 1994). Limestone hills are surrounded by level ground and jungle vegetation and we found that Hutan Simpan Buntai in Sukau is threatened by

land development for oil palm plantations. Many more sites may be lost in the near future, but the snails of most of the hills are not being investigated. It is estimated that there are many land snail species going extinct as a result of the development. Further research in support of conservation of biodiversity in Sabah is urgently needed.

Korsgaard, L. & Redder, T.B. 2000. Caves of Tabin Wildlife Reserve. In: *Tabin Limestone Scientific Expedition 2000* (ed. Mohamed, M., Schilthuizen, M. & Andau, M.), p. 9-15. Universiti Malaysia, Sabah.

Schilthuizen, M. 2006. Land snails. *In*: *Inventory & Collection. Total Protocol for Understanding of Biodiversity* (ed. Hashimoto, Y., Rahman, H. & Maryati, M.), 2nd edition, p. 167-173. BBEC Program, Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, Kota Kinabalu.

Schilthuizen, M &Vermeulen, J. J. 2000. The land snails of the Tabin limestone hill. In: *Tabin Limestone Scientific Expedition 2000* (ed. Mohamed, M., Schilthuizen, M. & Andau, M.), p. 93-98. Universiti Malaysia, Sabah.

Schilthuizen, M., Teräväinen, M.I.F., Tawith, N.F.K., Ibrahim, H., Chea, S.M., Chuan, C.P., Daim, L.J., Jubaidi, A., Madjapuni, M.J., Sabeki, M. & Mokhtar, A. 2002. Microsnails at microscales in Borneo: distributions of Prosobranchia versus Pulmonata. *Journal of Molluscan Studies* 68: 255-258.

Schilthuzen, M., Chai, H.-N., Kimsin, T. E. & Vermeulen, J.J. 2003. Abundance and diversity of land-snails (Mollusca: Gastropoda) on limestone hills in Borneo. *The Raffles Bulletin of Zoology* 51: 35-42.

Schilthuizen, M., Liew, T.-S., Elahan, B.B. & Lackman-Ancrenaz, I. 2005. Effects of karst forest degradation on pulmonate and prosobranch land snail communities in Sabah, Malaysian Borneo. *Conservation Biology* 19(3): 949-954.

Schilthuizen, M., van Til, A., Salverda, M., Liew, T.-S., James, S.S., bin Elahan, B. &Vermeulen, J.J. 2006a. Microgeographic evolution of snail shell shape and predator behavior. *Evolution* 60: 1851-1858.

Schilthuizen, M., Liew, T.S. & Til, A.V. 2006b. Land snails. In: *Biodiversity and Conservation of the Meliau Range: a Rainforest in Sabah's Ultramafic Belt* (ed. Chung, A.Y.C.), p. 74-75. Natural History Publications (Borneo), Kota Kinabalu.

Uchida, R. Bakhtiar E.Y., Ahmad, A.H., Sapaat, A. & Tomiyama, K. 2013. Land snail fauna of Sabah, Borneo, Malaysia. *Venus* 71(1-2): 49-59.

Vermeulen, J. J. 1994. Notes on the non-marine molluscs of the island of Borneo 6. The genus *Opisthostoma* (Gastropoda Prosobranchia: Diplommatinidae), part 2. *Basteria* 58: 75-191.

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MONITORING FRESHWATER MUSSEL POPULATIONS IN BRASIL: A TOOL FOR CONSERVATION

By Jéssica Beck Carneiro, Igor Christo Miyahira & Sonia Barbosa dos Santos

The freshwater mussel genus *Diplodon* Spix in Wagner, 1827, as is the case for most unionoid bivalves, has a life cycle in which the larval stage, known as a glochidium, is a fish parasite until it detaches and falls to the substrate, becoming a juvenile mussel (Mansur & Silva, 1999; Pimpão *et al*., 2012) (Fig. 1A-C).

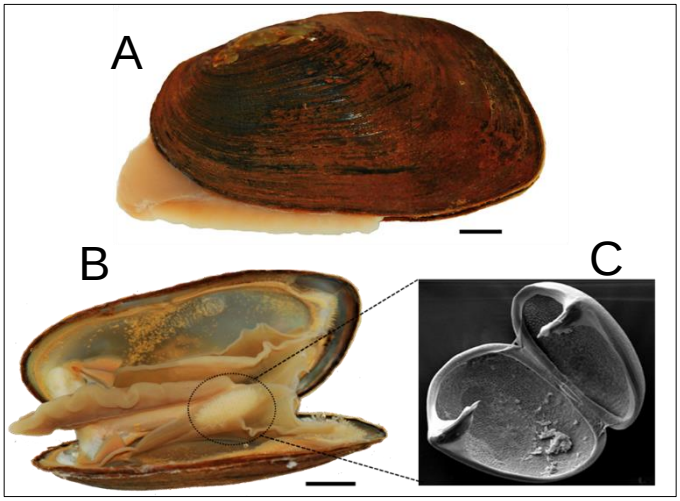

Fig. 1 *Diplodon ellipticus*. A, general view. B, *D. ellipticus* with an opened mantle cavity showing the marsupium at the internal demibranch. C, MEV photomicrograph of the glochidium. Scale bars = 1 cm. (Photos: A, B - R. Salgado; C - M. Franklin, prepared by I.C. Miyahira])

After the classic studies of, for example Spix (in Wagner, 1827), d'Orbigny (1835) and Dunker (1848), focusing on shell morphology, the Brasilian freshwater bivalve fauna was not studied again until the 1970s to 1990s, when, in addition to taxonomic studies, some aspects of the morphology of the soft parts and glochidium were investigated (Alvarenga & Ricci, 1979, 1981; Mansur & Anflor, 1981; Mansur, 1999, Mansur & Silva, 1999; Pimpão *et al*., 2012). Despite these major studies, there is still a lack of knowledge of the population dynamics and biological aspects of *Diplodon* species and their larval cycle.

Unionoid mussels are one of the most imperiled groups in the world (Ricciardi & Rasmussen, 1999). In Brasil, there are 26 freshwater mussel species, ten of them belonging to *Diplodon*, listed in the *Red Book of Brasilian Fauna Threatened with Extinction* (Machado *et al*., 2008). Several mussel populations are threatened because of the introduction of alien species such as *Corbicula fluminea* (Müller, 1774), *Corbicula largillierti* (Philippi, 1844), *Corbicula fluminalis* (Müller, 1774) and *Limnoperna fortunei* (Dunker, 1857), as well as the destruction of freshwater habitats (Amaral *et al*., 2008; Mansur *et al*., 2012; Miyahira *et al*., 2012).

Thinking about these issues, we initiated a research project in November 2012 with the objective of monitoring growth and reproduction of one population of *Diplodon ellipticus* Spix in Wagner, 1827 from Caiçaras Lake in the municipality of Piraí, Rio de Janeiro, Brasil (22°39' S, 43°50' W). The bivalves are being studied by monthly observations, with the objectives to elucidate population structure, dispersal and reproductive cycle. Lakes are perfect for this kind of work because they are essentially closed environments; moreover this lake is free of

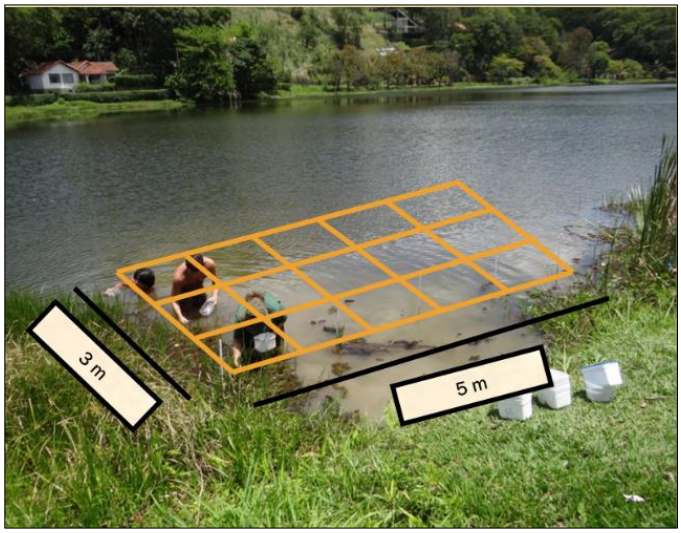

Fig. 2. Photo of a collecting locality in Caiçaras Lake, overlaid with the grid used to quantify the bivalves in each sub-area and to estimate dispersal. (Photo: L.E.M. Lacerda, edited by J.B. Carneiro).

alien mussels and supports a healthy native mussel population. Environments with these features are quite rare in Rio de Janeiro.

To achieve our objectives, we defined an area of 15 m^2, which we divided into 15 sub-areas of 1 m^2 (Fig. 2). We searched for bivalves, using bare hands and feet, for three minutes in each sub-area. All mussels collected were maintained in plastic boxes, one for each sub-area, marked with numbered tags (Fig. 3), measured and then released back to the same sub-area. For details of the technique, please see Fontoura-da-Silva *et al*. (2012).

The technique used (mark-recapture) has been successful, with 3,474 marked bivalves, and even after a year we can recapture animals marked on the first field trip. We are gathering all this information in a dataset to evaluate population dynamics of this species. Mortality rate and life expectancy are also being evaluated. The grid is used to quantify the bivalves in each sub-area and to estimate dispersal since we always re-sample at the same site and compare the position of each mussel marked with its position the previous month. Every month we collect 15 bivalves in order to study the annual reproductive cycle. In South America larval release usually occurs during the dry season when the fish hosts are concentrated in a smaller area (Callil *et al*., 2012). *Diplodon ellipticus* follows this pattern in this lake environment.

Although *D. ellipticus* is not in the Brasilian Red List (Machado *et al*., 2008), this kind of study is essential to answer many of the fundamental questions related to its population dynamics (Villella *et al*., 2004). This information is crucial when considering a threatened group of animals because it is used in the development of conservation strategies.

Preliminary results of this work will be presented at Mollusca 2014, to be held at the Universidad Nacional Autonoma de Mexico, Mexico City, 23-27 June 2014. This study is part of the Masters thesis of the first author, planned to be defended in February 2015. The study was conducted under Sisbio License 10812-1 and 23607-4 and supported by Capes and CNPq Protax (562291/2010-5).

Alvarenga, L.C.F. & Ricci, C. 1979. Variações morfológicas encontradas nas conchas de uma população de *Diplodon besckeanus* (Dunker, 1849) (Bivalvia; Unionoidea; Hyriidae). Fundação Zoobotânica do Rio Grande do Sul, *Anais do V Encontro Brasileiro de Malacologia*, p. 41-53.

Alvarenga, L.C.F. & Ricci, C. 1981. Morfologia das partes moles de *Diplodon* (*D.*) *besckeanus* (Dunker, 1849) (Bivalvia, Unionoidea, Hyriidae). *Boletim do Museu Nacional, Zoologia* 298: 1-8.

Amaral, A.C.Z., Ribeiro, C.V., Mansur, M.C.D., Santos, S.B., Avelar, W.E.P., Matthews-Cascon, H., Leite, F.P.P., Melo, G.A.S., Coelho, P.A., Buckup, G.B., Buckup, L., Ventura, C.R.R. & Tiago, C.G. 2008. A situação de ameaça dos invertebrados aquáticos no Brasil. In: *Livro vermelho da fauna Brasileira ameaçada de extinção* (ed. Machado, A.B.M., Drummond, G.M. & Paglia, A.P.), p. 156-301. Ministério do Meio Ambiente e Fundação Biodiversitas, Brasília.

Callil, C.T., Krinski, D. & Silva, F.A. 2012. Variations on the larval incubation of *Anodontites trapesialis* (Unionoida, Mycetopodidae): Synergetic effect of the environmental factors and host availability. *Brazilian Journal of Biology* 72(3): 545-552.

d'Orbigny, A. 1835. Synopsis terrestrium et fluviatilium molluscorum, in suo per Americam Meridionalem itinere. *Magasin de Zoologie* 5: 1-44.

Dunker, W. 1848. Diagnoses molluscorum novorum. *Zeitschrift für Malakozoologie* 5(12): 177-186.

Fontoura-da-Silva, V., Carneiro, J.B., Miyahira, I.C., Santos, S.B. & Caetano, C.H.S. 2012. Mark-recapture methodology: a simple and inexpensive technique for the study of bivalves and gastropods in Brasil. *Tentacle* 21: 13-16.

Machado, A.B.M., Drummond, G.M. & Paglia, A.P. (ed.) 2008. *Livro Vermelho da Fauna Brasileira Ameaçada de Extinção.* Volume 1. Ministério do Meio Ambiente e Fundação Biodiversitas, Brasília. 512 p.

Mansur, M.C.D. 1999. Gloquídio de *Diplodon martensi* (Ihering) (Mollusca, Bivalvia, Hyriidae) e seu ciclo parasitário. *Revista Brasileira de Zoologia* 16 (Supl.2): 185-194.

Fig. 3. Mussels of one of the sub-areas, stored in a plastic box before being measured, all marked with a numbered tag. (Photo: L.E.M. Lacerda)

Mansur, M.C.D. & Anflor, L.M. 1981. Diferenças morfológicas entre *Diplodon charruanus* Orbigny, 1835 e *Diplodon pilsbryi* Marshall, 1928 (Bivalvia, Hyriidae). *Iheringia Série Zoologia* 60: 101-116.

Mansur, M.C.D. & da Silva, M.G.O. 1999. Description of glochidia of five species of freshwater mussels (Hyriidae: Unionoidea) from South America. *Malacologia* 41(2): 475-483.

Mansur, M.C.D., Pimpão, D.M., Bergonci, P.E.A., dos Santos, C.P. & de Figueiredo, G.C.S. 2012. Morfologia e ciclo larval comparados de bivalves límnicos invasores e nativos. In: *Moluscos Límnicos invasores no Brasil - Biologia, prevenção, controle* (ed. Mansur, M.C.D., Santos, C.P., Pereira, D., Paz, I.C.P., Zurita, M.L.L., Rodriguez, M.T.R.,Nehrke, M.V. & Bergonci, P.E.A.), p. 95-110. Redes Editora, Porto Alegre.

Miyahira, I.C., dos Santos, S.B., Mansur, M.C.D. & Carneiro, J.B. 2012. Freshwater mussels in Brazil: past, present and future, at least, we hope they have one. *American Conchologist* 40(3): 16-18.

Pimpão, D.M., Mansur, M.C.D., Bergonci, P.E.A. & Beasley, C.R. 2012. Comparative morphometry and morphology of glochidial shells of Amazonian Hyriidae (Mollusca: Bivalvia: Unionida). *American Malacological Bulletin* 30(1): 73-84.

Ricciardi, A. & Rasmussen, J.B. 1999. Extinction rates of North American freshwater fauna. *Conservation Biology* 13(5): 1220-1222.

Villella, R.F., Smith, D.R. & Lemarié, D.P. 2004. Estimating survival and recruitment in a freshwater mussel population using mark-recapture techniques. *The American Midland Naturalist* 151(1): 114-133.

Wagner, J.A. 1827. *Testacea fluviatilia quae in itinere per Brasiliam annis MDCCCXVII-MDCCCXX jussu et auspiciis Maximiliani Josephi I. Bavariae regis augustissimi suscepto collegit et pingenda curavit Dr. J. B. de Spix*. Wolf, Munich. iv + [ii] + 36 p., 29 pls.

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THE AMERICAN MALACOLOGICAL SOCIETY CONSERVATION COMMITTEE'S U.S. IMPERILED SPECIES LEGISLATIVE AND REGULATORY NEWS

By Jay Cordeiro

As we are all aware, despite their distinction as possibly the second most diverse group of organisms on Earth in terms of described species, molluscs face a degree of imperilment and associated decline found in few, if any, other groups of organisms. Ongoing threats due to inherent factors such as small geographic range (restricted distribution, disjunct populations), poor range expansion potential (island species, local river endemics, isolated spring species, cave obligates), and limited habitat tolerance (small extent of occurrence coupled with area of occupancy), K-selection (extreme longevity, slow growth, low fecundity), coupled with human-induced imperilment factors (over-exploitation, habitat loss and modification, agriculture, pollution, fire, human encroachment, overharvest/fishing), invasive species and climate change, have contributed to this decline. Knowledge of issues related to these groups of imperiled animals falls largely outside of public awareness.

The American Malacological Society (AMS) is an organization that promotes the science of malacology. According to its Conservation Policy, AMS supports measures to: 1) protect natural biodiversity in general, proactively; 2) protect threatened and endangered species; 3) protect natural ecosystems of sufficient size and configuration to be self-sustaining; 4) manage adequately natural reserves established for the conservation of biodiversity; 5) prevent invasion of natural ecosystems by non-indigenous organisms; 6) prevent human-produced pollution from degrading ecosystems and threatening their natural biota. Since 2010, I have served as the AMS Conservation Committee chair. At a joint annual meeting with the Conchologists of America (COA) in Philadelphia in 2012, I put forth the idea of keeping AMS members up to date on current and proposed U.S. Federal legislation and regulations regarding molluscs. The purpose of this proposal was to allow fellow AMS members to play an active role in molluscan conservation. Since that time, I have posted five reports (including two annual reports) to all active members of AMS. Each installment lists current petitioned, proposed, candidate, listed and delisted mollusc species added or modified within the time frame delineated. Comment periods, including submission deadlines, are also included to inform the reader better as to the progress of each proposal and to provide adequate time for public comment. I have also posted these reports on the listserv Conch-l, sponsored by the Conchologists of America (COA) and most recently to other listservs relevant to conservation of aquatic organisms. These include UNIO (focus on freshwater mussels), MOLLUSCA (general molluscan focus), BENTHOS-L (focus on benthic science), and pnwmussel (focus on freshwater mussels of the Pacific Northwest of the USA). Prior and future postings can be downloaded as pdf files from the AMS Conservation web page.

A brief outline of U.S. regulations regarding listing of any species or population as Endangered or Threatened, as defined by the U.S. Endangered Species Act (ESA), is provided here. This quick overview provides a basic understanding of the listing process and how interested parties might contribute their own knowledge or insight. Many of us with interest in mollusc conservation are unaware that anyone can actively contribute to the ESA listing process. Comments on any proposed U.S. legislation are encouraged and welcomed without restriction. Because the listing process is not self-evident, reading through reports is tedious, and government documentation can be overwhelming (try reading a U.S. Federal Register document for fun on the train on the way to work), many of us are disconnected with which and how species are added or removed. We consign ourselves to deal principally in what occurs leading up to listing (i.e. determining distribution, viability, threats) and what occurs

after listing (i.e. management and preservation). We opt to leave the process itself to the 'experts', when in fact, we, as malacologists, are the experts.

The two major federal institutions that share responsibility for formally administrating molluscan conservation in the United States are the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) through the U.S. Endangered Species Act (ESA) of 1973. Both institutions accomplish their goals by conducting assessments to identify species most in need of protection and working through partnerships to conserve these species by improving habitat and removing threats. The ESA requires both institutions to designate Critical Habitat and develop and implement Recovery Plans for threatened and endangered species.

Amendments to the Act include the Critical Habitat Amendment (1978) which required designation of Critical Habitat as mandatory for listed species and a 1982 amendment which added the word 'solely' to prevent any consideration other than the biological status of a species. Critical Habitat is an extremely important component and is defined as a specific geographic area of habitat essential to the conservation of the species. Ideally, a Critical Habitat designation protects areas necessary for conservation beyond that given by the ESA to species as a whole (a noble and practical idea). Although issued with good intentions, the 1978 amendment linked the listing procedure with Critical Habitat designation and economic considerations, something very difficult to establish for species with limited available information (e.g. molluscs). Subsequent regulations in 1986 severely limited the protective status of Critical Habitat which almost completely halted new listings, with almost 2,000 proposed species being withdrawn from consideration (a dark time for mollusc conservation!). A Congressional moratorium on new species listings lasted until 1996 resulting in almost no action on a long list of species that needed proposal as Threatened or Endangered. Since then, the USFWS and NMFS have assigned a lower priority to meeting the demands of Critical Habitat so more species in need of protection can be protected (breathe a sigh of relief; grant funding returns!). Although designation of Critical Habitat is still required, it is often not completed until sometime after the species is listed (a maximum one year deadline from the time of issue is required).

Formal notices are published by the USFWS and NMFS in what is called the Federal Register Endangered Species Program. Rules are enacted only for taxa and populations specifically named in a Federal Register Notice of Review, Proposed Rule or Final Rule section (Code of Federal Regulations C.F.R. 50 Part 17). Federal Register Notices are issued *daily*. Also included are notices of scheduled hearings, proposed rulings, formal rules and regulations, and in extreme circumstances, presidential orders and proclamations. Public comments are solicited on proposed rules but *must be submitted within a given time period*. I try, in these listserv postings, to summarize each relevant Federal Register document in as concise a manner as possible (yes, I really do read these). For those who want to see the details, all Federal Register documents related to the ESA are available online immediately upon release. Although plenty of informative material is contained in these documents, reading them can be dull and even mind-numbing! Information on select species and habitats, however, can be indispensable for many aspects of conservation, management and research. Ideally, a short summary of everything known about distribution, population dynamics, viability, occupied habitat, threats, and trends of a species or population should be included within each proposal. The idea is that assembling as much information as possible will allow for the best evaluation of proposed candidacy under the ESA.

It is at this stage that we can impart our own positive influence on imperiled species conservation. Information for Candidate Species is gathered from a variety of sources: state and federal agency staff, faculty and instructors at colleges, universities, and secondary schools, non-governmental agency staff and volunteers, non-profit organizations, and the general public. A major source is the U.S. Natural Heritage Programs and Canadian Conservation Data Centers. Each state and U.S. possession is required to produce a Wildlife Action Plan outlining the steps necessary to conserve wildlife and habitat in each state or territory. The completion of these plans is *absolutely necessary* in order for individual states to receive federal funding from the United States State Wildlife Grants (SWG) program and Wildlife Conservation and Restoration program. Species not listed on state plans are *not eligible* for federal funds allocated for conservation and management. If you are not familiar with the SWG plan or the Natural Heritage Program or Conservation Data Center in your state or province, *get to know them today*! You can be actively involved in species and ecosystem conservation simply by allying yourselves with these program staff to exchange information and assist with imperiled species evaluation. Become an advocate for mollusc conservation.

Currently, there are 134 U.S. Federally Endangered or Threatened mollusc taxa (88 freshwater bivalves, 44 terrestrial and freshwater and 2 marine gastropods) listed under the ESA. In addition, there are 14 Candidate Species (5 freshwater mussels, 3 freshwater snails, 6 tree snails).

Before reading any AMS Conservation Committee posts, you would find it useful to familiarize yourselves with the basic criteria used for listing of species as Endangered or Threatened. A species is first assessed by the USFWS to determine if a proposed listing is appropriate based on the best available data for listing consideration (ESA, Section IV). Under the Act, a species may be listed as Endangered or Threatened based on any of five factors: 1) the present destruction, modification or curtailment of its habitat or range; 2) overutilization for commercial, recreational, scientific or educational purposes; 3) disease or predation; 4) inadequacy of existing regulatory mechanisms; or 5) other natural or man-made factors affecting its existence. Species previously identified as candidates can also be re-assessed based on updated information. A Species Assessment Document is prepared by candidate conservation staff (including non-governmental agency staff with intimate knowledge of any aspect of the natural history of a species). This document is then presented to the USFWS Director (currently Daniel M. Ashe) to determine if a species' status as a candidate should be

changed (a bit arbitrary, I know). Assessments are updated annually through a Candidate Notice of Review (CNOR). Update summaries for all species can be found at: http://www.fws.gov/policy/frsystem/default.cfm.

To make personal direct contributions to the listing process, submit your own knowledge when comment periods are opened via one of the following methods:

- Electronically. Go to the Federal eRulemaking Portal. In the Search field, enter Docket No. FWS–R5–ES– 2012–0054, which is the docket number for this action. Then click on the Search button. You may submit a comment by clicking on ‘‘Comment Now!’’
- By hard copy. Submit by U.S. mail or hand-delivery to: Public Comments Processing, Attn: FWS–R5–ES–2012–0054; Division of Policy and Directives Management; U.S. Fish and Wildlife Service; 4401 N. Fairfax Drive, MS 2042–PDM; Arlington, VA 22203.

Once again, look for postings on the Conch-l, UNIO, MOLLUSCA, and BENTHOS-L listservs and on the American Malacological Society Conservation web page to stay up-to-date on the latest legislative action. The latest endangered species news stories can be viewed on-line. Rest assured that these should hold your attention at least a little bit longer than the Federal Register documents will!

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PACIFIC ISLAND LAND SNAILS

Partulid conservation in the western Pacific islands of Belau (Republic of Palau, Oceania)

By Rebecca J. Rundell & Jesse E. Czekanski-Moir

Partulids are charismatic Pacific-endemic tree snails that rank among the most endangered animals on Earth. There are about 120 species known, half of which are now extinct (Clarke *et al.*, 1984; Cowie, 1992). Some partulid species are extant only through captive breeding programs at European and American zoos, and still others are barely hanging on in the wild (e.g. Marianas partulids: Eldredge, 1988; Hopper & Smith, 1992). Western Pacific partulids have been in particular danger for some time, having been all but extirpated from many islands, including those of the Federated States of Micronesia.

Conservation of partulids in the western Pacific is urgently needed. One of the new focal areas for this work is Belau (Fig. 1), where the land snail biota is extraordinarily diverse (Rundell, 2010) and can be claimed as part of the Republic of Palau's vast national biodiversity treasure (Anonymous, 2013). (For explanation of the name of the country see the footnote). Among Belau's endemic species are three partulids (*Partula calypso*, *P. leucothoe* and *P. thetis*), at least two of which (*P. calypso* and *P. thetis*; Fig. 2) are still extant. *Partula calypso* and *P. leucothoe* were listed as Critically Endangered B2ab(iii), and *P. thetis* is listed as Endangered B1ab(iii)+2ab(iii) (Ó Foighil & Rundell, 2012a,b,c) as part of a recent effort to assess the conservation status of species under the purview of IUCN Oceania (Sauturaga & Pippard, 2013). Belau's partulids are all arboreal (e.g. on *Pandanus* spp.) and their geographic distributions now include only a very few limestone Rock Islands in Koror State and the Oikull-area limestone karst outcrops of southeastern Babeldaob (Airai State).

Extensive land snail surveys conducted in Belau by the authors and colleagues between 2003 and 2013 have uncovered previously unpublished localities for partulid tree snails. However, at all sites partulids are not common, and shells with clear evidence of non-native rodent predation have been collected. Furthermore, the geographic distribution of each species is now highly restricted (Ó Foighil & Rundell, 2012a,b,c) and evidence from past (Y. Kondo, unpublished data, 1964) and recent surveys suggests that geographic ranges were once more extensive, even on the largely volcanic island of Babeldaob (Rundell, unpublished data, 2013). There is hope that *P. leucothoe* may yet be discovered alive, but to date this evidence is in the form of a single rat-eaten shell found in 2007 (Rundell & Czekanski-Moir, unpublished data). This was the first documented collection of this species since 1936 (Kondo, unpublished data; Ó Foighil & Rundell, 2012b).

The relatively recent completion of the Compact Road around Babeldaob, the demand for new roads and paving materials (Fig. 3), increased pressure for building new land-based tourism experiences, and increased settlement in and around the main population centers of Koror and Airai States, indicate that the Republic of Palau is in a critical phase of its development. There are many interests to balance. And although land snails may not initially rank among these interests, preliminary evidence suggests that some partulid sites are also indigenous plant and bird hotspots (e.g. Oikull: Rundell, A. Kitalong & H. Ketebengang, unpublished data, 2013) or land tourism focal points (e.g. on Ulong: Fig. 4).

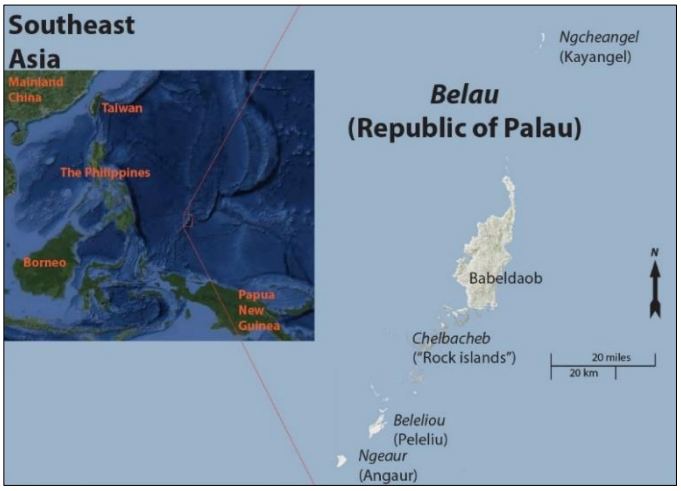

Fig. 1. Map of *Belau* (Republic of Palau). Not shown: Fanna, Sonsorol, Pulo Anna, Merir, Hatohobei (Tobi), Hotsarihie (Helen Reef Island), which are collectively known as the Southwest Islands.

Fig. 2. The Belau endemic tree snail *Partula thetis*.

Both of these factors underscore the possibility that Belau's unique partulids (and other endemic land snails) could be celebrated and protected as an important part of the indigenous lowland rainforest on which Belauans (and tourists alike) depend for water, enjoyment and traditional resources (e.g. medicine, *olik* Palau fruit bat, *bekai* Palau megapode and *belochel* Micronesian imperial pigeon).

There are many causes for optimism with respect to conservation in Belau. A large percentage of Belau's original lowland rainforest remains, both on and off the charismatic karst Rock Islands (reviewed by Rundell, 2010). And, our acknowledgements section is testament to the number of governmental and non-governmental organizations in Belau that are sympathetic, if not expressly dedicated, to the conservation of terrestrial biodiversity. However, the construction of a large resort by foreign investors, intensified interest by the U.S. military, or the economic ambitions of a future political regime could quickly and substantially alter the Belauan landscape to the detriment of its spectacular biota. As scientists, we have a duty to continue to work with organizations in Belau to educate people about the intrinsic value and fascinating biology of their endemic partulids.

Fig. 3. A new limestone quarry to supply local road construction materials, Oikull, Airai State, Republic of Palau.

Fig. 4. Ulong, a popular area for both Belauan and tourist use, and a new potential focal point for land-based tourism in Koror State.

Ultimately, it is our hope that further research and outreach could lead to a Belauan 'snail ethic', by which the intrinsic value of these rare organisms might serve to dissuade developers in the most pristine habitats in this dazzling archipelago. Ongoing work with the Palau Conservation Society, local communities, state governments, and other stakeholders aims to provide data and expertise to help inform critical decisions confronting the Republic of Palau in the coming decade.

We thank the following individuals and organizations for their important contributions to conservation dialogue and/or for their interest in this work: Palau Conservation Society, the Community Leaders of Oikull, Association of Palau Conservation Officers, Koror State Government, Koror State Rangers and Princess Blailes, Airai State Government, Ann Kitalong, Joel Miles and the Palau Bureau of Agriculture, the Coral Reef Research Foundation, Belau National Museum, Belau Cares, Inc., Diarmaid Ó Foighil, the Bishop Museum Malacology Collections and the Field Museum of Natural History Invertebrates Division.

Footnote: Palau is the English word for Belau. In general, when writing in English, people from Palau use the English spelling: the United Nations, and many world atlases refer to the sovereign nation as the 'Republic of Palau'. Many organizations within Palau use this spelling to refer to themselves when important parts of their names are in English: e.g., Palau Community College, Palau National Communications Corporation, etc. However, some organizations opt to emphasize their cultural heritage, and use 'Belau' along with English words, as in the 'Belau National Museum,' or 'Belau Cares.' We adopt this usage here, along with the vernacularly common Palauan-English hybrid adjective 'Belauan' in hopes of promoting the unique culture of Belau and emphasizing the sovereignty of its people.

Anonymous 2013 Spectacular diversity discovered in Palau's unique land snail biota. *Tia Belau* 22 [October 28]: 2, 11.

Clarke, B., Murray, J. & Johnson, M.S. 1984. The extinction of endemic species by a program of biological control. *Pacific Science* 38: 97-104.

Cowie, R.H. 1992. Evolution and extinction of Partulidae, endemic Pacific island land snails. *Philosophical Transactions of the Royal Society of London Series B Biological Sciences* 335: 167-191.

Eldredge, L.G. 1988. Case studies of the impacts of introduced animal species on renewable resources in the U.S.-affiliated Pacific islands. In: *Topics reviews in insular resource development and management in the Pacific U.S.-affiliated islands* (ed. Smith, B.D.), p. 118-146. Technical Report No. 88. University of Guam Marine Laboratory, Mangilao.

Hopper, D.R. & Smith, B.D. 1992. The status of tree snails (Gastropoda: Partulidae) on Guam, with a resurvey of sites studied by H.E. Crampton in 1920. *Pacific Science* 46: 77-85.

Ó Foighil, D. & Rundell, R.J. 2012a. *Partula calypso.* In: *IUCN Red List of Threatened Species* (IUCN 2012). Version 2012.2. www.iucnredlist.org. Accessed 31 December 2012.

Ó Foighil, D. & Rundell, R.J. 2012b. *Partula leucothoe.* In: *IUCN Red List of Threatened Species* (IUCN 2012). Version 2012.2. www.iucnredlist.org. Accessed 31 December 2012.

Ó Foighil, D. & Rundell, R.J. 2012c. *Partula thetis.* In: *IUCN Red List of Threatened Species* (IUCN 2012). Version 2012.2. www.iucnredlist.org. Accessed 31 December 2012.

Rundell, R.J. 2010. Diversity and conservation of the land snail fauna of the western Pacific islands of Belau (Republic of Palau, Oceania). *American Malacological Bulletin* 28: 81-90.

Sauturaga, S. & Pippard, H. 2013. New species from the Pacific added to IUCN Red List. *Tentacle* 21: 3.

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Update on the Northern Mariana Islands

By Michael G. Hadfield

The last year has seen a surge of resistance to military plans for the takeover of large areas on Tinian Island and all of Pagan Island (Fig. 1) for live-fire training. Awareness of the U.S. Marines' plans for the islands has led to vigorous resistance among the residents and elected officials in Saipan, including renewed efforts to re-open Pagan Island for 'homesteading' by the many families that consider it 'home'. The Commonwealth of the Northern Marianas Islands (CNMI) legislature has issued statements of open opposition to the military plans to turn Pagan Island into yet another bomb target, which will surely destroy it forever, as the U.S. military has done with many other islands.

In addition to growing local resistance to the destructive plans of the military, our on-going studies of population genetics and surveys by others have revealed that populations of *Partula gibba* (Fig. 2) on each island are unique. New populations of the snail have been found on Guam and Tinian. The rapid decline of all of the tree snails on Guam has been documented, and is largely attributed to the many introduced snail predators on the island (rats, *Euglandina rosea*, and the New Guinea flatworm *Platydemus manokwari*). Military practices on much of the island have also led to degradation of the native forest on which the snails depend. This is fascinating radiation of tree snails from old volcanic and coral-formed islands in the south, to active volcanoes in the north. The very low rate of gene flow among the islands has led to

Fig. 1. Pagan Island. (Photo: D. Sischo)

genetic differentiation that could rank almost every island population of *P. gibba* as a subspecies. They deserve conservation.

The website savepaganisland.org/ continues to serve as a valuable resource for recent information and news about activities in the CNMI, as well as a petition site.

We have now combined three separate petitions for which we had permission: savepaganisland.org, Sierra Club and RootsAction. The total is more than 20,000 signatures to petitions resisting military takeover of Pagan Island. In addition, more than 20,000 people signed the RootsAction 'action', meaning they addressed letters to U.S. Congress people demanding that Congress move to block the military action in the Northern Marianas.

A fourth online petition, Care2, which is still open, has posted the largest number of signers for a petition to save Pagan Island, but with a different wording from those on savepaganisland.or and the Sierra Club. The Care2 petition currently lists 72,972 signatures on this statement:

> *The United States Military is planning to occupy all of Pagan Island for military training and live-fire exercises, including bombing. These exercises are sure to devastate the island and its indigenous inhabitants.*
>
> *Pagan Island is one of the most biologically and ecologically diverse locations in the Marianas. It is home to many threatened and endangered species, and has*

Fig. 2. *Partula gibba* on Pagan. (Photo: D. Sischo)

supported ancestors of Pagan Islanders for over 3,000 years.

Military training is sure to compromise the health of Islanders and devastate the island's resources. Ballistic disturbances will erode the coast and damage Pagan's coral reefs, and toxins left behind will pollute the island for centuries. Please sign the petition to convince the U.S. Military to spare Pagan Island!

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MARINE MATTERS

Volcanic CO_2 vents reveal effects of ocean acidification on molluscs

By Jason M. Hall-Spencer

Average global surface ocean pH has already fallen from a pre-industrial value of 8.2 to 8.1, corresponding to an increase in acidity of about 30 %. Values of 7.8-7.9 are expected by 2100, representing a doubling of acidity. The damaging impacts of ocean acidification at present seem localised (e.g. to the oyster farming industry of the United States Pacific Northwest) or remote (e.g. to Southern Ocean pteropods) but in fact all around the world vast areas of the seabed are becoming exposed to waters that are corrosive to calcium carbonate (IGBP, IOC, SCOR, 2013). What might happen in coastal waters globally is demonstrated at naturally occurring seeps of carbon dioxide. Here experimental studies show that a few types of organisms benefit from the levels of acidification predicted this century, with a proliferation of algae, seagrasses and soft-bodied organisms like anemones and jellyfish (Hall-Spencer *et al*., 2008). However, there is a consistent pattern of biodiversity loss as CO_2 levels rise, many mollscs are unable to recruit from the plankton and there are radical changes in the ecology of these systems at around pH 7.8 (Cigliano *et al*., 2010). The following examples are predicted effects of ocean acidification:

- Seagrasses are expected to thrive since they grow very well at natural carbon dioxide seeps in the Mediterranean and around Papua New Guinea, although the biodiversity of these habitats falls as calcified algae and organisms such as gastropods (e.g. Fig. 1) and bivalves are lost.
- Temperate rocky reefs exhibit a dramatic loss of coralline algae and sea urchins, yet diatoms and brown algae appear to benefit from the increase in dissolved inorganic carbon, which they use for photosynthesis. This is a concern since coralline algae provide settlement cues for molluscs and can provide brood stock areas for bivalves.

Fig. 1. Top left: *Osilinus turbinata* snail grazing on low intertidal bedrock encrusted with coralline algae, *Chthamalus stellata* barnacles and tube-dwelling *Vermetus triqueter* molluscs in normal pH waters. Top right and bottom, respectively: *O. turbinata* and *Patella caerulea* with severe shell dissolution grazing diatom dominated biofilm on otherwise bare low intertidal bedrock near carbon dioxide seeps off Castello Aragonese, Ischia, Italy.

- Mollusc species with an outer layer of protective tissue are more able to withstand acidified seawater than some other species. However, higher temperatures projected under climate change are likely to worsen the impact of ocean acidification, even affecting those that are otherwise resistant to higher levels of CO_2 (Rodolfo-Metalpa *et al*., 2011).
- Tropical coral reefs dissolve and very few corals survive as CO_2 levels rise, leading to reduced habitat complexity, which further reduces reef biodiversity (Fabricius *et al*., 2014).

Long-term ocean acidification could exceed the tolerance limits of molluscs that live in coastal waters, even though they may have evolved strategies to deal with fluctuating pH on short timescales where the daily and seasonal changes in seawater pH are much greater than in the open ocean. Evolutionary adaptation to reduced pH can occur quickly when populations are large and robust. Populations of molluscs reduced by other coastal ocean problems may have more limited ability to adapt to acidification, hence the need to act locally by reducing pressures on coastal ecosystems.

I have been working in this field for eight years now and am deeply concerned by what some of the research is showing – we now know that warming, another CO_2 related problem, makes the effects of ocean acidification much worse and this double impact of warming and acidification is happening rapidly. The scientific evidence strongly suggests that if the world's governments fail to make the commitments we need on oceans then we will be facing a crisis threatening food security.

Cigliano, M., Gambi, M.C., Rodolfo-Metalpa, R., Patti, F.P. & Hall-Spencer, J.M. 2010. Effects of ocean acidification on invertebrate settlement. *Marine Biology* 157: 2489-2502.

Fabricius, K.E., De'ath, G., Noonan, S. & Uthicke, S. 2014. Ecological effects of ocean acidification and habitat complexity on reef-associated macroinvertebrate communities. *Proceedings of the Royal Society B Biological Sciences* 281: 20132479.

Hall-Spencer, J.M., Rodolfo-Metalpa, R., Martin, S., Ransome, E., Fine, M., Turner, S.M., Rowley, S.J., Tedesco, D. & Buia, M.-C. 2008. Volcanic carbon dioxide vents reveal ecosystem effects of ocean acidification. *Nature* 454: 96-99.

IGBP, IOC, SCOR (2013). *Ocean Acidification Summary for Policymakers – Third Symposium on the Ocean in a High-CO_2 World*. International Geosphere-Biosphere Programme, Stockholm, Sweden.

Rodolfo-Metalpa, R., Houlbrèque, F., Tambutté, E., Boisson, F., Baggini, C., Patti, F.P., Jeffree, R., Fine, M., Foggo, A., Gattuso, J.-P. & Hall-Spencer, J.M. 2011. Coral and mollusc resistance to ocean acidification adversely affected by warming. *Nature Climate Change* 1: 308-312.

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Coral reef scientists' perceptions of giant clam conservation and ecology

By Mei Lin Neo & Peter A. Todd

In the late 1960s to early 1990s, giant clams (Bivalvia: Cardiidae: Tridacninae) garnered considerable attention within the coral reef science community as intensive exploitation had depressed wild clam stocks to a point of non-sustainability (e.g. Bryan & McConnell, 1976; Pearson, 1977). Since then, giant clam researchers have enthusiastically developed mariculture of giant clams to aid the restoration of depleted populations (Mingoa-Licuanan & Gomez, 2002; Teitelbaum & Friedman, 2008). Many of these mariculture efforts had great success in producing young clams, which were later restocked to areas where species had been extirpated or were only present in extremely low densities (Gomez & Mingoa-Licuanan, 2006; Guest *et al.*, 2008; Heslinga, 2013). However, the plight of giant clams seems to be less prominent than it was a few decades ago. During discussions, senior reef scientists would comment on how these iconic invertebrates used to receive substantial attention at coral reef workshops and conferences. This spurred us to assess current perceptions of giant clams among coral reef experts. Therefore in 2012 we surveyed delegates at the 12th International Coral Reef Symposium in Cairns, Queensland, Australia. Symposium participants were also asked for their opinions on the ecological significance of giant clams on coral reefs. To our knowledge, this survey is the first of its kind.

In total, we obtained 130 responses, of which 125 were usable for analysis. The majority of the respondents (85.6 %) indicated that they had worked or are working within the geographic range of giant clams (i.e. from southern Africa to the Red Sea, Japan, Polynesia and Australia; bin Othman *et al.*, 2010). The survey consisted of questions covering three areas: 1) general knowledge, 2) threats, and 3) ecological importance. We first tested the participants' general knowledge of giant clams with six questions relating to the number of extant giant clams species, their CITES-protection status, general biology and ecology, and human uses. Only

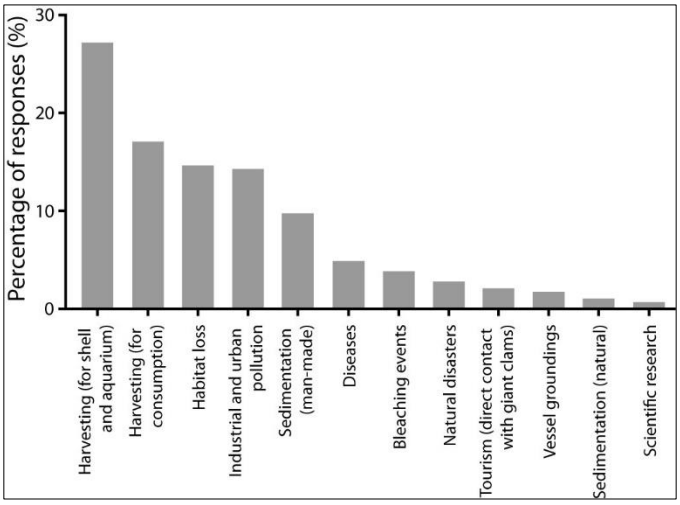

Fig. 1. Responses of scientists (n=96) regarding the major threats to giant clams.

48 % correctly answered at least three questions, and none correctly answered all the questions posed.

We then asked the respondents whether they thought giant clam populations are threatened. If their response was 'yes', they were asked to indicate their top three threats (in no ranking order) based on a list of 12 provided (see Fig. 1). Among the respondents, 23.2 % replied that giant clams are not threatened or they were uncertain of their status, while 76.8 % replied that giant clams are threatened. 'Harvesting (for shell and aquarium)' was the most chosen threat, followed by 'harvesting (for consumption)' and 'habitat loss' (Fig. 1). These, in fact, reflect very well what are generally considered the main threats to giant clams. Their meat, adductor muscles, and shells have been, and still are, significant resources, particularly for islanders (Kinch & Teitelbaum, 2010), while the increasing loss of habitat due to coastal development and reef degradation concomitantly leads to the loss of reef fauna, including giant clams (Neo & Todd, 2012).

Finally, we asked the respondents for their level of agreement with the statement: 'Giant clams are an ecologically important component of coral reefs.' Over 78 % of the scientists agreed that giant clams are important, while 15 % were neutral and 7 % disagreed. We also asked what the ecological roles that giant clams fulfilled might be and collated these into eight categories (Fig. 2). Filtering water, providing habitats and substrate for organisms, being a food source (prey), and contributing towards reef building, accounted for over three quarters of the responses. Again, these align well with the various ecological functions that giant clams are thought to have on coral reefs (although these roles have yet to be quantified) (Hutchings, 1986; Mercier & Hamel, 1996; Mingoa-Licuanan & Gomez, 2002).

Our survey has captured a snapshot of contemporary coral reef scientists' perceptions of the status, threats, conservation and ecology of giant clams. The results provide some insight into present levels of understanding and awareness among respondents who may be expected to have more knowledge than the general public. Their identification of the threats to giant clams, plus their opinions on the ecological roles of giant

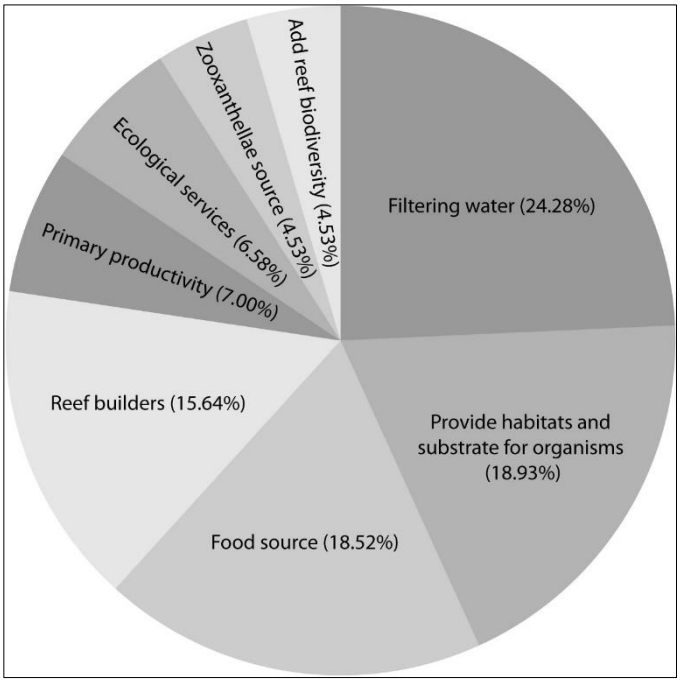

Fig. 2. Scientists' (n=102) perceptions on the ecological roles fulfilled by giant clams.

clams on coral reefs, suggest that coral reef scientists still have a strong appreciation and substantial knowledge of giant clam issues and importance. We find this encouraging, and slightly surprising, considering that relatively few researchers are currently actively studying these charismatic organisms.

bin Othman, A.S., Goh, G.H.S. & Todd, P.A. 2010. The distribution and status of giant clams (family Tridacnidae) – a short review. *The Raffles Bulletin of Zoology* 58: 103-111.

Bryan, P.G. & McConnell, D.B. 1976. Status of giant clams stocks (Tridacnidae) on Helen Reef, Palau, Western Caroline Islands, April 1975. *Marine Fisheries Review* 38(4): 15-18.

Gomez, E.D. & Mingoa-Licuanan, S.S. 2006. Achievements and lessons learned in restocking giant clams in the Philippines. *Fisheries Research* 80: 46-52.

Guest, J.R., Todd, P.A., Goh, E., Sivalonganathan, B.S. & Reddy, K.P. 2008. Can giant clams (*Tridacna squamosa*) populations be restored in Singapore's heavily impacted coral reefs? *Aquatic Conservation: Marine and Freshwater Ecosystems* 18: 570-579.

Heslinga, G.A. 2013. *Saving giants. Cultivation and conservation of Tridacnid clams.* e-book, 222 p.

Hutchings, P.A. 1986. Biological destruction of coral reefs. *Coral Reefs* 4: 239-252.

Kinch, J. & Teitelbaum, A. 2010. *Proceedings of the regional workshop on the management of sustainable fisheries for giant clams (Tridacnidae) and CITES capacity building. 4-7 August 2009, Nadi, Fiji.* Secretariat of the Pacific Community, Noumea, New Caledonia. 52 p.

Mercier, A. & Hamel, J.-F. 1996. The secret of giant clam. *Freshwater and Marine Aquarium* 19: 112-113.

Mingoa-Licuanan, S.S. & Gomez, E.D. 2002. Giant clam conservation in Southeast Asia. *Tropical Coasts* 3: 24-31, 56.

Neo, M.L. & Todd, P.A. 2012. Population density and genetic structure of the giant clams *Tridacna crocea* and *T. squamosa* on Singapore's reefs. *Aquatic Biology* 14(3): 265-275.

Pearson, R.G. 1977. Impact of foreign vessels poaching giant clams. *Australian Fisheries* 8-11, 23.

Teitelbaum, A. & Friedman, K. 2008. Successes and failures in reintroducing giant clams in the Indo-Pacific region. *SPC Trochus Information Bulletin* 14: 19-26.

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Impacts of concrete jetties on the composition of shore molluscan assemblages

By Leanne Bonnici, Joseph A. Borg, Julian Evans & Patrick J. Schembri

Rocky shores have undergone considerable modification worldwide through resource harvesting, disturbance and the introduction of artificial structures, among other impacts. Construction of artificial structures results in the destruction of natural habitats and the creation of novel colonisable surfaces. The ability of particular species to settle and survive on such surfaces will depend on the properties of the new substratum (Perkol-Finkel *et al*., 2006), the hydrodynamic regime (Lam *et al*., 2009) and the extent of colonisable area (Chapman, 2003), but construction of structures such as jetties often causes irreversible changes to these physical factors. For instance, jetties jutting out from the shoreline modify the hydrodynamic regime of the area in their vicinity. In particular, jetties have vertical or near-vertical sides, whilst the natural shores they replace are often gently sloping. Vertical faces tend to deflect waves, rather than enabling wave break and dissipating the wave energy, and hence molluscs on jetty walls are subjected to higher energy impacts than on sloping shores (Lam *et al*., 2009). Artificial structures may also retain or dissipate heat in a modified manner, such that they could be cooler than natural shorelines (Williams & Morritt, 1995). In addition, the composition of the substratum determines its surface chemistry, microtopography and durability, which in turn could affect settlement and recruitment of benthic organisms (Chapman, 2003; Spieler *et al*., 2001). Moreover, the surfaces of jetties and other artificial structures tend to be smoother than those on natural shores, which are naturally rugged (Chapman, 2006). Rugged surfaces present a multitude of microhabitats such as rock pools, crevices and overhangs, each with different microclimates, and molluscs that are constrained to such microhabitats may be unable to survive on smooth surfaces.

Since erection of jetties leads to irreversible alteration of the physical environment, we hypothesised that the shore molluscan assemblages would not recover to their original state following construction works. Thus, extensive habitat modification via construction of artificial structures and the associated destruction of natural habitat would lead to permanent changes in the structure and composition of molluscan assemblages inhabiting the shore and could potentially lead to the loss of particular species. Understanding the impacts of concrete jetties on molluscan assemblages can provide insight into the conservation measures that would be required to minimise such impacts and ensure sustainable

Fig. 1. Jetty structures at White Tower Bay; a highly modified shoreline.

development of the coast. We tested this hypothesis at two localities in the north-east of the Maltese Islands: Ghajn Zejtuna and White Tower Bay. These two localities were chosen because they have similar exposure and geomorphology, and have sections that have been modified through the construction of concrete jetties more than a decade ago (Fig. 1) and others where the natural rocky substratum is still unmodified. We chose to focus specifically on the molluscan assemblages of the mediolittoral zone because on the microtidal Maltese shores (maximum tidal range 20 cm), the vertical walls of jetties also result in a reduction in the extent of this zone (≤ 50 cm on jetties in contrast to 1-3 m on the natural shoreline).

Two concrete jetties and two natural rocky shores at the two study localities were sampled along three replicate transects on each. Only the jetties' seaward-facing vertical side was considered since this has the same orientation with respect to the sea as the natural shore in its vicinity. Each transect covered the extent of the mediolittoral zone and the molluscs collected were identified to the lowest possible taxon and counted. Twenty species of molluscs were recorded on natural shores only; nine species were found on both jetties and natural shores, while no species were found exclusively on jetties (Tables 1 and 2). This suggests that some mollusc species typically found on natural shores find it difficult to survive on jetties. A number of species encountered on the natural shores at both localities were either absent or had very low abundances on jetties. These were very small in size, usually juveniles (not exceeding 6 mm in shell length), and included species of the genera *Eatonina* and *Cerithium*, which on the natural shores are typical of moisture-retaining and sheltered microhabitats in the upper infralittoral or lower mediolittoral zones. Such microhabitats are mostly absent on jetties since these lack crevices. Interestingly, species of the genera *Patella* and *Gibbula* reached higher densities on jetties than on natural shores. This could be due to reduced interspecific competition, since the abundance of other grazers on the artificial substratum was low.

Overall our results show that mollusc assemblages are greatly impoverished on jetties relative to natural rocky shores, with only a few genera being represented and an even smaller fraction being able to reach similar or higher densities than on the natural shores. The argument sometimes made, that jetties merely replace the natural rock and would eventually be colonised by the same suite of species, is not supported by our results. Hence, new constructions should attempt to mimic as closely as possible the topography of natural shores to include a viable wider range of microhabitats.

Table 1. Average abundance of species found on both shore types (* 1-25 ind/m^2, ** 26-50 ind/m^2, *** >50 ind./m^2).

Species	Natural shore	Concrete jetties
Brachidontes pharaonis	**	*
Eatonina cossurae	***	*
Eatonina fulgida	***	**
Gibbula spp.	*	***
Mytilaster minimus	*	*
Patella caerulea	*	***
Patella ulyssiponensis	*	**
Patella rustica	*	**

Table 2. Species recorded only on natural shores.

Opistobranchia sp.	*Lepidochitona corrugata*
Acanthochitona sp.	*Mitra cornicula*
Alvania lanciae	*Ocinebrina edwardsii*
Omalogyra atomus	*Phorcus turbinatus*
Cardita calyculata	*Paludinella* sp.
Cerithium spp.	*Pisania striata*
Columbella rustica	*Pisinna glabrata*
Conus ventricosus	*Setia* spp.
Irus irus	*Odostomia* sp.
Jujubinus gravinae	*Rissoa* spp.

This work was partially funded through the European Social Fund under the Strategic Educational Pathways Scholarship (STEPS) scheme grants.

Chapman, M.G. 2003. Paucity of mobile species on constructed seawalls: effects of urbanization on biodiversity. *Marine Ecology Progress Series* 264: 21-29.

Chapman, M.G. 2006. Intertidal seawalls as habitats for molluscs. *Journal of Molluscan Studies* 72(3): 247-257.

Lam, N.W.Y., Huang, R. & Chan, B.K.K. 2009. Variations in intertidal assemblages and zonation patterns between vertical artificial seawalls and natural rocky shores: a case study from Victoria Harbour, Hong Kong. *Zoological Studies* 48(2): 184-195.

Perkol-Finkel, S., Shashar, N. & Benayahu, Y. 2006. Can artificial reefs mimic natural reef communities? The roles of structural features and age. *Marine Environmental Research* 61(2): 121-35.

Spieler, R.E., Gilliam, D.S. & Sherman, R.L. 2001. Artificial substrate and coral reef restoration : what do we need to know to know what we need. *Bulletin of Marine Science* 69(2): 1013-1030.

Williams, G. A. & Morritt, D. (1995). Habitat partitioning and thermal tolerance in a tropical limpet, *Cellana grata*. *Marine Ecology Progress Series* 124: 89-103.

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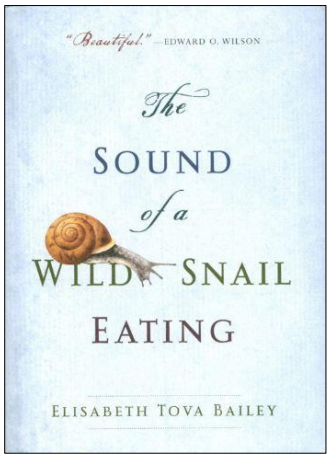
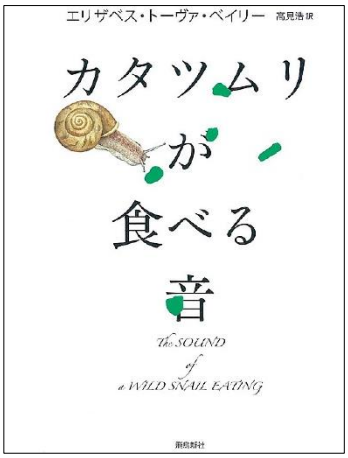
RECENT PUBLICATIONS RELEVANT TO MOLLUSC CONSERVATION

All reviews and comments are by the Editor of *Tentacle*, Robert Cowie.

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 most recently Japan. It is increasingly used in education at levels from primary school to higher education. It has received accolades globally. Seriously, if you have not obtained a copy, go and get one! Check out the author's website.

The Wild Snail website has in fact just been redesigned and includes a page with all the foreign editions. There is also now an active Facebook page that malacologists can 'like' if they would like too! The new website and the facebook page will launch in early April.

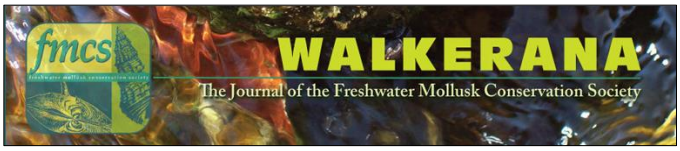
MalaCo – an online journal

MalaCo (ISSN 1778-3941), a peer reviewed journal referenced by the *Zoological Record*, is an electronic open access publication. Articles, in French or English, focus on the ecology, biology, systematics and conservation of non-marine European molluscs. *MalaCo* publishes original work as well as news, short notes and practical tools for species identification.

Since November 2007, articles have become available on the *MalaCo* website as soon as they are accepted. To submit papers, please see author recommendations and contact the editorial team: J.-M. Bichain, X. Cucherat, B. Fontaine, O. Gargominy and V. Prié.

For more information contact Mollusc Specialist Group member jean-michel.bichain@educagri.fr

Walkerana – another online journal



Walkerana returned to publication in 2012 as the on-line journal of the Freshwater Mollusk Conservation Society, based in North America. Four issues (two in each of volumes 15 and 16), containing 18 papers have since been published.

Journal of Threatened Taxa

The latest issue (Vol. 6, No. 3) of the *Journal of Threatened Taxa* is available on line now.

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*.

Abernethy, E., McCombs, E., Siefferman, L. & Gangloff, M. 2013. Effect of small dams on freshwater mussel population genetics in two southeastern USA streams. *Walkerana* 16(1): 21-28.

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.

Barker, N.P., Fearon, J.L. & Herbert, D.G. 2013. Moisture variables, and not temperature, are responsible for climate filtering and genetic bottlenecks in the South African endemic terrestrial mollusc *Prestonella* (Orthalicoidea). *Conservation Genetics* 14(5): 1065-1081.

Boyer, S., Wratten, S.D., Holyoak, A., Abdelkrim,J. & Cruickshank, R.H. 2013. Using next-generation sequencing to analyse the diet of a highly endangered land snail (*Powelliphanta augusta*) feeding on endemic earthworms. *PLoS ONE* 8(9): e75962.

Curry, P.A. & Yeung, N.W. 2013. Predation on endemic Hawaiian land snailis by the invasive snail Oxychilus alliarius. *Biodiversity and Conservation* 22: 3165-3169.

Durkan, T.H., Yeung, N.W., Meyer, W.M., III, Hayes, K.A. & Cowie, R.H. 2013. Evaluating the efficacy of land snail survey techniques in Hawaii: implications for conservation throughout the Pacific. *Biodiversity and Conservation* 22: 3223-3232.

Gutiérrez Gregoric, D.E., Beltramino, A.A., Vogler, R.E., Cuezzo, M.G., Núñez, V., Gomes, S.R., Virgillito, M. & Miquel, S.E. 2013. First records of four exotic slugs in Argentina. *American Malacological Bulletin* 31(2): 245-256.

Hawksworth, D.L. & Cowie, R.H. 2013. The discovery of historically extinct, but hitherto undescribed, species: an under-appreciated element in extinction-rate assessments. *Biodiversity and Conservation* 22: 2429-2432.

Heise, R.J., Cope, W.G., Kwak, T.J. & Eads, C.B. 2013. Short-term effects of small dam removal on a freshwater mussel assemblage. *Walkerana* 16(1): 41-52.
Henley, W.F., Pinder, M.J., Watson, B.T. & Neves, R.J. 2013. Status of freshwater mussels in the middle fork Holston River, Virginia. *Walkerana* 16(2): 68-80.
Horsák, M., Schenková, V. & Páll-Gergely, B. 2013. Fossil records of *Marstoniopsis insubrica* (Küster, 1853) suggest its wide distribution in central Europe during the early Holocene. *Malacologia* 56(1-2): 339-342.
IGBP, IOC, SCOR (2013). *Ocean acidification summary for policymakers – third symposium on the ocean in a high-CO_2 world*. International Geosphere-Biosphere Programme, Stockholm, Sweden.
Inoue, K., Monroe, E.M., Elderkin, C.L. & Berg, D.J. 2014. Phylogeographic and population genetic analyses reveal Pleistocene isolation followed by high gene flow in a wide ranging, but endangered, freshwater mussel. *Heredity* 12: 282-290.
Jankowiak, A. & Bernard, R. 2013. Coexistence or spatial segregation of some Vertigo species (Gastropoda: Vertiginidae) in a Carex rich fen in central Poland. *Journal of Conchology* 41(3): 399-406.
Johnson, P.D., Brown, K.M., Burkhead, N.M., Cordeiro, J.R., Garner, J.T., Hartfield, P.D., Lepitzki, D.A.W., Mackie, G.L., Pip, E., Tarpley, T.A., Tiemann, J.S., Whelan, N.V & Strong, E.E. 2013. Conservation status of freshwater gastropods of Canada and the United States. *Fisheries* 38(6): 247-282.
Jurkiewicz-Karnkowska1, E. & Karnkowski, P. 2013. GIS analysis reveals the high diversity and conservation value of mollusc assemblages in the floodplain wetlands of the lower Bug River (East Poland). *Aquatic Conservation: Marine and Freshwater Ecosystems* 23(6): 952-963.
Książkiewicz, Z., Kiaszewicz, K. & Gotdyn, B. 2013. Microhabitat requirements of five rare vertiginid species (Gastropoda, Pulmonata: Vertiginidae) in wetlands of western Poland. *Malacologia*, 56(2): 95-106.
Meyer, W.M., III, Ostertag, R. & Cowie, R.H. 2013. Influence of terrestrial molluscs on litter decomposition and nutrient release in a Hawaiian rainforest. *Biotropica* 45: 719-727.
Mumladze, L., Tarkhnishvili, D. & Murtskhvaladze, M. 2013. Systematics and Evolutionary History of Large Endemic Snails from the Caucasus (*Helix buchii* and *H. goderdziana*) (Helicidae). *American Malacological Bulletin* 31(2): 225-234.
Murphy, M.J. & Shea, M. 2013. Survey of the terrestrial and freshwater molluscan fauna of the Pilliga forest area in northern inland New South Wales, Australia. *Molluscan Research* 33(4): 237-253.
Neo, M.L. & Todd, P.A. 2013. Conservation status reassessment of giant clams (Mollusca: Bivalvia: Tridacninae) in Singapore. *Nature in Singapore* 6: 125–133.
Newton, T., Sauer, J. & Karns, B. 2013. Water and sediment temperatures at mussel beds in the upper Mississippi river basin. *Walkerana* 16(2): 53-62.
Oke, C.O. 2013. Terrestrial mollusc species richness and diversity in Omo Forest Reserve, Ogun State, Nigeria. *African Invertebrates* 54(1): 93-104.
Ota, N., Kawai, T. & Hashimoto, A. 2013. Recruitment, growth, and vertical distribution of the endangered mud snail *Cerithidea rhizophorarum* A. Adams, 1855: implications for its conservation. *Molluscan Research* 33(2): 87-97.
Parkin, J. & Newell, D.A. 2013. Australian land snails: a review of ecological research and conservation approaches. *Molluscan Research* 33(2): 116-129.
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.
Peters, H., O'Leary, B.C., Hawkins, J.P., Carpenter, K.E. & Roberts, C.M. 2013. *Conus*: first comprehensive conservation Red List assessment of a marine gastropod mollusc genus. *PLoS ONE* 8(12): e83353.
Reid, N., Keys, A., Preston, J.S., Moorkens, E., Roberts, D. & Wilson, C.D. 2013. Conservation status and reproduction of the critically endangered freshwater pearl mussel (*Margaritifera margaritifera*) in Northern Ireland. Aquatic Conservation: Marine and Freshwater Ecosystems 23(4): 571-581.
Richling, I. & Bouchet, P. 2013. Extinct even before scientific recognition: a remarkable radiation of helicinid snails (Helicinidae) on the Gambier Islands, French Polynesia. *Biodiversity and Conservation* 22: 2433-2468.
Salvador, R.B. & Cavallari. D.C. 2013. A new *Oxychona* apecies (Gastropoda: Pulmonata: Orthalicidae) from Bahia state, Brazil. *Journal of Conchology* 41(3): 315-318.
Sartori, A.F., Gargominy, O. & Fontaine, B. 2013. Anthropogenic extinction of Pacific land snails: a case study of Rurutu, French Polynesia, with description of eight new species of endodontids (Pulmonata). *Zootaxa* 3640(3): 343-372.
Schenková, V. & Horsák. M. 2013. Refugial populations of *Vertigo lilljeborgi* and *V. genesii* (Vertiginidae): new isolated occurrences in central Europe, ecology and distribution. *American Malacological Bulletin* 31(2): 323-329.
Zanatta, D.T. & Harris, A.T. 2013. Phylogeography and genetic variability of the freshwater mussels (Bivalvia: Unionidae) Ellipse, *Venustaconcha ellipsiformis* (Conrad 1836), and Bleeding Tooth, *V. Pleasii* (Marsh 1891). *American Malacological Bulletin* 31(2): 267-279.

IUCN, SSC AND MOLLUSC SPECIALIST GROUP NEWS AND ANNOUNCEMENTS

www.iucn.org/

News and announcements provided by Mary Seddon, chair of the Mollusc Specialist Group of the IUCN Species Survival Commission.

Annual report of the IUCN SSC Mollusc Specialist Group 2013

CHAIR: Mary Seddon (UK)

MISSION: To conserve the diversity of Mollusca and their habitats globally by:

1) assessing their threat status according to the IUCN Red List,
2) communicating through production of newsletters, species profiles, workshops, social media
3) developing conservation plans for management of Critically Endangered Species

and 4) promoting sustainable use of harvested species (marine, freshwater and terrestrial realms)

MEMBERSHIP: Following various meetings of the Mollusc Specialist Group at the World Congress of Malacology in the Azores in July 2013, four new subgroups have been established, with formal RLA coordinators appointed by the SSC Chair, Simon Stuart.

Freshwater Bivalve Red List Authority Coordinator: Manuel Lopes-Lima (Portugal)

Conus Red List Authority Coordinator: Howard Peters (UK)

Cephalopoda Red List Authority Coordinator: Louise Alcock (Eire)

European Red List Authority Coordinator: Eike Neubert (Switzerland)

PROGRESS ON RED LISTING: In 2013 over 650 new mollusc assessments were published, so by latest update (2013.2), we have assessed 6,809 Molluscs, 12.7 % of all assessed animals on the list, but less than 10 % of all known molluscs. We are now 55 % towards our target of the completion of the Global Freshwater Mollusc Assessment (c. 6,000 species).

FRESHWATER HABITATS AND THEIR SPECIES (3,408 freshwater species on Red List): In cooperation with the IUCN Freshwater Biodiversity Unit in Cambridge, efforts have been focussed on the Red List assessments for the SW Asia and Eastern Mediterranean regions in 2013. Two workshops have reviewed the species considered threatened in the region and then using these data defined the key biodiversity areas for freshwater molluscs in the region. Further field surveys in Turkey lead to the rediscovery of species not seen for decades.

The ***Freshwater Bivalves Red List Authority*** subgroup was established under the coordination of Manuel Lopes-Lima to deal with the c. 1,000 species of this keystone group in freshwater systems. Over 50 % of the species are Red Listed with identified conservation actions. Work is ongoing to build the communication network to exchange knowledge and produce conservation tools and a discussion platform for future research. A bibliographic database and a mailing network is in development and production of several technical guidelines to help bivalve conservation practitioners is planned for 2014. Future meetings include 2nd International Meeting on Biology and Conservation of Freshwater Bivalves in 2015, as well as regional meetings in Cambridge (2014) and Mexico (July 2014).

A similar Red List Authority for the ***Freshwater Gastropods*** is being developed, to assist with further assessment work. The Sampled Red List Index of Freshwater Mollusc assessment co-ordinated by Monika Bohm (ZSL) in collaboration with the MSG, is nearing completion. Each time we think that we have the required number of species (1,500), taxonomic issues with species are reviewed requiring more species assessments. The revised Conservation Assessment for North American species using the US system of Global Heritage Ranking was published in 2013 and is now available on-line.

MARINE HABITATS AND THEIR SPECIES (1,041 marine species on Red List): The ***Conus Red List Authority,*** led by Howard Peters (University of York), completed the publication on the Red List of 632 species in 2013. This is the first comprehensive study into the status of a marine gastropod genus for the Red List, bringing together shell dealers and research scientists. Cone snails provide excellent indicators for future monitoring on the impact of elevated sea-surface temperatures and ocean acidification on many calcium-carbonate/aragonite forming species. A PLoS publication identified exceptional areas of diversity and threats in Cape Verde Islands with conservation action plans targeted for 2014.

The ***Cephalopoda Red List Authority*** subgroup led by Louise Alcock met in the Azores, and discussed taxonomic issues relating to target families for Red Listing, with a further 200 species with ongoing assessments intended for publication in 2014.

The IUCN Global Marine Species Assessment project has also conducted an assessment of the reef-forming bivalves, and these species will be added to the Red List during 2014.

TERRESTRIAL HABITATS AND THEIR SPECIES (2,490 land snails on Red List): The ***European Landsnail Red List Authority*** subgroup led by Eike Neubert (National Museum, Berne) met in the Azores to discuss targets for future Red Listing, as 800 species remain to be assessed. Over the next three years, threatened species from further families will be targeted for documentation.

A new group specialising in ***African Non-marine Molluscs*** met in the Azores, developed plans for 2014 including communication networks to facilitate discussions about taxonomic issues, conservation breeding and Red List assessments, especially for forest species in Ghana, Kenya, Tanzania and South Africa. Mary Seddon will act as the Red List Authority for these species.

The ***Oceania*** subgoup combining scientists from USA, French Polynesia, France, Fiji and New Zealand have recently completed Red List assessments for 140 species in the region, with further assessments planned, now that scientists are familiar with SIS.

CONSERVATION PROJECTS: A project is being developed for submission on four Threatened species of freshwater bivalves in Morocco. The project aims to raise awareness of the role of freshwater bivalves cleaning water within river catchments. This will form part of the proposed Invertebrate Conservation Sub-Committee actions on testing IUCN conservation planning processes for the SSC strategic plan.

The iconic *Partula* species are currently in active management programmes to protect reintroduced populations in Tahiti, with funding support from various donors and assistance from the French Polynesian ministry. Justin Gerlach is mounting various field research programmes in 2014 with other regional scientists to improve the status of the genus *Partula*, meanwhile Zoos around the world continue to manage the conservation breeding programme for those species which are Extinct in the Wild.

A large landsnail from Viet Nam, *Bertia cambodjiensis*, the latest rediscovery of a species thought to be extinct, is now

part of a conservation breeding programme combining Viet Nam state agencies and organisations, the Natural History Museum (London) and London Zoo. Further research and conservation applications are in progress for this magnificant land snail, which will be Red Listed in 2014, and CITES listing is being considered, given that one threat is commercial shell collectors.

Major threats on the Madeiran Islands are the increased frequency of forest fire and flooding events, possibly a climate change related threat, and they are impacting many of the endemic species. Recent work supported by Natura 2000 and EU Life projects to re-establish grassland and stabilise the steep slopes where the endemic Madeiran Storm Petrel breeds, have also benefitted the endemic land snails at high altitude.

The new heritage centre at Cave and Basin, Banff, features the Banff Spring Snail, an endemic species that is present in the first of all Canadian National Parks. The site re-opened in April 2013 after major redevelopments over the last 4 years. This species is one of the most studied gastropods, with regular monthly surveys over the last 15 years. Dwayne Lepitzki is the latest recruit to the IUCN SSC MSG, and brings expertise on the monitoring and sensitive redevelopment of thermal springs sites.

OUTREACH: *Tentacle*, our annual newsletter, is produced electronically as downloadable pdfs, from the University of Hawaii. One issue was produced in March 2013, with the next one planned in 2014. Three posters on the work of the SSC Mollusc Specialist Group were presented at the World Malacological Congress 2013. This provided much media coverage for the amazing endemic species found on the islands of the Azores and the surrounding oceans.

UNITAS Malacologica sponsored over 34 students to attend the World Malacological Congress 2013, including several with presentations on conservation biology. All 450 malacologists endorsed a resolution providing a statement of concern on the lack of awareness of governments relating to the threats to molluscs, calling on them to engage with national societies to work on the conservation of Mollusca and use the legislation in place to facilitate more conservation actions for Critically Endangered Species.

ACTIVITIES IN 2014: The main focus of activity remains the completion of the Global Freshwater Mollusca Assessment, with the next two regions being SW Asia for 2014 and South America in 2015. We are aiming to update the 1,397 out-dated IUCN Red List assessments dating from 1996 by 2016, a challenging target without external funding.

ACKNOWLEDGEMENTS
Thanks to the many zoos, snail farms, aquarium, aquaculture and fish farms around the world for their work in conserving populations of threatened land snails, marine molluscs and freshwater bivalves.

Thanks to the many sponsors of different activities of members of MSG: CEPF Mediterranean, CEPF Oceania, CEPF Indoburma, CEPF Western Ghats, NERC, University of York, Natural History Museum (London), Frozen Arc Project, Netherlands Organisation for Scientific Research, Zoological Society of London, Auckland Zoo, University of Seville, University of the Azores, University of Hawaii, Oahu Army Natural Resources Protection Program, Hawaii Department of Land and Natural Resources, the Nature Conservancy, Unitas Malacologica, North Carolina State Museum, Kadoorie Farm and Botanic Garden and the National Natural Science Foundation of China.

IUCN Red List - celebrating 50 years

Throughout 2014 we are celebrating the significant contribution of The IUCN Red List of Threatened Species in guiding conservation action and policy decisions over the past 50 years. The IUCN Red list is an invaluable conservation resource, a health check for our planet – a Barometer of Life. Join us in celebrating the contribution that The IUCN Red List has made in guiding conservation for 50 years – spread the word, get involved, follow our news during this anniversary year! www.facebook.com/iucn.red.list

Launch of the first online Global Freshwater Biodiversity Atlas

IUCN is one partner contributing to a new online Atlas of freshwater biodiversity presenting spatial information and species distribution patterns that was launched at the 'Water Lives' symposium, bringing together European Union policy makers and freshwater scientists. Fresh waters are incredibly diverse habitats; they cover less than 1 % of the Earth's surface yet are home to 35 % of all vertebrate species. Sadly, freshwater life is declining at an alarming rate, faster than any other component of global biodiversity. This new Atlas is a response from freshwater scientists to the policy challenge of how to integrate protection of freshwater life and the ecosystem services it provides, with real and pressing demands on freshwater resources from the energy, food and sanitation sectors. At present the mollusc data are limited but will be added over the next year, providing a resource for better, evidenced-based decision making in the area of water policy, science and management.

European Natura 2000 Award

The European Commission has launched a new award designed to celebrate and promote best practices for nature conservation in Europe. The European Natura 2000 Award aims at bringing the success of the network to the public's attention and to demonstrate its importance for protecting biodiversity across Europe. The Award is annual, is open to any entity involved in the implementation of activities related to the management of Natura 2000 sites. The first call for Natura 2000 Award applications is closed with 163 projects submitted under five main categories, including some molluscs, for example the *Unio crassus* project in Sweden. Find out more about the applicants, their projects, their achievements on the web-site.

Training opportunities

Smithsonian-Mason School of Conservation professional training course: Estimating Animal Abundance and Occupancy

The course is designed to provide a strong theoretical and analytical background to both graduate students and professionals in distance sampling, mark-recapture, and occupancy modeling techniques, with a strong focus on the practical use of field data in the programs DISTANCE, MARK and PRESENCE. The course will be taught by Gary White, Jim Nichols, Jim Hines and Joe Kolowski and will take place 19-30 May 2014. Email CBItraining@si.edu for more details.

Durrell Conservation Academy: Endangered Species Recovery

This course will give an introduction to issues such as the value of and threats to biodiversity, planning species and ecosystem recovery programmes, small population biology, captive species management, and community conservation. Participants will also be introduced to a wide range of practical research skills. The course will include current case studies of conservation work by Durrell on some of the most critically endangered primates, birds, reptiles and amphibians.

The course will take place 14-25 July 2014 and be based at the Durrell Conservation Academy at the Durrell Wildlife Conservation Trust headquarters in Jersey. Teaching will be delivered by Durrell's own conservation specialists and several internationally renowned experts brought in from elsewhere.

Course fee: £1,400 (reduced to £1,120 if paid at least 8 weeks prior to the start of the course). Full board on site accommodation can be provided at an additional cost of £420.

Add IUCN's Amazing Species to your website for 2014

For 'Amazing Species', we have created an eye-catching button to place on your website, which will link directly to our Amazing Species webpage. It's easy to use, simply ask your webmaster to embed the following code:
<iframe src="http://feeds.iucnredlist.org/amazing-species" frameborder="0" width="180" height="205" scrolling="no"></iframe>
Once this code has been added to your website, no further changes on your part are necessary. Even the picture on the button itself will change automatically each day!

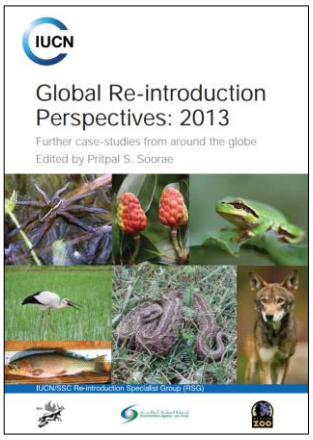
CZS CBOT Endangered Species Fund: open for applications

The Chicago Zoological Society is soliciting new proposals for the Chicago Board of Trade Endangered Species Fund. Projects that will assist directly in the protection of populations of threatened and endangered species; or a specific habitat that is of high biological value or that is substantially threatened (IUCN Red List Status) will be preferred. This includes quantitative assessment of population and environmental status with indications of best conservation strategy. The development of educational projects and training that assist in building local conservation capacity are given higher priority. Grants are open to SSC Specialist Group Chairs and Officers, AZA/WAZA Chairs and Officers, and all interested researchers. The Fund will support small projects usually up to $5,000 (smaller requests will fare better).

Nominations open for the Midori Prize for Biodiversity 2014

The MIDORI Prize, a biennial international prize co-organized by the AEON Environmental Foundation and the Secretariat of the Convention on Biological Diversity (CBD), honours individuals who have made outstanding contributions to the conservation and sustainable use of biodiversity. Established by the AEON Environmental Foundation during the 2010 International Year of Biodiversity, the Prize aims to encourage positive action for biodiversity and inspire others by showcasing the notable work of those it honours. Nominations from the public and experts who are academics, scientists and others working on biodiversity around the world are accepted through the MIDORI Prize website from 1 March until 31 May 2014.

Publications



A global perspective on re-introduction

From mangroves to spiders, trout to bobcat, the latest edition of Global Re-introduction Perspectives from the IUCN SSC Re-introduction Specialist Group presents 52 case studies on re-introduction projects from around the world. Re-introduction is a conservation technique that returns viable populations of animals and plants to an area they previously inhabited. Re-introduced populations are bred in captivity or translocated from one area to another; however, success is only achieved with a great deal of research and preparation.

***Conus*: first comprehensive conservation Red List assessment of a marine gastropod mollusc genus**
Peters, H., O'Leary, B.C., Hawkins, J.P., Carpenter, K.E. & Roberts, C.M. 2013. PLoS ONE 8(12): e83353.

Marine molluscs represent an estimated 23 % of all extant marine taxa, but research into their conservation status has so far failed to reflect this importance, with minimal inclusion on the authoritative Red List of the International Union for the Conservation of Nature (IUCN). The status of all 632 valid species of the tropical marine gastropod genus *Conus* (cone snails) was assessed using Red List standards and procedures to lay the groundwork for future decadal monitoring, one of the first fully comprehensive global assessments of a marine taxon.

MEETINGS 2014-15

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.

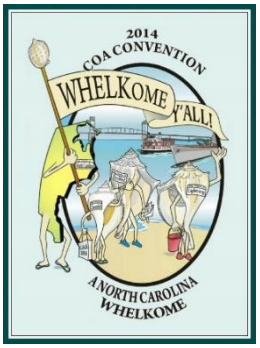
Mollusca 2014: The Meeting of the Americas

Mollusca 2014: The Meeting of the Americas, the first All-America malacological conference, will be held at Universidad Nacional Autonoma de Mexico, Mexico City, 23-27 June 2014.This first All-America meeting is jointly organized by Sociedad de Malacología de Mexico, Western Society of Malacologists, American Malacological Society and Asociacion Latinoamericana de Malacologia. The President is Dr. Edna Naranjo from UNAM.

Western Society of Malacologists 2014 American Malacological Society 2014 meeting

The American Malacological Society and the Western Society of Malacologists will both hold their 2014 meetings in conjunction with Mollusca 2014 in Mexico City. Check the AMS meetings website and the WCM website for details.

Conchologists of America 2013 Convention



The COA will hold its 2014 convention in Wilmington, North Carolina, USA, 9-15 August 2014. See the COA conventions page for more details.

IUCN and the World Parks Congress, Sydney 12-19 November 2014

Registration is now open for the IUCN World Parks Congress (WPC), the landmark global forum on protected areas held every 10 years. The event takes place in Sydney, Australia, 12-19 November 2014, with the theme 'Parks, people, planet: inspiring solutions' designed to help deliver IUCN's three priority areas of work. The WPC 2014 will articulate the vital role of protected areas in conserving nature, while delivering essential ecosystem services, position protected areas within the goals of economic and community well-being in the post-2015 development agenda, and show how this can be achieved in practice. Keep updated with the latest news through social media or the newsletter - find all you need to know on the World Parks Congress website.

Brasilian Society of Malacology: 24th EBRAM

The Brasilian Society of Malacology (SBMa – Sociedade Brasileira de Malacologia) will hold its XXIV Brasilian Malacological Meeting in 2015. Details are not yet available but will be posted at the SBMa website.

Society for Conservation Biology 2014 and 2015

The SCB's International Congress for Conservation Biology, previously annual, is now biennial and the next one will be in 2015.

However, the SCB 2014 North America Congress for Conservation Biology will be held in Missoula, Montana, USA, 13-16 July 2014.

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

IUCN Invasive Species Specialist Group

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

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* 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 organizations, 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 malacolgical 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.

The Malacological Society of London

One of my favourite logos, *Pomacea canaliculata* by David Reid, modified from the original Malacological Society of London logo. Research and travel grants and awards are made each year.

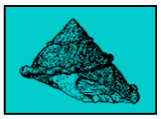
American Malacological Society

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

Conchologists of America

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

Western Society of Malacologists



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

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 *Walkerana* 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.

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 Wales – Mollusca

The Mollusca page of the National Museum of Wales provides information on the global projects on molluscs underway based in Cardiff.

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.

Tropical land snail project at the Natural History Museum, London

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

Samoan Snail Project

The Samoan Snail Project 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.

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.

Jamaican land snail project

A key to Jamaican land snails is now online, on the DiscoverLife website. The key, with many excellent photographs, is part of Gary Rosenberg's work on the Jamaican fauna. Comments can be sent to Gary Rosenberg, Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, Pennsylvania 19103-1195, USA. Tel +1 215 299 1033, fax +1 215 299 1170, rosenberg@ansp.org.

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 2500 type lots, of land 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.

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.

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.

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/

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

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