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

TENTACLE

UNITAS MALACOLOGICA

EDITORIAL

This issue, the largest ever, represents 20 almost continuous years of publication of *Tentacle*, the first issue having appeared in December 1989. The newsletter has developed from a typed original, cyclostyled and distributed to a limited readership in the mail, to a full colour, web-based publication read much more widely and with contributions from almost every corner of the globe. Yet the underlying issues remain the same – molluscs are still severely threatened, with many on the brink of extinction. A recent paper by Claire Régnier and colleagues of the Muséum nationale d'Histoire naturelle in Paris, published in *Conservation Biology* in November 2009 (vol. 23, pages 1214–1221), asks what we really know about the true level of mollusc extinctions and whether the global IUCN *Red List* accurately reflects this knowledge. The answer provides much food for thought.

The IUCN *Red List* is an important tool in conservation – only with knowledge of which species are extinct and which are threatened can conservation action be appropriately targeted. More mollusc species than species in any other group are listed as extinct in the *Red List*. Yet, how accurate is the *List*? Perhaps quite accurate for vertebrates, but what about invertebrates? In the first article in this issue of *Tentacle*, Régnier summarizes their *Conservation Biology* paper. The results show that the *Red List* seriously under-estimates the number of extinct mollusc species. The problems lie primarily in (1) the lack of sufficient specialists to address the diversity of what is the second largest animal phylum (in terms of numbers of described species), compared to the relatively large numbers of people recording vertebrates, (2) the geographic locations of those specialists, which for the most part do not match the locations facing the greatest levels of threat, and (3) the longer process leading to listing of invertebrates than vertebrates because it is taxonomists rather than field ecologists and conservation biologists who accrue the knowledge of invertebrate population trends, resulting in an additional step in the trajectory from field-derived knowledge to listing. [Insects of course represent an even great problem.] It is an important paper and I recommend that everyone reads it.

Robert H. Cowie, Editor

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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. 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 journal. 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.

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

Also, 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 this and recent issues. It takes me many many hours simply inserting commas or semi-colons or italicizing 'et al.' – please do it for me!

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. 56 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, in January).

MANY UNNOTICED EXTINCTIONS: DO MOLLUSCS REALLY ACCOUNT FOR HALF THE TOLL?

By Claire Régnier

As practitioners in mollusc conservation, we usually know that molluscs are the group most affected by extinction (IUCN, 2008) and this despite the facts that most mollusc species on the *IUCN Red List* have not been re-evaluated since 1996, or in some cases 2000, and that the quality of information for invertebrates is far lower than for vertebrates. Altogether 302 species are listed as extinct on the *2008 IUCN Red List*. We re-evaluated mollusc species listed as extinct through bibliographic research and consultation with experts. We found that the number of known mollusc extinctions is almost double that of the *IUCN Red List* (Régnier *et al*., 2009).

In order to do this we reviewed all mollusc species listed as extinct in the *Red List*. We contacted the assessor of each species and asked them to provide the source that led to the listing. We scanned selected references for unlisted cases of extinct species. We obtained an expanded list with numerous additions of mollusc extinctions. For all listed species (both those on the *Red List* and those newly assessed as extinct), we asked several experts to:

- confirm or contradict the conservation status of the species in our list, supported by literature references or a "pers. com."
- draw our attention to species omitted from the expanded list

Of the 302 listed species, the experts recognized 33 species as still extant. Information from the literature and the experts provided 288 new cases of extinct species. Thus, following our study, 566 mollusc species have to be considered as extinct (Fig. 1). Among these 566 mollusc extinctions, 422 were terrestrial, 140 freshwater and only 4 marine.

With these new figures we highlighted several geographical biases in the knowledge of extinct mollusc species (Fig. 2). North America and Pacific islands are over-represented for terrestrial species. This biased distribution is not a new discovery: for invertebrate species, our knowledge of conservation status comes from taxonomists the majority of

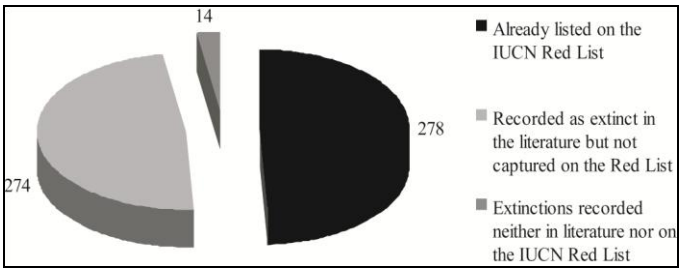

Fig.1. Summary of the updated mollusc species extinctions.

whom are based in Europe and the United States (Gaston & May, 1992). For freshwater too, geographical biases were important. Apart from the two main areas (United States and the Balkans, with respectively 83 and 29 extinctions), known freshwater extinctions are rare and scattered. Last but not least, among the 566 extinct mollusc species, 400 are from oceanic islands, representing 71 % of all listed mollusc extinctions. And among these 400 extinct mollusc species, 327 are endemic to the most isolated islands of the world. These numerous mollusc extinctions from oceanic islands may be explained by three factors. One is the intrinsic vulnerability of oceanic islands species (Purvis *et al*., 2000). The second is inherent to the difficulty of recording extinctions: on very small islands, when an endemic species is not found despite considerable survey efforts, there is practically no doubt about its extinction (Abdou & Bouchet, 2000). Ultimately, the listed extinct island species are mostly from Hawaii, French Polynesia, and the Mascarene islands, where research is very active, which introduces another geographical bias within the listing of extinct island species.

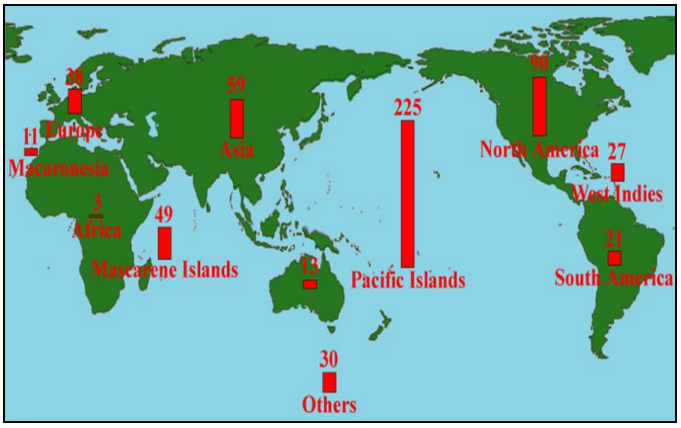

Fig. 2. Geographical distribution of extinct molluscs.

As a result of our study, the number of known mollusc extinctions has almost doubled and is higher than the number of extinctions of all other taxa combined. So molluscs surely account for half the toll of documented extinctions but certainly not for half the toll of what is really extinct (i.e., both documented and overlooked extinctions). No doubt the mismatch between the numbers of terrestrial vertebrate experts and the very few taxonomists specialized in invertebrate taxa influences this uneven number of documented extinctions. Yet, the difficulties encountered in recording mollusc extinctions are less critical than those faced in recording extinctions in other invertebrate taxa, such as insects. Indeed, recording mollusc extinctions in the field is facilitated by the fact that we can still find dead shells from species that became extinct during the nineteenth century (Bouchet & Abdou, 2003; Griffiths & Florens, 2006). Compared to molluscs, the number of documented insect extinctions is amazingly small: 61 extinctions out of about 1 million species described (Baillie *et al*., 2004). This gives an insight into the huge number of extinctions we are surely missing and shows how much our present listing of extinctions is biased.

Abdou, A. & Bouchet, P. 2000. Nouveaux gastéropodes Endodontidae et Punctidae (Mollusca, Pulmonata) récemment éteints de l'archipel des Gambiers (Polynésie). *Zoosystema* 22**:** 689-707.

Baillie, J.E.M., Hilton-Taylor, C. & Stuart, S.N. (eds.). 2004. *2004 IUCN Red List of threatened species. A global species assessment*. IUCN, Gland, Switzerland, and Cambridge, UK. xxiv + 191 p.

Bouchet, P. & Abdou, A. 2003. Endemic land snails from the Pacific islands and the museum record: documenting and dating the extinction of the terrestrial Assimineidae of the Gambier Islands. *Journal of Molluscan Studies* 69**:** 165-170.

Gaston, K.J. & May, R.M. 1992. The taxonomy of taxonomists. *Nature* 356**:** 281-282.

Griffiths, O.L. & Florens, V.F.B. 2006. *Nonmarine molluscs of the Mascarene Islands (Mauritius, Rodrigues and Réunion) and the northern dependencies of Mauritius*. Bioculture Press, Mauritius.

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Purvis, A., Gittleman, J.L., Cowlishaw, G. & Mace, G.M. 2000. Predicting extinction risk in declining species. *Proceedings of the Royal Society of London* B 267**:** 1947-1952.

Régnier, C., Fontaine, B. & Bouchet, P. 2009. Not knowing, not recording, not listing: numerous unnoticed mollusk extinctions. *Conservation Biology* 23(5): 1214–1221.

Claire Régnier, Muséum National d'Histoire Naturelle, Département Systématique et Evolution, USM 603/UMR 7138 "Systématique, Adaptation, Evolution" Equipe "Exploration de la Biodiversité", case postalen° 51, 55 rue Buffon, F-75231 Paris Cedex 05, France. Tel +33 (0)1 40 79 31 02, cregnier@mnhn.fr

THE MOUNTAINSNAILS OF CYPRESS HILLS, ALBERTA, CANADA

By Dwayne A.W. Lepitzki, Robert G. Forsyth & Brenda M. Lepitzki

The terrestrial gastropod fauna of Alberta, Canada, is poorly known. Lepitzki (2001) provided the first known compilation of snails and slugs for the province using published scientific literature and recommended preliminary status ranks for all species. Forsyth (2006) then provided an annotated checklist and bibliography of terrestrial molluscs of Alberta using additional literature sources. As part of a multi-year project to document and update the species list for the province, Lepitzki and Forsyth began a systematic survey of the terrestrial gastropods in the summer of 2008. They began their project in Waterton Lakes and Banff National Parks, concentrating on the Mountainsnails, *Oreohelix* spp. (Lepitzki & Forsyth, 2008) as the "endangerment status of the species of *Oreohelix* in the Cypress Hills and in southern British Columbia … require[s] careful evaluation" (Clarke, 1977).

Fig. 1. Small form of *Oreohelix* observed above Reesor Lake, Cypress Hills Interprovincial Park, Alberta. (Photo: D.A.W. Lepitzki)

Fig. 2. Large form of *Oreohelix* observed at Firerock Campground, near Elkwater Lake, Cypress Hills Interprovincial Park, Alberta. (Photo: D.A.W. Lepitzki)

One subspecies of the Rocky Mountainsnail, *Oreohelix subrudis limitaris*, is a regional endemic that was originally described by Dawson (1875) from along the shore of Waterton Lake. Another apparent endemic, *Oreohelix strigosa stantoni*, which is generally considered a synonym of *O. strigosa cooperi*, was described from Cypress Hills (Dall, 1905). One of our objectives is to establish the relationships of these subspecies and populations with nearby Mountainsnail taxa and determine the distribution of Mountainsnails in the Canadian Rockies from Waterton Lakes National Park northward to Banff National Park and eastward to Cypress Hills Interprovincial Park.

In 2009, we observed two forms of *Oreohelix* at Cypress Hills: a smaller form more consistent with the description of *Oreohelix strigosa stantoni* and a larger form (Figs. 1-3). There appeared to be a gradient with the larger form being confined to low-lying areas near streams or lakes and in forests and the smaller form being typically confined to higher elevations, in grasslands and at the edges of woody patches.

Now that we have collected some live specimens of both forms of *Oreohelix* from Cypress Hills, examination of their genitalia after dissection (Pilsbry, 1939) should allow us to determine if they fall into the *strigosa* or *subrudis* groups of *Oreohelix*.

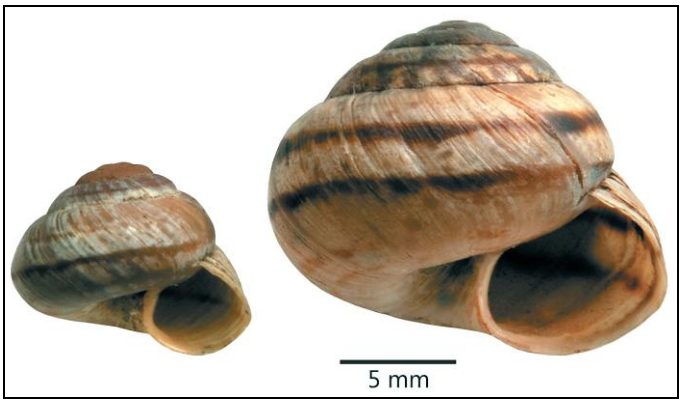

Fig. 3. Small (left) and large (right) forms of *Oreohelix* from Cypress Hills, at the same scale. The small form is from above Reesor Lake while the large form is from the Elkwater Lake campground. (Photos: R.G. Forsyth)

Furthermore, the dissections may help us determine if *O. strigosa stantoni* is a valid subspecies or possibly even a valid species. Neither Dall (1905) nor Russell (1951) mentioned anyone having ever dissected specimens of *O. strigosa stantoni*. Pilsbry (1939) stated: "*Oreohelix strigosa stantoni* Dall agrees with small examples of *cooperi*. It has not been dissected." Perhaps no specimens similar to the original description of *Oreohelix strigosa stantoni* have been collected since 1903, apart from our collections in 2009. Additional collections and more fieldwork examining the apparent ecological and geographical isolation of the two forms also will be required.

Collecting was done under the following permits: Parks Canada Agency Research and Collection Permit No. WL-2008-1891; Alberta Tourism, Parks and Recreation, Parks Division, Research and Collection Permit No. 09-035.

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Dall, W.H. 1905. *Land and Fresh Water Mollusks*. Harriman Alaska Expedition Vol. 13. Doubleday, Page & Co., New York. 171 p., 2 pls.

Dawson, G.M. 1875. Land and fresh-water Mollusca collected during the summers of 1873-74, in the vicinity of the forty-ninth parallel – Lake of the Woods to the Rocky Mountains. In: *Report on the geology and resources of the region in the vicinity of the forty-ninth parallel*, Appendix E, p. 347-350. British North American Boundary Commission, Dawson Brothers, Montreal.

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Pilsbry, H.A. 1939. Land Mollusca of North America (north of Mexico). *The Academy of Natural Sciences of Philadelphia. Monograph* 3, Part 1(1): xvii, 1-573.

Russell, L.S. 1951 [1952]. Land snails of the Cypress Hills and their significance. *The Canadian Field-Naturalist* 65: 174-175.

Dwayne A.W. Lepitzki[1*], Robert G. Forsyth[2*] and Brenda M. Lepitzki[1]
[1] Wildlife Systems Research, Box 1311, Banff, Alberta T0L 0C0, Canada. lepitzki@telusplanet.net
[2] Research Associate, Royal British Columbia Museum, 675 Belleville Street, Victoria, British Columbia V8W 9W2, Canada; PO Box 3804, Smithers, British Columbia V0J 2N0, Canada. Tel +1 250 847 6699, r.forsyth@telus.net, rforsyth@mollus.ca
* Co-chairs, Molluscs Species Specialist Subcommittee of COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

OTALA PUNCTATA (MÜLLER, 1774) ESTABLISHED ON MALTA

By Nicholas Barbara & Patrick J. Schembri

Otala punctata (Müller, 1774) is a typically western Mediterranean helicid land snail with a range extending from France to northwest Algeria (Maurel, 2006; Falkner, 1990). In a recent survey of sites on the Maltese Islands (Central Mediterranean) where alien terrestrial molluscs might possibly have been introduced, we documented an established population of *Otala punctata* around a plant nursery in Mosta, in the centre of Malta (Fig. 1). We have determined that *Otala punctata*, which may have been first introduced with imported plant material as early as 2003 (Mifsud *et. al.*, 2003), occurs as variably aged individuals, and it is confirmed as a newly established alien helicid for Malta. This thermophilic species, sharing a similar morphology, ecology and life cycle to some local Helicidae such as the ubiquitous *Eobania vermiculata* (Müller, 1774), is well adapted to the strongly bi-seasonal Mediterranean climate of Malta and is highly likely to extend its range from this point of origin.

Otala punctata's distribution in Mosta, Malta, was mapped and the population was estimated to occupy an area of about 50,000 m^2 in the immediate vicinity of the plant nursery; the snails did not show any particular preference for substratum or habitat. We found all snails attached to a variety of flora, ubiquitous in the Maltese Islands, and with varying densities not correlated to distance from the suspected point of origin in 2003, indicating that the specimens were not recent escapees.

Differences in shell diameter, thickness and height confirmed the presence of variably aged individuals indicating reproductive success of the alien species. We analysed the range of shell diameter in the population, a reliable trait for aging snails (Lazaridou-Dimitridou & Kattoulas, 1981), by developing a size-frequency distribution – distinct cohorts or generations are distinguished by such analyses as separate modes along a shell diameter axis, each mode corresponding to a distinct reproductive event. We used Bhattacharya's method for modal class progression analysis (Bhattacharya, 1967).

Our analysis confirmed that by 2006, three differently sized (and aged) cohorts of *Otala punctata* occurred in the area.

Fig. 1. Variably aged individuals of *Otala punctata*, a newly established helicid on Malta. Photo shows snails attached to tree mallow, *Lavatera arborea* (a ruderal species), close to a plant nursery in Mosta (central Malta). (Photo: Nicholas Barbara, 23 May 2006)

corresponding to at least a parent population that had contributed to two successive offspring generations at the time of our survey. This compares with the 2-3 yr lifespan recorded for *Eobania vermiculata* by Lazaridou-Dimitriadou & Kattoulas (1981).

The dispersal mechanisms involved in the proliferation of this western Mediterranean species in the Maltese countryside may be complex and are not known. However, we believe that the biology of this species makes its further proliferation and dispersal highly likely. This might have unknown effects on local ecosystems, possibly resulting in competition with endemic Helicidae that share a similar ecology, such as *Cernuella caruanae* (Kobelt, 1888) and *Marmorana* (*Murella*) *melitensis* (Férussac, 1821).

The recent introduction and establishment of *Otala punctata* in Malta highlights the perils of a poorly controlled horticultural trade for the introduction of alien malacofauna, which is not an isolated case for the Maltese Islands. Liberalised trade, especially between affiliated countries such as Malta and other European Union member states, has relaxed quarantine measures and thereby increased the chances of further introductions.

More details of our study of *Otala punctata* are given by Barbara & Schembri (2008).

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Bhattacharya, C.G. 1967. A simple method of resolution of a distribution into Gaussian components. *Biometrics* 23: 115-135.
Falkner, G. 1990. Binnenmollusken. In: *Steinbachs Naturführer. Weichtiere* (Fechter, R. & Falkner, G), p. 112-280. Mosaik-Verlag, Munich.
Lazaridou-Dimitriadou, M. & Kattoulas, M.E. 1981. Contribution à l'étude de la biologie et de la croissance des escargots commercialisés en Grèce: *Eobania vermiculata* (Müller) et *Helix aspersa* Müller. *Haliotis* 11: 129-137.
Mifsud, C., Sammut, P. & Cachia C. 2003. On some alien terrestrial and freshwater gastropods (Mollusca) from Malta. *Central Mediterranean Naturalist* 4(1): 35-40.
Maurel, J.-P. 2006. *Otala punctata* (O.F. Müller, 1774) à Toulouse (Haute-Garonne, France). *MalaCo* 2: 31-32.

Nicholas Barbara, 139, St. Anthony Street, Zabbar ZBR3474, MALTA. Tel +356 2166 6672, nikbarbara@gmail.com
Patrick J. Schembri, Department of Biology, University of Malta, Msida MSD2080, MALTA. Tel +356 2340 2789, fax +356 2132 3781, patrick.j.schembri@um.edu.mt

TERRESTRIAL MALACODIVERSITY OF LIMESTONE OUTCROPS OF HAINAN ISLAND

By Min Wu & Qin Wu

A recent study (2004-2007) investigated 13 limestone outcrops in Hainan Island, which has 1.8 % of the total amount of limestone outcrops in China. The highest concentration of limestone areas in Hainan is in Wangxia (N19° 00′43.8″, E109°08′10.6″), Changjiang County, where there are five limestone mountains higher than 1,000 m, with well developed karst landscape, totalling more than 160 km^2. Economic activity on the island, along with tourism and exploitation of limestone for cement production, is resulting in increasingly serious threats to such areas. In particular, cement production is rapidly destroying the landscape of the limestone outcrops. Almost alongside each limestone outcrop there is at least one cement factory that uses the limestone directly from the nearby outcrop without any ecological consideration.

This situation means that there is a very urgent need to evaluate the biodiversity status of the region. From 2004 to 2007, we conducted several malacodiversity surveys in nine limestone outcrops as well as in eight granite and two basalt localities in Hainan. Based on both the ecological information and the biological materials obtained, mainly from these 19 localities, we assessed the composition of the malacofauna, the historical formation of the local malacodiversity and the endangered status of terrestrial molluscs, all of which will be crucial in developing protection strategies for the local malaco-resources in the future.

Including the taxa found during our study, the land mollusc fauna of Hainan now comprises 59 species belonging to two subclasses (Prosobranchia, Euthynerua), four orders (Archaeogastropoda, Mesogastropoda, Stylommatophora, Soleolifera), 19 families (Helicinidae, Hydrocenidae, Cyclophoridae, Ariophantidae, Bradybaenidae, Camaenidae, Clausiliidae, Endodontidae, Enidae, Euconulidae, Helicarionidae, Trochomorphidae, Streptaxidae, Subulinidae, Succineidae, Rhytididae, Achatinidae, Vaginulidae (= Veronicellidae), Rathouisidae) and 41 genera. Of these, two families (Hydrocenidae and Rathouisidae), including four genera and five species, are new records for Hainan. The new records are: *Georissa sulcata* Moellendorff, 1884 (previously known from Guangdong); *Georissa hungerfordiana* Moellendorff, 1884 (previously known from Guangdong and Hunan); *Diplommatina triangulata* Yen, 1939 (previously known from Yunnan; Fig. 1); *Plectotropis fulvicans* Adams, 1866 (previously known from Taiwan); *Moellendorffia hensanensis* (Gredler, 1885) (previously known from Hunan); *Rathouisia* sp. (distinctly a new species and listed as a new record, but not identified because only one juvenile was found). Two species of *Opeas* are new to science (to be described elsewhere).

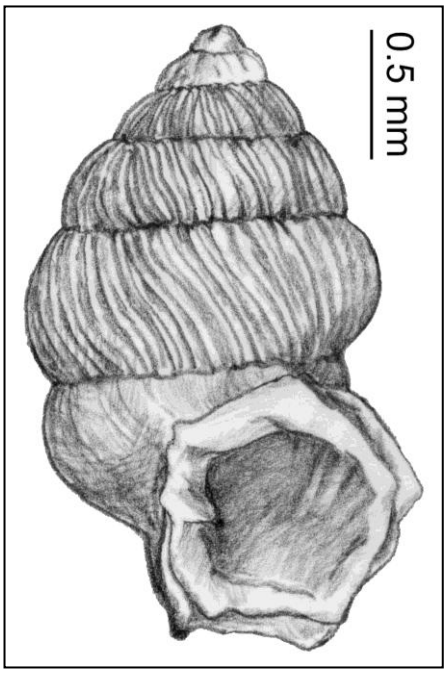

Fig. 1. *Diplommatina triangulata* Yen, 1939. New record for Hainan.

All species involved were described based on their conchological features. The interactive identification system DELTA (CSIRO Delta for Windows, vers. 1.04), with 27 unordered characters and a total of 76 character states, with seven numeric and five text characters, was employed for management of all information on the species and for prompt identification. All specimens are preserved in the Museum of Nanjing University.

Funding for this project was provided by the Kadoorie Farm and Botanic Garden, Hong Kong Special Administrative Region, China, and the National Natural Science Foundation of China (NSFC, 30670253).

Min Wu, School of Life Science, Nanjing University, Hankoulu 22, Nanjing 210093, China. Tel. +86 (0)25 83593389, fax +86 (0)25 83592705, minwu1969@yahoo.cn
Qin Wu, College of Life Sciences, Hebei University, Wusidonglu 180, Baoding 071002, China.

LIMESTONE LOSS LEADING TO DISASTER FOR LAND MOLLUSCS OF HAINAN ISLAND

By Min Wu & Jiabin Pang

Monsoon rains falling on Hainan are instrumental in generating the monsoon forest landscape of this island. Furthermore, the climate of alternating half year periods of aridity and of almost continuous rainfall has profoundly shaped and is influencing the terrestrial malacofauna. With the more changeable global climates and much increased human activity, the local land molluscs are facing increasingly serious threats. For example, during our field survey, Hainan Island suffered the most serious drought for 50 years. In the limestone area of Hainan, human impacts are changing almost all the monsoon forest. Most of the original and secondary forest is being replaced by plantations of rubber trees, eucalypts (for paper pulp), Chinese pine (for rosin and wood) and various tropical fruits, under which the local herbaceous plants can hardly grow any more. The exposed limestone outcrops are destroyed as the main material in cement production and for road construction.

However, people know almost nothing about the status of the limestone fauna. Therefore, to assess the situation, we conducted field work on terrestrial molluscs over four years from 2004 to 2007. The work resulted in a list including 59 land snail species from 19 localities. We used data from 43 of these species to determine the relationships among 14 of the localities, including six limestone localities (localities at which only alien species or taxonomically doubtful species were excluded).

The most preferred area cladogram (Fig. 1; L = 68, CI = 0.66, RI = 0.57; tree-selecting method after Wu, 2004) based on presence/absence of the 43 species at each of the 14 localities was selected from numerous trees of equal length because it is the tree that is topologically identical to the tree (L = 334, CI = 0.91, RI = 0.79) constructed using weighted character states. These trees were preferred as representing the relationships among the localities and for indicating speciation and extinction events that may have occurred. The trees suggest that each of the paired localities on either side of the Changhua River (DZ-LB; MG+BT-WX+EX) have a close relationship in terms of the history of their terrestrial malacodiversity (Fig. 2). They also suggest that speciation may have occurred more frequently in the limestone areas, with a higher average of 2.00 speciation events per locality, than in the non-limestone areas, which averaged 0.29 speciation events per locality. Limestone areas also exhibit a lower possible extinction rate (average 2.83 species lost) than non-limestone areas (average 4.28 species lost), which means that limestone areas act as refuges for terrestrial molluscs in Hainan.

Following the IUCN criteria for assessing endangered status (version 3.1), and excluding 10 species for which there is insufficient information, that are invasive aliens or are taxonomically dubious, the status of the terrestrial snails of Hainan were evaluated as follows: nine critically endangered

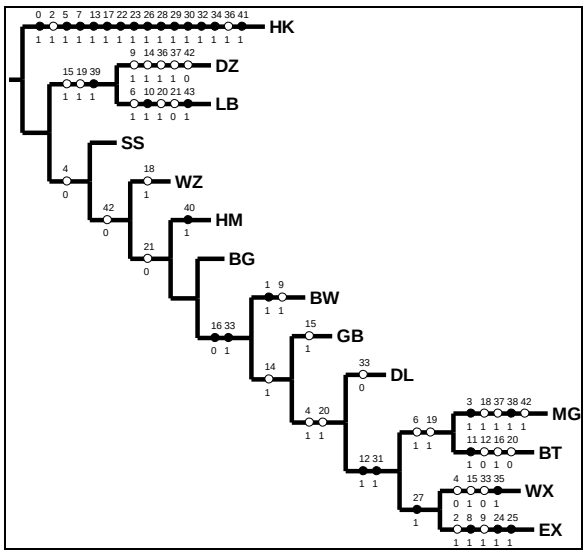

Fig. 1. Most preferred area cladogram with studied localities as terminals. Numbers above circles on branches represent the species; numbers 1 and 0 below the circles represent presence and absence, respectively. The localities, with rock type indicated (B, basalt; G, granite; S, slate; L, limestone), are: Haikou (HK; B), Shishan (SS; B), Danzhou (DZ; G), Bawang (BW; G), Wangxia (WX; L+G), Exian (EX; L), Guangba (GB; G), Baoguo (BG; L), Hongmao (HM; S+G), Wuzhishan (WZ; G), Diaoluoshan (DL; G), Maogan (MG; L), Baoting (BT; G), Luobidong (LB; L).

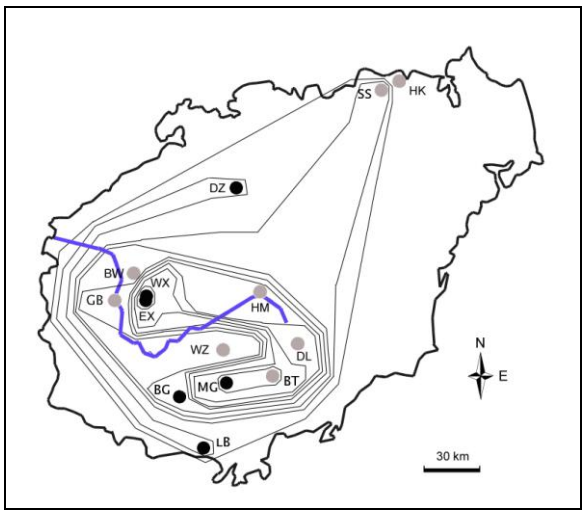

Fig. 2. Preferred historical relationships of the Hainan terrestrial malacodiversity, as inferred from the cladogram in Fig. 1. Black dots, limestone localities; grey dots, non-limestone localities; blue line, Changhua River.

species (CR), 20 endangered species (EN), 13 vulnerable species (VU), eight species of least concern (LC). Of the total Hainan species assessed, 59 % are evaluated as critically endangered or endangered. In comparison, 55 % of the pulmonate species of mainland China have been evaluated as critically endangered or endangered in the *China Species Red List* (Wang & Xie, 2004). In the limestone areas, 13 species were evaluated as CR (7) and EN (6), more than in the granite areas (CR – 3; EN – 4), and the basalt areas (0 – CR; 12 – EN). In addition, we found the alien giant African snail (*Achatina fulica*) in abundance at every locality, especially in the most disturbed regions.

This study suggests that in Hainan the limestone areas are the most important in maintenance of terrestrial malacodiversity. In particular, Xianan stone-forest (676 m asl, N18°35′55″, E109°25′27″) in Baoting County and Exianling (316 m asl, N19°00′33.5″, E109°05′15.8″) in Dongfang County, and the surrounding zones should be seriously conserved and protected urgently against malacodiversity loss.

Funding for this project was provided by the Kadoorie Farm and Botanic Garden, Hong Kong Special Administrative Region, China, and the National Natural Science Foundation of China (NSFC, 30670253).

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Min Wu, College of Life Sciences, Hebei University, Wusidonglu 180, Baoding 071002, China; present address, School of Life Science, Nanjing University, Hankoulu 22, Nanjing 210093, China. Tel. +86 (0)25 83593389, fax +86 (0)25 83592705, minwu1969@yahoo.cn

Jiabin Pang, College of Life Sciences, Hebei University, Wusidonglu 180, Baoding 071002, China.

IS CONSERVATION DEPENDENT ON CHARISMA?

By Joan P. Jass

Wisconsin zoologists Levi & Levi (1950) made several trips throughout the state during the summer of 1949, primarily to collect arachnids, but terrestrial gastropods occupying the same localities were collected also, as a by-product of the primary research goal. Their field work was undertaken on at least 32 dates from 7 May to 25 September and they collected at 61 sites in 43 counties – mostly in habitats they described as deep woods. These sites yielded from 1 to 19 species each, 5 being the average. They included a warning that their methodology may have resulted in smaller shells having been overlooked.

To analyze this aspect of their results, shell measurement ranges (Burch, 1962) were used to assign each species collected by Levi & Levi (1950) to one of the size classes of Burch & Pearce (1990) for North American land snails: minute (< 3 mm), small (3-10 mm), medium (11-30 mm), large (> 30 mm). Of the 46 species collected, those with minute (21) and small (16) shells made up 81% of their finds. The three most frequently collected snails were by far the small-sized *Zonitoides arboreus* (48 occurrences), the medium-sized *Anguispira alternata* (28 occurrences) and the minute-sized *Strobilops labyrinthicus* (26 occurrences). None of these frequently found species falls into the large class, though *A. alternata* comes close. Only 4 of the 46 species, all polygyrids, were assigned to the large size class, these collectively occurring at 30 of the 61 sites.

Half a century after the Levis' work, Jass *et al.* (1999) reported on another Wisconsin survey, the method used being collection of 1 m^2 leaf litter samples. In this survey, minute snails such as *Punctum minutissimum* were the species found most frequently. Both *P. minutissimum* and the Levis' most frequently collected snail, *Zonitoides arboreus* (Fig. 1), are listed by the state of Wisconsin as having a conservation status of 'Unrankable', due to the lack of or conflicting information, despite the data from these surveys. The four large polygyrid species from the 1949 survey are also currently considered Unrankable, in spite of their relative size and attractiveness.

Fig. 1. *Zonitoides arboreus*, the quick gloss, is a black-bodied zonitid with a shiny, helix-shaped shell (width 6 mm). It occurred at 33 % of Wisconsin sites in the survey reported by Jass *et al*. (1999).

Large and attractive vertebrates have often been used by conservationists to draw public attention and resources to the broad conservation issues affecting entire ecosystems and their faunal components. These symbolic organisms, such as the polar bear, are sometimes termed 'charismatic megafauna'. Those of us with a knowledge of the terrestrial Gastropoda of temperate habitats have long faced the realization that by far the greatest biodiversity in this group is to be found among species only a few millimeters in size, whose features often need magnification for their aesthetic appeal to be appreciated. However, perhaps adjusting the focus of conservation efforts to include species of the microfauna surrounding us all can be aided by the insights of noted biodiversity champion E.O. Wilson, who said (Gorman, 2002) "Untrammeled nature exists in the dirt and rotting vegetation beneath our shoes. The wilderness of ordinary vision may have vanished—wolf, puma and wolverine no longer exist in the tamed forests…but another, even more ancient wilderness lives on."

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Joan P. Jass, Invertebrate Zoology, Milwaukee Public Museum, 800 West Wells Street, Milwaukee, Wisconsin 53233-1478, USA. Tel +1 414 278 2761, fax +1 414 278 6100, jass@mpm.edu

MASSACRE OF LAND SNAILS AFTER CROP HARVEST IN TURKEY

By Burçin Aşkım Gümüş

Turkey is an important zoogeographical region situated at the gateway between Europe and Asia and its fauna has affinities with the European, Caucasian, Turanian and Eremial faunas. Because of this the Turkish fauna shows external penetration by species from neighbouring regions, with some local radiation (Cook, 1997). It has an interesting aquatic and terrestrial mollusc fauna that is richer than that of its neighbours in Europe and Asia (Demirsoy, 1999).

The Turkish malacofauna has attracted foreign scientists since the late the 18th century (e.g. Bruguière, Olivier). Turkish malacologists started their studies in the 1960s and have published the results of their studies in numerous journals both in Turkey and abroad in recent years. Several international joint projects are currently being carried out dealing with the Turkish malacofauna.

Non-marine molluscs belong to the second most diverse animal phylum in terms of numbers of described species. Non-marine molluscs (terrestrial and freshwater) are one of the most diverse and imperilled groups of animals, although not many people, other than a few specialists who study the group, seem to be aware of their importance. As of 16 May 2003 a total of 708 freshwater and 1222 terrestrial mollusc species were included in the 2002 *IUCN Red List of Threatened Species.* A staggering 42 % of the 693 recorded extinctions of animal species since the year 1500 are molluscs (260 gastropods and 31 bivalves). Although terrestrial vertebrate extinctions are well documented, invertebrate extinctions often go unnoticed by the general public, by most biologists, and by many conservation agencies (Lydeard *et al*., 2004).

During my malacological fieldwork throughout Turkey since 2000, I realized that development of housing and industrial facilities in natural areas threatened the ecology of many areas. Also, in agricultural areas natural resources are being polluted by heavy metals, pesticides and herbicides, and fires started by farmers after harvesting the fields – the subject of this article – often cause disaster. The farmers set the fields ablaze after the harvest as an easy way to get rid of the stalks of wheat and corn. This is in spite of the fact that this procedure is forbidden by law. It has, for example, a negative impact on the fertility of the fields because the fire kills a major component of the beneficial micro-organisms living in the soil. Land without plants on the surface can suffer erosion. The fire can also easily spread to adjacent fields, woods and houses if it can not be controlled in time. It can also impact the fauna (both vertebrates and invertebrates, especially those with limited mobility) and destroy the vegetation (Fig. 1).

Many trrestrial gastropods live under the ground surface litter in the woods, playing an important role in forest productivity, and in the crevices of limestone rocks, walls of ruins, and under stones, as well as occasionally in beach debris. Some species prefer damp shady places whereas other species prefer to aestivate on limestone outcrops exposed to sunlight.

Fig. 1. Burning off crop stubble in Turkey.

Troglobiotic and troglophilic land snails inhabit caves. Some of the 'blind snails' (Ferussaciidae) are usually found in subterranean environments and feed on fungi, moulds, algae and decaying organisms (Mienis, 1992; Beetle, 1997; Schütt, 2005). Some species escape from the heat of the ground by climbing up the stalks of wheat, shrubs and cacti during day time, descending to crawl on the ground during the night (Gümüş, unpublished field observations) (Fig. 2).

Nekola (2002), based on a search of the literature, pointed out that species richness of grassland land snail faunas was reduced by approximately 30 % on burned sites, while abundance was reduced by 50-90 %. Kiss & Magnin (2003) evaluated the roles of environmental variables and vegetation on recolonization of some Mediterranean land snails following burning. They also (Kiss & Magnin, 2006) found that Mediterranean land snail faunas are resilient to fires, and although abundance is drastically reduced in the short term, species richness and community diversity are preserved provided that the time lapse between two successive fires is longer than the time required for recovery (5 yr). In their study, recovery was considered to be due to the presence, within burned areas, of cryptic refuges that allowed initial land snail survival, malacofauna persistence after successive fires and consistent biogeographical patterns in the long term.

Fig. 2. *Chondrus tournefortianus* (Férussac, 1821) on above-ground vegetation during the day.

Fig. 3. Location of the study site in Turkey.

Beetle (1997) observed re-colonization by land and freshwater pulmonates in burned aspen groves after the fires of 1988 in Yellowstone National Park, Wyoming, USA.

On 12 August 2009, my sister and I collected land snail specimens from a wheat field following burning of stubble in Oran, Ankara (Fig. 3). The land snails collected from the site and identified were:

Family ENIDAE, subfamily ENINAE
Jaminia loewii (Philippi, 1844)
Zebrina detrita (Müller, 1774)

Family HYGROMIIDAE, subfamily MONACHINAE
Monacha (*Methatheba*) *samsunensis* (Pfeiffer, 1868)
Cernuella virgata (Da Costa, 1778)

Family HELICIDAE, subfamily HELICINAE
Helix (*Helix*) *cincta* Müller, 1774

The burnt snail shells were scattered around the field. Some of the *Cernuella* and *Monacha* specimens were photographed in the field, and the burnt and peeled periostracum of the shells can be seen clearly in the photographs of the *Z. detrita* specimens (Fig. 4).

In the light of this brief study, I realized, as a Turkish malacologist, that molluscan conservation strategies in Turkey, including field surveys and taxonomic research, have to be supported by public education policies and by conservation laws (the laws of National Parks, Fisheries, National and Natural Values, Wetlands, etc). Although Turkey ratified the 1992 Convention on Biodiversity and a taxonomic database is maintained by TUBITAK (Turkish Scientific Research Foundation), studies of the Turkish malacofauna, preparation


Fig. 4. Top: dead shells of *Monacha samsunensis* and *Cernuella virgata* in the field after stubble burning. Bottom: Burnt shells of *Zebrina detrita* collected from the field.

of IUCN lists of the vulnerable species, and monitoring their conservation status are urgently needed.

I thank my sister Ezgi Oya Gümüş and my mother Nuray Kayıkçı for their support and Henk Mienis (Hebrew University of Jerusalem and Tel Aviv University, Israel) for his help in my snail studies, as a colleague and a dear friend, and for reviewing the text.

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Burçin Aşkım Gümüş, Gazi University, Science and Literature Faculty, Biology Department, Ankara, Turkey.
burcinaskim@gazi.edu.tr burcinaskim@gmail.com

THE DECLINE OF *POLYMESODA SOLIDA* IN THE VIA PARQUE ISLA DE SALAMANCA (COLOMBIA) AND ITS DEPLETION IN THE POZA VERDE LAGOON, COLOMBIA

By Maria Virginia De La Hoz & Carmen Alicia López

The natural park and RAMSAR site Vía Parque Isla de Salamanca (VPIS) is a brackish lagoon system on the deltaic plain of the Magdalena River, Caribbean coast of Colombia (11°7′19″ - 10°53′07″N; 74°20′34″ - 74°51′00″E) (De la Hoz, 2005) (Fig. 1). The clam *Polymesoda solida* Phillippi, 1846 (Veneroidea, Corbiculidae) (Fig. 2) is the most important fishing resource at the VPIS, living in silty substrates of about ten interconnected lagoons, of which only Poza Verde, El Torno and Atascosa support high enough densities to make it an important source of human food (INVEMAR, 2002).

The most important lagoon in this region regarding biomass and production of *P. solida* used to be Poza Verde (Rueda & Urban, 1998; De La Hoz, 2005, 2009, 2010) (Fig. 3). However, since 2008, fishermen have reported the absence of the species from this lagoon, assuming the high sedimentation and dredging of the Alimentador Channel to be the most probable causes (López-Anaya, 2009).

Polymesoda solida in Colombia is listed as Vulnerable according to global IUCN categories. It has previously gone extinct elsewhere in the deltaic plane of the Magdalena river (the main river of Colombia), having disappeared from the Ciénaga Grande de Santa Marta and Complejo Pajarales (east of the VPIS) (Fig. 4) by 1978 (Ardila *et al.*, 2002).

The VPIS can therefore be considered a relictual habitat for this species throughout this entire region. However, the *P. solida* fishery exhibits worrying signs there: the total catch between 2002 and 2005 increased greatly but by 2008 already showed a sharp decline (López-Anaya, 2009) (Fig. 5); also, while in 2002 the clams were well above the optimum catch

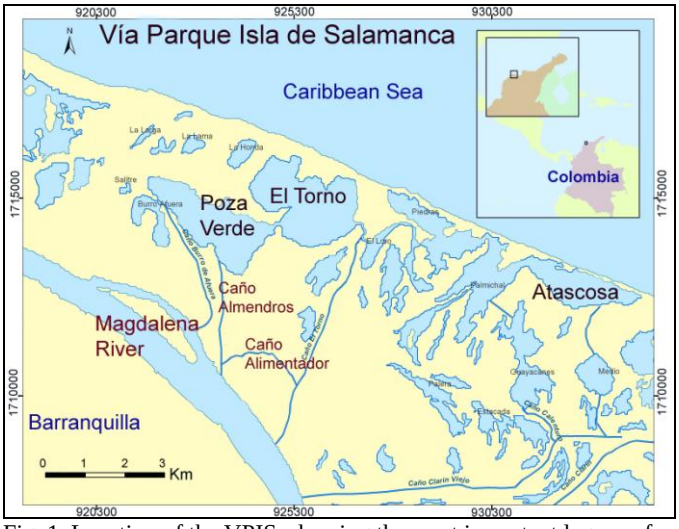

Fig. 1. Location of the VPIS, showing the most important lagoons for the *Polymesoda solida* fishery: Poza Verde, El Torno and Atascosa.

Fig. 2. *Polymesoda solida* individuals caught by hand on the shallow bottoms of Poza Verde in the VPIS.

Fig. 3. Left: Caño Almendros, the channel connecting Poza Verde to the Magdalena River. Right: Poza Verde.

Fig. 4. Satellite view of the deltaic plain of the Magdalena River, showing the VPIS and the surrounding regions where *Polymesoda solida* is extinct. (Source: Google Earth)

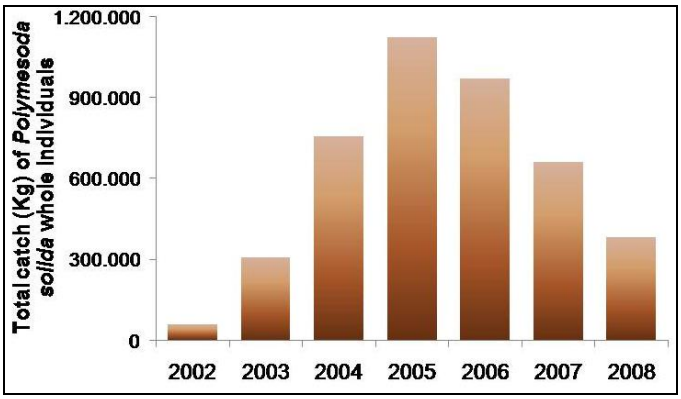

Fig. 5. Total catch of *P. solida* between 2002 and 2008 at the VPIS. (Source: SIPEIN V. 3.0; Narváez *et al.*, 2006)

size (> 30 mm), with a mean of 47.7 ± 0.7 mm, from 2003 onwards many individuals below 30 mm began to be caught, with a mean catch size in 2004 of 30.1 ± 4.9 mm (De La Hoz, 2005, 2009).

Moreover, there has not been a policy regulating exploitation of natural resources in this natural park. Therefore, fishermen and their families are allowed to live in the park on a semi-legal basis (Rueda & Urban, 1998). It is only recently that conservation managers have suggested the possibility of closures.

It is very worrying that since 2008 the fishermen of the region report that they have not found *P. solida* in Poza Verde lagoon (López-Anaya, 2009), which was considered to have the optimal environmental conditions for the development of this bivalve, including low salinities and a high content of suspended matter due to its proximity to the Magdalena River. In fact, the highest percentage of meat, highest body weight and highest rate of sexual maturity has been recorded there, which until 2005 led to the best yield throughout the VPIS (De La Hoz, 2009, 2010).

In addition, since *P. solida* in the VPIS is structured as metapopulations, a structure that is frequent in systems of discontinuous habitats, Poza Verde has been suggested as a source, given the high densities, presence of many size classes including fast-growing sizes (< 25 mm) and greater percentage of mature individuals (De La Hoz, 2009)

Fishermen have argued that *P. solida* populations decline periodically, as seems to be happening in Poza Verde, increasing cyclically when the effects of high sedimentation decline. However, there is no previous record of such events and without long term monitoring this statement will be impossible to confirm. For this reason, further investigations are urgently needed, either to monitor potential extinction processes or to detect cycles of depletion and renewal of this clam population.

This is a challenge because to achieve this aim, it is fundamental that environmental authorities attach more importance to biological research and provide funds to carry out rigorous long term studies focusing on conservation programs for these bivalves at the regional level of the Magdalena River delta. Although there is an official monitoring proposal (López-Anaya, 2009), because of the inevitable bureaucratic processes, it is unknown whether it will be implemented in the near future.

Furthermore, the occurrence of the Asiatic clam, *Corbicula fluminea*, an invasive species, was recorded recently at the VPIS (De La Hoz, 2008). Unfortunately, research focused on sustainable management of mollusc bioinvasions, has not been among the priorities of the management policies of this natural park.

Only if continued research on these corbiculid bivalves takes place in this important Caribbean wetland, will we have an answer to some important questions. Is *P. solida* heading towards extinction in Poza Verde or in another lagoon at the VPIS? And if so, will this event impact on the remaining water bodies of this natural park or of other places of the deltaic plain of the Magdalena River where this clam is present? And additionally, will biological invasions have any ecological impact on the native fauna of the region?

Today, there is a need to be able to meet these goals by working with any environmental authority interested in providing contributions to the research projects on this endangered bivalve in Colombia, with a view to contributing to the design of conservation and management strategies.

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Maria Virginia De La Hoz, Instituto Latinoamericano de Ciencias Marinas y del Ambiente. www.instituto-latino-ciencias-marinas-ambiente.org, mvdelahoz@hotmail.com
Carmen Alicia López-Anaya. Universidad del Magdalena - Geotec Ingenieria Ltda, Santa Marta, Colombia.
carmen.lopez@geotecingenieria.com

GASTROCOPTA PROCERA, NEW STATE RECORD FOR PENNSYLVANIA

By Timothy A. Pearce

The Pennsylvania Land Snail Atlas Project has documented hundreds of new county records and several new state records over and above those in Hubricht's (1985) snail atlas through examination of museum specimens as well as new field surveying. The most recent new state record is 104 specimens

Fig. 1. Three individuals of *Gastrocopta procera* from Blair County, Pennsylvania, CM98096, collected 13 April 2009 by Mark Klingler. Scale bar is 1 mm.

of *Gastrocopta procera* (Gould, 1840) (Fig. 1). The lot is vouchered at the Carnegie Museum of Natural History Section of Mollusks. This species is not likely to be a new introduction; instead, it has probably been living in this area but has been overlooked. Whether it needs conservation efforts is unknown, since our current field survey efforts focus on forest species, so open area species like *G. procera* are undersampled. New records like this highlight the need for surveys to fill knowledge gaps about land snail distributions.

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Timothy A. Pearce, Section of Mollusks, Carnegie Museum of Natural History, 4400 Forbes Ave, Pittsburgh, Pennsylvania 15213-4080, USA. Tel +1 412-622-1916, fax +1 412-622-8837, PearceT@CarnegieMNH.org

ALIEN PLANARIAN DOES NOT FEED ON PHILOMYCID SLUGS IN CAPTIVITY

By Aydın Örstan & Megan Paustian

Hyman (1943) described the land planarian *Bipalium adventitium* (Platyhelminthes: Tricladida: Terricola: Bipaliidae) from specimens collected in Pasadena and Berkeley, California. However, she believed the species had been introduced to North America. The native range of *B. adventitium* is now assumed to be eastern Asia, although there are apparently no records of it outside of the US (Ogren, 1984). *Bipalium adventitium* has since been recorded from many locations in the US, especially in the northeast (Ogren, 1984; Ducey & Noce, 1998; Zaborski, 2002).

Hyman (1954) and Klots (1960), without giving details, claimed that *B. adventitium* fed on slugs and earthworms. Several workers have indeed reported that captive *B. adventitium* consumed numerous species of earthworms (Ducey & Noce, 1998; Ducey *et al*., 1999; Zaborski, 2002). However, according to Ducey & Noce (1998), captive *B. adventitium* did not prey on two species of slugs (*Arion* sp. and *Deroceras* sp.). All *Arion* and *Deroceras* species, except perhaps *D. laeve*, found in North America are non-native. Since in the wild *B. adventitium* is likely to come in contact with the native slugs of North America in the family Philomycidae, we decided to test the potential predatory behavior of *B. adventitium* towards the philomycids. Here, we present the results of our tests so far conducted with one individual of *B. adventitium* and two species of philomycids, *Megapallifera mutabilis* (Hubricht, 1951) and *Philomycus carolinianus* (Bosc, 1802), and with the non-native *Arion intermedius* Normand, 1852.

The specimen of *B. adventitium* used for these tests was collected in a wooded area in Georgetown, Washington, DC in September 2009. The philomycid slugs, which are native to the eastern US, were taken in parks in Maryland and the specimen of *A. intermedius* was from a residential garden. The planarian was kept in a small plastic container lined with wet tree leaves and fed earthworms at irregular intervals. We conducted several tests during which the starved planarian was confined with slugs in small containers for at least a day. During the first several hours we observed the planarian's behavior and often photographed its interactions with the slugs.

Dindal (1970), Ducey *et al*. (1999), Zaborski (2002) and Fiore *et al*. (2004) described the predatory behavior of *B. adventitium*. Our observations generally agree with the literature. When a hungry planarian makes contact with an earthworm, it climbs on the worm and everts its pharynx (Fig. 1). The earthworm is quickly immobilized apparently by the planarian's pharynx. The planarian then starts to consume the worm. During this process the worm continues to move its head or tail for up to 45 min, but is otherwise incapable of freeing itself from the planarian. If the size of the earthworm is roughly similar to that of the planarian, the planarian eats almost all of the worm in about 2-3 h, leaving behind bits and pieces and the contents of the worm's intestine.

Fig. 1. *Bipalium adventitium* feeding on an earthworm. The light colored tissue covering a portion of the earthworm's body is the planarian's everted pharynx (arrow).

In one of our tests, the planarian, which had not eaten for 22 days, was placed together with an adult *M. mutabilis*. During the next several hours we saw the planarian climb on the slug many times, but without a visible attempt to feed on it (Fig. 2). This slug remained unharmed during a total of 25 h of confinement with the planarian. After the slug was removed,

Fig. 2. *Bipalium adventitium* enveloping the slug *Megapallifera mutabilis*; the planarian's head was below and to the right of the slug's head. The slug survived its encounters with the planarian unharmed.

we presented the planarian with an earthworm, which it quickly overcame and ate. This indicated that the planarian had indeed been hungry.

We also kept two specimens of *A. intermedius* in the planarian's container for about 29 h. Both slugs remained alive. After the slugs were removed, the planarian was offered an earthworm, which it attacked and ate.

In another test, the planarian, this time starved for 20 days, was placed in a petri dish with two juvenile *P. carolinianus*. During the following several hours of observation, the planarian contacted both slugs many times (Fig. 3). But we never saw the planarian evert its pharynx on a slug. Both slugs survived 24 h of confinement with the planarian unharmed. After the slugs were removed, an earthworm was placed near the planarian, and the planarian attacked and ate it.

Fig. 3. *Bipalium adventitium* in contact with a juvenile *Philomycus carolinianus*. This and another juvenile survived a day long confinement with the planarian.

Our results, along with those of Ducey & Noce (1998), demonstrate that *B. adventitium* does not consume these three species of slugs in captivity. Therefore, the dispersal of this planarian throughout North America may not be a conservation issue as far as terrestrial gastropods are concerned. Recently, however, Ducey *et al*. (2007) reported that another alien planarian, *Bipalium* cf. *vagum*, found in Florida and Texas, preyed on snails and slugs in captivity. Also, Okochi *et al*. (2004) observed that three species of planarians, including a *Bipalium* sp., occurring on Hahajima Island, Japan, consumed snails in captivity and speculated that the planarians may be contributing to the decline of the endemic snail fauna on that island. The potential threat of such proven predatory planarians to the US terrestrial gastropod fauna is unknown.

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Aydın Örstan, Section of Mollusks, Carnegie Museum of Natural History, 4400 Forbes Avenue, Pittsburgh, Pennsylvania 15213-4080 USA. pulmonate@earthlink.net
Megan Paustian, Department of Entomology, University of Maryland, College Park, Maryland 20742-4454, USA. mpaustia@umd.edu

CONSERVATION PRIORITIES FOR URUGUAYAN LAND AND FRESHWATER MOLLUSCS

By Cristhian Clavijo, Alvar Carranza, Fabrizio Scarabino & Alvaro Soutullo

Uruguayan land and freshwater molluscs are still poorly known. To date, there are 46 terrestrial gastropods, 53 freshwater gastropods and 41 native freshwater bivalve species reported for the country. Yet comparisons with neighbouring areas suggest that these figures probably represent only 60 %

Table 1. Reported native species richness and estimated total native species richness (in parentheses) for Uruguay, with perecentage of the known species that are in need of conservation action.

Taxonomic Group	Species richness
Freshwater Gastropoda	53(85) – 60 %
Caenogastropoda	33 – 88 %
Heterobranchia	20 – 3 %
Terrestrial Gastropoda	46(92) – 63 %
Bivalvia	41(56) – 93 %
Palaeoheterodonta	32 – 100 %
Heterodonta	9 – 67 %
Total	140(233) – 71 %

Sources: Scarabino (2003), Scarabino (2004b), Scarabino & Mansur (2008), Clavijo & Olazarri (2009)

of the species actually present in Uruguay (Table 1), reflecting the lack of appropriate study of some particularly diverse groups and/or lack of exploration of certain environments and/or regions.

Biogeographically, Uruguay is located within the large hydrographical system of the Río de la Plata basin, in a transition zone from subtropical to temperate biomes. In the country, the Uruguay River basin supports the largest number of endemic aquatic species including an endemic genus, the gastropod *Felipponea* (Fig. 1).

Freshwater mussels are particularly diverse, including at least 32 species, representing 7 genera as follows: *Diplodon* (15 spp.), *Castalia* (3 spp.), *Anodontites* (7 spp.), *Mycetopoda* (2 spp.), *Monocondylaea* (3 spp.), *Fossula* (1 sp.), *Leila* (1 sp.) (Scarabino & Mansur, 2008; Clavijo & Olazarri, 2009). The detailed distribution of the majority of the species in the country have not been studied, but recently Clavijo (2009) and Clavijo *et al*. (2008) reported the distribution of the species of Mycetopodidae and *Pomella megastoma* (Ampullariidae), respectively. The lack of such studies is critical considering that *Monocondylaea minuana*, *Anodontites lucidus*, *A. ferrarisii*, *Diplodon charruanus*, *D. rhuacoicus*, *D. delodontus wymanii* and *D. funebralis* are species whose distribution is mostly restricted to Uruguay.

Owing to the creation of the NSPA (National System of Protected Areas, Uruguay), there is a need to define conservation priorities for this fauna in order to support the location of potential protected areas. Recently, Scarabino & Clavijo (2007) elaborated a list of species of threatened land

Fig. 1. *Felipponea* sp., representative of an ampullariid genus endemic to the Uruguay River basin.

Table 2. Criteria used to identify species to be protected within Uruguay's NSPA.

CRITERION 1 – Species restricted to Uruguay, or to a portion of the South American continent that includes at least some portion of Uruguay and not exceeding the total area of the country (< 200,000 km^2).
CRITERION 2 – Species listed as Threatened, Endangered or Critically endangered in the IUCN *Red List* 2006 (www.iucnredlist.org).
CRITERION 3 – Migrant species that use some portion of the country in some stage of their migration.
CRITERION 4 – Species with a Uruguayan distribution not exceeding an area equal to 10 % of the country (< 20,000 km^2 or occurring in ≤ 30 cells of the 1 : 50,000 SGM (Military Geographic Service, Uruguay) grid).
CRITERION 5 – Species that have suffered more than 20 % population decline in Uruguay in the last 20 years, as inferred from a) loss of suitable habitat, b) systematic removal of individuals associated with declines in abundance at local scales and c) lack of reliable records in the last 10 yr at sites where the species was previously recorded.
CRITERION 6 – Species with national conservation needs mentioned in previous studies.
CRITERION 7 – Species of taxonomic or ecological dstinctiveness, including bioengineering and keystone species.
CRITERION 8 – Species of medicinal economic or cultural value and wild varieties of cultured or domestic species.

and freshwater molluscs that need to be protected within the NSPA. Conservation considerations were based on information in collections, the scarce regional and national published studies and personal field observations. To identify priorities for future conservation actions, we followed the criteria listed in Table 2: a) contribution of the country to the global conservation of the species (criteria 1-3); b) urgency – the need to implement strategies to avoid further decline of the species in the country (criteria 4-6); and c) importance – current or potential contribution of the species to human well-being (criteria 7-8).

Our survey showed that almost three quarters (71 %) of the Uruguayan non-marine molluscs are in need of conservation action. The most threatened groups are the freshwater clams (Palaeoheterodonta) and caenogastropods (operculate freshwater snails) (Table 1). The main threats to non-marine molluscs include exotic bivalve species, damming, urbanization, deforestation, agrochemicals, monoculture forest with exotic species, urban and industrial pollution and field burning.

Exotic species are one of the most pressing threats. Since their arrival, *Limnoperna fortunei* (Scarabino & Verde, 1995), *Corbicula fluminea* and *C. largillierti* (Veitenheimer-Mendes & Olazarri, 1983) have colonized most of the Uruguay River basin, probably causing the decline of native species. In particular, the native corbiculid genus *Cyanocyclas* is facing local extinction in Uruguay. In most localities where *Cyanocyclas* spp. used to be common, these species have been replaced by *Corbicula fluminea* (Veitenheimer-Mendes & Olazarri, 1983; Clavijo *et al.* 2009a). In addition, field observations suggest that the endangered species *Leila blainvilliana* (Fig. 2) can also be affected by the golden mussel (Clavijo *et al.*, 2009b). For terrestrial gastropods, habitat loss is clearly the major threat, in the form of deforestation, planting of monocultures with exotic species and other inappropriate land use practices (Scarabino 2004a).

Fig. 2. *Leila blainvilliana*, a rare and endangered freshwater mussel.

The almost complete lack of taxonomists working on land and freshwater molluscs and the lack of official support for their work, coupled with the lack of support for the institutions in charge of malacological collections and databases on Uruguayan diversity (mainly the Museo Nacional de Historia Natural – MNHN) are key factors limiting the availability and use of information for the conservation and management of the Uruguayan non-marine malacofauna. This has direct impact on our knowledge of species composition and distribution, and thus in disciplines relying on this basic information. This poses serious limitations on the implementation of conservation actions for these species. However, with very limited resources, and often in the context of other activities, such as education (Fig. 3), our group is carrying out surveys of unexplored areas and studies of distributions as well as preserving specimens in alcohol for DNA and anatomical studies. Synergistic links among national institutions (MNHN – DINARA (Dirección Nacional de Recursos Acuáticos) – FCIEN (Facultad de Ciencias (Universidad de la República) – NSPA) hold much promise for improvement of the current situation. In this vein, links between current research groups with strong interests in biodiversity conservation and MNHN should be strengthened, thereby serving as a nucleus to foster future conservation initiatives.

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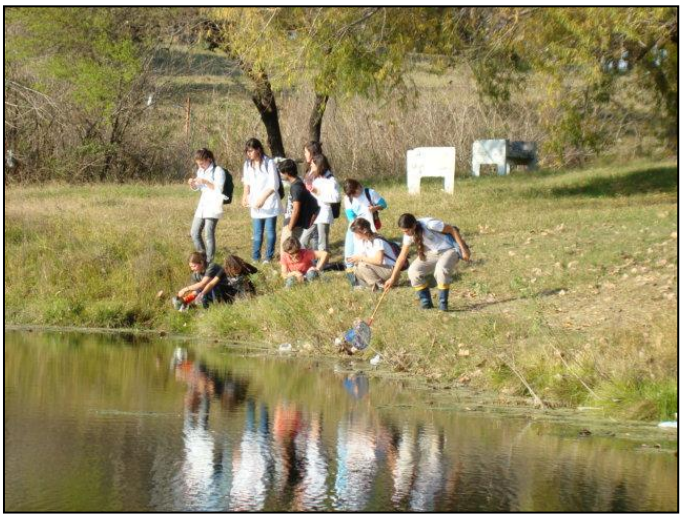

Fig. 3. Students in the field.

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Cristhian Clavijo [1,2], Alvar Carranza[1], Fabrizio Scarabino[1, 2], Alvaro Soutullo[1,3]

[1] Museo Nacional de Historia Natural, CC. 399, CP 11000, Montevideo, Uruguay. [2] Dirección Nacional de Recursos Acuáticos, Constituyente 1497, CP 11200, Montevideo, Uruguay. [3] Grupo de Investigación Zoología de Vertebrados, Universidad de Alicante, Apartado correos 99, E-03080, Alicante, Spain.
mycetopoda@gmail.com (Cristhian Clavijo, corresponding author)
alvar.carranza@gmail.com (Alvar Carranza)

IN SEARCH OF THE THERMAL SPRINGS SPECIES *BITHYNIA RUMELICA* AND *MELANOPSIS PARREYSSI* IN BULGARIA

By Dilian G. Georgiev

Two species of freshwater molluscs were collected during the 20th century from single localities in Bulgaria but their presence in the country has remained uncertain for a long time.

Melanopsis parreyssi Philippi, 1847, known from thermal springs in Romania (Grossu, 1956), was reported by Angelov (2000) from a spring at Pyasachnik Dam in the Upper Thracian lowland (water temperature 19° C). The material was

collected on 16 May 1962 by Professor Rusev and deposited in the collection of Professor Angelov, who published the locality in late 2000. The only thermal spring near the Pyasachnik Dam is on its western side (approximate GPS coordinates 42°24′52.41″N, 24°31′17.11″E) and this is probably the locality at which Professor Rusev collected the material.

Bithynia rumelica Wohlberedt, 1911 (Fig. 1) was described as a new species from a thermal spring (water temperature 20° C) in the Rhodopes Mountains near the town of Krichim (Wohlberedt, 1911). The only known such spring is Krichimski Vircheta, near the Vacha River (approximate GPS coordinates 41°59′51.13″N, 24°28′46.08″E) (Fig. 2). The taxonomic status of the species is unclear. It was considered a synonym of *Bithynia* (*Codiella*) *leachi* by Angelov (2000). Given the recent description of the genus *Pseudobithynia* from nearby Greece, representatives of which are very similar to species in the subgenus *Codiella* of the genus *Bithynia* (Glöer & Pešić, 2006), we cannot even be sure to which genus *B. rumelica* belongs.

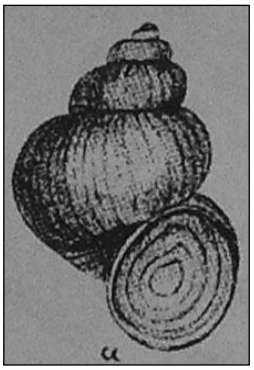

Fig. 1. Drawing of *Bithynia rumelica* by Wohlberedt (1911).

In November 2008 and April 2009 the only known Bulgarian localities of *M. parreyssi* and *B. rumelica* were visited. The spring on the Pyasachnik Dam bank had been piped and its water flowed into a small pool intensively used for watering of domestic cattle. Cow footprints were visible everywhere on its bottom which was highly disturbed. Similar destruction of the benthic area was recorded at Krichimski Vircheta spring as a result of many people washing themselves in the hot water. In both springs pollution from plastic and other materials was obvious.

No individuals or even shell remains of either species were found after an intensive search (checking all types of substrates, sieving mud and sand deposits). If these localities are indeed the only ones for these species in Bulgaria, *B. rumelica* and *M. parreyssi* can be considered extinct in the country.

I thank Peter Glöer and Zdravko Hubenov for literature and for encouraging me to search for these two species and throw some light on their status in Bulgaria. My thanks also go to Angel Tsekov who showed me the thermal spring localities. I also thank Slaveya Stoycheva for her help in the field.

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Dilian G. Georgiev, Department of Ecology and Environmental Conservation, University of Plovdiv, Tzar Assen Str. 24, BG-4000 Plovdiv, Bulgaria,email: diliangeorgiev@abv.bg

NON-MARINE MOLLUSC SPECIES IN THE REGIONAL RED DATA BOOKS OF THE URALS AND SIBERIA (RUSSIAN FEDERATION)

By Maxim E. Grebennikov & Maxim V. Vinarski

Compilation and publication of *Red Data Books* is considered to be one of the most effective approaches to biodiversity conservation (Bouchet, 1997). In the USSR, the first edition of the national *Red Data Book* was published in 1974 and two updated editions of it were issued prior to 1991. The first edition of the *Red Data Book* of the Russian Federation (formerly the Russian Soviet Federative Socialistic Republic – RSFSR) was published in 1983 (a volume devoted to plant species) and 1988 (a volume containing endangered animal species). In the same decade, some republics of the RSFSR (Buryatia, Bashkiria and several others) published their own *Red Data Books*.

In 1995, the federal law of the Russian Federation entitled ‘On the Fauna’ was passed. This law requires each region of Russia (there are 84 regions now in the Russian Federation) to publish its own *Red Data Book* and update it at least once within 10 yr. Sixty regional *Red Data Books* were published by 2003 (Gorbatovsky, 2003) and now almost all regions of Russia have such editions.

It is not surprising that most animal taxa included in these regional editions are vertebrates, with apparent prevalence of birds and mammals. Possibly, this reflects a global trend of paying more public attention to the most attractive species. Vertebrates are well studied and public opinion doubtless acknowledges their practical and aesthetic significance. There is surely hardly anyone who would deny the importance of

survival of the Giant Panda or White Rhinoceros. Regrettably, invertebrate species are relatively neglected subjects in the regional *Red Data Books* of Russia (Gorbatovsky, 2003), though their diversity is much higher than that of vertebrates. The main cause of this is ignorance of invertebrate species diversity in most of regions. For example, nobody knows today how many species of insects inhabit the Omsk Region, although its area (139,000 km^2) exceeds that of such European countries as Belgium (30,500 km^2), Portugal (about 92,000 km^2) and Greece (132,000 km^2).

Here we analyse the *Red Data Books* of Russian regions in the Urals and Siberia. We aimed to learn how extensively continental mollusc species are represented in these books. Our analysis covers both freshwater and terrestrial species.

In the 1980s, the number of mollusc species in the *Red Data Books* of the USSR and RSFSR was low and only endemic species distributed in some remote areas of the country were acknowledged as endangered. For instance, in the second edition of the national *Red Data Book* of the USSR (Borodin *et al*., 1984) only 19 species of molluscs were included. Of this number, 14 were large unionid mussels living in waterbodies of the Russian Far East, one was the European pearl mussel, *Margaritifera margaritifera* (Linnaeus, 1758), and the rest were gastropods (the Transcaucasian endemic *Helix buchi* Dubois de Montpéreux in Pfeiffer, 1853 and 3 rare species of *Melanoides* Olivier, 1804 from central Asia).

The current *Red List* of rare and threatened animal species of the Russian Federation (Danilov-Danilyan, 2001) continues to include local endemic species of molluscs predominantly. There are no continental gastropod species in this *Red List*, whereas 33 out of 34 species of freshwater bivalves included are Far Eastern unionid mussels with quite local distributions. It should be noted that the taxonomic independence of some of these endemic mussel species has recently been questioned (Chernyshev, 2004).

In our opinion, this situation demands inclusion of more continental mollusc species in the regional *Red Data Books*. This would attract more attention to the conservation of rare molluscs, which are overlooked by the compilers of the national *Red List*. There are a number of species that cannot be considered as threatened on the national scale but that are rare at a regional scale and hence worth protecting.

We examined 19 *Red Data Books* of Uralian and Siberian regions (Table 1) and found that continental mollusc species are represented in only four (21 %) of them. The largest number of endangered species (5) is included to the *Red Data Book* of the Kirov Region. Three species of continental molluscs are represented in the *Red Data Book* of the Chelyabinsk Region (Fig. 1).

All 11 species included (Table 2) are Gastropoda (6 freshwater and 5 terrestrial). Bivalves were represented earlier in the *Red Data Book* of the Bashkirian Autonomous Republic (Kucherov, 1984) by the species *Unio pictorum* (Linnaeus, 1758); however this species was subsequently excluded from the Republic's *Red List* and in the most recent edition

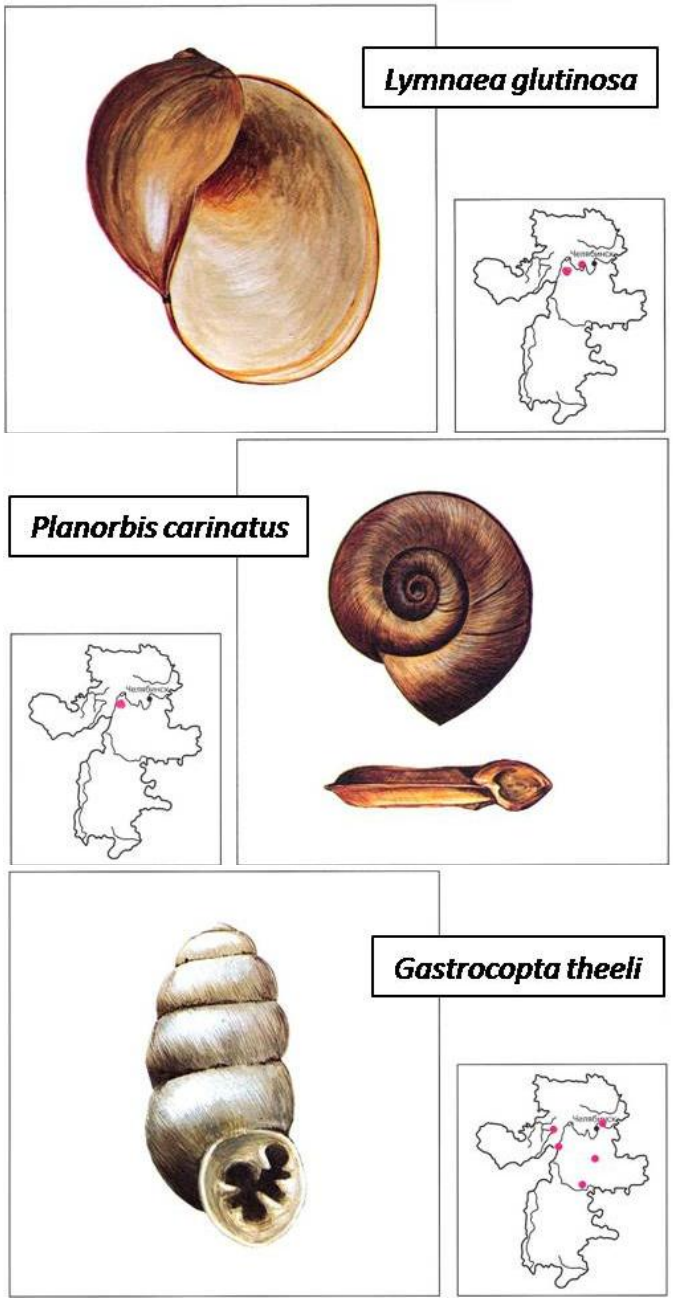

Fig. 1. Three species of continental molluscs represented in the *Red Data Book* of the Chelyabinsk Region, with their known localities. (from Korytin, 2005)

(Bayanov, 2004) it is not considered as threatened in Bashkiria since "its abundance does not decline and special efforts for its conservation are not needed".

In most cases, continental molluscs are placed in category 3 – 'rare species', and only *Hippeutis fontana* (Lightfoot, 1786) in the *Red Data Book* of the Komi Republic was placed in category 2 – 'rare vulnerable species, whose abundance is declining'. Notably, no species of such diverse molluscan families as the Valvatidae, Bithyniidae or Sphaeriidae is included in the regional *Red Lists* of Siberia and Urals.

Interestingly, although there are nearly 50 Siberian endemic species of non-marine molluscs, only one of them is included

Table 1. List of regional *Red Data Books* for regions of Siberia and Urals available to date, indicating whether any mollusc species are included (+) or not included (–).

Region	Reference	Molluscs
Altay Region	Irisova *et al*., 2006	–
Bashkirian Autonomous Republic	Kucherov, 1984	+
Bashkortostan Republic (formerly Bashkirian Autonomous Republic)	Bayanov, 2004	–
Buryatia Republic	Plotnikov *et al*., 1988	–
Chelyabinsk Region	Korytin, 2005	+
Kemerovo Region	Gagina & Skalon, 2000	+
Khanty-Mansiyskii Automomous District (part of the Tyumen Region)	Vasin, 2003	–
Kirov Region	Dobrinsky & Korytin, 2001	+
Komi Republic	Taskayev, 1998	+
Kurgan Region	Shevelev, 2002	–
"Middle Urals" (Perm and Sverdlovsk Regions)	Bolshakov, 1996	–
Novosibirsk Region	Yudkin & Shaulo, 2008	–
Omsk Region	Sidorov & Rusakov, 2005	–
Orenburg Region	Vasilyev, 1998	–
Tatarstan Republic	Schchepovskikh, 1995	–
Tomsk Region	Revushkin, 2002	–
Udmurtian Republic	Zubtsovsky, 2001	–
Yakutia-Sakha Republic	Solomonov, 1987	–
Yamalo-Nenetskii Automomous District (part of the Tyumen Region)	Dobrinsky, 1997	–

in a regional *Red Data Book*: *Sibirobythinella kuznetzkiana* Johansen & Starobogatov, 1982, belonging to the family Pomatiopsidae. This mollusc is still known only from the type locality (Mountain Shoria, Kemerovo region in the south-east part of western Siberia).

So, we may conclude that continental molluscs are highly under-represented in the recent regional *Red Data Books* of Siberia and Urals. In our opinion, the main cause of this is that there are too few professional malacologists for this large territory and most parts of the Uralo-Siberian region have still not been covered by malacological surveys due to its remoteness and absence of communication.

Table 2. Continental mollusc species included in regional *Red Data Books* of the Urals and Siberia, with their conservation category. Category 2: rare vulnerable species, whose abundance is declining; category 3: rare species.

Species	Region (Republic)	Category
BIVALVIA		
Family UNIONIDAE		
Unio pictorum (Linnaeus, 1758)*	Bashkirian Autonomous Republic	–
GASTROPODA		
Family CLAUSILIIDAE		
Cochlodina laminata (Montagu, 1803)	Kirov Region	3
Lacinaria cana (Held, 1836)	Kirov Region	3
Family ENIDAE		
Ena montana (Draparnaud, 1801)	Kirov Region	3
Family GASTROCOPTIDAE		
Gastrocopta theeli (Westerlund, 1877)	Chelyabinsk Region	3
Family LIMACIDAE		
Limax cinereoniger Wolf, 1803	Kirov Region	3
Family LYMNAEIDAE		
Lymnaea carelica Kruglov & Starobogatov, 1983	Kirov Region	3
Lymnaea glutinosa (Müller, 1774)	Chelyabinsk Region	3
Family PHYSIDAE		
Physa adversa (Da Costa, 1778)	Komi Republic	3
Family PLANORBIDAE		
Hippeutis fontana (Lightfoot, 1786)	Komi Republic	2
Planorbis carinatus (Müller, 1774)	Chelyabinsk Region	3
Family POMATIOPSIDAE		
Sibirobythinella kuznetzkiana Johansen & Starobogatov, 1982	Kemerovo Region	3

* In the most recent edition (Bayanov, 2004) this species was excluded from the list of endangered animals.

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Maxim E. Grebennikov, Curator of the Malacological collection of the Zoological Museum, Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences. Yekaterinburg, Russian Federation. gme@ipae.uran.ru
Maxim V. Vinarski (corresponding author), Museum of Siberian Aquatic Molluscs, Omsk State Pedagogical University. Omsk, Russian Federation. radix.vinarski@gmail.com

LAND MOLLUSC CONSERVATION PROBLEMS IN EL GIGANTE ECOLOGICAL RESERVE, EASTERN CUBA

By David Maceira Filgueira & Yovanis Batista

El Gigante Ecological Reserve is located in Granma province, in the Sierra Maestra mountain range, eastern Cuba (Fig. 1). The reserve is 10.46 km^2 in area with a maximum elevation of 1339 m above sea level (El Gigante itself). Minimum and maximum temperatures are 9.7-19.7°C and 20-27°C, respectively. Annual precipitation exceeds 1350 mm. The land snail fauna of the reserve has not previously been studied. The land snail fauna of the Sierra Maestra mountain range has been reported to comprise 155 species, 75 % endemic to Cuba, (Maceira, 2000). A few specific protected areas in Sierra Maestra have been inventoried for molluscs: 12 species in the Gran Piedra Protected Natural Landscape (Maceira, 2005a); 21 species (91 % endemic to Cuba) in the Siboney-Juticí Ecological Reserve (Maceira, 2005b); 13 species, all endemic, in La Bayamesa National Park (Maceira, 2005c); and 12 species (83 % endemic to Cuba) in the Pico Mogote Ecological Reserve (Maceira, 2006). The Cauto River basin has also been studied, as it is the most extensive river in Cuba; 64 land snail species (88 % endemic to Cuba) were recorded (Maceira, 2004). At present, the mollusc fauna of most of the the protected areas in the eastern Cuban mountains is unknown, as are the threats they face and the use that the residents of local communities make of them. This study contributes to the knowledge of the terrestrial molluscs of El Gigante Ecological Reserve and the threats they face.

During 2-7 December 2008 the terrestrial molluscs in the litter and soil, and on rocks, fallen trunks and vegetation were collected in the montane rain forest. Because of the frequent, intense and cold rain in the study area during the field work period it was impossible to develop a methodology to estimate species abundance, so only species composition, endemism and threats were assessed. All samples are deposited in the Malacological Collection of BIOECO (BSC-M).


Fig. 1. El Gigante hill.

Ten species of land snails were recorded, of which eight are endemic to Cuba and two are introduced. Of these, seven species live in the soil and three live on trees. It is possible that the low number of species recorded may be related to the low temperatures during December. More species might be detected if surveys were carried out during spring and summer.

Originally the montane rain forest vegetation covered a larger area in the Sierra Maestra, as suggested by the 44 % similarity in mollusc species composition between the present El Gigante and La Bayamesa protected areas. In La Bayamesa, two species of *Cysticopsis* occur: *C. pemphigodes* (Pfeiffer) and *C. lesavillei* (Gundlach). Also, there are two species of *Obeliscus*: *O. clavus flavus* Pilsbry and *O. lata* Gundlach in Pilsbry. While both *Obeliscus* species also occurred in El Gigante, only one species of *Cysticopsis* was found: *C. pemphigodes*. Another similarity between these two protected areas is the genus *Coryda* of which *C. lindoni* (Pfeiffer) occurs in La Bayamesa and *C. alauda* (Férussac) in El Gigante. These similarities indicate that perhaps a connection existed between these two areas that facilitated exchange of species and that during the current process of habitat degradation some species may have disappeared.

Threats to the conservation of land molluscs inhabiting the montane rain forest in El Gigante Ecological Reserve include intense human activity over an extensive period that has resulted in destruction and fragmentation of the original plant formation and the introduction of two species of terrestrial molluscs not characteristic of this ecosystem (*Deroceras reticulatum*, *Succinea angustior*). Also, damage to the vegetation structure has been reported. Inappropriate agricultural practices on the steep mountain slopes have lead

to erosion, with both soil and litter loss. In addtion to this habitat loss and deforestation, other threats include introduction of exotic plants and animals, droughts, hurricanes and natural and human caused fires. There are difficulties in obtaining the necessary resources to develop the necessary technical and administrative infrastructure to support establishment of an ecological station for the development and maintenance of research. In addition, lack of personnel for patrolling and protecting the area, the nonexistence of means of communication among personnel and the absence of vehicles suitable for montane conditions add to the problems. Patches of the reserve lacking vegetation are susceptible to erosion. Natural forests of *Pinus maestrensis* occur in the protected area, and fires originating in this vegetation type could affect the mollusc fauna of the montaine rain forest. Communities of people resident in the reserve ignore the value of the natural resources in their surroundings and a program of environmental education does not exist. There is illegal extraction of wood for coal, firewood and building houses.

The goals of our research and monitoring program are:

- To carry out additional inventories during spring and summer in the protected area to complete the land snail inventory.
- To reforest with montane rain forest species to recover the original vegetation structure.
- To assess *Zachrysia bayamensis* population densities as an indicator of ecosystem condition.
- To get the necessary financing to establish an ecological station and to guarantee the permanency of investigators and personal for protection of the area.
- To establish a program of environmental education and measures against erosion and forest fires.

Land mollusc species list

Class GASTROPODA

Subclass PROSOBRANCHIA

Family HELICINIDAE

Alcadia spectabilis (Pfeiffer, 1858): endemic to eastern Cuba.

Subclass GYMNOMORPHA

Family VERONICELLIDAE

Veronicella cubensis (Pfeiffer, 1840): Cuban endemic; also introduced to many Caribbean islands and elsewhere. Fig. 2.

Subclass PULMONATA

Family SUBULINIDAE

Obeliscus clavus flavus Pilsbry, 1907: endemic to Sierra Maestra.

Obeliscus lata Gundlach in Pilsbry, 1907: endemic to eastern Cuba. Fig. 3.

Family OLEACINIDAE

Oleacina solidula (Pfeiffer, 1840): Cuban endemic.

Family SUCCINEIDAE

Succinea angustior (Adams, 1850): introduced in Cuba.

Family AGRIOLIMACIDAE

Deroceras reticulatum (Müller, 1774): European species, introduced to Cuba. Fig. 4.

Family CAMAENIDAE

Zachrysia bayamensis (Pfeiffer, 1854): endemic to Sierra Maestra, although some authors report it from Gibara, Holguín.

Fig. 2. *Veronicella cubensis*.

Fig. 3. *Obeliscus lata*.

Fig. 4. *Deroceras reticulatum*.

Family XANTHONICHIDAE

Cysticopsis pemphigodes (Pfeiffer, 1846). endemic to eastern Cuba. Fig. 5.

Coryda alauda denninsoni (Pfeiffer, 1853): endemic to Sierra Maestra. Fig. 6.

We thank Unidad de Medioambiente (UMA), Granma, and the Centro Oriental de Ecosistemas y Biodiversidad (BIOECO, Cuba) for support of the field work.

Fig. 5. *Cysticopsis pemphigodes*.

Fig. 6. *Coryda alauda denninsoni*.

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David Maceira Filgueira, Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), Enramadas No. 601 esquina Barnada, Santiago de Cuba 90100, Cuba. davidmaceira@yahoo.es
Yovanis Batista, Unidad de Medio Ambiente (UMA)
Delegación Provincial del Ministerio de Ciencia, Tecnología y Medio Ambiente, Granma, Cuba.

LAND MOLLUSCS OF THE SILLA DE ROMANO PROTECTED AREA, NORTH COAST OF CUBA, AND THEIR CONSERVATION PROBLEMS

By David Maceira Filgueira, Ramón Pascual Pérez & Jorge Reyes Brea

Silla de Romano Ecological Reserve is located in Romano Key, Sabana – Camagüey archipelago, north coast of Cuba. The reserve is 2141 ha in area and has a maximum elevation of 62 m above sea level. For Romano Key in particular, there is only one study of land molluscs (Rodríguez *et al*., 2006), which reported 17 species in semideciduous forest, representing 10 families and 17 genera. These authors also reported two undetermined genera of Annulariidae. The land mollusc fauna of this archipelago has been studied in general previously by Rodríguez-León Merino *et al*. (2007) who reported totals of 70 species, 31 genera and 19 families, but without providing a list of taxa. These authors found the greatest diversity of terrestrial molluscs in areas of semideciduos forest.

Fig. 1. Semideciduous forest. (Photo: Ansel Fong)

During 15-19 October 2008 terrestrial molluscs in the litter and soil, and on rocks, fallen tree trunks and vegetation were collected in the semideciduos forest areas (Fig. 1) and in areas of xeromorphic shrubs in the localities Silla de Cayo Romano, Pica del Gallego, Playa del Muerto and Aguada del Inglés. All samples are deposited in the Malacological Collection of BIOECO (BSC-M). Because of the intense plague of mosquitos – *Ochlerotatus taeniorhynchus* (Wiedemann) (Diptera: Culicidae) – it was impossible to develop a methodology that allowed estimation of populational densities of the land molluscs and we were only able to assess the species composition, endemism and threats. For Annulariidae, Torre & Bartsch (1938, 1941) was used to identify the species and nomenclature followed Watters (2006).

For the Silla de Romano protected area we report 25 terrestrial mollusc species. Of these 5 species are introduced (20 %) and 19 are endemic to Cuba (76 %). One species (4 %) has a wide

Fig. 2. Deforestation. (Photo: Ansel Fong)

Fig. 3. Habitat fragmentation. (Photo: Ansel Fong)

distribution in the Caribbean (*Truncatella caribaensis*). Pulmonates were the dominant group (72 %) with prosobranchs (24 %) and gymnomorphs (4%) making up the remainder. Silla de Romano is only the second reported locality for six species (24 %) that previously were considered local Cuban endemics. This adds value to the protected area, considering that this second locality is in a more fragile ecosystem than the type locality on the Cuban mainland. In this protected area more than a third (36 %) of the terrestrial mollusc fauna reported for the Sabana – Camagüey archipelago by Rodríguez-León Merino *et al*. (2007) are found.

In our study we found 14 of the species reported by Rodríguez *et al*. (2006). *Chondropoma confertum perplexum* Torre & Bartsch and two species of undetermined Annulariidae genera were not observed. We here report eight more species than Rodríguez *et al*. (2006) for Romano Key. Those authors did not list slugs and endemism was about 82 %. Pulmonate snails were much more numerous than prosobranchs and gymnomorphs, as we also found.

Human activity has caused deforestation (Fig. 2) and fragmentation (Fig. 3) of the original habitat with the associated introduction of four species of terrestrial snails not characteristic of this ecosystem (*Pupoides marginatus nitidulus*, *Lacteoluna selenina*, *Hawaiia minuscula*, *Praticolella griseola*). Wild pigs (*Sus scrofa*) are a real and potential danger for snail eggs in the soil and for the bigger species (*Zachrysia auricoma* and *Liguus fasciatus romanoensis*), which are used as a food source. In addition to deforestation and habitat fragmentation, other threats include erosion, introduction of exotic plants (*Dichrostachys cinerea* (L.), *Casuarina equisetifolia* and *Leucaena leucocephala* (Lam.)), introduction of exotic animals (*Bos taurus*, *Sus scrofa*, *Felis catus*, *Rattus rattus*, *Canis familiaris*, *Odocoileus virginianus*), droughts, hurricanes and fires (natural and caused by people). Although there is a camp operating as an ecological field station, it does not have the necessary resources to develop appropriate technical and administrative infrastructure to support research. There is also insufficient

Fig. 4. Patches without vegetation. (Photo: Ansel Fong)

personnel for patrolling and protecting the area, as well as communication difficulties and lack of suitable vehicles. In addition, there is ignorance among the public of the value of the natural resources, illegal extraction of wood for charcoal and firewood and illegal hunting and fishing.

Our goals are as follows:

- To carry out further inventories to complete our assessment of the land mollusc faunal composition.
- To undertake population density studies of *Zachrysia auricoma* and *Liguus fasciatus romanoensis*, which because of their humidity and vegetation density requirements may act as indicator mollusc species reflecting needs for ecosystem conservation.
- To obtain appropriate financing to establish an ecological station and for permanent support for investigators and personnel for patrolling and protecting of the area.
- To establish measures against erosion, forest fires and illegal hunting and fishing.
- To reforest with native plant species of the semideciduous forest and xeromorphic shrub habitats to recover the original vegetation structure and to eliminate patches without vegetation (Fig. 4).

Fig. 5. *Liguus fasciatus romanoensis*. (Photo: Luis Omar Melián Hernández)

Land mollusc species list

Subclass PROSOBRANCHIA

Order ARCHEOGASTROPODA

Family HELICINIDAE

Helicina sp.: endemic to Cuba and Romano Key.

Alcadia minima (d'Orbigny, 1842): endemic to Cuba (Espinosa & Ortea, 1999).

Order NEOTAENIOGLOSSA

Family ANNULARIIDAE

Parachondria (*Parachondria*) *revinctus biserranus* (Torre & Bartsch, 1938): previously considered a local endemic in Dos Sierras, Zulueta, Villa Clara (Torre & Bartsch, 1938); Silla de Romano is the second reported locality, 71 yr since its original description.

Parachondria (*Parachondria*) *delatreanus santafeus* (Torre & Bartsch, 1938): previously considered a local endemic in Loma de Santa Fe, Villa Clara (Torre & Bartsch,1938); Silla de Romano is the second reported locality, 71 yr since its original description.

Opisthosiphon (*Opisthosiphona*) *quinti quinti* (Torre & Bartsch, 1941): previously considered a local endemic in Isla de Turiguanó, Camagüey (Torre & Bartsch, 1941). Silla de Romano is the second reported locality, 68 yr since its original description.

Family TRUNCATELLIDAE

Truncatella caribaensis Reeve, 1826: occurs on many Caribbean islands.

Subclass GYMNOMORPHA

Order SOLEOLIFERA

Family VERONICELLIDAE

Veronicella sp.: endemic to Cuba.

Subclass PULMONATA

Order STYLOMMATOPHORA

Family PUPILLIDAE

Pupoides marginatus nitidulus (Pfeiffer, 1839): introduced to Cuba and Romano Key.

Family ORTHALICIDAE

Liguus fasciatus romanoensis Jaume, 1942: local endemic to Romano Key (Fig. 5) (Espinosa & Ortea, 1999).

Family UROCOPTIDAE

Macroceramus sp.: endemic to Cuba.

Microceramus sp.: endemic to Cuba.

Family CERIONIDAE

Cerion palmeri Sánchez Roig, 1948: local endemic to Romano Key (Espinosa & Ortea, 1999).

Cerion circumscriptum circumscriptum Aguayo *et* Jaume, 1951: local endemic to Romano Key (Espinosa & Ortea, 1999).

Cerion sanzi romanoensis Aguayo & Sánchez Roig, 1953: local endemic to Romano Key (Espinosa & Ortea, 1999).

Cerion sanzi sellare Aguayo & Sánchez Roig, 1953: local endemic to Silla de Romano (Espinosa & Ortea, 1999).

Cerion mumia cuspidatum Aguayo & Sanchez Roig, 1953: local endemic to Romano Key (Espinosa & Ortea, 1999).

Family SUBULINIDAE

Obeliscus homalogyrus homalogyrus (Shutleworth in Pfeiffer, 1851): endemic to Cuba (Espinosa & Ortea, 1999).

Family Oleacinidae

Oleacina solidula (Pfeiffer, 1840): endemic to Cuba (Espinosa & Ortea, 1999).

Family SAGDIDAE

Lacteoluna selenina (Gould, 1839): introduced to Cuba and Romano Key (Espinosa & Ortea, 1999).

Family VITRINIDAE

Hawaiia minuscula (Binney, 1840): introduced to Cuba and Romano Key (Espinosa & Ortea, 1999).

Family POLYGYRIDAE

Praticolella griseola (Pfeiffer, 1841): introduced to Cuba and Romano Key (Espinosa & Ortea, 1999).

Family CAMAENIDAE

Zachrysia auricoma (Férussac, 1822): endemic to Cuba (Espinosa & Ortea, 1999).

Family XANTHONICHIDAE

Cysticopsis naevula (Morelet, 1849): endemic to north coast of Camagüey, Las Tunas and Holguín provinces (Espinosa & Ortea, 1999).

Hemitrochus amplecta (Gundlach *in* Pfeiffer, 1860): endemic to north cost of Camagüey and Las Tunas provinces (Espinosa & Ortea, 1999).

Euclastaria euclasta (Shuttleworth, 1854): introduced to Cuba and Romano Key (Espinosa & Ortea, 1999).

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David Maceira Filgueira & Jorge Reyes Brea, Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), Enramadas No. 601 esquina Barnada, Santiago de Cuba 90100, Cuba. davidmaceira@yahoo.es
Ramón Pascual Pérez, Empresa para la Protección de la Flora y la Fauna, Camaguey, Cuba.

CAUSES OF EXTINCTION AMONG LAND AND FRESHWATER MOLLUSCS IN ISRAEL DURING THE LAST 15,000 YEARS

By Henk K. Mienis

During the last 15,000 years, from the beginning of the Natufian period, i.e. when humans started to build permanent settlements, 19 taxa of non-marine molluscs have become extinct in Israel (Mienis & Ortal, 1994; unpublished data), while numerous other taxa are on the brink of extinction. The extinct taxa are almost equally divided between terrestrial and aquatic species. Noteworthy among the terrestrial snails is the large number of hygrophilous ones. The extinct taxa are listed in Table 1.

Table 1. Extinct land and freshwater molluscs in Israel.

Heleobia longiscata (Bourguignat, 1856)
Cleopatra bulimoides syriaca Pallary, 1929
Acroloxus lacustris (Linnaeus, 1758)
Segmentina nitida (Müller, 1774)
Gyraulus crista (Linnaeus, 1758)
Biomphalaria alexandrina (Ehrenberg, 1831)
Radix auricularia auricularia (Linnaeus, 1758)
Carychium tridentatum (Risso, 1826)
Vertigo antivertigo (Draparnaud, 1801)
Gastrocopta sp.
Vallonia costata (Müller, 1774)
Vallonia pulchella (Müller, 1774)
Vallonia enniensis (Gredler, 1856)
Calaxis sp.
Euconulus fulvus (Müller, 1774)
Leguminaia saulcyi (Bourguignat, 1852)
Potomida littoralis delesserti (Bourguignat, 1852)
Unio mancus eucirrus Bourguignat, 1857
Pisidium milium Held, 1836

Of importance is the fact that the list includes two species of land snails that have never been formally described.

If we can reconstruct the reasons why these 19 taxa have become extinct during the past 15,000 yr, perhaps by the introduction of more advanced conservation guidelines we can avert the same fate for numerous other species that are now on the brink of extinction in Israel. For example the fact that all the molluscs in Israel have already been protected by law for more than 40 yr does not mean that we can sleep quietly.

None of the 19 taxa that became extinct during the past 15,000 yr disappeared because of over-collecting. In fact, none of the species listed above has ever been considered a commercial species and only during extreme situations of famine might the large freshwater mussels have been collected for food for short periods. The real reasons for extinction are various and probably include a combination of natural and anthropogenic causes.

Natural extinctions might have been triggered by changes in the climate resulting either in higher or lower temperatures and increase or decrease in rainfall. These changes might occur even during very short periods: in the rainy season of the winter of 1991-1992 most areas in Israel received two to three times the average amount of rainfall. Whole streams were washed clean of almost everything living in them; other streams changed their courses considerably and became intermittently flowing streamlets because of the great amounts of obstructions in their new streambeds. However, in the past 5 yr the annual rainfall has been far below the average amount, causing the drying up of permanent streamlets and waterholes and a sharp decline in the water level of the only large lake in Israel, the Sea of Galilee. All these natural events may have a disastrous effect on the aquatic mollusc fauna and land snails living in moist habitats such as riverbanks, swamps, etc.

Anthropogenic extinctions may have been triggered by the destruction of habitats, for example the drainage of swamps and rapid conversion of large areas characterized by natural vegetation into agricultural fields dominated by monocultures. However, building activities have also resulted in the urbanization of vast areas especially since the establishment of the State of Israel in 1948. During these early years of the State of Israel and the sudden increase of the population, pollution of streams by untreated urban and industrial effluents caused havoc among the aquatic fauna. Also, health measures taken by the British Mandate during the anti-malaria campaign that began in the early 1920s and continued well after Israeli independence, as well as the anti-bilharzia (now schistosomiasis) campaign during the 1950s carried out in some of the southern coastal rivers, impacted the mollusc fauna because of the intensive use of insecticides, herbicides and molluscicides.

Hardly anything is known about the possible negative influences of introduced species on the local mollusc fauna, although at least the freshwater fauna has to cope with intense competition from numerous exotic species that seem to be better adapted to the increasingly deteriorating conditions of the inland waters.

Examples of extinctions

Some of the local freshwater and terrestrial snails seem to have become extinct because of a slow but steady increase in temperature. Into this category falls the unknown *Calaxis* species. This species is known from the Mesolithic Natufian period of En Mallaha (Eynan) and the Neolithic period of Motza, but then disappears suddenly from the fauna of Israel.

The last findings of the freshwater mussel *Leguminaia saulcyi*, which occurred only in the coastal rivers, date back to the end of the 19th century (material in the collections in Paris, Frankfurt and Geneva). Not a single record of living material is known from British Palestine since the start of the 20th century and only quite recently have several subfossil specimens been found during excavations along the streambed of the river Yarqon near Tel Aviv. The rivers during the early 20th century were still more-or-less unspoiled and did not suffer from pollution, so we therefore we have to look for the most likely cause of extinction in a drop in stream flow, which might have been effected not only by a drop in rainfall but also by the building of dams in the river for water-powered mills.

In the last quarter of the 20th century two other large mussel species, *Potomida littoralis delesserti* and *Unio mancus eucirrus*, became extinct in the coastal rivers as a result of diversion of most of the water from the springs to reservoirs, which resulted in temporary drying up of parts of the streambeds, for example in the Tanninim and Yarqon rivers, and by pollution of the middle part of the latter river by urban effluents.

Drainage of swamps in the inner coastal region (since 1920) and the Hula Valley (in the 1950s) and the afforestation of parts of these former wetlands with exotic *Eucalyptus* trees has resulted in the extinction of *Heleobia longiscata*, *Acroloxus lacustris*, *Segmentina nitida*, *Gyraulus crista*, *Radix auricularia auricularia* (although *Radix auricularia virginea* (Preston, 1913), endemic to the Sea of Galilee, remained unaffected), *Carychium tridentatum*, *Vertigo antivertigo*, three species of *Vallonia* and *Euconulus fulvus.* Overpumping of water from the aquifer in the dune area has led to the extinction of an undescribed endemic species of *Gastrocopta.*

In the 1950s an anti-bilharzia campaign was carried out in the river Yarqon and Wadi Rubin, the lower part of the river Soreq. The target species was *Biomphalaria alexandrina*, the intermediate host of *Schistosoma mansoni*. Not only were large amounts of molluscicide used to extirpate the snail but also huge quantities of herbicides were used to get rid of an invasion of water hyacinth (*Eichhornia crassipes*), which was blocking the flow of water in the Yarqon. Although they caused a lot of harm to non-target species, it has remained questionable whether the chemicals killed the target snail species or that it succumbed because of the heavy pollution of the Yarqon. The latter impact caused the complete disappearance of all freshwater molluscs in the Soreq. In each case, along with the disappearance of *Biomphalaria alexandrina* another African element in the fauna of Israel, *Cleopatra bulimoides syriaca*, disappeared at the same time from the southern coastal rivers of Israel.

From the data presented briefly above it should be clear that simply placing a species, a family or even a whole phylum on an official list of protected species does not mean that they are safe and nothing can happen to them. All activities associated with development (in any form) should be screened for their direct and indirect impacts on the fauna and flora in general and in our case on the molluscs in particular. Land and freshwater molluscs are an important component of a sound terrestrial and aquatic biota and it is therefore of utmost importance to maintain them at the same level or even to improve their status. In other words, nature conservation and particularly conservation of molluscs requires more attention in planning schemes than it has been given in the past.

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Henk K. Mienis, National Collections of Natural History, Department of Zoology, Tel Aviv University, IL-69978 Tel Aviv, Israel; and National Natural History Collections, Berman Building, Hebrew University of Jerusalem, IL-91904 Jerusalem, Israel.
mienis@netzer.org.il

FIRST INVASION OF THE APPLE SNAIL *POMACEA INSULARUM* IN EUROPE

By Miguel Angel López, Cristian R. Altaba, Karl B. Andree & Verònica López

On 1 August 2009 an incipient invasion of apple snails was detected in the Ebro Delta, on the Mediterranean shore of Catalonia, Spain (Fig. 1). Conspicuous, bright reddish egg masses appeared on vegetation along a small canal (Fig. 2), which turned out to harbor a dense population of apple snails.

Pomacea canaliculata and closely related South American species have been introduced into South-east Asia, Japan, Hawaii and North America, causing many economic and ecological problems (Cowie *et al*., 2005; Estebenet *et al*.,

Fig. 1. Area of initial infestation in the Ebro Delta, close to l'Ermita de l'Aldea. Small irrigation canals divide extensive rice fields.

Fig. 2. Apple snail egg masses on water-edge vegetation at the canal shown in Fig.1.

2006; Rawlings *et al*., 2007; Hayes *et al*., 2008). The Ebro Delta specimens fall within the morphological variability and ecological range of *Pomacea insularum*, and their mitochondrial DNA variation matches that of *P. insularum*. This is the first instance of an invasion by apple snails in Europe.

Spreading from their initial occurrence at the Sèquia Mare canal, very close to l'Ermita de l'Aldea and adjacent to a fish farm, the apple snail population grew exponentially. At the beginning of August the population reached amazing densities of about 1 kg m^{-2}. By early September the spread of the apple snails was tremendous (Fig. 3), and they had colonized half of the interconnected canals in the northern half of the delta (up to 5.1 egg masses m^{-1}) as well as the main river channel (up to 6.2 egg masses m^{-1}). In the extensive rice fields, economic losses appear to be important. Research on this population's biology and possible control methods is ongoing (López *et al*., 2009, in prep.).

Apple snails reproduced continuously throughout the summer and have survived severe cold spells at the end of the autumn. They have been observed burrowing in order to survive desiccation. Dispersal has so far occurred only following aquatic habitats. The slow flow (~ 0.1 m s^{-1}) in the irrigation canals induces active upstream crawling (Fig. 4). When disturbed, however, the apple snails retreat into their shells and are then dispersed passively, rolling along the bottom substrate up to some 20 m downstream or floating longer distances. Thus their ability to thrive and disperse in the Ebro Delta shows that this bridgehead is firmly established.

The Ebro Delta is a heavily managed coastal plain, where freshwater habitats are almost completely anthropogenic. The economic impact on rice fields could be great (Fig. 5) but *P. insularum* can be kept under some control through planned,

Fig. 3. A dense population of *Pomacea insularum* just one and a half months after the species was detected.

Fig. 4. Counter-current crawling behavior of *P. insularum* in the Ebro Delta.

periodic management and desiccation. The main river channel, however, will remain as a reservoir of apple snails for reinvasion of canals. In ecological terms, a major change in food webs and biomass distribution is occurring in the agricultural areas. In contrast, most of the Ebro Delta Natural Park includes coastal, brackish or saline lagoons, so apple snails may not have an important impact there. However, human-mediated expansion of this biological invasion to other Mediterranean wetlands with different characteristics is most likely to happen soon, potentially affecting the local biodiversity, including native molluscs.

Spanish television news broadcasts about the invasion of apple snails in the Ebro Delta can be found at the following websites:
www.tv3.cat/videos/1423789/TN-migdia-10082009
The first news of this biological invasion. The news item follows the advertising - go to minute 27:15.
www.tv3.cat/videos/1478229/El-caragol-poma-envaeix-lEbre
The news item follows the advertising. This video can be freely inserted on any non-profit web site.

News of this invasion is also on the Biological Invasions Specialist Group Spanish blog:

General information about apple snails can be found at:
http://www.applesnail.net/

Fig. 5. Egg mass of *Pomacea insularum* on a maturing rice spike in the Ebro Delta.

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Miguel Angel López , Forestal Catalana SA, Sabino de Arana 34, 1r 1ª, 08028 Barcelona, Catalonia, Spain. MAngel.Lopez@irta.cat
Cristian R. Altaba, Laboratory of Human Systematics, University of the Balearic Islands, 07071 Palma, Balearic Islands, Spain. cristianr.altaba@uib.cat
Karl B. Andree, IRTA, Centra Poble Nou, Km 5.5, 43540 Sant Carles de la Ràpita, Catalonia, Spain.
Verònica López, Parc Natural del Delta de l'Ebre, 43580 Deltebre, Catalonia, Spain.

MOLLUSC SPECIES ASSESSED BY COSEWIC IN 2009

By Robert Forsyth & Dwayne Lepitzki

In 2009 the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed or re-assessed four species of molluscs.

Alasmidonta varicosa (Brook Floater) was newly assessed in April as Special Concern. This medium-sized freshwater mussel is confined to 15 widely scattered watersheds in Nova Scotia and New Brunswick. It was never abundant, usually representing only 1-5 % of the total freshwater mussel fauna present. The habitat is subject to impacts (shoreline development, poor agricultural practices and other water quality issues) with potential cumulative degradation on larger stretches of rivers. Populations appear to have been lost from two historic locations, although new populations have been found recently. Because this mussel has disappeared from approximately half of its US locations, the Canadian population now represents an important global stronghold for the species.

Barnea truncata (Atlantic Mud-piddock) was newly assessed in November as Threatened. In Canada this intertidal marine bivalve is restricted to a single population in the Minas Basin, Nova Scotia. Although *B. truncata* is adapted to boring into hard clay and soft rock, in Canada it is entirely dependent on a single geological formation, the red-mudstone facies within the basin, having an area less than 0.6 km^2. *Barnea truncata* settles on and bores into the mudstone, and once settled is immobile. Any changes in deposition of sediments can smother individuals or cover entire areas of habitat. Disturbances that change the sediment depositional regime are considered the main threat. Most serious is the increased frequency and severity of storms, due to climate change, which have the potential to rapidly bury habitat and smother individuals. It is expected that erosion from rising sea levels (storm surges) and increased rainfall (floods) would also contribute to habitat loss by sediment deposition. Proposed development in the basin could also alter or add to sediment deposition. The Canadian population is clearly disjunct from the nearest population, 350 km south, in Maine, and rescue is very unlikely.

Under Canada's Species at Risk Act (SARA), COSEWIC is required to review its assessments of species every ten years. Two species were re-assessed this year.

Haliotis kamtschatkana (Northern Abalone) was up-listed to Endangered in April. Highly valued for its meat, this marine mollusc is patchily distributed along the west coast of Canada. Despite a total moratorium on harvest in 1990, the species was designated as Threatened in 2000. Poaching is the most serious threat and continues to reduce population abundance, particularly the larger, more fecund component; however, all size classes have declined significantly over the past three generations (i.e. since 1978) with mature individuals declining an estimated 88-89 %. Low densities may further exacerbate the problem by reducing fertilization success in this broadcast spawner (the Allee effect). Although predators such as the recovering sea otter population are not responsible for recently observed declines, they may ultimately influence future abundance of abalone populations.

Alasmidonta heterodon (Dwarf Wedgemussel) was last assessed as Extirpated in 2000; this status was re-examined and confirmed in November 2009. In Canada this freshwater mussel was found only in the Petitcodiac River of New Brunswick. Considered common in 1960, it was extirpated from the river in 1968 following the construction of a

causeway across the river's estuary, eliminating passage of the host fish. There are plans to replace the causeway with a 280 metre long bridge; opening the gates to allow fish passage is expected in the spring of 2010. This is but the first step in the species' recovery. The Canadian status of this mussel is unlikely to change until the gates are functional, fish hosts are re-established, and Dwarf Wedgemussels are translocated directly from the US or through propagation from US populations.

COSEWIC was established in 1977 and made its first assessment in 1978. In 2003, the Species at Risk Act (SARA) established COSEWIC as an advisory body for government's decisions to list species under the Act. Twice each year, the Committee meets to assess the status of wild species, subspecies, varieties or other important units of biological diversity considered to be at risk in Canada. COSEWIC uses the best available scientific, aboriginal traditional and community knowledge provided by experts from governments, academia and others.

For more information on COSEWIC and links to status reports see www.cosewic.gc.ca.

Robert Forsyth, Research Associate, Royal British Columbia Museum, 675 Belleville Street, Victoria, British Columbia V8W 9W2, Canada; PO Box 3804, Smithers, British Columbia V0J 2N0, Canada. Tel +1 250 847 6699, r.forsyth@telus.net, rforsyth@mollus.ca
Dwayne Lepitzki, Wildlife Systems Research, Box 1311, Banff, Alberta T0L 0C0, Canada. lepitzki@telusplanet.net
Co-chairs, Mollusc Species Specialist Subcommittee, COSEWIC

INVASIVE EARTHWORMS: A THREAT TO EASTERN NORTH AMERICAN FOREST SNAILS?

By Arnold W. Norden

Forested areas of northeastern North America support a large number of snail species, many of which inhabit the forest floor (Hubricht, 1985). The fallen leaves and more finely divided vegetative material that comprise the upper layers of the forest floor provide snails with food, concealment, hibernation/ aestivation sites, and act as a sponge to absorb and retain moisture. As shown by Boag (1985) and Locasciulli & Boag (1987), the presence of some snail species is strongly correlated with a well developed leaf/humus layer, and some even extend their distribution below the surface into the litter/soil column. Clearly, the survival of those species of snails is dependent on the continued presence and yearly replenishment of leaf litter on the forest floor.

The past decade has seen the publication of numerous papers (Addison, 2008; Burtelow *et al*., 1998; Bohlen *et al*., 2004; Frelich *et al*., 2006; Gundale, 2002; Holdsworth *et al*., 2007) discussing the impact of invasive species of earthworms in the eastern United States and Canada. This research shows that non-native earthworms introduced into forested areas of northeastern North America can completely eliminate the upper leaf litter layer, move organic matter deeper and change the distribution of nutrients in the soil column and reduce their availability. The result is significant change in the flora of the forest floor and in the composition of the upper soil horizons.

Although little has been published about the impact of these changes on the forest floor fauna, Norden (2008) suggested that destruction of the leaf litter/humus layer by non-native earthworms at a site in Maryland resulted in fewer genera and species of land snails. Several authors, however, have noted that invasive earthworms are associated with the decline of plant community diversity (Holdsworth *et al*., 2007; Gundale, 2002), including the extirpation of at least one rare fern. Larson *et al*. (2009) found that the impact of exotic earthworm invasion can be so great that it is reflected in the tree rings of some deciduous trees. There are also indications that the changes brought about by exotic earthworm feeding enhance conditions for the germination of invasive weeds and may enhance their spread (Bohlen *et al*., 2004). That could also adversely impact land snail diversity. For instance, at his study site in Maryland Norden (2008) found that several species of snails (*Novisuccinea ovalis*, *Ventridens ligera*) regularly occurred on native herbaceous plants but not on the introduced *Alliaria petiolata*. Unfortunately, *A. petiolata*, a species identified by Bohlen *et al*. (2004) as possibly benefitting from the activity of exotic earthworms, is rapidly dominating the area, which could reduce food resources for those species of snails.

While the research cited above targets areas that were previously glaciated and do not support native earthworms, there is now documentation that these same invasive earthworms have successfully colonized areas of eastern North America well below the maximum extent of late Pleistocene glaciation. For instance, Norden (2008) noted that the exotic *Amynthas agrestis* was the dominant earthworm at his Maryland study site and Szlavecz & Csuzdi (2007) showed that non-native earthworms can dominate forested areas of Maryland. Callaham *et al*. (2004) also found *A. agrestis* to be prominent at sites that they examined in the southern Appalachian Mountains of Georgia. This suggests that the impact of the exotic earthworm invasion will affect a very large area of the Eastern Deciduous Forest.

Since non-native invasive earthworms continue to spread throughout forested areas of eastern North America, surveys should be conducted to determine how these very successful invaders are impacting the land snail fauna, and how significantly. Eliminating invasive earthworms once they have become established may not be feasible. However, it seems likely that their rapid spread is at least partly due to the release of excess bait by fisherman, the use of imported earthworms by organic gardeners, and the translocation of root-balled trees and shrubs. Restricting or eliminating these activities could slow the expansion of exotic earthworms.

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Arnold W. Norden, Maryland Department of Natural Resources, 580 Taylor Avenue, Annapolis, Maryland 21401, USA.
bnorden@dnr.state.md.us

HOW MANY SPECIES ARE INTRODUCED EVERY DAY? SOME INSIGHTS FROM A TROPICAL INSULAR STREAM IN BRASIL

By Igor C. Miyahira, Luiz E. M. de Lacerda, Sonia B. dos Santos

How many species are introduced every day? This is a central question in invasion ecology (Carlton & Geller, 1993). But this question does not have a simple answer because studying exotic species in this arrival and establishment phase is not common (Puth & Post, 2005), although it is during the first stages of introduction that invasion is more readily stopped (Simberloff, 1993). In general, at the beginning of the invasion process, the invaders do not cause any perceptible ecological problem and the population could be so small that they are not detected. Because of these difficulties an estimative of how many species are introduced every year is very difficult to obtain, althouth there are estimates in the literature (Carlton & Geller, 1993; Gaston *et al*., 2003). We do not have the final solution for this problem, but we have some insights into this question.

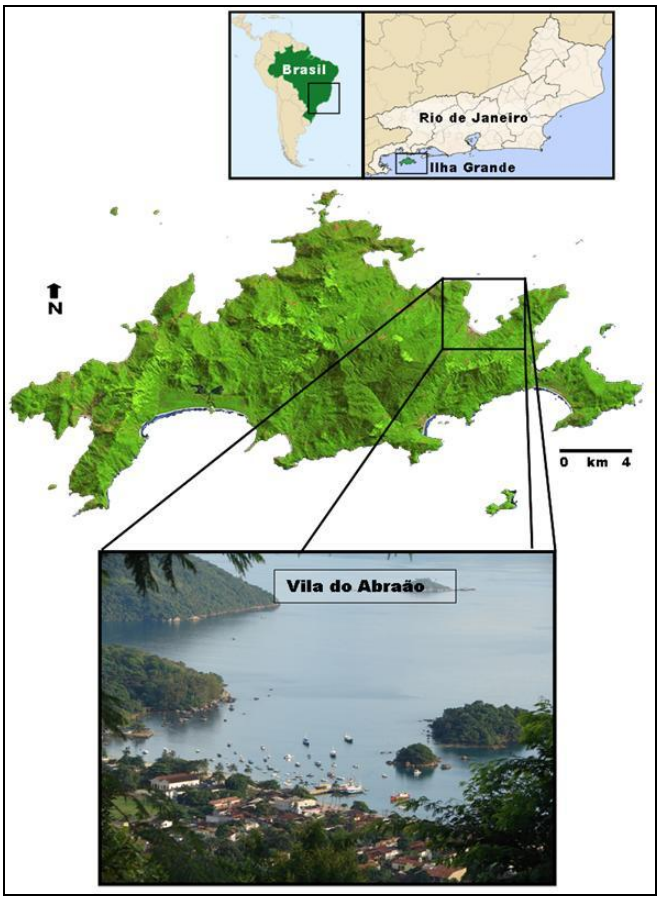

Fig. 1. Location of Vila do Abraão in Ilha Grande, Rio de Janeiro state, Brasil. The picture shows a panoramic view of Vila do Abraão. Noteworthy are the large number of boats in the bay, indicating a high flow of people. (Photo: I.C. Miyahira)

Since 2005, we have been studying the population dynamics of *Melanoides tuberculatus* (Müller, 1774), introduced into an insular stream in Ilha Grande (23° 05´ - 23° 15´ S; 44° 05´ - 44° 23´ W), the biggest continental island in Rio de Janeiro state, south-eastern Brasil (Santos *et al*., 2007). This stream is located at Vila do Abraão, the principal village in Ilha Grande, where the island's principal harbour is located (Fig. 1). After a long time as a prison-island, since the prison closed in 1995 a lot of people moved to the island. In addition, there is intense and increasing tourist activity, especially in the summer. Nowadays, as a consequence of urban development, this stream is subject to human impacts including domestic sewage discharge.

Previous work on the Vila do Abraão freshwater snail fauna reported the occurrence of only *Pisidium punctiferum* (Guppy, 1867), *Antillorbis nordestensis* (Lucena, 1954), *Gundlachia ticaga* (Marcus & Marcus, 1962), *Gundlachia* sp. and *Ferrissia* sp. (Haas, 1953; Santos *et al*., 1999; Thiengo *et al*. 2004). All these species are native Brasilian species. After we

detected the arrival of *M. tuberculatus* and also *Biomphalaria tenagophila* (d'Orbigny, 1835) in this stream in August 2005 (Santos *et al*., 2007) we decided to study the invasive behaviour of *M. tuberculatus*.

Eight collecting stations were established (P8 the most downstream; P1 the most upstream) at which snails were collected using a hand held metal scoop every two months for two years beginning in July 2006. At the start of the surveys we found *M. tuberculatus* only at the collecting stations near the stream mouth (P8, P7, P6) but after almost a year, in September 2008, it reached P3 (Miyahira *et al.*, 2009). Concerning *B. tenagophila*, the first live specimens were first found at P5 and apparently moved downstream. Considering we did not have *M. tuberculatus* or *B. tenagophila* in the stream until at least 2002 (Thiengo *et al*., 2004), in a three year period we had two successful snail introductions.

During our work we also collected *M. tuberculatus* at P1 (February 2009), accompanied by the pulmonate *Physa acuta* Draparnaud, 1805, another exotic snail (Paraense & Pointier, 2003). As we thus had a gap in the distribution of *M. tuberculatus* in the stream, absence of previous records of *P. acuta* and the appearance of the invasive plant *Eichhornia* sp., we considered it possible that we had a second *M. tuberculatus* introduction to the stream, perhaps introduced attached to *Eichhornia* sp. This aquatic plant did not become established in the stream but the snails are flourishing.

The establishment of these snails brings up some points of concern. Huge assemblages occur with thousands of snails (Fig. 2). We estimate maximum density as 47,555 snails/m^2 from the observed value of 4,280 snails/0.09m^2. This is a high value even for *M. tuberculatus* populations. The first concern is regarding the physical environment because such assemblages change sediment dynamics both quantitatively and qualitatively, as reported by Dudgeon (1982) in Hong Kong. Moreover, the *M. tuberculatus* population in this stream may be using previously unused nutrients. So, it is possible that this species can also modify nutrient dynamics in Vila do Abraão. However, we do not yet know how it is affecting native species, especially the small benthic bivalve *Pisidium punctiferum*.

Melanoides tuberculatus and *P. acuta* are widespread snails around the world (e.g. Fernandez *et al*., 2003; Paraense & Pointier, 2003). Negative effects of exotic snails on native ones have been reported for *M. tuberculatus* (Pointier, 1993, Fernandez *et al*., 2003) and for *P. acuta* (Zukowlski & Walker, 2009). The negative effects on the native fauna, both molluscs and other macro-invertebrates, are currently being investigated in Vila do Abraão stream.

In a six or seven year period we saw at least two *M. tuberculatus*, one *B. tenagophila* and one *P. acuta* introductions. Four successful introductions in a couple of years may not seem a lot, but this is a small insular stream in a village of 2,000 people. How many new introductions might occur in a river near or within a big city? Probably much more than four! A good example of an analysis of historical

Fig. 2. *Melanoides tuberculatus* (Müller, 1774) in Vila do Abraão stream, Ilha Grande, Rio de Janeiro state. (Photo: I.C. Miyahira)

invasions is the paper of Gaston *et al*. (2003), who reported 71 pterygote insect introductions in Gough island, part of the Tristan da Cunha archipelago in the middle of the south Atlantic Ocean. All these snail introductions to Vila do Abraão are probably due to the aquarium trade, as there are ornamental freshwater aquariums as well as small decorative ponds in many of the houses and hotels. Although most of Ilha Grande is designated as a protected area, inspection of goods that enter the island is almost nonexistent, so exotic freshwater snail introductions are probably underestimated.

Rigorous control of the aquarium trade is needed in order to control such invasions of freshwater habitats, as we know this kind of commerce spreads freshwater snails around the world. This will be the first step to stop these repeated introductions. Concerning Ilha Grande, the establishment of control strategies could prevent *M. tuberculatus*, a species able to colonize brackish waters (Barroso & Matthews-Cascon, 2009), from reaching Praia do Sul lagoons where endemic hydrobioids are found.

As already stated, invasive species can modify physical and biological environments. So, it is important for mollusc conservation to mitigate this problem. Repeated introductions constitute increased propagule pression (Lockwood *et al*., 2005), which increases the probability of exotic species establishment. If species introductions are stopped or at least reduced, the establishment of exotics species will decrease, reducing the negative effects of biological invasions.

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Igor C. Miyahira, Luiz E. M. de Lacerda & Sonia B. dos Santos, Universidade do Estado do Rio de Janeiro, Instituto de Biologia Roberto Alcantara Gomes, Laboratório de Malacologia Límnica e Terrestre, Rio de Janeiro, Brasil. icmiyahira@yahoo.com.br, lacerdauerjbio@yahoo.com.br, gundlachia@yahoo.com.br

THE MOLLUSC FAUNA OF SANTA CATARINA STATE, SOUTHERN BRASIL: KNOWLEDGE GAINED FROM 13 YEARS OF RESEARCH

By A. Ignacio Agudo-Padrón

After 13 yr (1996-2009) of systematic field work in diverse habitats including river basins, highlands, forests, coastal areas, traditional agricultural and fishing communities, as well as the necessary museum research and interaction with several regional and international researchers (Agudo & Bleicker, 2006; Agudo, 2007; Agudo-Padrón, 2009a-d; Agudo-Padrón & Bleicker, 2009a-b; Agudo-Padrón *et al*., 2009), we are now able to present an overall summary of current knowledge of the mollusc fauna of the small geographical territory of Santa Catarina (Fig. 1), until now considered one of the more poorly studied regions of southern Brasil in terms of its malacological biodiversity (Agudo & Bleicker, 2006: 8).

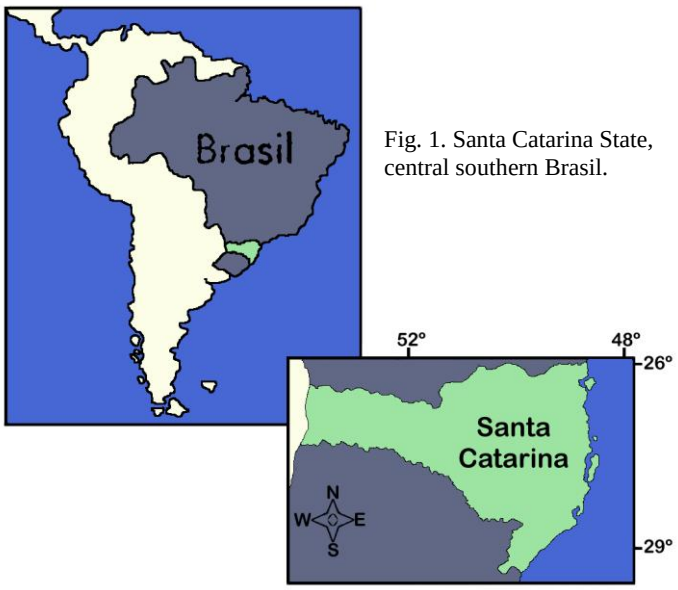

Fig. 1. Santa Catarina State, central southern Brasil.

Marine / estuarine taxa

We recorded a total of 675 species and confirmed subspecieses: 10 Polyplacophora, 412 Gastropoda, 10 Scaphopoda, 230 Bivalvia and 13 Cephalopoda (42 % of the total recorded from Brasil). Of these, 6 Gastropoda have previously been considered of conservation concern (for information on regional threat status see Mansur *et al*., 2003); 4 are recognized exotics (9 % of the total confirmed in Brasil); and at least 10 are directly involved in human activities (Agudo & Bleicker, 2006: 9).

Freshwater / limnic taxa

We recorded a total of 74 species and confirmed subspecies: 31 Bivalvia and 43 Gastropoda (20 % of the total recorded from Brasil). Of these, 12 Bivalvia and 1 Gastropoda have previously been considered of conservation concern. Based on the IUCN "Restricted Distribution" criterion, an additional 15 Gastropoda and 8 Bivalvia are strong candidates for threat status. In addition, of the total of 74 taxa, 5 are recognized exotics (12 % of the total confirmed in Brasil); 7 are intermediate vectors of human and veterinary disease parasites; and 2 are severe agricultural pests.

The following is a list of the freshwater taxa considered threatened or endangered in Santa Catarina state.

Class GASTROPODA

CAENOGASTROPODA

Family AMPULLARIIDAE Gray, 1824

Genus *Pomacea* Perry, 1811

Pomacea lineata (Spix, 1827) – Suggested category: ENDANGERED (EN). Occurrence in restricted area (artificially flooded areas, formerly small waterfalls and rapids of the Caveiras River [Salto do Rio Caveiras], Santa Catarina plateau). Strong regional threat from hydroelectric development. Preliminary population studies (Santos *et al*., 2005).

Pomacea sordida Swainson, 1822 – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (upper Mampituba River basin; Joinville region).

Family HYDROBIIDAE Stimpson, 1865

Genus *Potamolithus* Pilsbry, 1896

Potamolithus catharinae Pilsbry, 1911 – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (upper Itajaí River valley; Santa Catarina plateau; upper Tubarão River basin). Studied by Silva & Veitenheimer-Mendes (2004).

Potamolithus kusteri (Ihering, 1893) – Suggested category: ENDANGERED (EN). Occurrence in restricted area (artificially flooded areas, formerly small waterfalls and rapids of the Caveiras River [Salto do Rio Caveiras], Santa Catarina plateau). Strong regional threat from hydroelectric development. Preliminary population studies (Santos *et al*., 2005).

Potamolithus lapidum (d'Orbigny, 1835) – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley). Under strong agricultural influence.

Potamolithus philippianus Pilsbry, 1911 – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (upper Itajaí River valley).

PULMONATA

Family ANCYLIDAE Rafinesque, 1815

Genus *Hebetancylus* Pilsbry, 1913

Hebetancylus moricandi (d'Orbigny, 1846) – Suggested category: ENDANGERED (EN). Occurrence in restricted areas under severe human influence (Campos Novos municipal district, Canoas River basin). Studied by Lanzer (1996).

Uncancylus concentricus (d'Orbigny, 1835) – Suggested category: ENDANGERED (EN). Occurrence in restricted areas under severe human influence (Campos Novos municipal district, Canoas and Ibicui River basins; Uruguay River valley). Studied by Lanzer (1996).

Genus *Burnupia* Walker, 1912

Burnupia ingae Lanzer, 1991 – Suggested category: ENDANGERED (EN). Occurrence in restricted areas under severe human influence (Sombrio municipal district; Uruguay River valley). Studied by Lanzer (1996).

Genus *Ferrissia* Walker, 1903

Ferrissia gentilis Lanzer, 1991 – Suggested category: CRITICALLY ENDANGERED (CR). Occurrence in fragile restricted area of coastal sandbank lagoons under severe human influence (Sombrio municipal district). Studied by Lanzer (1996).

Family CHILINIDAE Dall, 1870

Genus *Chilina* Gray, 1828

Chilina fluminea (Maton, 1809) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (Tacuaruçú River basin, Santa Catarina plateau; Nova Teutônia, Uruguay River valley).

Chilina globosa Frauenfeld, 1881 – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (Canoas River basin, Santa Catarina plateau; upper Itajaí River valley).

Chilina parva Martens, 1868 – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (upper Mampituba River basin; Nova Teutônia, Uruguay River valley).

Family ELLOBIIDAE Pfeiffer, 1854

Genus *Pedipes* Férussac, 1821

Pedipes mirabilis (Mühlfeld, 1816) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (upper Itajaí River valley; Itapema) and in fragile restricted insular areas (Arvoredo Island – Marine Biological Reserve) [normally considered a marine species, but apparently with wide ecological tolerance; Agudo, 2004]

Famíly PLANORBIDAE Rafinesque, 1815

Genus *Acrorbis* Odhner, 1937

Acrorbis petricola Odhner, 1937 – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Class BIVALVIA

UNIONOIDA (freshwater mussels/naiads)

Family HYRIIDAE Swainson, 1840

Genus *Diplodon*, Spix, 1827

Diplodon parallelipipedon (Lea, 1834) – Suggested category: ENDANGERED (EN). Occurrence in restricted area (artificially flooded areas, formerly small waterfalls and rapids of the Caveiras River [Salto do Rio Caveiras], Santa Catarina plateau). Strong regional threat from hydroelectric development. Preliminary population studies (Santos *et al*., 2005).

VENEROIDA (freshwater clams)

Family CORBICULIDAE Gray, 1847

Genus *Cyanocyclas* Blainville, 1818

Cyanocyclas (= *Neocorbicula*) *limosa* (Maton, 1809) – Suggested category: ENDANGERED (EN). Occurrence in areas under severe human influence (upper Mampituba River basin; Fragosos River [Lageado dos Fragosos], Concórdia municipal district, Uruguay River valley).

Family SPHAERIIDAE Deshayes, 1854

Genus *Eupera* Bourguignat, 1854

Eupera klappenbachi Mansur & Veitenheimer-Mendes, 1975 – Suggested category: CRITICALLY ENDANGERED (CR). Occurrence in fragile restricted area of strait sandbank streams (drainage channels), under severe human influence (fields of the Baixada do Maciambú, Serra do Tabuleiro Ecological State Park). See Agudo-Padrón & Bleicker (2009a: 10).

Eupera platensis Doello-Jurado, 1921 – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Fragosos River [Lageado dos Fragosos], Concórdia municipal district, Uruguay River valley) under severe human influences.

Genus *Pisidium* Pfeiffer, 1821

Pisidium globulus Clessin, 1888 – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Pisidium observationis (Pilsbry, 1911) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (Tacuaruçú River basin, Santa Catarina plateau).

Pisidium pipoense (Ituarte, 2000) – Suggested category: ENDANGERED (EN). Occurrence in restricted area (São José River [Lageado São José], Chapecó municipal district, Uruguay River valley) under severe human influence. Preliminary population studies (Perizzolo, 2003).

Pisidium taraguyense (Ituarte, 2000) – Suggested category: ENDANGERED (EN). Occurrence in restricted area (São José River [Lageado São José], Chapecó municipal district, Uruguay River valley) under sever human influence. Preliminary population studies (Perizzolo, 2003).

Terrestrial /amphibious taxa

We recorded a total of 116 species and confirmed subspecies

of Gastropoda (17 % of the total recorded from Brasil). Of these, 6 have previously been considered of conservation concern. Based on the IUCN "Restricted Distribution" criterion, an additional 31 are strong candidates for threat status. In addition, of the total of 116 taxa, 12 are exotic (27 % of the total confirmed in Brasil); 12 are intermediate vectors of human and veterinary disease parasites; and 13 are severe agricultural pests.

The following is a list of the terrestrial taxa considered threatened or endangered in Santa Catarina state.

Class GASTROPODA

CAENOGASTROPODA

Family HELICINIDAE Férussac, 1822

Genus *Oxyrhombus* Fischer & Crosse, 1893

Oxyrhombus densestriatus Wagner, 1910 – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Genus *Alcadia* Gray, 1840

Alcadia iheringi Wagner, 1910 – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Family DIPLOMMATINIDAE Pfeiffer, 1856

Genus *Adelopoma* Döring, 1884

Adelopoma paraguayana Parodiz, 1944 – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

PULMONATA

Family BULIMULIDAE Tryon, 1867

Genus *Drymaeus* Albers, 1850

Drymaeus henselii (Martens, 1868) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe agricultural influence (São José do Oeste municipal district, Uruguay River valley).

Drymaeus papyrifactus (Pilsbry, 1898) – Suggested category: CRITICALLY ENDANGERED (CR). Occurrence in fragile restricted area (Moleques do Sul Island, Serra do Tabuleiro Ecological State Park). See Agudo-Padrón & Bleicker (2009a: 10).

Genus *Naesiotus* Albers, 1850

Naesiotus eudioptus (Ihering in Pilsbry, 1897) – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Family AMPHIBULIMIDAE Fischer, 1873

Genus *Simpulopsis* Beck, 1837

Simpulopsis (*Eudioptus*) *araujoi* Breure, 1975 – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Simpulopsis (*Simpulopsis*) *pseudosulculosa* Breure, 1975 – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Simpulopsis (*Simpulopsis*) *wiebesi* Breure, 1975 – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Family MEGALOBULIMIDAE Leme, 1973

Genus *Megalobulimus* Miller, 1878

Megalobulimus gummatus (Hidalgo, 1870) (Fig. 2) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe agricultural influence (Uruguay River valley). Shells used for artisanal souvenirs.

Megalobulimus haemastomus (Scopoli, 1786) (Fig. 3) – Suggested category: ENDANGERED (EN). Occurrence in restricted areas under severe human influence (extreme west, Uruguay River valley; Ganchos, Governador Celso Ramos municipal district of greater Florianópolis). Shells used for artisanal souvenirs.

Family STROPHOCHEILIDAE Pilsbry, 1902

Genus *Strophocheilus* Spix, 1827

Strophocheilus pudicus Müller, 1774 (Fig. 4) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (Tacuaruçú River basin, Santa Catarina plateau).

Genus *Mirinaba* Morretes, 1962

Mirinaba unidentata (Sowerby, 1825) (Fig. 5) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (Teresópolis and São Bonifácio, greater Florianópolis highland region).

Genus *Anthinus* Albers, 1850

Anthinus (= *Gonyostomus*) *turnix* (Gould, 1846) (Fig. 6) – Suggested category: CRITICALLY ENDANGERED (CR). Occurrence in restricted areas (Morro da Lagoa, Santa Catarina Island) under strong and diverse human influences.

Family ODONTOSTOMIDAE Pilsbry & Vanatta, 1898

Genus *Bahiensis* Jousseaume, 1877

Bahiensis punctatissimus (Lesson, 1830) – Suggested category: CRITICALLY ENDANGERED (CR). Occurrence in restricted areas (coastal damp forests on Santa Catarina Island) under strong and diverse human influences.

Genus *Macrodontes* Swainson, 1840

Macrodontes grayanus (Pfeiffer, 1845) (Fig. 7) – Suggested category: ENDANGERED (EN). Occurrence in restricted areas (Teresópolis, greater Florianópolis highland region) under severe human influence.

Macrodontes gargantua (Férussac, 1821) (Fig. 8) – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Macrodontes fasciatus (Pfeiffer, 1869) – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Family STREPTAXIDAE Gray, 1806

Genus *Streptaxis* Gray, 1837

Streptaxis iheringi Thiele, 1927 – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (Corupá, northern region).

Genus *Rectartemon* Backer, 1925

Rectartemon muelleri (Thiele, 1927) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (Blumenau, upper Itajaí River valley).

Family SYSTROPHIIDAE Thiele, 1926

Genus *Prohappia* Thiele, 1927

Prohappia besckei (Dunker, 1847) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (Blumenau, upper Itajaí River valley).

Genus *Happia* Bournat, 1889
Happia insularis (Boettger, 1889) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe agricultural influence (Santa Catarina plateau region).
Happia vitrina muelleri Thiele, 1927 – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (Blumenau, upper Itajaí River valley).

Genus *Happiella* Thiele, 1927
Happiella grata (Thiele, 1927) – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Genus *Miradiscops* Backer, 1925
Miradiscops brasiliensis (Thiele, 1927) – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Family CHAROPIDAE Hutton, 1884

Genus *Radiodiscus* Pilsbry & Ferris, 1906
Radiodiscus bolachaensis Fonseca & Thomé, 1994 – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.
Radiodiscus costellifer Scott, 1957 – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.
Radiodiscus goeldii (Thiele, 1927) – Suggested category: ENDANGERED (EN). Occurrence in restricted area (Nova Teutônia, Uruguay River valley) under strong agricultural influence.

Genus *Zilchogyra* Weirauch, 1965
Zilchogyra clara (Thiele, 1927) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influence (Santa Catarina plateau; Nova Teutônia, Uruguay River valley).

Genus *Lilloiconcha* Weirauch, 1965
Lilloiconcha gordurasensis (Thiele, 1927) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influences (Santa Catarina plateau; Nova Teutônia, Uruguay River valley).

Family EUCONULIDAE Baker, 1928

Genus *Habraconus* Fischer & Crosser, 1871
Pseudoguppya (= *Habroconus*) *semenlini* (Moricand, 1846) – Suggested category: VULNERABLE (VU). Occurrence in areas under severe human influences (São João do Oeste and Nova Teutônia, Uruguay River valley).

For more complete and detailed information concerning the species recognized to date in Santa Catalina state, please contact the author of this contribution.

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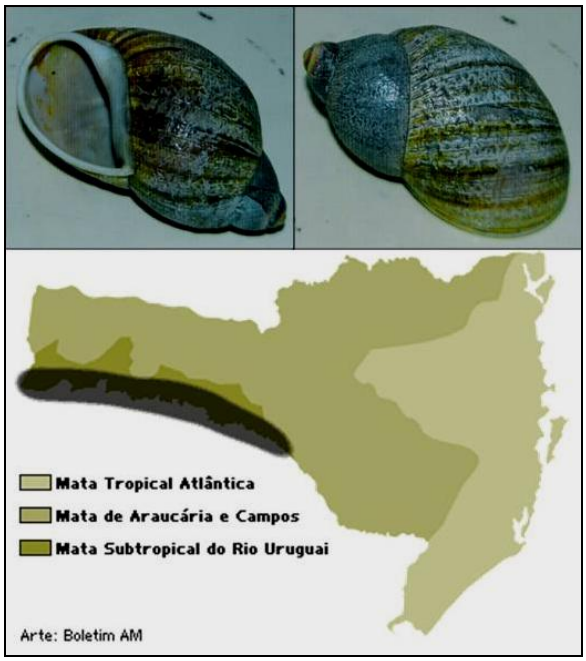

Fig. 2. *Megalobulimus gummatus* (Hidalgo, 1870) and its occurrence in the Uruguay River Valley, SC. (Photos: Agudo-Padrón)

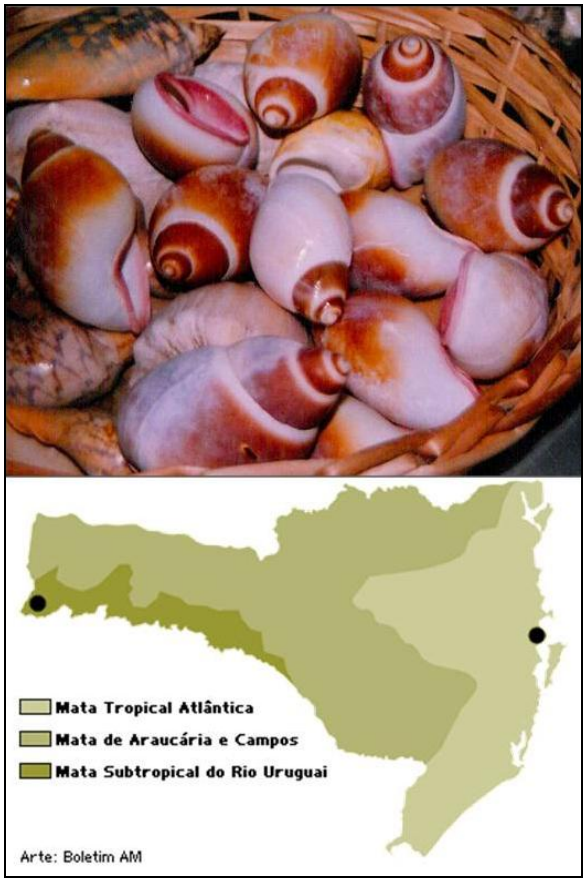

Fig. 3. *Megalobulimus haemastomus* (Scopoli, 1786) and its restricted occurrence in the Uruguay River valley (map – left) and greater Florianópolis (map – right) regions. (Photo: Agudo-Padrón)

Fig. 4. *Strophocheilus pudicus* Müller, 1774 of the Santa Catarina State Plateau. (Photo: Agudo-Padrón)

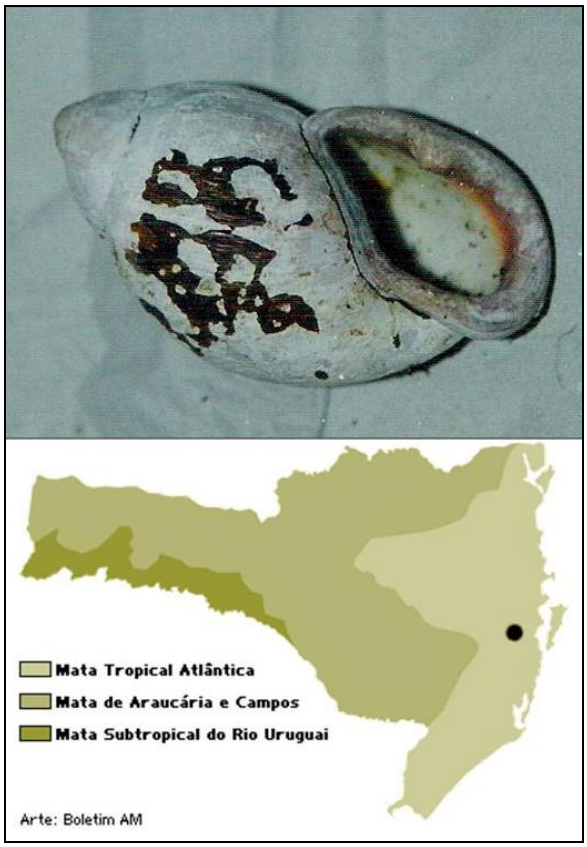

Fig. 5. *Mirinaba unidentata* (Sowerby, 1825) and its occurrence in the greater Florianópolis highland region. (Photo: Agudo-Padrón)

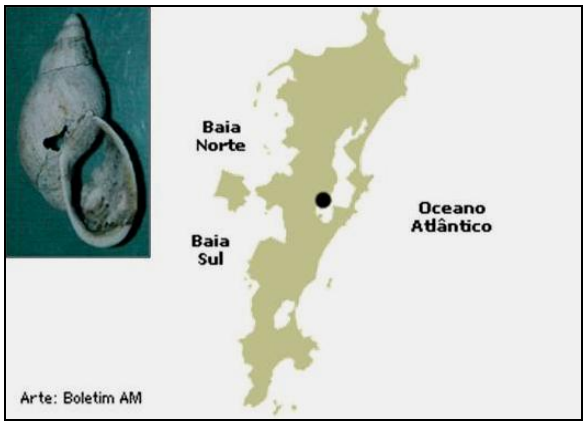

Fig. 6. *Anthinus* (= *Gonyostomus*) *turnix* (Gould, 1846) and its restricted occurrence in Santa Catarina Island. (Photos: Agudo-Padrón)

Fig. 7. *Macrodontes grayanus* (Pfeiffer, 1845) and its restricted occurrence in the greater Florianópolis highland region. (Photos: Agudo-Padrón)

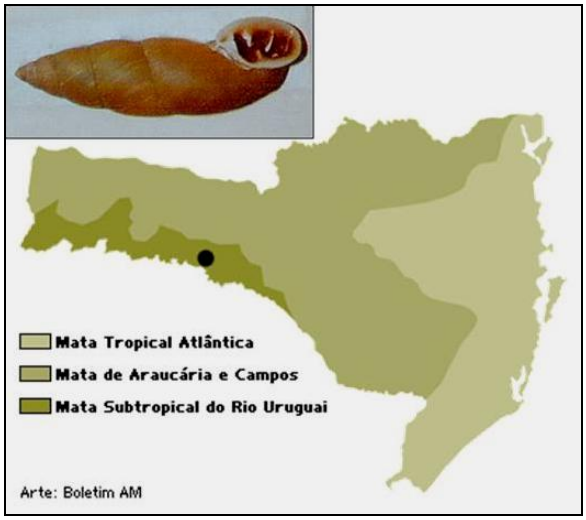

Fig. 8. *Macrodontes gargantua* (Férussac, 1821) and its restricted occurrence in the Uruguay River Valley. (Photo: Agudo-Padrón)

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A. Ignacio Agudo-Padrón, Project Avulsos Malacológicos, P.O. Box 010, 88010-970 Centro, Florianópolis, Santa Catarina - SC, Brasil. ignacioagudo@gmail.com www.malacologia.com.br

INTRODUCED AND INVASIVE MOLLUSCS IN BRASIL: A BRIEF OVERVIEW

By A. Ignacio Agudo-Padrón & Paulo Lenhard

Initially questioned by local specialists (Santos, 2006), recently (November 2008) the presence of the European slug *Milax valentianus* Férussac, 1821 (Milacidae) was definitively confirmed in the southern Brasil region of Santa Catarina (SC) and Rio Grande do Sul (RS) states (Agudo-Padrón 2008b, in press) (Fig. 1). This should not be surprising given the range expansion of this species worldwide, which is an agricultural and horticultural pest. It has also become an issue for the trade of plants whether for food or ornamental purposes.

Fig. 1. The European slug *Milax valentianus* Férussac, 1821 (Milacidae), a new confirmed record of an invasive alien non-marine mollusc in southern Brasil. (Photos: Paulo Lenhard)

Because of the globalization of trade, individuals of this species are even transported passively among continents with little customs intervention. Another case of passive introduction through trade is that of the small exotic slug *Deroceras laeve* (Müller, 1774) (Thomé *et al*., 2007).

An additional global ecological threat is that of exotic bivalves such as species of limnic mussels and clams (Scarabino & Mansur, 2007). In Brasil, major efforts on exotic species are now focused on freshwater bivalves (Mansur, 2008b).

The environmental and socioeconomic impacts of two of the several species of exotic molluscs detected in Brasil (Fig. 2) have been reviewed (Agudo[- Padrón], 2007): the giant African land snail, *Lissachatina fulica* (Bowdich, 1822) (Achatinidae) and the small Asian golden mussel, *Limnoperna fortunei* (Dunker, 1857) (Mytilidae). The latter is considered to have potentially major ecological impact due to its capacity to modify the environment and to its forming of macrofouling on native bivalves, impeding them from filtering their food (Mansur, 2008a, b). Historically, such species have attracted public attention and governmental action including control programmes (Agudo-Padrón 2008a).

Asian golden mussels have invaded the La Plata River Basin between Argentina and Uruguay and the watersheds of the Paraná, Paraguay and Uruguay Rivers. Already six Brasilian states have been invaded, including Rio Grande do Sul and Paraná in the south, Mato Grosso do Sul and Mato Grosso in the central-western region and Minas Gerais and São Paulo in the south-east. It is feared that the mussels could soon spread to Santa Catarina state as well as to Brasilian Amazônia (Agudo[-Padrón], 2007; Agudo-Padrón, 2007, 2008a). These regions have already been invaded by other species such as the limnic Asian clams *Corbicula* spp. (Callil *et al*., 2007).

Currently 44 exotic species of mollusc have been reported from Brasil: four freshwater mussels and clams, seven freshwater gastropods, five marine and estuarine bivalves, 20 terrestrial snails and eight slugs. They represent 32 genera, 23 families and two classes (Boffi, 1979; Fonseca & Thomé, 1995; Domaneschi & Martins, 2002; Miquel *et al*., 2004; Souza *et al*., 2005; Agudo[-Padrón] & Bleicker, 2006; Simone, 2006; Simone & Gonçalves, 2006; Thomé *et al*.,

Fig. 2. Asiatic golden mussel *Limnoperna fortunei* (left) and giant African snail *Achatina fulica* (right), the most important invasive exotic molluscs in Brasil. (Photos: A. I. Agudo-Padrón)

2006, 2007; Thiengo *et al*., 2007a, b; Agudo[-Padrón], 2008; Mansur, 2008a). There is also the potential for other exotic species already detected in neighboring countries to invade Brasil (Campos & Calvo, 2006; Simone, 2006; Thomé *et al*., 2006, 2007).

The following list of confirmed introduced molluscs in Brasil is based mainly on the contributions of Simone (2006) and Thomé *et al*. (2006, 2007).

Terrestrial taxa

GASTROPODA – 28 taxa

Family ACHATINIDAE
Achatina fulica (Bowdich, 1822) – Fig. 2.
Achatina monochromatica (Pilsbry, 1904) – Species kept in captivity (commercial heliciculture and laboratory).

AGRIOLIMACIDAE
Deroceras agreste (Linnaeus, 1758)
Deroceras laeve (Müller, 1774)
Deroceras reticulatum (Müller, 1774)

Family BRADYBAENIDAE
Bradybaena similaris (Rang, 1831) – Fig. 3.

Family DISCIDAE
Anguispira alternata (Say, 1816)

Family GASTRODONTIDAE
Zonitoides arboreus (Say, 1816) – Placed in Zonitidae by Campos & Calvo (2006).
Zonitoides nitidus (Müller, 1774) – Placed in Gastrodontidae by Simone (2006) but in Zonitidae (genus *Oxychilus*) by Salgado & Coelho (2003) and Thomé *et al*. (2007).

Fig. 3. Giant garden leopard slug, *Limax maximus* Linnaeus, 1758 (left), and common garden snail *Bradybaena similaris* (Rang, 1831) (right). (Photos: Paulo Lenhard)

Fig. 4. European slugs *Milax gagates* (Draparnaud, 1801) (Milacidae), a new confirmed record of this invasive alien continental mollusc in southern Brasil (Agudo-Padrón, 2009). (Photos: Paulo Lenhard)

Family HELICIDAE
Helix (*Cornu*) *aspersa* Müller, 1774
Helix lucorum (Linnaeus, 1758) – Species kept in captivity (commercial heliciculture and laboratory).
Helix pomatia Linnaeus, 1758 – Species kept in captivity (commercial heliciculture and laboratory).

Family LIMACIDAE
Limacus flavus (Linnaeus, 1758)
Limax maximus Linnaeus, 1758 – Fig. 3.

Family MILACIDAE
Milax gagates (Draparnaud, 1801) – Fig. 4.
Milax valentianus Férussac, 1821 – Fig. 1. Treated as *Lehmannia valentiana* (Limacidae) by most authors, including Simone (2006).

Family PHILOMICIDAE
Pallifera sp. – Fig. 5. Specific identity undetermined (Thomé *et al*., 2006, 2007).

Family PUNCTIDAE
Paralaoma servilis (Shuttleworth, 1852)

Family SPIRAXIDAE (= OLEACINIDAE)
Euglandina rosea (Férussac, 1821) – Reported from the Amazonian State of Pará by Silva & Silva (2006) but may be the native species *Euglandina striata* (Müller, 1774) (see Simone, 2006).

Family SUBULINIDAE
Lamellaxis clavulinus (Potiez & Michaud, 1838)
Opeas opella Pilsbry & Vanatta, 1905
Opeas pumilum (Pfeiffer, 1840)
Rumina decollata (Linnaeus, 1758) – Fig. 5.

Family THYSANOPHORIDAE
Thysanophora caeca (Guppy, 1866-68) – Placed in Polygiridae by Thomé *et al*. (2007).

Family VALONIIDAE
Pupisoma discoricola (Adams, 1845) – Placed in Vertiginidae by Simone (2006).
Vallonia pulchella (Müller, 1774)

Family VERTIGINIDAE
Vertigo ovata Say, 1822

Fig. 5. Undetermined exotic slugs *Pallifera* sp. (left) and carnivorous Mediterranean snail *Rumina decollata*, with eggs (right). (Photos: A. I. Agudo-Padrón)

Family ZONITIDAE
Oxychilus cellarius (Müller, 1774)

Freshwater / limnic taxa

GASTROPODA – 7 taxa

Family AMPULLARIIDAE
Pomacea paludosa (Say, 1829)

Family PHYSIDAE
Aplexa rivalis (Maton & Rackett, 1807)

Family PLANORBIDAE
Biomphalaria pfeifferi (Krauss, 1848)
Bulinus tropicus (Krauss, 1848)
Helisoma caribaeum (d'Orbigny, 1845)
Helisoma duryi (Wetherby, 1879)

Family THIARIDAE
Melanoides tuberculatus (Müller, 1774)

BIVALVIA – 4 taxa

Family CORBICULIDAE
Corbicula fluminalis (Müller, 1774)
Corbicula fluminea (Müller, 1774)
Corbicula largillierti (Philippi, 1844)

Family MYTILIDAE
Limnoperna fortunei (Dunker, 1857) – Fig. 2.

Marine / estuarine taxa

BIVALVIA – 5 taxa

Family OSTREIDAE
Crassostrea gigas (Thumberg, 1795) – Species kept in captivity (commercial marine farms) in southern Brasil (Agudo[-Padrón] & Bleicker, 2006: 7).
Crassostrea virginica (Gmelin, 1791) – Species kept in captivity (commercial marine farms) in southern Brasil (Agudo[-Padrón] & Bleicker, 2006: 7).

Family ISOGNOMONIDAE
Isognomon bicolor (C. B. Adams, 1845)

Family MYTILIDAE
Myoforceps aristatus (Dillwyn, 1817)

Family DREISSENIDAE
Mytilopsis leucophaeta (Conrad, 1831)

In addition to the above confirmed introduced species, the origins as native or exotic of seven species are currently unresolved.

BIVALVIA

Family MYTILIDAE
Perna perna Linnaeus, 1758 – marine/estuarine. Considered exotic in Brasil by Souza *et al*. (2004), but native by Schaefer *et al*. (2009) based on material from prehistoric archaeological sites in Brasil.

GASTROPODA

Family PHYSIDAE
Physa acuta Draparnaud, 1805 –freshwater/limnic. Considered native in Brasil by Simone (2006).

GASTROPODA

Family VERTIGINIDAE
Gastrocopta servilis oblonga (Pfeiffer, 1853)
Gastrocopta pellucida hordeacella Pilsbry, 1890 – Considered native in Brasil by Simone (2006).

Family SUBULINIDAE
Lamellaxis gracilis (Hutton, 1834)
Leptinaria monodon (Adams, 1849) – Considered native in Brasil by Simone (2006).
Subulina octona (Bruguière, 1789) – Considered native in Brasil by Thomé *et al*. (2006).

Finally, below are listed a further 16 non-indigenous mollusc species, not found in Brasil, including three marine and estuarine bivalves, two marine and estuarine snails, two freshwater bivalves, two freshwater gastropods, six terrestrial snails and one slug (15 genera, 12 families, 2 classes), with the potential for invading Brasil.

Marine/estuarine taxa

BIVALVIA

Family MYTILIDAE
Mytilus galloprovincialis (Lamarck, 1819)
Perna viridis (Linnaeus, 1758)

Family CORBULIDAE
Potamocorbula amurensis (Schrenck, 1867)

GASTROPODA

Family ELLOBIIDAE
Myosotella myosotis (Draparnaud, 1801)

Family MURICIDAE
Rapana venosa (Valenciennes, 1846)

Freshwater/limnic taxa

BIVALVIA

Family UNIONIDAE
Anodonta (*Cristaria*) *woodiana* (Lea, 1831)

Family DREISSENIDAE
Dreissena polymorpha Pallas, 1771

GASTROPODA

Family PLANORBIDAE
Biomphalaria alexandrina (Ehrenberg, 1831) – Previously mentioned by Morretes (1953) and Paraense (2001).

Family THIARIDAE
Tarebia granifera (Lamarck, 1822)

Terrestrial taxa

GASTROPODA

Family ARIONIDAE
Arion subfuscus (Draparnaud, 1805)

Family CHONDRINIDAE
Chondrina pallida amicta (Pareyss in Pfeiffer, 1854)

Family FERRUSSACIIDAE
Cecilioides acicula (Müller, 1774)

Family HELICIDAE
Helicella variabilis (Draparnaud, 1801)
Otala lactea (Müller, 1774)
Otala punctata (Müller, 1774)

Family SUBULINIDAE
Opeas goodalli (Miller, 1822)

In addition to environmental changes, native Brasilian molluscs face potentially enormous competition from introduced species, which are also impacting human health and agricultural and commercial activities. Given that these exotic species lack natural biological controls they may cause the extinction of native ones.

For more complete and detailed information concerning the species recognized to date in Brasil, please contact the first author of this contribution.

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A. Ignacio Agudo-Padrón ignacioagudo@gmail.com
Paulo Lenhard paulolenhard@gmail.com
Project Avulsos Malacológicos, P.O. Box 010, 88010-970 Centro, Florianópolis, Santa Catarina - SC, Brasil. www.malacologia.com.br

FRESHWATER BIVALVES IN NORTH AMERICA

The Asian clam, *Corbicula fluminea*, in eastern Canada: discovery of a large population near Gentilly, Québec, in the St. Lawrence River

By André L. Martel , Anouk Simard, Annie Paquet, Charles Jutras, Yves Robitaille, Réhaume Courtois and Pierre U. Blier

The Asian clam, *Corbicula fluminea*, a corbiculid native to South-east Asia, was introduced to North America's freshwater systems nearly a century ago, with the first record originating from Nanaimo, British Columbia, Canada, in 1924 (Counts, 1981; McMahon, 1983). McMahon & Bogan (2001) considered this species as one of the most invasive of all North American bivalves. Since that first discovery in Nanaimo, this bivalve has become established in numerous temperate to warm-water bodies across the United States. Low water temperature (and ice formation) during winter appears to limit its northern distribution in North America, including Canada, because its survival is compromised below 2° C (see review by McMahon, 1983). For instance, in 2000, a few live *C. fluminea* were observed in the shallow waters of the delta of Lake St. Clair, Ontario, although further searches the following year failed to reveal any live specimens (Dave Zanatta, pers. comm.). It is believed that this bivalve does not survive winter conditions east of the Rocky Mountains in Canada. *Corbicula fluminea* prefers shallow water habitats (Karatayev *et al*., 2003) where, in most of Canada, winter ice forms and water temperatures approach 0° C for extended periods. Coastal regions of British Columbia, such as Vancouver Island and the greater Vancouver region offer more favourable temperate climate regimes. Recently, a population of *C. fluminea* was discovered in a lake system near Victoria, adjacent to the Sooke Lake watershed, where the city takes up its water supply (Kirkendale & Clare, 2008).

During fall 2009 a large and reproducing population of the Asian clam was discovered in the St. Lawrence River, in the discharge plume of the nuclear power plant of Gentilly-2, near the towns of Gentilly and Bécancour, Québec, Canada. The first specimen, an empty shell 16 mm in length (Fig. 1), was collected during a survey of unionid mussels in the area in September 2009. To determine whether a population of live Asian clams was indeed present in the St. Lawrence, during November 2009 we set up 21 stations where bottom samples were collected using an Eckman grab (0.1 m^2). Bottom sediments were collected both upstream and downstream from the Gentilly-2 nuclear station. We found 54-344 live individuals per m^2 (in addition to shell remains), varying in size from a few millimetres up to 25 mm shell length, suggesting the establishment of a permanent population. These observations confirm the establishment of an Asian clam population in the St. Lawrence River.

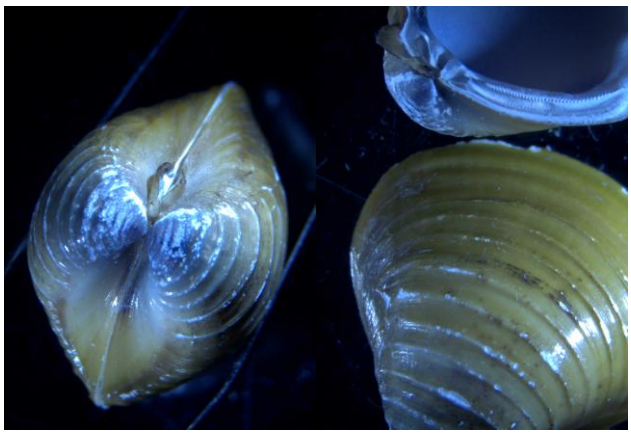

Fig. 1. First confirmed specimen of the Asian clam, *Corbicula fluminea*, collected in shallow water in the St. Lawrence River, near Gentilly, Québec, in July 2009.

We have not yet found any specimens upstream from the power station but individuals were present at least 2 km downstream. The likelihood of spread of this invasive mollusc to other sectors of the St. Lawrence River is unknown. In this case, however, the warm water plume of the power plant downstream of the Gentilly-2 power station appears the key factor allowing this species to become established and successfully overwinter. In the Laurentian Great Lakes drainage system, *C. fluminea* had been previously discovered living in the warm-water discharge plume of a steam-electric power plant on the St. Clair River (French & Schloesser, 1991) and on the lower Connecticut River (Morgan *et al*., 2004). In northern regions where winters are cold and water temperatures unfavourable to *C. fluminea*, studies have shown that warm water discharge plumes of power-generating plants create favourable and permanent habitats for this invasive species (McMahon, 1983; French & Schloesser, 1991).

The present study constitutes the most northerly record of this invasive species for North America, as well as the first record for this species in the province of Québec. The long-term ecological impact this invasive bivalve will have on the native molluscan communities of the St. Lawrence River is unknown. The native unionids of the St. Lawrence River have already been severely impacted by the introduction of the zebra mussel and quagga mussel. These invasive dreissenids out-compete and eventually eliminate native unionid mussels by secreting and attaching a large number of byssal threads onto the native shell, as well as feeding on the same planktonic resources. The adult Asian clam lives slightly buried or on top of the sediment and does not secrete byssal threads, nor does it attach to the shell of native unionids as dreissenids do. It does have an extremely high reproductive output and displays rapid

population growth when temperature and other hydrological conditions are favourable. In terms of wet biomass, *Corbicula fluminea* can dominate the benthic community it invades (McMahon, 1983). Recently Karatayev *et al*., (2003) showed that this species represented 97 % of the wet benthic biomass in the littoral zone of a reservoir. At high densities it could potentially out-compete native bivalves for similar planktonic food resources in the littoral zone (Karatayev *et al*., 2003). The ability of the Asian clam to spread and therefore its potential impact on the native molluscan communities of the St. Lawrence River system remains to be evaluated. Presently, little is known about its current distribution in this large river system. The effects of current climate warming trends on the spread of this species are also unknown but our observations clearly show that additional data are needed for a full understanding of factors limiting its northern distribution.

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André L. Martel[1], Anouk Simard[2], Annie Paquet[2], Charles Jutras[2,3], Yves Robitaille[4], Réhaume Courtois[2] & Pierre U. Blier[3]

[1] Malacology, Life Sciences, Canadian Museum of Nature, P.O. Box 3443, Station D, Ottawa, Ontario K1P 6P4, Canada. amartel@mus-nature.ca

[2] Ministère des Ressources naturelles et de la Faune du Québec, 880 chemin Ste-Foy, 2e étage, Québec G1S 4X4, Canada.

[3] Université du Québec à Rimouski, 300, allée des Ursulines, C. P. 3300 succ. A, Rimouski, Québec G5L 3A1, Canada.

[4] Ministère des Ressources naturelles et de la Faune du Québec, 100 rue Laviolette, local 207, Trois-Rivières (Québec) G9A 5S9, Canada.

PACIFIC ISLAND LAND SNAILS

Land snail biodiversity surveys of Pohnpei, Federated States of Micronesia

By Brenden Holland

Land snail biodiversity, defined as the number of native species per unit of land area, is well known to be disproportionately higher on islands than on continents (Holland, 2009). As a result of a number of threats, island species diversity has been declining rapidly on a global scale in recent decades. As part of an effort to understand and identify critical island regions where once high biodiversity is being lost, the first in a series of planned land snail surveys of the island of Pohnpei, Federated States of Micronesia (FSM), was conducted in collaboration with Brian Lynch and Donald Buden of the College of Micronesia in July 2009 (Fig. 1). Additional high elevation Pohnpei surveys are planned for the spring of 2010. Our goal is to assess the conservation status of the endemic land snail fauna and document changes in biodiversity since the last work was done there, by Yoshio Kondo (Bishop Museum, Honolulu) in 1936.

Fig. 1. Participants in the 2009 Pohnpei land snail surveys. Top: Brian Lynch (left) and Brenden Holland (right). Bottom: Brenden Holland and volunteer assistants.

Fig. 2. The snail-eating invasive triclad flatworm *Platydemus manokwari*. Although we found *P. manokwari* at many of the survey locations, including a number of specimens in trees, we did not observe any *Euglandina rosea*, the predatory snail introduced widely in the Pacific in ill-conceived control efforts against the giant African snail, *Achatina fulica*. We assume, therefore, that *P. manokwari* may be a more important invasive predator than *E. rosea* on Pohnpei.

Kondo traveled from Hawaii to FSM, including Pohnpei, to examine and document the snail fauna as part of an expedition sponsored by the Japanese government just prior to World War II, at a time when Pohnpei and many other Pacific islands were occupied by the Japanese military. Although never published, Kondo documented 26 native land snail species, and work with the material he collected, which was deposited in the Bishop Museum, yielded a number of new species, subspecies and a subfamily (Clench, 1946). Although no thorough survey work has been done on Pohnpei's snail fauna in the ensuing years, a few surveys focusing on specific groups such as the Diplommatinidae, by Rundell (2008), and the Partulidae, by Peltin Peltep and Michael Hadfield (unpublished), have been conducted in the past decade.

Pohnpei (6°52′N, 158°13′E) is the largest (355 km^2), highest (> 800 m) and wettest (485-1015 cm of rain per year) island in the FSM, which also includes the states of Chuuk, Yap and Kosrae. The island is dominated by central highlands with lush tropical rain forests, where native broadleaf trees reach 30 m at elevations of 200-600 m, and the majority of human settlement is located around the periphery of the island. Nonetheless there is evidence that habitat degradation is occurring; native upland

Fig. 3. *Thaanumella cookei*, in a native tree fern, photo taken along the Nanpil River in central Pohnpei.

Fig. 4. *Pupina* sp., collected under the bark of palm trees along the banks of the Nanpil River at 200 m.

Fig. 5. *Kororia palaensis*, photographed on *Pandanus* frond at about 300 m elevation, from central Pohnpei.

forest cover over a 20 yr period has decreased from 42 % to 15 % (Trustrum, 1996). In addition to habitat loss, introduction of invasive species, including predators (Fig. 2), is considered a primary factor in loss of snail faunal diversity.

Some of the species we encountered are illustrated in Figs. 3-5. Following completion of our land snail field surveys on Pohnpei, we plan to publish the results in a scientific journal as well as make the data available to all interested parties both within the FSM and outside of the region.

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Brenden S. Holland, Center for Conservation Research and Training, Pacific Biosciencese Research Center, University of Hawaii, 3050 Maile Way, Gilmore 406, Honolulu, Hawaii 96822, USA. Tel +1 808 956 6176, bholland@hawaii.edu

Partulids at the Paleontological Research Institution, Ithaca, New York

By Marla Coppolino

I am in the process of recurating (re-housing, re-ordering, with plans to catalogue and database) the collection of recent snails donated by Dr. Julian Smith to the Paleontological Research Institution (PRI) in Ithaca, New York. Dr. Smith, now 90 years young, is a serious amateur malacologist and former head of Cornell University's Department of Chemical Engineering. The collection was originally given to Cornell University in 1995 and recently became incorporated into collections at the PRI. It contains mostly land snails, but also some freshwater and marine snails.

Among the most notable are some tree snails of the genus *Partula* from the Pacific islands. These specimens were originally collected between 1906 and 1909 by Dr. Henry Crampton, a malacologist from the American Museum of Natural History, on his expeditions to the islands. Once abundant, the *Partula* snail populations have experienced a sharp decline since the 1960s, to the point where some species are critically endangered and even extinct in their native habitats (see *Tentacle* issue 17). Dr. Smith's collections contain specimens of some of these precious lost species, including *Partula faba* (Gmelin, 1791), *Partula filosa* Pfeiffer, 1851, *Partula gibba* Férussac, 1821, *Partula otaheitana* (Bruguière, 1792), and *Eua zebrina* (Gould, 1848) (Fig. 1).

Overall, this collection represents an impressive array of taxa, collecting localities and span of time. Dr. Smith collected 371 lots of snails between 1952 and 1992, of at least 203 species in at least 34 families, from more than 100 collecting localities worldwide. He accumulated valuable specimens of land snails in his resident area of Tompkins County, New York, some of

Fig. 1. Some of the partulids in the Smith collection at the Paleontological Research Institution.

which have become rare today as a result of changed ecosystem conditions. He recorded quality data to accompany his specimens, adding more value to the collection. The collection also contains specimens that Dr. Smith received as gifts, including the partulids mentioned above.

Dr. Smith's lots are a very welcome contribution to PRI's recent snail collections and an invaluable resource for land snail research.

Marla Coppolino, Groton, New York, USA. Tel. +1 347 495 9861, marlacoppolino@gmail.com

MARINE MATTERS

Research-action project: the blue mussel fishery in Punta del Este, Uruguay – exploring strategies for the control of invasive species

By Alvar Carranza

Oyster and mussel beds are some of the most threatened marine ecosystems in the world (Beck *et al*., 2008, 2009; Carranza *et al*., 2008, 2009b). In Latin America, overfishing, habitat loss and invasive species are major threats to native molluscs (Orensanz *et al*., 2002). Subtidal *Mytilus edulis* beds in Maldonado Bay, Uruguay, are no exception, as their populations are fully exploited (Defeo *et al*., 2008, 2009; Carranza *et al*., 2009b). Moreover, the exotic invasive gastropod *Rapana venosa*, which actively preys on mussels, has been found recently in large quantities in the area (Scarabino *et al*., 2006; Carranza *et al*., 2009a; Lanfranconi *et al*., 2009. In this context, the goal of our project is to assess

the condition of the mussel beds and explore options for co-management of this fishery with local fishermen. Additionally, the project will explore the design of a pilot program aiming to eradicate or at least control the population of *R. venosa*.

In April 2009, using SCUBA and analysis of photographic and submarine video records in Punta del Este and Gorriti Island, the first *in vivo* observations of *R. venosa* in Uruguay were made (Figs. 1 & 2). The observations showed that *R. venosa* is undoubtedly an active predator of mussels in natural habitats and that mussel banks may be severely depleted, presumably due to the combination of extraction, habitat degradation and predation by *R. venosa* (Carranza *et al.*, 2009a).

As a result, the opening of a local or international market for *R. venosa* is considered a promising option for providing an incentive to exploit this gastropod, generating economic benefits for fishermen and helping to ensure long term sustainability of mussel exploitation. Furthermore, experimental evidence on recolonization rates from surveys performed in Punta del Este harbour showed that the recolonization potential of this gastropod is extremely high, with densities multiplying 6-fold in one month after defaunation (Carranza, unpublished data).

This initiative is part of a South American network of related projects aimed at generating and linking local projects in several countries. The specific objectives are:

- to increase awareness in the scientific community regarding the conservation of native South American molluscs, with emphasis on bio-engineering bivalve species
- to improve assessments of the conservation status of keystone species
- to identify and map conservation opportunities
- to discuss and disseminate lessons learned from conservation and management experiences in order to increase or extend its effectiveness
- to develop a common methodology for analysis of the status of these species.

The fieldwork was done with the kind collaboration of the crew of the F/V *Piruleta* (Bocha, María and Cristhian). Financial support from The Rufford Booster grants for Nature Conservation to A.C. is acknowledged. We also thank SCUBA divers J. Durán and Gonzalo Irrazabal for assistance during sampling and Yamandú Marín, Omar Defeo, Arianna Masello, Gastón Martínez and Daniel Gilardoni of the Dirección Nacional de Recursos Acuáticos. Mike Beck and Rob Brumbaugh (The Nature Conservancy) are acknowledged for support during fund raising.

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Fig. 1. SCUBA diving and video and photographic surveys were performed in Gorriti Island (A) and Punta del Este harbour (B), where large numbers of the invading *Rapana venosa* were found (C). (Photos: Alvar Carranza & Camila DeMello)

Fig. 2. In Gorriti Island, high densities of *Rapana venosa* (A) were found associated with rocks showing little or no mussel cover (B), in contrast to subtidal areas where the *R. venosa* is not present (C & D). (Photos: Alvar Carranza & Jorge Durán)

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Alvar Carranza, Alvar Carranza, Unidad de Ciencias del Mar (UNDECIMAR), Facultad de Ciencias, Universidad de la República, Iguá 4225, CP 11440, Montevideo, Uruguay. Tel +598 2 628 2869, alvardoc@fcien.edu.uy alvar.carranza@gmail.com http://alvar.carranza.googlepages.com

Second meeting of the South American network for conservation and sustainable use of bivalve molluscs

By Alvar Carranza

This meeting took place on 9-11 December 2009 at the Ecological Research Center of Guayacan, Universidad de Oriente, and 12-13 December 2009 at the Fidaes-Idea Marine Station, Government of Sucre, Bolivarian Republic of Venezuela

Reefs and banks of oysters, mussels and other bivalves provide a variety of important ecosystem goods and services and sustain a high diversity of associated species. However, these marine and estuarine habitats are among the most degraded globally. In 2009, a team of scientists convened by The Nature Conservancy (USA) published a comprehensive analysis of the conservation status of native species of habitat-forming bivalves globally, which included the first estimates of the overall condition of mussel and oyster banks in South America (Beck *et al*., 2009; Carranza *et al*., 2008, 2009). The most noteworthy findings included the observation that about half of the oyster and/or mussel populations in South America are moderately or highly threatened by overexploitation or environmental degradation. This is somewhat in contrast to the findings for most of the northern hemisphere, where reefs and banks of bivalves are in much worse condition.

An initial meeting of a small group of bivalve experts from South America was convened in 2008 in Valdivia, Chile, to explore the idea of creating a South American network to encourage the development of conservation, sustainable use and/or restoration initiatives and to link groups of active researchers in this field. With support from The Nature Conservancy, the Group of Biology of Molluscs of the Universidad de Oriente, the Fundación para la Investigación y Desarrollo de la Acuicultura del Estado de Sucre, the Fondo Nacional de Ciencia, Tecnología e Innovación and the Consejo de Investigación, Universidad de Oriente (Venezuela), the second meeting of the South American Network for Conservation and Sustainable Use of Bivalve Molluscs took place on 9-13 December 2009. The objectives of this meeting were to 1) reunite network members, 2) report on progress on restoration projects and opportunities for conservation, 3) integrate undergraduate and postgraduate students in Network activities, 4) contribute to the development of a restoration project for *Crassostrea rhizophorae* in Mochima National Park, Venezuela, 5) define the objectives, structure and specific activities of the Network, and 6) establish a work schedule for 2010. This meeting brought together more than 40 scientists from Venezuela, Uruguay, Brasil, Argentina, Peru, Colombia and the USA. The event was held as part of the commemoration of the 50th anniversary of the Instituto Oceanográfico de Venezuela.

The objectives were fully achieved and progress reports on ongoing projects and identification of opportunities for conservation were presented. In particular, these included several case studies from Venezuela and an update of the projects under development in Argentina, Uruguay and Brasil. Also, opportunities to develop new initiatives in Colombia and Peru were identified. Several local graduate students participated in this meeting, thus fulfilling an important role in the generation of new human resources. We also ran an initial workshop for the drafting of a restoration project on *Crassostrea rhizophorae* in Mochima National Park, which was attended by officials of the Instituto Nacional de Parques. To approach this objective, we worked in a participatory manner to define conservation objectives, using a situation analysis to identify causality and linkages between threats and the current condition of *C. rizophorae* in the Park, and to establish some initial strategies for developing the project.

In plenary session, we discussed the objectives, structure and specific activities of the Network, concluding that there is a need for an adaptive and non-restrictive vision that allows, if warranted, new initiatives to be included that are aligned with the philosophy of the Network. We also agreed upon the necessity of including the terms Conservation and Sustainable Use, since the need for concerted conservation and socioeconomic targets was identified as a priority.

For 2010, identification of potential partners as well as the adoption of a guide for design and monitoring of restoration programs with examples from South America were considered priority objectives.

During the meeting, Dr. Antulio Prieto, a pioneer of Venezuelan malacology was honored, receiving a plaque from Dr. Cesar Lodeiros.

Last but not least, field trips were organized to Lobo Island and Caribbean Island off the Araya Peninsula, Mochima National Park. During these trips, participants had the opportunity to inspect the local coastal ecosystems and shellfish areas. These activities resulted in opportunities for collection of marine species, mini-workshops and findings of some mollusc species previously unknown in Venezuela, and

presumably, for science, thus contributing to knowledge of local biodiversity.

For more information contact the Network at RSCUSMB@googlegroups.com

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Alvar Carranza, Unidad de Ciencias del Mar (UNDECIMAR), Facultad de Ciencias, Universidad de la República, Iguá 4225, CP 11440, Montevideo, Uruguay. Tel +598 2 628 2869, alvardoc@fcien.edu.uy alvar.carranza@gmail.com http://alvar.carranza.googlepages.com

RECENT PUBLICATIONS RELEVANT TO MOLLUSC CONSERVATION

New Book

Verdú, J. and Galante, E. 2009. *Atlas de los Invertebrados Amenazados de España (Especes en peligro critico y en peligro)*. Direccion General para la Biodiversidad, Ministerio de Medio Ambiente, Madrid. ISBN978-84-8014-753-8

This new book is a revised version of the on-line *Red List* released in 2007. It provides comprehensive data sheets on the Critically Endangered and Endangered species, including 10 freshwater molluscs as well as 15 terrestrial species from Spain. There is also a summary list of the status of 237 species from Spain (including Canary Islands, Balearic Islands and mainland). These data-sheets are in colour with maps, photographs of the habitats, summaries of the taxonomy and identification of the species, lists of potentially damaging activities, current threats to the species and proposed conservation activities. It is an excellent resource on these species, as it does not just give the status, but provides infomation on actions required for future management of sites.

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IUCN, SSC AND MOLLUSC SPECIALIST GROUP NEWS

www.iucn.org/

All news items provided by Mary Seddon, chair of the Mollusc Specialist Group of the IUCN Species Survival Commission. Her contact details are at the end of this issue of *Tentacle*.

Red List of globally threatened species: updates and additions

We have seen radical changes to the information system used to host information for the IUCN *Red List* in the last year. The information on the entire *Red List*, which now has over 45,000 species, has been migrated into the Species Information System (SIS), which is a single database system (with mirror sites) that can be used by many users simultaneously over the Internet, allowing data-entry through an internet browser such as Chrome, Firefox or Safari (not Microsoft Internet Explorer). This replaces the multiple databases used by individuals on their own computers based on Microsoft Access, which all needed to be migrated into the global database after the peer-review process.

Taxonomic names: We have undertaken a lot of work to upload species names for the regions of current major projects. Hence, there are now nearly 5,000 molluscan names in SIS, with each project adding new species lists.

To add new species into the system we need to establish a taxonomic listing. We welcome the addition of new taxa in SIS. We encourage specialists to send complete lists of endemic species for countries, as we need to have assessments of the non threatened species as well as the threatened species in the long term. In order to add species lists to SIS we need an excel spreadsheet with the list of proposed names with the following data columns. For gastropod species, the family assigned should follow the approved list of family names in Bouchet & Rocroi (2005):

- Family [mandatory]
- Genus [mandatory]
- Species name [mandatory]
- Author, date (for the species name) [mandatory]
- Common name
- Source of the name (field guide, checklist, research paper) [mandatory]
- Distribution: comment on range, to permit checking against the current list
- Endemic to the country

Marine specialists should liaise with Philippe Bouchet, who is currently coordinating a world-wide effort to complete a list of marine molluscs.

In order to use the SIS web database system, some basic training is required, providing each expert with sufficient knowledge on data required by the IUCN *Red List* Categories and Criteria (version 3.1), as well as updating the experts on the latest revised version of the guidelines for use of the categories and criteria (July 2009). Training sessions specifically directed at molluscs will be held at the World Congress of Malacology in July 2010 (see p. 54). There is now a *Red List* Training Officer, Rebecca Miller, based at the Species Survival Commission (SSC) Cambridge office, and she will be running various training workshops in different parts of the world over the coming year. The dates for these workshops are posted in *Species* (the e-bulletin) and posted electronically to members of the SSC mailing list. Members of Specialist Groups and IUCN project participants are invited to take part in the workshops in Thailand. Places on the IUCN-led training courses are limited and some workshops are dedicated to specific projects.

The documentation requirements to support a species listing on the global *Red List* are now very rigorous, to ensure that we consistently apply the categories and criteria in the same way to all animals and plants. As funders, such as the Global Environment Facility (GEF) and the Critical Ecosystem Partnership Fund (CEPF), use the number of threatened species within the region as one of the criteria for deciding on funding levels, it is important that we have high data-entry standards to support listings.

There is a major change to the way in which the species is assigned a category of threat. Now, this is calculated automatically, based on the information entered into the criteria calculator fields during the data entry. It should be noted that the calculator takes a precautionary attitude to uncertainty of data.

Basic Data Requirements for documenting species:

1. *Taxonomic notes* (optional field). Data can be submitted on any taxonomic issue that is known about the species, including for example, number of subspecies, varieties commonly in use, whether the species limits have been confirmed by anatomical or molecular review. Nomenclatural issues, common names and synonyms can also be captured.
2. *Distribution* (mandatory field for B and D criteria). Add your comments to the text box describing the distribution, then tick boxes, and add justification where required against the main forms of distributional information required.
    a. Extent of occurrence: the area contained within a line drawn around all point localities of the distribution (area in km^2).
    b. Area of occupancy: sum of the areas where the species is actually found (this method requires a buffer of 2 km^2 around each point).
    c. Very restricted range (usually known from less than 5 localities, typically with an area of occupancy of less than 20 km^2). This tends to be used for range restricted species occupying a specific narrow habitat (limestone outcrops, springs, fens or for small island endemics, alpine montane endemics, scree slope specialists).
    d. For widespread, but declining species, information to support the case that the species range has become fragmented to a point at which it will impact the ability of the species to continue to breed successfully.
    e. The number of localities where the species is found (note that this differs from the number of sites and is in part determined by the threats).
3. *Occurrence* (mandatory field). All countries where the species occurs, or formerly occurred, with boxes ticked for each country noting status (extant, possibly extinct, extinct, uncertain) and origin (e.g. native, introduced, reintroduced, prehistoric introduction, unknown).
4. *Population* (the only mandatory field is the population trend: increasing, decreasing, stable, unknown). Many species of molluscs have limited data on their population status; however, if you wish to use the A criterion for population declines for widespread species, then more of these boxes needed to filled in. Please contact either the Chair, Training Officer or a project officer to get advice on entering data for this aspect of SIS.
5. *Habitats and ecology* (several mandatory fields). Add your comments to the text box describing the habitats, and then all species must be classified as terrestrial, freshwater and/or marine. Each species should be classified using the tick box system against one of the many habitats recognised in the system, notes as to whether this habitat is suitable or marginal, and an estimate of whether the majority or a minority of the populations live in this habitat.
6. *Use and trade.* Tick box as to whether the species is used for human livelihood.
7. *Threats.* Add your comments to the text box describing the threats and then each species should be classified using the tick box system against one of the many threats categorised in the system, with a pull-down box adding whether this threat causes direct stress on the ecosystem or the species.
8. *Conservation actions*. Add your comments to the text box describing any conservation actions for the species. There are also tick boxes to summarise the types of conservation action in place and those research and conservation actions needed. Tick boxes include species that live in protected areas, have species management plans and those covered by international legislation.
9. *Ecosystem services*. Tick box on whether the species provides any ecosystem services, and if so, what type of services (e.g. habitat for other species, water filtration, biocontrol).
10. *Red List assessments*. Add your comments to the text box providing a rationale for the *Red List* category given, including notes on possible future changes to the status given the current and future threats. If the species has previously been assessed please provide comments on reasons for category changes (e.g. new data, different taxonomic entity - splitting or lumping).

In addition, all submissions require a summary distribution map (either GIS shape file or Google KTM file) to be submitted so that analytical tools for the *Red List* can be used for supplying overview data to countries.

Species Assessors are encouraged to supply photographs to ARKive (see p. 50), to ensure that there is a source picture to use on the web site when providing summary information on the threatened species.

The Species Assessment is maintained under the name of the person who supplied the assessment, in a similar way to an electronic publication, and the author is given a citation format

that can be used. All detailed data supplied (such as point locality data) to support species assessments is the property of the data holder and would only be released by IUCN with the permission of the data owner.

At present about 25 people have data-entry rights for molluscan species, but we welcome other species assessors to join the task of evaluating and maintaining the Global *Red List* of Molluscs.

Over the next six months we are prioritising the review of all species for which the last assessment was more than 10 yr ago, and past contributors will be contacted with a view to updating these records.

The *Red List* of globally threatened species will now be updated two or three times a year. In the last release (November, 2009), molluscs from Malaysia and Seychelles were uploaded and released. Justin Gerlach's assessments for Seychelles were the first comprehensive assessments for an island group, and included the first assessments of molluscan extinctions due to climate change. Different taxon groups and projects will be targetted for release dates, with cut-off dates when data-sets are locked for final consistancy checks and analysis about three months prior to release. The next *Red List* releases will be in May (cut-off date in March) and October 2010 (cut-off date 15 July 2010).

Bouchet P. & Rocroi J.-P. 2005. Classification and nomenclator of gastropod families. *Malacologia* 47(1-2): 1-397.

Valuing ecosystem services provided by molluscs

"The concept of ecosystem services is a metaphor that was designed to build stronger support among people, including decision makers, for ensuring that the genes, species, and ecosystems that provide the foundation for all of these services receive the attention they require to survive, and prosper, in a time of rapid change. Species remain the most tangible and readily recognized element in this equation, and the one with which people most readily identify. But the concept of ecosystem services also recognizes that no species exists by itself, being dependent on an extensive network of other species, as prey, predators, parasites, resting places and so forth. Effective conservation of species can be strengthened by adopting the fundamental principles of ecosystem services as a means of demonstrating the utility of species to people. This should not be considered simply 'putting a price tag on species', but rather recognizing how much human welfare depends on the continued prosperity of the rest of the species with whom we share our planet." – Jeff McNeely**,** Chief Scientist, IUCN.

Over the next four years there will be an increasing demand for information relating to the value molluscs deliver in terms of providing ecosystem services. These ecosystem services will include aspects such as:

- ***Provisioning services***, such as food, timber, fibre, genetic resources, and water, as well as products from the wild (usually species). For example, many marine molluscs provide food sources for artisanal and commercial levels of exploitation. Some rare species can attain very high values for resale, whereas others are basic subsistence level foods.
- ***Regulating services***, derived from the control of natural processes by ecosystems, for example regulating air quality, climate, water, erosion, disease and pests. The most obvious example would be the level to which freshwater bivalves provide water filtration, thereby cleaning and maintaining river systems.
- ***Supporting services***, which are the underlying processes necessary for the production of all other ecosystem services. These include nutrient cycling, soil formation, primary production, photosynthesis and water cycling. Soil formation is dependent on the species that live in the soil, including molluscs, earthworms, termites and thousands of other types of invertebrates and microbes. Species-rich soils should help to reduce soil erosion, store more carbon, and cycle more water, thereby contributing to many ecosystem services.
- ***Cultural services***, which are the non-material benefits people obtain from ecosystems. These include ethical, spiritual, religious and other values people attach to ecosystems, landscapes or species. A well known service would be the sacred conch in India.

The SSC Mollusc Specialist Group (MSG) needs to establish a working group to bring together experts who have been working on valuing ecosystem services in the widest sense, so that we can put forward case studies of the ecosystem values that molluscs provide to SSC's working panels when they are established. We are looking for volunteers for both the Focal Point position to chair the working group, as well as researchers (at any level, including students, shell-collectors, professors) who are working on projects that could provide data about the value of ecosystem services.

Please contact Mary Seddon, Chair of the Mollusc Specialist Group, if you are interested in participating in this working group over the 2009-2012 quadrennium. Her contact details are in the list of MSG members on the *Tentacle* website and at the end of this issue of *Tentacle*).

ARKive extends its tentacles in the hunt for imagery

ARKive, the world's centralised digital library of films and photographs of threatened animals, plants and fungi, is calling on all *Tentacle* readers to help in the search for imagery of endangered molluscs (Figs. 1 & 2).

A project of the UK-based NGO Wildscreen, ARKive's objective is to raise public awareness of the world's threatened species and the need for their conservation through the power of wildlife imagery.

Fig. 1. Caterpillar slug – *Laevicaulis haroldi*.

To date, ARKive has created digital multi-media profiles for over 5,000 species, digitising and storing more than 38,000 still images and over 100 hr of moving footage, from over 3,000 contributors, including the BBC, National Geographic and a wide variety of photographers, scientists and conservationists. These important audio-visual records are being preserved and maintained for the benefit of future generations and are made freely available for non-commercial awareness-raising and educational purposes via the ARKive website. The ARKive website regularly receives over 30,000 visits a day from around the world, with visitor demography ranging from research scientists, conservationists and educators to the general public.

Fig. 2. Dlinza pinwheel – *Trachycystis clifdeni*.

Having recently become a formal partner of the IUCN *Red List*, ARKive's immediate aim is to compile audio-visual profiles for the c. 18,000 species at most risk of extinction (CR – VU), including all 1,036 threatened mollusc species. ARKive is collaborating with the IUCN Species Programme and the Species Survival Commission to find photos and films for as many of these threatened species as possible, with all images sourced under the partnership being made available for use in IUCN *Red List* activities.

Despite being one of the most numerous invertebrate groups on the IUCN *Red List*, the lack of readily available media has left the molluscs of the planet comparatively under-represented on ARKive. However, with your help, it is hoped that ARKive will become home to the most comprehensive online collection of still and moving images of mollusc species. If you have films or photographs of any *Red List* molluscs, or indeed of any of the world's threatened species, then ARKive would be delighted to hear from you.

Contact the ARKive team at arkive@wildscreen.org.uk

Please note that ARKive does not sell photographs, but rather the ARKive website acts as a showcase for image providers, displaying copyright and contact details with every image, as well as links to each media donor's own web activities.

Freshwater biodiversity assessments in Asia

IUCN has recently obtained funds to undertake four freshwater biodiversity assessment projects in Asia. These projects involve assessing the threatened status of all species of freshwater fishes, molluscs, odonates and selected families of aquatic plants within the water catchments of the region (Fig. 1). The aim is to produce a vital resource for informing conservation and developmental decision-making for the region. The projects follow the same model as the African projects (see *Tentacle* issue 17), working closely with the IUCN SSC Mollusc Specialist Group to identify experts for each project – usually taxonomists or ecologists – who compile relevant taxonomic and ecological data directly into the IUCN SIS database. More detail can be found on all projects through the Freshwater Biodiversity Unit website.

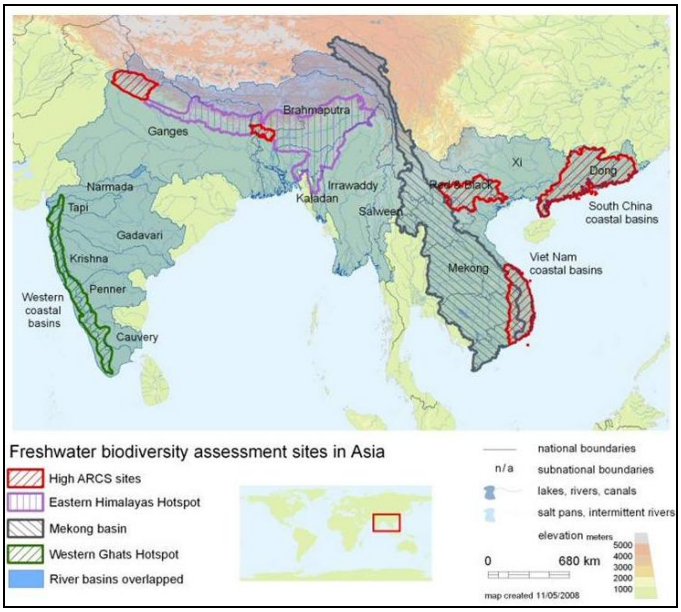


Fig. 1. Freshwater biodiversity assessment projects in Asia – current and proposed.

Indo-Burma assessment

This project was initiated in September 2009 and runs until January 2011. The project is funded by the Critical Ecosystem Partnership Fund (CEPF). Experts have been invited to join the project and start to compile the data and produce a

distribution map for each species showing the known distribution (based on point locality data from survey and museum records) or the inferred distribution (the actual range, based on the experts' knowledge – to overcome problems of lack of field survey). A training workshop was held in Cambodia at the end of November for the experts invited to participate in the project, at which training was provided in GIS mapping and IUCN *Red List* data-entry.

There will be a workshop (scheduled for mid-2010) to review the assessments and maps. Following this, the assessments will be published on the IUCN *Red List*.

If you have any unpublished knowledge of the freshwater molluscs in the region, please contact the project co-ordinator:

David Allen, IUCN Freshwater Biodiversity Unit, Species Programme, IUCN – International Union for Conservation of Nature, 219c Huntingdon Road, Cambridge CB3 ODL, UK. Tel +44 (0)1223 277 966, fax +44 (0)1223 277 845, david.allen@iucn.org

Eastern Himalayas assessment

This project was initiated in July 2009 and runs until June 2010. The project is funded by the MacArthur Foundation. Experts have been invited to join the project and start to compile the data and produce a distribution map for each species showing the known distribution (based on point locality data from survey and museum records) or the inferred distribution (the actual range, based on the experts' knowledge – to overcome problems of lack of field survey). A training workshop was held during 22-26 July 2009 in Kathmandu, Nepal, for the experts invited to participate in the project, at which training was provided in GIS mapping, IUCN *Red List* data-entry and application of the *Red List* Categories and Criteria.

There will be a workshop (scheduled for March/April 2010) to review the assessments and maps. Following this, the assessments will be published on the IUCN *Red List*.

If you have any unpublished knowledge of the freshwater molluscs in the region, please contact the project co-ordinator:

David Allen, IUCN Freshwater Biodiversity Unit, Species Programme, IUCN – International Union for Conservation of Nature, 219c Huntingdon Road, Cambridge CB3 ODL, UK. Tel +44 (0)1223 277 966, fax +44 (0)1223 277 845, david.allen@iucn.org

High ARCS project

This is a 4 yr project led by the Centre for Environment and Society at the University of Essex; the IUCN Species Programme is a partner in this project. The project is funded under the EC Framework 7 programme.

High ARCS will complete a detailed multidisciplinary situation analysis of highland aquatic resources, focused on values, livelihoods, conservation issues and wise-use options at five sites in Asia (Guangdong, China; Uttrakhand and West Bengal, India, and northern and central Vietnam). The IUCN Species Programme is conducting the baseline assessment of the distribution, conservation status and livelihood values of all known freshwater fishes, molluscs, odonates and selected aquatic plants throughout the region.

The project began in June 2009 with a training workshop in Kolkata, India. Training was provided in GIS mapping, IUCN *Red List* data-entry and application of the *Red List* Categories and Criteria.

During the project, factors assessed will include biodiversity and ecosystem services, including provisioning, regulating, supporting and cultural services. Livelihood strategies of households dependent on ecosystem services derived from highland aquatic resources, in particular poor, food-insecure and vulnerable people, will be assessed within a sustainable livelihoods framework and opportunities to enhance such livelihoods assessed.

If you have any unpublished knowledge of the freshwater molluscs in the region, please contact the project co-ordinator:

Kevin Smith, IUCN Freshwater Biodiversity Unit, Species Programme, IUCN – International Union for Conservation of Nature, 219c Huntingdon Road, Cambridge CB3 ODL, UK. Tel +44 (0)1223 277 966, fax +44 (0)1223 277 845, kevin.smith@iucn.org

Western Ghats assessment

This project was initiated in November 2009 and runs until April 2011. The project is funded by the Critical Ecosystem Partnership Fund (CEPF). Experts have been invited to join the project and start to compile the data and produce a distribution map for each species showing the known distribution (based on point locality data from survey and museum records) or the inferred distribution (the actual range, based on the experts' knowledge – to overcome problems of lack of field survey). A training workshop was held in Coimbatore, India, in January 2010 for the experts invited to participate in the project, at which training was provided in GIS mapping and IUCN *Red List* data-entry.

There will be a workshop (scheduled for late 2010) to review the assessments and maps. Following this, the assessments will be published on the IUCN *Red List*.

If you have any unpublished knowledge of the freshwater molluscs in the region, please contact the project co-ordinator:

Kevin Smith, IUCN Freshwater Biodiversity Unit, Species Programme, IUCN – International Union for Conservation of Nature, 219c Huntingdon Road, Cambridge CB3 ODL, UK. Tel +44 (0)1223 277 966, fax +44 (0)1223 277 845, kevin.smith@iucn.org

For general information on the work of the Freshwater Biodiversity Unit please contact:

William Darwall, IUCN Freshwater Biodiversity Unit, Species Programme, IUCN – International Union for Conservation of Nature, 219c Huntingdon Road, Cambridge CB3 ODL, UK. Tel +44 (0)1223 277 966, fax +44 (0)1223 277 845, william.darwall@iucn.org

2010 – International Year of Biodiversity

The 10th Conference of the Parties of the Convention on Biological Diversity meets in Nagoya, Japan, in October 2010. One important aspect for the IUCN Species Survival Commission (SSC) is the need to agree a new target or targets to replace the existing 2010 Biodiversity Target. A long series of preparatory meetings is already under way, and SSC has been involved in many of these, pushing for an ambitious new biodiversity target that includes a broad understanding of biodiversity, encompassing species, ecosystems and the services to people provided by species and ecosystems. SSC will be implementing a focused communications strategy throughout 2010, which will include targeted *Red List* updates for critical events.

As part of SSC's strategy, there will be a 'species a day' launched on the web site promoting threatened species from the *Red List*. This will include a significant number of molluscs as well as other invertebrates.

MEETINGS 2010

Foundations of Biodiversity: saving the world's non-vertebrates

A Zoological Society of London (ZSL) symposium: 25-26 February 2010

Fungi, invertebrates and plants represent the majority of earth's biodiversity. They are the main players in ecosystem services, such as pollination and soil formation, play important roles in the establishment of food webs and provide us with biocontrol agents. Their fate is intimately linked to ecosystem health and the continued existence of megafauna and humans alike.

In the past, biodiversity conservation has concentrated on more charismatic megafauna, while attention to non-vertebrates still lags a long way behind that of vertebrates. One of the major conservation challenges ahead is to address this imbalance by improving our knowledge of non-vertebrate conservation issues and finding effective solutions to safeguard the 'Foundations of Biodiversity'. This will enable us to gauge more accurately the impact of humans on the ecosystem services they use.

This symposium will bring together researchers and conservation practitioners from a wide range of backgrounds in invertebrate and plant conservation to highlight and debate the importance of non-vertebrate biodiversity from ecological, social and economic perspectives. Our current state of knowledge of non-vertebrate conservation issues will be reviewed and important knowledge gaps will be addressed in order to provide recommendations on how these can be filled. Most importantly, we will try to find practical solutions to raise the profile of non-vertebrate conservation.

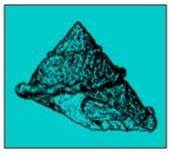
After all, without the 'Foundations of Biodiversity', life on earth as we know it would be impossible.

Full details including an up-to-date programme for this two-day symposium can be found along with registration and poster submission forms at the meeting website.

The deadline for registrations is 11 February 2010 and all poster abstracts should be submitted by 28 January 2010 for consideration.

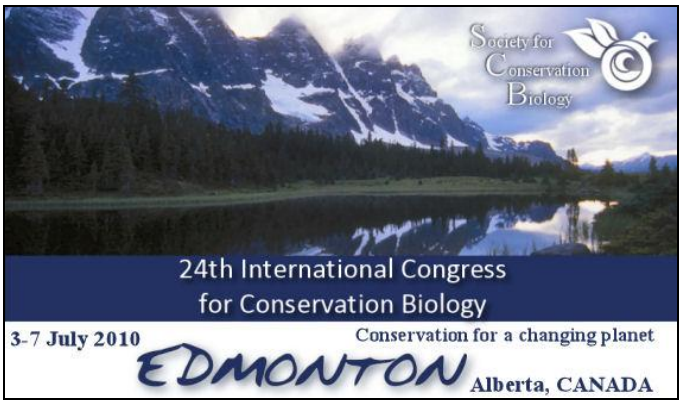
This symposium is organised by Jonathan Baillie (ZSL), Ben Collen (ZSL), Michael Samways (Stellenbosch University) and Monika Böhm (ZSL).

American Malacological Society 2010 Western Society of Malacologists 2010

AMS   WSM

The 76th meeting of the American Malacological Society and the 43rd meeting of the Western Society of Malacologists will be a joint meeting held 27 June - 1 July 2010 in San Diego, California, at the San Diego State University Convention Center. For more information contact AMS President Dr. Doug Eernisse (deernisse@fullerton.edu) or WSM president Dr. George Kennedy (gkennedy@bfsa-ca.com).

Society for Conservation Biology 2010



The Society for Conservation Biology (SCB) and the University of Alberta in Edmonton invite you to Edmonton, Alberta, Canada, 3-7 July 2010 for SCB's 24th International Congress for Conservation Biology. SCB's International Congress is recognized as the most important global meeting for conservation professionals and students. For more information go to the Society's website.

World Congress of Malacology 2010

UNITAS MALACOLOGICA

The 17th International Congress of Unitas Malacologica, the next World Congress of Malacology (WCM), will be held on the island of Phuket, Thailand, 18-24 July 2010 (inclusive), at the majestic and luxurious Royal Phuket City Hotel. This is the first time that the WCM has been held in Asia and it is jointly organized by Unitas, Chulalongkorn University and the Biodiversity Research and Training Program of Thailand. Phuket, often called the "Pearl of Andaman", is one of the most beautiful islands in the Andaman Region, located in the south-west of Thailand within and next to the Sirinath and Phang-Nga Bay National (Marine) Parks, respectively, and a short boat trip away from the equally well known Krabi (Hat Noppharat Thara National Park) and Phi Phi Island. It thus offers internationally renowned excellent recreational beaches and scuba diving in addition to outstanding marine wildlife including, of course, molluscs. However, both the island of Phuket itself, as well as the nearby mainland (including Khao Sok National Park), offer exciting opportunities to study a diverse range of freshwater and terrestrial wildlife and to go trekking, or to just explore the diverse local and world famous Thai culture, cuisine and hospitality. The congress will adopt the style of the last highly successful Congress in Antwerp, Belgium (2007), and we expect the Phuket meeting to be at least as successful. The congress offers a great opportunity for people who work on or are interested in molluscs to come to Phuket, Thailand.

Currently, 13 symposia are planned:

- Ecology, Evolution and Biology of Freshwater Bivalves by Arthur Bogan and Randy Hoeh
- The Biology and Evolution of Limpets by Alan Hodgson
- Evolution of the Bivalvia by Rüdiger Bieler, Gonzalo Giribet and Paula Mikkelsen
- Community Ecology of Tropical Forest Land Snails by Dinarzarde Raheem and Peter Tattersfield
- The Last 50 Years of Malacology: Specialization, Methodological Transformation and Globalization by Robert Hershler and David Lindberg
- Studies on Opisthobranch Molluscs by Manuel Malaquias, Juan Lucas Cervera and Terry Gosliner
- Emerging Molluscan Models: Biological Questions in the 21st Century by Mónica Medina, Sam Loker and Sandie Degnan
- Evolutionary Ecology and Genetics of Molluscan Populations by Takahiro Asami
- The Systematics of Asian Land Snails by Fred Naggs, Min Wu and Somsak Panha
- Mollusc Aquaculture by Zulfigar Yasin, Aileen Tan Shau-Hwai and Somchai Bussarawit
- Countdown 2010: Towards a Global Freshwater Assessment of Threatened Species by Mary Seddon (SSC Mollusc Specialist Group) and Will Darwall (IUCN)
- Reproduction and Mating Systems in Hermaphroditic Molluscs by Kurt Jordaens and Joris Koene
- Speciation: insights from insular isolation to global patterns by Matthias Glaubrecht and Thomas von Rintelen

In addition to the main symposia, there will also be contributed paper sessions and poster sessions, which are open to cover all aspects of Malacology.

The conference will start with an icebreaker on Sunday evening, 18 July 2010, with the sessions being held on Monday, Tuesday, Thursday and Friday. Wednesday is set aside for excursions, and the conference dinner and farewell evening will be on Friday night. Three-star hotel accommodation will be available at the conference venue itself (Royal Phuket City Hotel), as well as at nearby hotels. These are established tourist hotels and thus well suited to cater for diverse cultural (and electrical appliance) requirements and languages. This conference will be one of, if not the cheapest and yet impressive meetings ever held, and so will represent ideal value!

Further information on both scientific (conference) and related matters, including international transport details, expected weather, suitable dress and local customs and nearby sites of malacological or tourist interest for those planning an extended stay, is available on the conference website. Information can also be obtained from the conference organizer, Somsak Panha: somsakp@sc.chula.ac.th.

XXII Brasilian Malacological Meeting 2010 – XXII EBRAM

The Brasilian Society of Malacology (SBMa – Sociedade Brasileira de Malacologia) will hold its XXII Brasilian Malacological Congress at Fortaleza city, Ceará state, northeast Brasil, in September 2010. The congress will be hosted by the Federal University of Ceará (UFC). The congress will be organized as our last highly successful XXI EBRAM Congress in Rio de Janeiro (July 2009). Special sessions of contributed papers, oral presentations and poster sessions will be open to all aspects of Malacology, including taxonomy, ecology, biology, evolution, distribution and conservation of terrestrial, marine and freshwater molluscs, fisheries and other topics. Some symposia are also planned. It will be a great opportunity for all people who study or are

interested in molluscs, as the major goal of the XXII Brasilian Malacological Congress is to provide conditions for students and researchers to discuss and exchange their results. More information after March 2010 at the Society's website.

Dra. Sonia Barbosa dos Santos – President of the Brasilian Society of Malacology (2009-2011): gundlachia@yahoo.com.br

Freshwater Mollusk Conservation Society 2010

The 2010 workshop of the Freshwater Mollusk Conservation Society will be held 19-21 October 2010 in Kirkwood, Missouri, USA. The workshop will focus on regional fauna identification and sampling techniques. A panel of regional fauna experts representing Texas, Gulf Coast, upper Ohio Basin, south-east US, Mobile Basin, Atlantic Slope, Cumberlandian, Interior Basin, western US and the Ozark regions has been assembled. The experts will give presentations on mussels unique to their area, common species shared with other regions that 'just look different here', and the ever popular 'problem children'. They will also give tips and pointers on unique collecting methods used in the region. Additional experts will give presentations on general freshwater mussel identification and sampling techniques. In addition to presentations, there will be ample time to view representative specimens from the regions, and time to spend discussing characters with the experts.

The workshop will be held at the Missouri Department of Conservation's Powder Valley Conservation Nature Center, located in a 45 ha [112 acre] oak-hickory forest just south-west of St. Louis, Missouri, in the lower Meramec River watershed. In addition to two floors of exhibits, a large aquarium, and three hiking trails, the center has three classrooms and a 250 seat auditorium. Powder Valley is located at the intersection of Interstates 270 and 44 just south-west of St. Louis, Missouri, and is easily accessible from multiple Interstates and Lambert-St. Louis International Airport. We have secured a block of rooms for workshop attendees at the Holiday Inn Southwest Viking Conference Center (www.stlouis.com/holiday-inn-southwest). Registration will include box lunches for Tuesday and Wednesday and a social on Tuesday night. There are numerous nearby dining and entertainment options and downtown St. Louis is reasonably accessible.

Following the workshop, field trips to the nearby Meramec River, Mississippi River and the US Geological Survey's Columbia Environmental Research Center are planned.

Be sure to register early, as we will have to limit the workshop to 200 attendees.

For more information please contact Steve McMurray (Stephen.McMurray@mdc.mo.gov, +1 573 882 9909) or Heidi Dunn (hdunn@ecologicalspecialists.com, +1 636 281 1982).

INTERNET RESOURCES: LISTS, WEBSITES, ETC.

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 www.iucnredlist.org

IUCN Invasive Species Specialist Group

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

CITES

CITES-L is a bulletin board restricted to trade issues for endangered species, coverd by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). It is managed by the World Conservation Monitoring Centre in Cambridge. The majority of information relates to mammal and bird trade, but updates to the CITES lists are posted there. To subscribe send a one line message to:

majordomo@wcmc.org.uk

with the command line (in message body):

subscribe cites-l

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

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).

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* as well as the newsletter *Ellipsaria*.

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 continental [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

American Malacological Society

The homepage of the American Malacological Society carries a link to its conservation policy. Student research grants are available.

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.

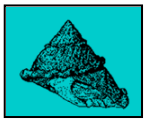
The Malacological Society of London

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.

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.

Field Museum land snails

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

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.

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.

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.

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.

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.

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.

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.

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.

Oregon/Washington, USA – Interagency Special Status/Sensitive Species Program

The Pacific Northwest Regional Office of the U.S. Forest Service and Oregon/Washington State Office of the U.S. Bureau of Land Management have an interagency program for the conservation and management of rare species including more than 100 molluscs. Species Fact Sheets, Conservation Assessments and survey reports are available online and constantly being updated.

Other useful links

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

SSC MOLLUSC SPECIALIST GROUP

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

Chair

Mary B. Seddon, Bracken Tor, Saxongate, Okehampton, Devon EX20 1QW, UK. Tel +44 (0)1837 54771, fax +44 (0)1837 53965, Mary@mollusca.org.uk Landsnails@gmail.com

Editor (*Tentacle*)

Robert H. Cowie, Center for Conservation Research and Training, Pacific Biosciences Research Center, University of Hawaii, 3050 Maile Way, Gilmore 408, Honolulu, Hawaii 96822, USA. Tel +1 808 956 4909, fax +1 808 956 0956, cowie@hawaii.edu www.hawaii.edu/cowielab/

Members

Christian Albrecht, Department of Animal Ecology and Systematics, Justus Liebig University, Heinrich-Buff-Ring 26-32 IFZ, D-35392 Giessen, Germany. Tel +49 (0)641 99 35722, fax +49 (0)641 99 35709, Christian.Albrecht@alzool.bio.uni-giessen.de www.uni-giessen.de/cms/faculties/f08/department-of-biology/tsz-en/wilke/staff/albrecht?language_sync=1

Ma. Rosario Alonso, Universidad de la Laguna, Departamento de Biologia Animal, Astrofisico Francisco Sánchez, s/n, 38206 La Laguna, Tenerife, Canary Islands, 38206 Spain. Tel +34 22 603746, fax +34 22 253344, malonso@ull.es

David Aldridge, Aquatic Ecology Group, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, UK. Tel +44 (0)1223 334436,fax +44 (0)1223 336676, d.aldridge@zoo.cam.ac.uk

Rafael Araujo, Museo Nacional de Ciencias Naturales (CSIC), c/ José Gutiérrez Abascal 2, E-28006 Madrid, Spain. Tel +34 91 411 13 28, fax 915645078, rafael@mncn.csic.es http://www.fauna-iberica.mncn.csic.es/CV/CVAraujo.html

N.A. Aravind Madhyastha, The Academy for Conservation Science and Sustainability Studies, Ashoka Trust for Research in Ecology and the Environment, Royal Enclave, Srirampura, Jakkur PO, Bangalore 560064, India. Tel +91 80 23635555 ext 225, fax +91 80 23530070, aravind@atree.org www.atree.org/aravind.html

Takahiro Asami, Department of Biology, Shinshu University, Matsumoto, 390-8621 Japan. Tel/fax +81 263 574 190, asami99@gipac.shinshu-u.ac.jp

Gary M. Barker, Biodiversity & Biosecurity, Landcare Research, Private Bag 3127, Hamilton, New Zealand. Tel. +64 7 858 3708, fax +64 7 858 4964, BarkerG@LandcareResearch.co.nz

Jean-Michel Bichain Muséum national d'Histoire naturelle, Département Systématique et Evolution, USM 603/UMR 7138 "Systématique, Adaptation, Evolution", Equipe "Exploration de la Biodiversité", Case Postale 51, 55 Rue Buffon, F- 75231 Paris Cedex 05, France, Tel +33 (0)6 42 56 66 24, jean-michel.bichain@educagri.fr

Arthur E. Bogan, North Carolina State Museum of Natural History, Research Laboratory, 4301 Reedy Creek Road, Raleigh, North Carolina 27607, USA.Tel +1 919 715 2606, fax +1 919 715 2614, arthur.bogan@ncmail.net

Kevin J. Bonham, Department of Geography and Environmental Studies, University of Tasmania, c/o 410 Macquarie Street, South Hobart, Tasmania 7004, Australia. k_bonham@tassie.net.au

Philippe Bouchet Muséum national d'Histoire naturelle**,** Département Systématique et Evolution, USM 603/UMR 7138 'Systématique, Adaptation, Evolution', Equipe 'Exploration de la Biodiversité', Case Postale 51, 55 Rue Buffon, F-75231 Paris Cedex 05, France. Tel +33 (0)1 40 79 31 03, fax +33 (0)1 40 79 57 71, pbouchet@mnhn.fr

Prem Budha, Department of Zoology, Tribhuvan University, Kiritpur, Kathmandu, Nepal. prembudha@yahoo.com

Simone Cianfanelli Museo di Storia Naturale dell'Università degli Studi di Firenze, sez. Zoologica "La Specola", Via Romana, 17, 50125 Firenze, Italy. Tel 055-2288260, fax 055-225325, simone.cianfanelli@unifi.it www.msn.unifi.it/

Stephanie A. Clark, Chicago Academy of Sciences Notebaert Nature Museum, 4001 North Ravenswood Avenue, Suite 201, Chicago, Illinois 60613, USA. Tel +1 773 477 4295, fax +1 773 755 5199, mobile +1 205 310 9942, sclark@naturemuseum.org

David Clarke (Focal Point for Pacific Island Land Snail Group), Invertebrate Conservation Centre, Zoological Society of London, Regent's Park, London NW1 4RY, UK. Fax +44 (0)171 722 5390.

Ken Emberton, c/o Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611-2035, USA. Tel +1 904 392 1721, fax +1 904 392 8783.

Gerhard Falkner, Bayerische Staatssammlung für Paläontologie und historische Geologie, Richard-Wagner-Strasse 10/11, D-8000, München 2, Germany. KLD1105@mail.lrz-muechen.de

Hiroshi Fukuda, Faculty of Agriiculture, Okayama University, Tsushima-naka 1-1-1, J 700-8530, Okayama, Japan. suikei1@cc.okayama-u.ac.jp

Daniel Geiger, Santa Barbara Museum of Natural History, 2559 Puesta del Sol Road, Santa Barbara, California 93105, USA. Tel +1 805 682 4711 x152, fax +1 805 563 0574, geiger@vetigastropoda.com www.vetigastropoda.com

Benjamin Gomez-Moliner, Departmenta de Zoologia, Universidad de Pais Vasco, Paseo de la Universidad, 7, Vitoria 01006, Spain. Tel +34 945 013 044, fax +34 945 013 014, ggpgomob@vc.ehu.es

Terrence Gosliner, California Academy of Sciences, Golden Gate Park, San Francisco, California 94118-4599, USA. Tel +1 415 750 7318, fax +1 415 750 7346, tgosline@calacademy.org www.calacademy.org/research/curators/gosliner.htm

Daniel L. Graf, Department of Biological Sciences, 409 MH Bryant Hall (Box 870345), University of Alabama, Tuscaloosa, Alabama 35487, USA. Tel +1 205 348 2537, dlgraf@bama.ua.edu http://bama.ua.edu/~dlgraf/

Owen Griffiths, Bioculture (Mauritius) Ltd., Senneville, Rivière des Anguilles, Mauritius. Tel +230 6262903, fax +230 6262844, olgmas@bow.intnet.mu

Michael G. Hadfield, Kewalo Marine Laboratory, University of Hawaii, 41 Ahui St., Honolulu, Hawaii 96813, USA. Tel +1 808 539 7319, fax +1 808 599 4817, hadfield@hawaii.edu www.kewalo.hawaii.edu/labs/hadfield/index.html

Jason Hall-Spencer, School of Biological Sciences, University of Plymouth, Drake Circle, Plymouth, UK. jason.hall-spencer@plymouth.ac.uk www.plymouth.ac.uk/pages/dynamic.asp?page=staffdetails&id=jhall-spencer&size=l

Joseph Heller, Department of Evolution, Systematics and Ecology, Hebrew University, Jerusalem 91904, Israel. Tel +972 2 658 5713, fax +972 2 658 4741, heller@vms.huji.ac.il

David (Dai) Herbert, Natal Museum, Private Bag 9070, Pietermaritzburg 3200, South Africa. Tel +27 (0)33 345 1404, fax +27 (0)33 345 0561, dherbert@nmsa.org.za www.nmsa.org.za

Frank Köhler, Australian Museum, 6 College Street, Sydney NSW 2010, Australia. Tel. +61 2 9320 6382, fax +61 2 9320 6352, Frank.Koehler@austmus.gov.au www.wallacea.info/frank-koehler

Thomas K. Kristensen, (Focal contact for African Freshwater Assessment), Danish Bilharziasis Laboratory, Jaegersborg Allé 1 D, DK-2920 Charlottenlund, Denmark. Tel +45 77 32 77 60, fax +45 77 32 77 33, tkk@life.ku.dk

Charles Lange, Department of Invertebrate Zoology, National Museums of Kenya, PO Box 40658, Nairobi, Kenya. nzavi2001@yahoo.com

Charles (Chuck) Lydeard, Smithsonian Tropical Research Institute, 1100 Jefferson Drive, Suite 3123, MRC 705, Washington DC 20013, USA. Tel +1 202 633 4015, lydeardc@si.edu

Maria Cristina Dreher Mansur, Museu de Ciências e Tecnolo, Av. Jpiranga 6681, Prédio 40, Caixa Postal 1429, 90619-900 Porto Alegre RS, Brasil. Tel +55 51 320 3500 x4421, fax +55 51 320 3903, mcmansur@zaz.com.br

Alberto Martinez-Ortí, Museu Valencià d'Història Natural, Passeig de la Petxina, 15, 46008 Valencia, Spain. Alberto.Martinez@uv.es

Ristiyanti M. Marwoto, Research and Development Centre for Biology, Gedung Widyasatwaloka, Puslitbang Biologi, Jalan Raya Bogor Km 46, Cibinong 16911, Indonesia. Tel +62 21 876 5056, fax +62 21 876 5068, mzb@indo.net.id

Ellinor Michel, Department of Zoology, The Natural History Museum, Cromwell Road, London SW7 5BD, UK. Tel +44 207 942 5516, ellm@nhm.ac.uk, e.michel@nhm.ac.uk www.sorayavillalba.com/ellinor/index.php

Paula M. Mikkelsen, Paleontological Research Institution, 1259 Trumansburg Road, Ithaca, New York 14850, USA. Tel. +1 607 273 6623 ext 20, fax +1 607 273 6620, mikkelsen@museumoftheearth.org, pmm37@cornell.edu www.museumoftheearth.org

Evelyn Moorkens, 53 Charleville Square, Rathfarnham, Dublin 14, Ireland. Tel + 353 1 4948500, emoorkens@eircom.net

Richard Neves, Virginia Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife Sciences, Virginia Tech, Blacksburg, Virginia 24061-0321, USA. mussel@vt.edu

Christine Ngereza, National Museums of Tanzania, PO Box 512, Dar es Salaam, Tanzania. cngereza@yahoo.com

Somsak Panha, Department of Biology, Faculty of Science, Chulalongkorn University, Phyathai Road, Bangkok 10330 Thailand. Tel +66 2 218 5273, fax +66 2 253 0337, somsakp@sc.chula.ac.th

Timothy A. Pearce, Carnegie Museum of Natural History, 4400 Forbes Avenue, Pittsburgh, Pennsylvania 15213, USA. Tel +1 412 622 1916, fax +1 412 622 8837, PearceT@CarnegieMNH.org www.carnegiemnh.org/mollusks/index.htm

Paul Pearce-Kelly, Invertebrate Conservation Centre, Zoological Society of London, Regent's Park, London NW1 4RY, UK. Tel +44 (0)171 449 6470, fax +44 (0)171 722 5390, ppk@zsl.org

Kathyrn Perez, Department of Biology, University of Wisconsin at La Crosse, 1725 State Street, Cowley Hall 3009, La Crosse, Wisconsin 54601, USA. Tel +1 608 785 6998/8257, perez.kath@uwlax.edu www.uwlax.edu/biology/faculty/perez/Perez/PerezLab/Research/research.html

Beata M. Pokryszko, Museum of Natural History, Wroclaw University, Sienkiewicza 21, PL-50-335 Wroclaw, Poland. Tel +48 71 225041, fax +48 71 402800, bepok@biol.uni.wroc.pl

Winston F. Ponder, Australian Museum, 6 College Street, Sydney NSW 2010, Australia. Tel +61 2 9320 6120, fax +61 2 9320 6050, wponder@bigpond.net.au

Vincent Prié, Biotope - Recherche et Développement, 22 Boulevard Maréchal Foch, BP58, 34140 Mèze, France. Tel +33 (0)4 67 18 61 62. vprie@biotope.fr www.biotope.fr/index.php?theme=international-eco-volontariat

Ted von Proschwitz, Section of Invertebrate Zoology, Göteborg Natural History Museum, Box 7283, 402 35 Göteborg, Sweden. Tel +46 (0)31 775 24 40, ted.v.proschwitz@vgregion.se

David G. Robinson, USDA/APHIS/PPQ, Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, Pennsylvania 19103, USA. Tel +1 215 299 1175, fax +1 215 299 1170, robinson@acnatsci.org

Barry Roth, 745 Cole Street, San Francisco, California 94117, USA. Tel +1 415 387 8538, fax +1 415 387 2133, barryroth@earthlink.net

John Stanisic, Queensland Museum, PO Box 3300, South Brisbane, Queensland 4101, Australia. Tel +61 7 840 7718, fax +61 7 846 1918, johns@qm.qld.gov.au

Peter Tattersfield, Sunnybank, Manchester Road, Tideswell, Buxton SK12 8LN, UK. Tel +44 (0)1298 872918, fax +44 (0)870 0567851, peter@petertat.demon.co.uk

Fred G. Thompson, Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611-2035, USA. Tel +1 352 392 1721, fax +1 352 392 8783, fgt@flmnh.ufl.edu

Jackie Van Goethem, Royal Belgian Institute of Natural Sciences, Vautierstraat 29, B-1000, Brussels, Belgium. Tel +32 2 627 4343, fax +32 2 627 4141, jackie.vangoethem@naturalsciences.be www.naturalsciences.be

L'ubomira Vavrová, IUCN Sub-regional Office for South-eastern Europe, Dr. Ivana Ribara 91, 11070 Belgrade, Serbia. Tel +381 11 2272 411 (office), +381 63 358 102 (cell/mobile), fax: +381 11 2272 531, lubomira.vavrova@iucn.org

Jaap J. Vermeulen, Singapore Botanic Gardens, 1 Cluny Road, Singapore 259569. Tel +65 471 99 23, fax +65 475 42 95, Jaap_jan_vermeulen@nparks.gov.sg

Anton (Ton) J. de Winter, Nationaal Natuurhistorisch Museum, PO Box 9517, 2300 RA Leiden, The Netherlands. Tel +31 71 5687567, fax +31 71 5687666, Winter@nnm.nl

Min Wu, School of Life Science, Nanjing University, Hankoulu 22, Nanjing 210093, China. Tel. +86 (0)25 83593389, fax +86 (0)25 83592705, minwu1969@yahoo.cn

Xiaoping Wu, Departmental of Biological Sciences, Nanchang University, Nanchang, Jiangxi, 330047, P.R. China +86 791 8305213, Fax +86 791 8305207, wuxiao@public.nc.jx.cn