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

TENTACLE

UNITAS MALACOLOGICA

EDITORIAL

At the forefront of recent research on land snail conservation is the elegant work of University of Michigan researchers Taehwan Lee, Diarmaid Ó Foighil, John Burch and colleagues, including the ubiquitous Paul Pearce-Kelly of the Institute of Zoology in London (see *Tentacle* number 16, 2008) and others from the Muséum nationale d'Histoire naturelle in Paris and from French Polynesia, on the endangered partulid tree snails of the South Pacific.

Building on the classic work of Bryan Clarke, Jim Murray and Mike Johnson, the new work uses DNA sequencing to re-assess the conservation status of these iconic snails – the image adorning the front page of every issue of *Tentacle*, right from issue number 1, published in 1989, is a partulid from the French Polynesian island of Moorea.

Crucially, the researchers had the unanticipated opportunity to use material collected back in the 1960s by John Burch and Yoshio Kondo when the idea of DNA sequencing as a conservation tool was beyond anyone's wildest imagination. With marvellous foresight, Burch had tissue samples freeze-dried, and it is these samples, many of them representing lineages now extinct as a result of predation by deliberately introduced predatory snails, that have been the key to the work carried out and now being published by Lee and colleagues.

In the last issue's editorial I lamented the absence in recent issues of articles on partulids. This concern has now been laid to rest admirably, as this issue's Pacific Island Land Snail section features an important article summarizing the dramatic findings of the group. I encourage you to read it and look out for further papers to be published by the group in the near future.

Tentacle is now a web-based newsletter, accessed at www.hawaii.edu/cowielab/Tentacle.htm, where all issues are available. 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 addresses 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. 45 of this issue of *Tentacle*) and the UNITAS MALACOLOGICA members e-mail list.

In this issue: page

As always, I reiterate that the content of *Tentacle* depends on what you send me. *Tentacle* is one means to publicise the threats molluscs face – and the conservation successes. It reaches many far corners of the world and includes articles from diverse and distant locations dealing with a wide variety of molluscs, terrestrial, freshwater and marine. It is also a free, easy way to advertise your own projects! Sometimes I include

articles not directly dealing with threatened molluscs (alien species, for instance). But many issues are linked to the threats faced by molluscs and there is no good reason to exclude them from a newsletter such as this, although I do expect some explicit reference to conservation in your submissions. So I encourage anyone with anything relevant to mollusc conservation, even in a broad sense, to send me an article, however short. Don't wait until I put out a request for new material (usually via the MOLLUSCA listserver). Send me something now, and it will be included in the next issue (published once a year, in January). I would especially like to have more from members of the Mollusc Specialist Group – I have not heard from many of you for a long time!

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 indeed assess whether it really includes anything 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.

Increasingly, I receive (and publish in *Tentacle*) articles related to mollusc conservation that perhaps should be in the peer-reviewed literature – some articles presenting new data and analyses fall in this category. I am beginning to notice that, because I accept more or less everything submitted to me, *Tentacle* might be seen as an easy way to get your original data published without going through the rigours of peer- review. Perhaps there is a niche for a formal peer-reviewed journal of mollusc conservation, but *Tentacle* is not it. I will increasingly decline to publish articles that I feel should be in the peer-reviewed literature, especially if they are long. *Tentacle* is a newsletter and in my vew should remain a newsletter.

Please make every effort to format your article, including 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 attention to the format (paragraphing, fonts, etc.) in past 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, fill out the application form at the end of this issue of *Tentacle*.

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.

Robert H. Cowie, Editor, 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 2647, cowie@hawaii.edu, www.hawaii.edu/cowielab

NEWS

News items in this section are from external sources and the Mollusc Specialist Group cannot be held responsible for the authenticity of their content, nor for the continuing presence of original links. These items are provided for information only and are not intended to indicate policy.

Comment period reopens for Bliss Rapids snail review

Modified from: United States Fish and Wildlife Service News Release, 12 August 2008
http://www.fws.gov/news/NewsReleases/showNews.cfm?newsId=B7DADD39-F3D0-8DC7-CAF2011B2F21064C

The U.S. Fish and Wildlife Service announced today the opening of a second public comment period for the status review of the Bliss Rapids snail (*Taylorconcha serpenticola*).

On 6 June 2007, the Service announced a positive 90 day finding on a petition to remove the snail from the Federal List of Endangered and Threatened Wildlife, determining that an additional status review was needed to determine whether the species should be delisted. The Service was petitioned by the State of Idaho/Governor's Office of Species Conservation and Idaho Power Company to delist the Bliss Rapids snail in December 2006.

After the close of the 90 day finding public comment period on 4 September 2007, new information became available to the Service. The new information included a Draft Status Review for the Bliss Rapids snail prepared in February 2008; peer reviews of the Draft Status Review; a manuscript examining the genetic structure of Bliss Rapids snail populations; and documentation from an expert panel convened to assess the species' status.

"Because the Service has gained new information about the Bliss Rapids snail, we are asking the public to review this information, and provide comment to us by 27 August 2008", said Jeff Foss, Field Supervisor of the Snake River Fish and Wildlife Office in Boise, Idaho.

A 5 year Review was initiated on 27 July 2004 for this species. The results of the 5 year Review will be incorporated into the 12 month finding, and will be published simultaneously.

The Bliss Rapids snail is a small to medium-sized (2-4 mm in height) snail, with a clear to white shell. The snail occurs in springs and riverine habitats along a 91 km [57 mile] stretch of the Snake River in the Hagerman area of southern Idaho. It was listed on 14 December 1992 as a threatened species due to threats from proposed hydroelectric development, operation of existing hydroelectric dams, degraded water quality, diversion of water for irrigation and aquaculture, deteriorating water quality in the Snake River, lack of regulatory protections for spring habitats, and invasion of the introduced New Zealand mudsnail. A recovery plan for this and other Snake River snail species was completed on 26 November 1995.

At the conclusion of the status review and 5 year Review, the Service will issue its recommendation on the listing status of

this species. Any change in the listing classification of this species would require a separate rule-making process.

For further information, please contact Jeffery L. Foss, Field Supervisor, U. S. Fish and Wildlife Service, Snake River Fish and Wildlife Office, 1387 S. Vinnell Way, Suite 368, Boise, Idaho 83709, USA. Tel +1 208 378 5243, fw1srbocomment@fws.gov.

Size matters when it comes to conserving limestone karsts

News release forwarded by Mary B. Seddon

A team of biologists have come up with a scientific basis to identify limestone karsts for protection.

Using data from 43 karsts across Peninsular Malaysia and Sabah, the study discovered that larger karsts, particularly those more than 1 km^2, deserve greater protection as they contain higher numbers of endemic land snails, and potentially other endemic plants and animals.

"Larger areas tend to have greater habitat diversity, which enables them so support a higher number of unique species" says Reuben Clements, lead author of the study published in the November [2008] issue of the journal *Biological Conservation*.

Recognized as 'arks of biodiversity', karsts are home to many unique species of birds, bats, insects, snails, fish, mammals and plants. Animals inhabiting karsts provide important ecosystem services such as pollination and pest control in surrounding areas.

Left: Large pristine limestone karsts in Bau, Sarawak, Malaysia. Right: *Opisthostoma vermiculum*, a newly discovered land snail that is endemic to a large limestone karst, Gunung Rapat in Perak, Malaysia.

Unfortunately, many karsts are being quarried for cement and marble, with logging activities and land clearance around it also degrading these biodiversity havens.

"The protection of karsts has been mainly *ad hoc* and they are usually spared from quarrying by virtue of being situated within state and national parks, or if they possess some form of aesthetic or cultural value" says Clements, who is currently the species conservation manager for WWF-Malaysia.

In addition, groups of karsts that have been isolated from other groups by geographical barriers such as mountains and rivers potentially contain significantly distinct species compositions.

"Taking Peninsular Malaysia for example, our results suggest that we should set aside larger karsts on both sides of the Titiwangsa mountain range for protection if we want to maximize the conservation of endemic species" added Clements. "Protecting karsts on one side of the mountain chain is not enough".

Pressure to mine karsts for limestone is likely to increase. A previous study by Clements showed that Southeast Asia has the greatest annual average increases in limestone quarrying – 5.7 % a year.

"With our findings, we hope that governments would reconsider issuing mining concessions for larger karsts as they tend to be more biologically important." says Clements.

"Mining companies should also look towards extracting abundant limestone deposits below ground instead of leveling Earth's precious biodiversity arks".

For further information, please contact Reuben Clements at: rclements@wwf.org.my or call +60 13 2183992.

Previous press on studies of limestone karst conservation and biodiversity authored by Reuben Clements:
http://news.nationalgeographic.com/news/2006/09/060912-stone-karst.html
http://www.nytimes.com/2008/01/15/science/15obshel.html?_r=1&oref=slogin
http://www.nature.com/nature/journal/v451/n7176/full/451226a.html

Scots pearl poachers face £1.3 m fine over mussel death

From: The Daily Record, 30 October 2008
http://www.dailyrecord.co.uk/news/scottish-news/2008/10/30/scots-pearl-poachers-face-1-3m-fine-over-mussel-deaths-86908-20852670/

By James Moncur

Pearl poachers who killed 130 protected mussels in a Scots river could be fined £1.3 million if they're caught.

The possible penalty for each dead mussel is £10,000.

The poachers' crime was uncovered last week on the South Esk river near Brechin, Angus. Experts found that a third of the freshwater mussels on a stretch of the river had been illegally fished and prised open.

Scientist Dr Peter Cosgrove, who led the survey team that discovered the crime, said yesterday: "This was not an opportunistic half hour in the river.

"We worked hard to find these mussel beds and that suggests the pearl fishers must have made a similar effort.

"They would have had to have systematically been in the river for many days.

"In all my years doing this type of survey, this might be the largest kill I've seen."

Freshwater mussels were protected by law in 1998 after poaching left the species endangered. It's a crime to kill, injure or disturb them or damage their habitat.

The creatures live in 65 Scots rivers but the biggest population is in the South Esk.

Only two Scots jewellers are licensed to sell freshwater pearls and they can only trade in pearls collected before the ban.

John Lochtie, manager of one of the licensed dealers, Cairncross jewellers in Perth, said poached pearls would be very difficult to sell on the black market.

He added: "A good pearl could be worth £150 with a really good necklace making £15,000. But since the ban, no jewellers have been allowed to buy loose pearls."

Tayside Police wildlife crime officer Alan Stewart appealed to the public for information about the poachers.

High Court rules on snails

From: The Dominion Post [New Zealand], 16 December 2008
http://www.stuff.co.nz/dominionpost/4793900a6479.html

Endangered giant snails and other rare species threatened by mining will stay protected by the Wildlife Act after a High Court ruling. Solid Energy went to the High Court, asking if it had to seek permission under the Wildlife Act when protecting wildlife in mining areas. The issue arose after the company was told it needed special wildlife permits to move rare and endangered snails from its Stockton opencast coal mine near Westport. The snail move cost $10 million as the company met permit conditions. Solid Energy felt the process should have been covered by the Resource Management Act consent its mining was under. "We decided we wanted some clarity around the law", spokeswoman Vicky Blyth said. But in a just-released High Court decision, Justice Jill Mallon found the Wildlife Act still applied when it came to dealing with issues such as the giant snails. That meant gaining permission from the conservation and energy ministers for "actions relating to wildlife". She found the question of whether keeping the process under the Wildlife Act served any purpose "or merely serves to impose unnecessary time and cost" was a question for Parliament. Ms Blyth said the decision was "reasoned" and gave clarity around the law.

Abalone theft rife on the coast

From: Bay Post [Batemans Bay, New South Wales, Australia], 8 February 2008

Large quantities of undersized abalone have been seized in raids all along the south coast of New South Wales, Australia. The NSW Fisheries officers from the investigations group based in Merimbula raided the premises of an Asian grocery store in Ashfield, Sydney. The raid followed investigation into the distribution of abalone taken by illegal poaching syndicates based on the South Coast and resulted in the seizure of 2437 shucked abalone.
http://batemansbay.yourguide.com.au/news/local/general/abalone-theft-rife-on-the-coast/1178930.html

Black abalone may join endangered species list

Modified from: The Los Angeles Times, 12 January 2008

The [US] federal government proposed declaring the black abalone an endangered species, the first step in an effort to bring back the once-abundant mollusc ravaged by disease and excessive harvesting. The final decision expected (2009) would not have an immediate impact on the hunting of black abalone in California, which has been illegal since 1993. But the listing could bring in federal money to help restore populations of the species, set aside critical habitat and impose criminal penalties for importing the mollusc from Mexico.

Endangered status also could lead to a crackdown on power plants that use seawater as a coolant and release the warmed water into the sea. Other activities that elevate seawater temperature also could come under scrutiny as warmer waters have been linked to the spread of bacteria that can be fatal to abalone.

Melissa Neuman, a fisheries biologist with National Marine Fisheries Service, said that the scientists who discovered a mass die-off of black abalone near the Diablo Canyon nuclear power plant in San Luis Obispo County in the 1980s believe it was directly linked to heated effluent from the plant.

By 1997, state officials banned all abalone hunting off California, except for red abalone taken by sports divers without scuba gear north of San Francisco. White abalone were so rare they were placed on the federal endangered species list in 2001, but the others are not on the list. Black abalone have suffered some of the greatest losses from the double punch of excessive harvesting and disease outbreaks first spotted in the mid-1980s. Locally black abalone were reduced to a couple of viable populations off Southern California's San Miguel and San Nicolas islands, but further north are doing a bit better in colder waters north of Monterey, California. Scientists are concerned that disease may spread north with rising sea temperatures attributed to global warming.

Shell shock: abalone poacher jailed

From: Sydney Morning Herald, 21 July 2008

A 61 year old man found with illegally caught and undersized abalone has been jailed for four months and fined $900 for poaching abalone. The Narooma man was apprehended during a crackdown on illegal fishing, Primary Industries Minister Ian Macdonald said.
http://www.smh.com.au/news/national/shell-shock-abalone-poacher-jailed/2008/07/21/1216492316661.html

Abalone diving ban in South Africa

From: TRAFFIC, March 2008
http://www.traffic.org/seizures/2008/3/20/abalone-ban-upheld.html

A ban on diving has been implemented in coastal waters of southwestern South Africa, aiming to protect wild abalone

stocks in the area. South Africa's Environmental Affairs Minister Marthinus van Schalkwyk ordered the indefinite ban to protect existing natural stocks of the shellfish, which is threatened with extinction. The ban has been in place since 1 February 2008. A group of fisherman in Cape Town tried to challenge the ban, but the court dismissed their challenge.
http://africa.reuters.com/wire/news/usnL20835819.html
http://www.busrep.co.za/index.php?fSectionId=&fArticleId=4237523

Fish harvester fined for illegal possession of northern abalone

From: Fisheries and Oceans Canada, 11 August 2008

An investigation conducted by Fisheries and Oceans Canada in British Columbia has resulted in a conviction and $7000 fine against a Vancouver resident for illegal possession of northern abalone, which is listed as threatened under the Species at Risk Act.
http://www.dfo-mpo.gc.ca/media/npress-communique/2008/pr22-eng.htm

Overfishing of abalone in Western Australia

From: WA [WesternAustralia]Today, 9 December 2008
http://www.watoday.com.au/wa-news/abalone-restrictions-fail-to-stop-law-breakers-20081209-6une.html

Western Australia's strict abalone fishing season ended at the weekend, with more than 250 fishers accused of breaking the rules in the six week season. The Fisheries Department estimates about 30 tonnes of the prized catch were caught off the coast from Busselton to Greenough during the season. Despite strong penalties for overfishing the rock-dwelling marine snails, 16 people will face court in coming weeks charged with a range of offences, including having undersized abalone, fishing outside of prescribed hours and being in excess of limits. More than 175 people were issued with cautions for breaching fishing restrictions and 79 fishers were issued fines of up to $200 at fishing sites.

A department spokesman said the fishers facing court could be fined up to $5000 depending on the offence. He said a mandatory penalty also applied, which cost offenders 10 times the prescribed value of the fish. "The prescribed value for Roe's abalone is $80 per kilo or $3 per fish [sic] so when you times that by 10 it can become quite a significant penalty", he said.

Fisheries Department principal policy officer Nathan Harrison said the 30 tonnes of abalone caught during the season was a sustainable amount but the department would now start its annual assessment of the overall impact on abalone stocks. "Perth is probably the only city in the world to enjoy a sustainable abalone fishery on its doorstep, however, as abalone stocks are vulnerable to overfishing the fishery requires careful management", Mr Harrison said.

He said Perth's six-hour abalone fishing season over six weeks was one of the shortest in the world.

More than 20,000 recreational abalone fishing licences were issued for this year's season.

Thousands of fishers could be seen converging on Perth beaches for the one-hour fishing period each Sunday morning during the season.

Would be poachers shell shocked in Philippines

Summarized from: Inquirer.net, 22 October 2008

Forty-five people who attempted to bribe park rangers so they could illegally harvest ornamental *Trochus niloticus* shells from the Tubbataha National Marine Park have been arrested and face up to 20 years in prison.
http://newsinfo.inquirer.net/breakingnews/regions/view/20081022-167879/45-poachers-nabbed-in-Tubbataha-Reefs

Patagonian Sea Forum launches report on state of the sea

Forwarded by Mary B. Seddon

After four years of work involving more than 80 experts, the Forum for the Conservation of the Patagonian Sea and Areas of Influence is releasing its report assessing the state of conservation of the area. This is an electronic publication, at present only in Spanish, with English and Portuguese summaries. "Today we are still in time to maintain the ecological integrity and productive potential of this vast ecosystem", concludes the extensive report, of which a 300 page executive summary under the title *Review of the Status of Conservation of the Patagonian Sea and its Areas of Influence* is being published.

The Patagonian Sea is a three million square kilometre southwestern stretch of the Atlantic Ocean, running from southern Brasil to Uruguay, Argentina's southernmost province of Tierra del Fuego, and west around Cape Horn, along the Chilean fjords.

The Forum is an alliance of South American and international environmental groups formed in 2004; the Argentine members of the alliance include Fundación Patagonia Natural (the Natural Patagonia Foundation) and Fundación Vida Silvestre (the Wildlife Foundation), and the international members include the Wildlife Conservation Society, Conservation International and the Worldwide Fund for Nature (WWF). Forum coordinator Claudio Campagna, a marine mammal expert, explained that, in contrast to what occurs in other seas, "not a single species has been endangered to the point of extinction" in the Patagonian Sea. "We are heading towards the collapse of certain populations, and others are dropping considerably in numbers, but no species has gone extinct", he underlined. The report warns that illegal and non-sustainable fishing, the incidental catching of sea birds, mammals and turtles, the introduction of species for aquaculture purposes, and the discharge of untreated sewage are some of the "serious problems that are threatening the abundance of species and the economic potential" of this vast expanse of saltwater.

In addition to the many species that are commercially

important – such as squid, common hake, croaker and shrimp – the ecosystem's global significance resides in the fact that it provides a feeding ground for migratory birds, fish, turtles and sea mammals. As for invertebrates, there are 900 species of molluscs alone, some of which are only found in the Patagonian Sea. The report contains a chapter on the diversity of molluscs, and some of the threats, especially the impact of trawling on the fauna within the region.

"The international goal is to have 10 percent of the world's oceans under some form of protection by 2012", Campagna said. But for the Patagonian Sea, that target seems far away. Nonetheless, the Forum "does not share the simplistic view that the solution to the Patagonian Sea's conservation problems lies solely in the establishment of protected areas where all forms of economic activities are banned", he said. "The Forum has detected some areas where greater protection would be justified. But it deems that it is possible to achieve a form of ecosystem management that will promote economic activities without affecting biodiversity or the natural course of ecological processes", he added.

[For more information, see http://www.patagoniansea.org/ - Ed.]

INTO THE ANDES: THREE NEW INTRODUCTIONS OF *LISSACHATINA FULICA* (GASTROPODA, ACHATINIDAE) AND ITS POTENTIAL DISTRIBUTION IN SOUTH AMERICA

By Francisco J. Borrero, Abraham S.H. Breure, Carl C. Christensen, Modesto Correoso & Valentín Mogollón Avila

The giant African land snail, *Lissachatina fulica* (Bowdich, 1822), has been considered one of the most widely introduced and invasive land snail species in the world (Lowe *et al*., 2000; Raut & Barker, 2002). It has been introduced into many island countries in the Pacific and the Caribbean, into many Asian countries, as well as to Brasil (Thiengo *et al*., 2007). Fontanilla (2007) investigated phylogenetic relationships within the Achatinidae, concluding that the family is monophyletic and that the subgenus *Lissachatina* should be given generic rank, to distinguish it from *Achatina* species (Bequaert, 1950; Mead, 1995; Fontanilla, personal communication).

Lissachatina fulica has been introduced primarily by two main pathways: as "un-invited" cargo through the shipping and transportation industries (Robinson, 1999); and purposely as a pet, potential food item, ornamental snail, or as a source of "baba de caracol" (snail mucus) (Correoso, 2006). While *L. fulica* is mainly a vegetarian and has been identified as a major agricultural pest (Cowie, 2000), there is recent evidence that it can also act as a predator of other snails (Meyer *et al*., 2008).

It was by accident that one of us (FB) photographed two live specimens of *Lissachatina fulica* while on a land snail survey near Mindo, Province of Pichincha, Ecuador, in March 2008. The animals were kept by a young lady as pets and as her family was unwilling to part with them, only the pictures are available (Fig. 1). Initially, we were in doubt about their identity as we knew of no reports of achatinids from Andean countries, and some species of *Sultana* (Orthalicidae) known from Ecuador show a similar colour pattern. After one of the photographs had been posted in a blog (Breure, 2008) and the photographs shown to others, the correct identification was received from independent sources. In fact, the presence of the giant African snail in Ecuador had been mentioned on two earlier occasions and a preliminary control strategy had been formulated (Correoso, 2006). However, since the context of these reports was not biological, they remained unnoticed.

Fig. 1. *Lissachatina fulica* in Mindo, Ecuador. (Photo: F. Borrero, March 2008)

First, we discovered a mention of *L. fulica* on the website of CORPEI, a private non-profit organization that is recognized by the Ecuadorian Government as the official body for the promotion of exports and investments in the country. Snail farms were introduced some 10 years ago and some valleys in the Ecuadorian highlands offer an ideal temperature between 17° and 25°C, with long periods of sunlight and an adequate pH to grow snails (CORPEI, 2008). According to this source, only *Helix aspersa* Müller, 1774 and *Lissachatina fulica* are reared, the latter called "Chinese Escargot".

Later we found a second bit of information in the online newsletter of a tourist information service (Kreykenbohm, 2005). In this note, resulting from a newspaper interview with one of us (MC), it was stated that slime of the giant African snail was used to produce a cream "to receive a spotlessly clean skin", at the same time mentioning that the snail could destroy the ecosystem of the whole country. According to the note, "the Ministry of the Environment is concerned". Thus, we have to conclude that in 2005, the officials knew of the occurrence of *Lissachatina fulica* and the danger it posed (see also Anonymous, 2005). The snails, "which can be bought for one dollar a piece, are sold in Esmeraldas for example as domestic species" (Kreykenbohm, 2005; Correoso, 2006).

From other sources (Anonymous 2001, 2008a) we know that in 2001 there were at least 1300 snail farms in Ecuador. These are mainly located in the mountainous central part of the country (the provinces of Cañar, Chimborazo, Cotopaxi, Imbabura and Pichincha have been mentioned, but see below). However, it is not clear how many of these snail farms actually use *Lissachatina fulica*.

Conclusively, there is strong evidence that *Lissachatina fulica* has been purposely introduced for economic reasons in Ecuador. We do not know to what extent it may have escaped from snail farms. Clearly, the extent of this economic activity, the species used and the localities of the snail farms need further investigation in all countries concerned. This is especially urgent once snail farming becomes more popular or is even promoted for commercial reasons. Thus, the risk of accidental spread is great and this may lead to an economic disaster and serious environmental risk in the region, as has already been the case in Brasil (Thiengo *et al*., 2007). An eradication program for this invasive species was initiated in Ecuador in 2006, although it was not officially announced. Despite these efforts, *L. fulica* is still present in Mindo, with recent reports (by MC) from Santo Domingo Tsáchilas (where it was found in bananas) and Guayaquil (escaped from a snail farm outside the city). It is thus probable that these populations are at low levels, making future outbreaks possible.

A similar situation seems to occur in Colombia. So far, *L. fulica* has not been reported for the malacofauna of this country, but it has turned up in a rural area near Fusagasugá, close to Bogotá (Clara Inés Medina, personal communication). An escape from a snail farm is the probable cause again, as snail rearing has also become popular in this country (Alvis, 2006). Finally, the occurrence of the species in yet another Andean country was confirmed by the finding of live specimens in Ayabaca, Piura Department, northern Peru (VM, voucher in Leiden museum). The animals were purchased from a dealer, who said they originated from Pucallpa, Ucayali Department, in eastern Peru.

In South America, *Lissachatina fulica* has been introduced to Brasil and is spreading rapidly (Thiengo *et al*., 2007). Martinez & Martinez (1997) reported an incidental introduction in Venezuela, but recently the species has been reported as a pest from two other localities in that country (Anonymous, 2007, 2008b). Since the introduction of the species on the western side of the Andes opens up a new area, we would like to know the potential for the further spread of *Lissachatina fulica* in South America. We used Maxent software (Phillips *et al*., 2006) with the occurrences from the known distribution in Brasil (Thiengo *et al*., 2007), the Caribbean (Anonymous, 2004) and Venezuela (Anonymous 2007, 2008b), and the recent findings in Ecuador, Colombia and Peru. The resulting model showing the potential distribution is presented in Fig. 2. From this figure it is clear that several areas in the Neotropics may be vulnerable to the potential spread of this species. Further details are beyond the scope of this note, and will be given elsewhere (Breure & Borrero, 2008). *Lissachatina fulica* is said to exhibit wide environmental tolerances (Raut & Barker, 2002). Yet we found in the model that annual cloud cover is the most important factor in determining its potential distribution, followed by annual precipitation. This could be explained by the preference of this species for relatively high humidity. Takeda & Ozaki (1986) reported activity of *L. fulica* only when relative humidity is more than 50 %.

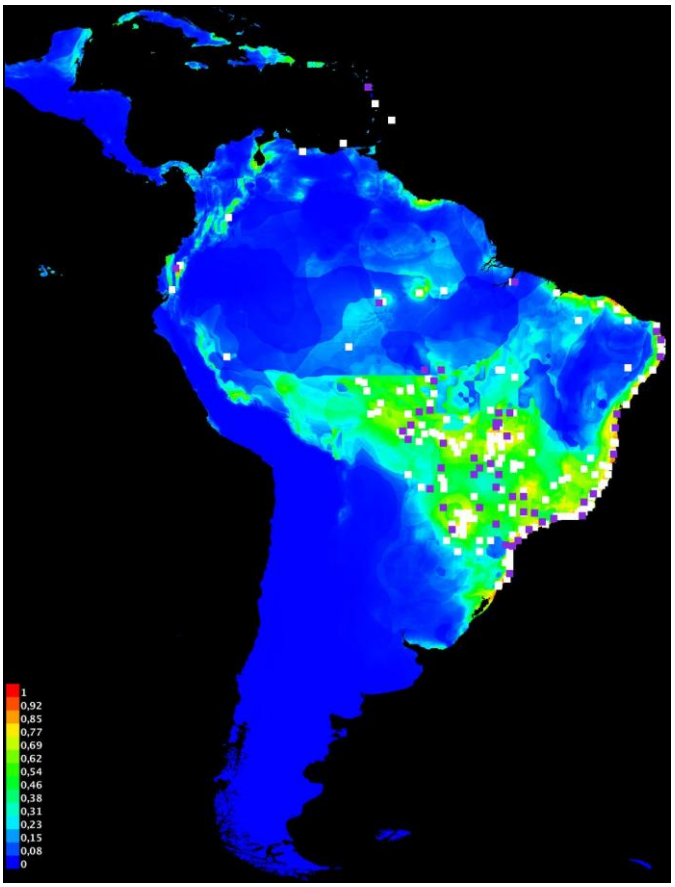


Fig. 2. Maxent model of potential distribution of *L. fulica*, given as logistic values. White squares are actual records of *L. fulica* (from the references cited in the text). Areas coloured green to red represent logistic values, showing increasingly better conditions for the occurrence of the species. Values of 0.23 and above are considered risky for further spread. White and purple squares denote, respectively, the localities used for training and testing of the Maxent model.

From Fig. 2 it may be concluded that several areas in western Brasil and southeastern Peru are at risk if *L. fulica* reaches them. Also French Guiana, Surinam and to some extent Guyana are vulnerable to colonization and establishment. Finally, given reported observations by Kreykenbohm (2005) and the records in Ecuador so far, the western part of the country is where the spread of *L. fulica* seems almost inevitable. It is possible that the low minimum temperatures in the Sierra (central region of Ecuador) may prevent its establishment there (see also Budha & Naggs, 2008); also, the high altitude of Ayabaca (2650 m) makes it unlikely that the species will survive there if it should escape or be deliberately released. A very serious danger is its potential introduction into the Galápagos, which are part of Ecuador. As Cowie & Robinson (2003) indicated, one of the common pathways for invasive species to be introduced is assosciated with cargo, either via sea or air. Guayaquil, where the species has also been reported, is both the main harbor and airport for shipment

of goods to the Galápagos. It has been estimated that more than a third of the endemic species of Orthalicidae in the Galapagos have become extinct during the last half century, in part due to the introduction of alien species (Coppois, 1995; see also Parent & Smith, 2006). From a conservation viewpoint, the presence of *Lissachatina fulica* in western Ecuador may be considered a major threat to "Darwin's Laboratory".

Alvis, A. 2006. Helicicultura en Colombia. http://www.monografias.com/trabajos37/helicicultura-colombia/helicicultura-colombia.shtml accessed 31 October 2008.

Anonymous 2001. A gourmand's delight: from Ecuador to your table…and still fresh. http://www.internationalreports.net/theamericas/ecuador/2001/agourmands.html accessed 4 July 2008.

Anonymous, 2004. Giant African snails: a foreign threat to U.S. Agriculture. http://www.aphis.usda.gov/lpa/pubs/pa_phgas.pdf accessed 6 July 2008.

Anonymous, 2005. El caracol gigante, un nuevo peligro. http://www.elcomercio.com/solo_texto.asp?id_noticia=2258 accessed 7 July 2008.

Anonymous, 2007. African snail attacks local flora. http://www.tierramerica.info/nota.php?lang=eng&idnews=eco&nro=239&olt=239 accessed 6 July 2008.

Anonymous 2008a. Caracoles. http://www.ecuadorexporta.org/productos_down/perfil_producto_caracoles546.pdf accessed 4 July 2008 [but no longer accesible].

Anonymous, 2008b. Descubren caracol africano en La Asunción. http://www.elsoldemargarita.com.ve/Noticias.aspx?NoticiaId=8275&Seccion=22 accessed 6 July 2008.

Bequaert, J.C. 1950. Studies on the Achatinidae, a group of African land snails. *Bulletin of the Museum of Comparative Zoology* 105: 1-216.

Breure, A.S.H. 2008. *Achatina* in Ecuador. http://www.ashbreure.nl/snailblog/snailblog.html accessed 2 July 2008.

Breure, A.S.H. & Borrero, F.J. 2008. An annotated checklist of the land snail family Orthalicidae (Gastropoda: Pulmonata: Orthalicoidea) in Ecuador, with notes on the distribution of the mainland species. *Zootaxa* 1768: 1-40.

Budha, P.B. & Naggs, F. 2008. The Giant African land snail *Lissachatina fulica* (Bowdich) in Nepal. http://www.malacsoc.org.uk/The_Malacologist/BULL50/Budha.htm accessed 7 July 2008.

Coppois, G., 1995. Vanishing Galapagos malacofauna. In: *Biodiversity and Conservation of the Mollusca* (eds. van Bruggen, A.C., Wells, S.M. & Kemperman, T.C.M.), p. 205-209. Backhuys Publishing, Oestgeest/Leiden.

CORPEI 2008. Snail. http://www.corpei.org/FrameCenter.asp?Ln=EN&Opcion=6_1_7_7_2 accessed 30 June 2008 [but no longer accessible].

Correoso, M., 2006. Estrategia preliminar para evaluar y erradicar *Achatina fulica* (Gastropoda: Achatineaceae) en Ecuador. *Boletin Técnico IASA, Serie Zoológica* 2: 45-52.

Cowie, R.H. 2000. Non-indigenous land and freshwater molluscs in the islands of the Pacific: conservation impacts and threats. In: *Invasive species in the Pacific - A Technical Review and Draft Regional Strategy* (ed. Sherley, G.), p. 143-172. South Pacific Regional Environmental Programme, Apia.

Cowie, R.H. & Robinson, D.G. 2003. Pathways of introduction of nonindigenous land and freshwater snails and slugs. In: *Invasive Species: Vectors and Management Strategies* (eds. Ruiz, G. & Carlton, J.T.). p. 93-122. Island Press, Washington DC.

Fontanilla, I.K. 2007. *Achatina fulica*, its molecular phylogeny and genetic variations in global populations. *The Malacologist* 48: 1. [Modified version with different authorship and text available at http://www.malacsoc.org.uk/The_Malacologist/BULL48/forum48.htm accessed 30 June 2008].

Kreykenbohm, B. 2005. False promises and African snails. http://ecuadorline.com/ecuador/newsletter/Newsletter200511.htm#a2221 accessed 3 July 2008.

Lowe, S., Browne, M., & Boudjelas, S. 2000. *100 of the World's Worst Invasive Alien Species. A selection from the Global Invasive Species Database*. Invasive Species Specialist Group, IUCN, Auckland. 12 p. http://www.issg.org/booklet.pdf accessed 6 July 2008.

Martinez, R. & Martinez, E. 1997. Nota acerca de la *Achatina* (*Lissachatina*) *fulica* (Bowdich, 1822) [sic]. Peligroso caracol africano (Pulmonata, Achatinidae) introducido en Venezuela. *Acta Biologica Venezuelica* 17: 37-40.

Mead, A.R. 1995. Anatomy, phylogeny, and zoogeography in the African land snail family Achatinidae. In: *Abstracts. 12th International Malacological Congress* (eds. Guerra, A. Rolán, E. & Roca, F.), p. 422-423. Instituto de Investigaciones Marinas, on behalf of Unitas Malacologica, Vigo.

Meyer, W.M., Hayes, K.A. & Meyer, A.L. 2008. Giant African snail, *Achatina fulica*, as a snail predator. *American Malacological Bulletin* 24: 117-119.

Parent, C.E. & Smith, R.P. 2006. Galápagos bulimulids: status report on a devastated fauna. *Tentacle* 14: 25-27.

Phillips, S.J., Anderson, R.P. & Schapire, R.E. 2006. Maximum entropy modeling of species geographic distributions. *Ecological Modeling* 190: 231-259.

Raut, S.K. & Barker, G.M. 2002. *Achatina fulica* Bowdich and other Achatinidae as pests in tropical agriculture. In: *Molluscs as crop pests* (ed. Barker G.M.). p. 55-114. CABI Publishing, Wallingford.

Robinson, D.G. 1999. Alien invasions: the effect of the global economy on non-marine gastropod introductions into the United States. *Malacologia* 41:413-438.

Takeda, N. & Ozaki, T. 1986. Induction of locomotor behaviour in the giant African snail, *Achatina fulica*. *Comparative Biochemistry and Physiology* 83A: 77-82.

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

Francisco J. Borrero, Cincinnati Museum Center, Cincinnati, Ohio 45203, USA. borrerof@countryday.net

Abraham S.H. Breure, National Museum of Natural History, Leiden, the Netherlands. breure@xs4all.nl

Carl C. Christensen, William S. Richardson School of Law, University of Hawaii, Honolulu, Hawaii 96822; and Bishop Museum, Honolulu, Hawaii 96817, USA. carlcc@hawaii.edu

Modesto Correoso, Escuela Politécnica del Ejército, Quito, Ecuador.

Valentín Mogollón Avila, Universidad Nacional Federico Villareal, Facultad de Oceanografía, Pesquería y Ciencias Alimentárias, Lima, Peru.

RARE NEW ZEALAND SNAILS UNDER DEBATE

By Kath J. Walker

The Rhytidae (Mollusca: Gastropoda: Pulmonata) are a group of large carnivorous land snails distributed in the southern hemisphere, with a particularly rich fauna in New Zealand. The genus *Powelliphanta*, endemic to New Zealand, consists of at least 10 species and many more recognised subspecies, most of which are restricted to the western margin of South

Island. *Powelliphanta* taxa tend to have restricted ecological and spatial ranges among the mountains of this region, with some species being limited to lowland forest and others to habitats at or above the treeline. Among recent discoveries is a population of snails occupying habitat on and around a peak called Mount Augustus, which is situated at the edge of a large and economically important coalfield. Since recognition of the potential biological significance of the Mount Augustus snails in 2004, almost all of their habitat has been destroyed by opencast mining, revealing a direct conflict between economic and biodiversity prioritisation. Our analysis of mtDNA sequence data (Trewick *et al*., 2008) indicate that *Powelliphanta* "Augustus" is a distinctive evolutionary lineage, more closely related to a nearby lowland species, *Powelliphanta lignaria*, than to the spatial and ecological neighbour *Powelliphanta patrickensis*. *Powelliphanta* "Augustus" appears to be a specialised local endemic species. Despite a growing international awareness of the importance of biodiversity conservation, the demand for foreign earnings continues to take priority over the protection of our biota.

Trewick, S.A., Walker, K.J. & Jordan, C.J. 2008 Taxonomic and conservation status of a newly discovered landsnail from Mount Augustus, New Zealand. *Conservation Genetics*. 9: 1563-1575.

Kath J. Walker, Research, Development and Improvement Division, Department of Conservation, Private Bag 5, Nelson 7042, New Zealand. kwalker@doc.govt.nz

MALACOLOGICAL RESEARCH IN THE SERRA DO TABULEIRO ECOLOGICAL STATE PARK, SANTA CATARINA STATE, SOUTHERN BRASIL

By A. Ignacio Agudo-Padrón & Mário Saraiva Bleicker

In the central Atlantic coastal plain region of Santa Catarina State, southern Brasil (Fig. 1), the administrative division of Mesorregião Grande Florianópolis is the headquarters of our regional malacological research, from the Ponta do Papagaio region in the north to the Guarda do Embaú Village in the south (Fig. 1), and notably in the coastal plain, the fields and sandbanks of the Baixada do Maciambú. The Mesorregião Grande Florianópolis has 21 municipalities with numerous rivers, streams, waterfalls and other natural water sources that discharge into the Atlantic Ocean. This is part of the so-called Atlantic Tropical Forest but also includes a richly diversified marine environment with a coast strongly dissected by bays, and with islands of a range of sizes, sustaining industrial fishing activities, cultivation in marine farms and local artisanal fishing for human consumption (Agudo-Padrón & Bleicker, 2006). Within this region is the Serra do Tabuleiro State Park (Figs. 1, 2), the largest ecological park – or unit of conservation – in this part of Brasil, with a total area of 87,405 ha, occupying approximately 1 % of the the area of Santa Catarina State (Fig. 1) and embracing six of the municipalities mentioned above, as well as three in the neighbouring Mesorregião Sul Catarinense (Micro-region Tubarão) and eight insular formations and the extreme southern part of Santa Catarina island. The park supports in their natural form five

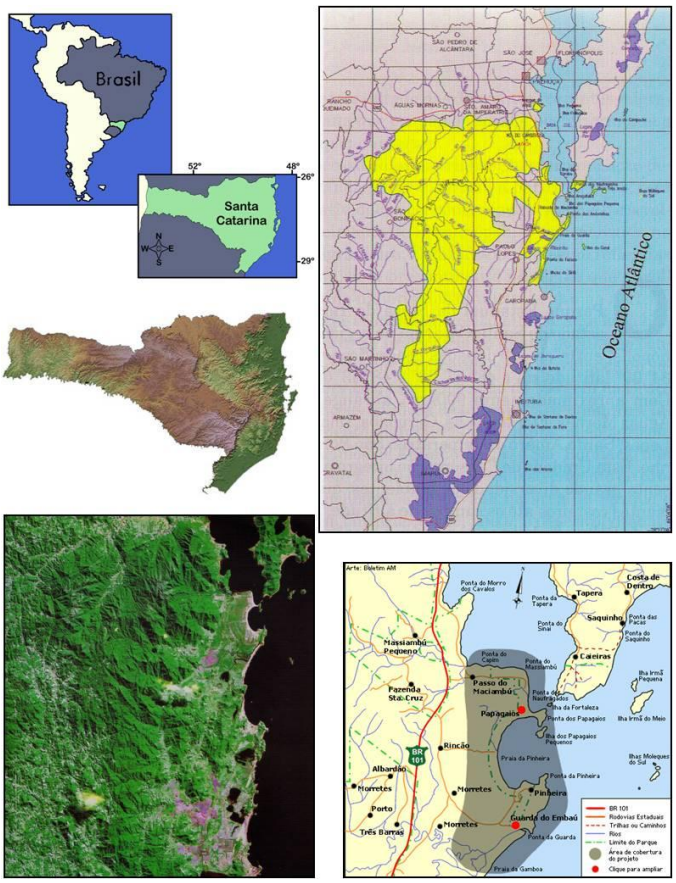


Fig. 1. Geographical position of Santa Catarina State (top left). General aerial view of the topography (middle left), with detail of the Serra do Tabuleiro State Park region, composed of mountain ranges and coastal plains (bottom left). Map of the Park (yellow) (top right), with location of malacological research stations in the Baixada do Maciambú (red dots) (bottom right).

of the six representative types of the well-known ecosystems or botanical communities in the State (Rosário, 2003).

The park starts at the coast, with the Restingas (sandbanks) landscape – maritime lands at the mouth of the Maciambú and Embaú Rivers (Figs. 1, 2). Inland, the park extends to the "pinhais" vegetation (araucaria forest) of the plateau, encompassing the pluvial forest of the Atlantic slope, the "matinha nebular" (little Atlantic fog forest) vegetation and the "campos de altitude" (highland fields) of the mountain plateau. One of the most imposing mountains of the park is Cambirela, at 1043 m above sea level, with the granitic "Pedra Branca" at 500 m (Fig. 2).

The geology of the area is also distinctive. In the coastal plain of Maciambú (Agudo-Padrón, 2002b; Agudo-Padrón & Bleicker, 2004), the sandy, semi-circular cords of the sandbank (Figs. 1, 3) are a world geological monument. The cords are marks of the retreat of the waters during the recent Quaternary period, and are rich in deposits of numerous shells of molluscs and other marine invertebrates (Caruso Júnior, 1992, 1995).

In general, most of the park is covered by the Tropical Atlantic Forest (Fig. 2). The Serra do Tabuleiro ecological State Park is on the list of critical natural habitats in Latin America and the Caribbean.

Fig. 2. General views of the Serra do Tabuleiro State Park (top), with the Cambirela mountain (lower left) and the granitic hill, Pedra Branca (lower right).

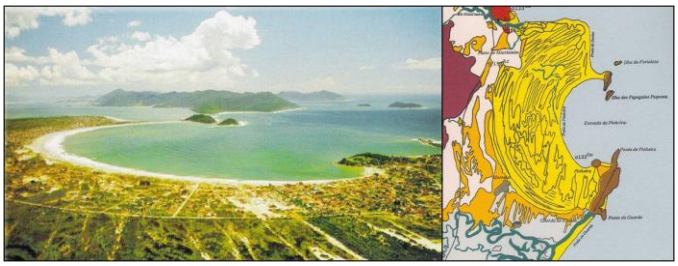


Fig. 3. The sandbank area of the coastal plain of Maciambú, a region of great paleontological interest.

As noted in previous contributions in *Tentacle* by Agudo-Padrón & Bleicker (2006) and Agudo-Padrón (2007b), the State of Santa Catarina (SC) is the smallest part of Brasil's southernmost subtropical region (Fig. 1). Integrated malacological inventories have been conducted since 1982, for the marine molluscs by the second author, and since 1996 in a systematic way for non-marine molluscs. Twelve years of exhaustive regional researches (1996-2008) were completed by March 2008.

On the few occasions when the biodiversity of an area is considered, often only the vertebrate fauna (which represents less than 5 % of living animals) is treated, as clearly exemplified in the contribution of Marterer & Cimardi (2003) regarding the area here considered. Meanwhile, the spineless ones, the molluscs among them, which constitute more than 95 % of animal species, are generally ignored (Thomé *et al*., 2007). This is one of the many reasons that motivated the present study.

Once again, our work in this region is based on wide bibliographic review, starting from the historical contributions of Morretes (1949), Gofferjè *in* Bigarella (1949) and Morretes (1953). More recent literature includes Rios (1994), for marine taxa, and Simone (2006), for the terrestrial and freshwater/limnic species. Our own work includes considerations of zoogeography, palaeontology, anthropological value and conservation, and involves historical regional study of these creatures, examination of specimens in institutional and private collections, and specimens obtained during field surveys or from sporadic donations (Agudo-Padrón, 2002a, b, 2003, 2005, 2006, 2007a, b, 2008; Agudo & Saalfeld, 2003, 2004; Agudo & Bleicker, 2004, 2005, 2006; Agudo-Padrón *et al*., 2007).

Non-marine forms

In total, 44 terrestrial and freshwater mollusc species and subspecies have been recorded: 41 Gastropoda, including 5 Caenogastropoda ("prosobranchs") (4 freshwater forms and 1 tree snail), 5 Gymnophila (native slugs) and 31 Pulmonata (3 slugs and 28 snails – 6 freshwater forms, 7 tree snails and 15 other terrestrial snail species), in 22 families and 29 genera (Figs. 4, 5, 6); and 3 Bivalvia, including 2 Unionoida (1 Mycetopodidae, 1 Hyriidae) and 1 Veneroida (Sphaeriidae), in 3 families and 3 genera. Of these, 7 are introduced invasive pest species (1 freshwater snail, 3 slugs and 3 terrestrial snails).

Fig. 4. Native terrestrial megasnail *Megalobulimus oblongus* (Müller, 1774) and eggs, typical inhabitant of the sandbanks (left); Exotic African invader *Achatina fulica* Bowdich, 1822, pest in local coastal forest, sandbanks and urban communities neighboring the park (right). (Photos: A.I. Agudo-Padrón)

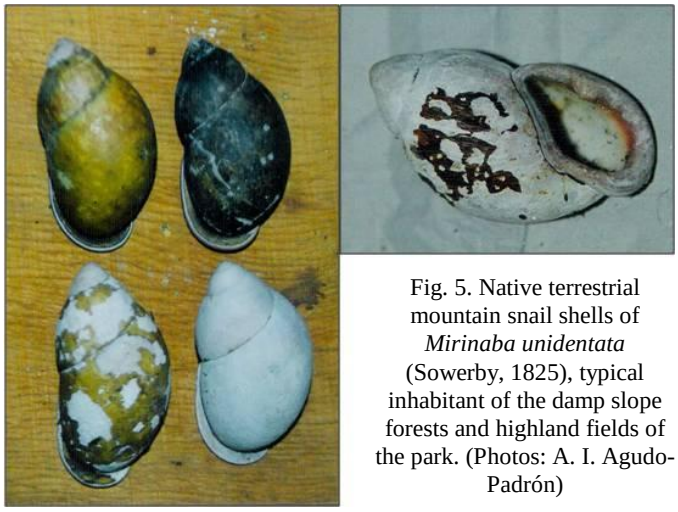


Fig. 5. Native terrestrial mountain snail shells of *Mirinaba unidentata* (Sowerby, 1825), typical inhabitant of the damp slope forests and highland fields of the park. (Photos: A. I. Agudo-Padrón)

Fifteen of the gastropod species recorded (7 introduced forms – 6 terrestrial (3 slugs and 3 snails), 1 freshwater snail; 9 natives – 4 freshwater snails, 4 slugs, 1 terrestrial snail) have been confirmed as intermediate vectors of human and animal parasitic diseases (Agudo-Padrón, 2006; Agudo-Padrón, 2008).

Of the species referred to above, 27 occupy the coastal plain and sandbanks of the Baixada do Maciambú and, surprisingly, a nearby small island that is part of the park, the Moleques do Sul island (Figs. 1, 2). Two species of native tree snails have been recorded from the island: *Drymaeus* cf. *papyrifactus* (Pilsbry, 1898) (Bulimulidae) and *Cyclodontina catharinae* (Pfeiffer, 1856) (Odontostomidae). These 27 species comprise

Fig. 6. Typical native tree snails present in the coastal tropical damp slope forests of the park: *Simpulopsis decussata* Pfeiffer, 1857 (top); *Cyclodontina catharinae* (Pfeiffer, 1856) (middle); *Drymaeus p. papyraceus* (Mawe, 1823) (bottom). (Photos: A.I. Agudo-Padrón)

26 Gastropoda (1 Caenogastropoda, 3 Gymnophila, 22 Pulmonata) and 1 Bivalvia (Sphaeriidae) (Agudo-Padrón 2002b, Agudo-Padrón & Bleicker, 2004). Some of these species also occur in the montane region.

The area of sandbanks of Maciambú, specifically in the lands of the farm "Rancho Alsaciano" (today transformed into a tourist inn, close to the village of Guarda do Embaú), supported, between 1988 and 1997, a major heliciculture operation involving European snails ("escargots" – *Helix aspersa* Müller, 1774). A million snails were maintained in 42 stone pens, with monthly production of 200 kg of meat, and the Rancho was well known as the largest heliciculture enterprise in Southern Brasil (Fig. 7).

Fig. 7. Remnants of the historical heliciculture operation at Rancho Alsaciano, today abandoned and forgotten in the middle of the sandbank. (Photos: A.I. Agudo-Padrón)

Marine forms

Of the regions so fur surveyed by us, the coastal region of Santa Catarina State around the area of the park known as the Baixada do Massiambú (Lowlands of Maciambú), in Palhoça Municipal District (Figs. 1, 3), supports the largest recorded species richness of marine molluscs (Agudo-Padrón & Bleicker, 2004; Agudo-Padrón *et al*., 2007). Currently, 222 species and subspecies have been confirmed: 4 Polyplacophora, 127 Gastropoda, 85 Bivalvia, 2 Scaphopoda and 4 Cephalopoda (Fig. 8), in 72 families and 143 genera.

Among these are confirmed recent records of the alien *Myoforceps aristatus* (Dillwyn, 1817) (Mytilidae), a severe invasive pest originating in the Caribbean, and the following new records of native marine species confirmed for the State: *Chlamys felipponei* (Dall, 1922) (Bivalvia: Pectiniidae), *Periploma ovata* d'Orbigny, 1846 (Bivalvia: Periplomatidae) and *Linatella caudata* (Gmelin, 1791) (Gastropoda: Ranellidae).

Just three exotic species of Bivalvia were recorded, one intentionally introduced, and traditionally cultivated in marine farms – *Crassostrea gigas* (Thunberg, 1795), and two invasive Caribbean species – *Isognomon bicolor* (C. B. Adams, 1845) and *Myoforceps aristatus* (Dillwyn, 1817).

Fig. 8. Marine shells present in the waters of the coastal region of the park: *Argonauta nodosa* Lightfoot, 1786, *Spirula spirula* Lamarck, 1801 and *Dentalium* (*Antalis*) *disparile* d'Orbigny, 1842 (top left); *Chaetopleura angulata* (Spengler, 1797) (top right); *Conus* spp. and *Argopecten noronhensis* (Smith, 1885) (middle); *Adelomelon* [= *Pachycymbiola*] *brasiliana* (Lamarck, 1811) and its egg capsule (lower left); *Zidona dufresnei* (Donovan, 1823) (lower right). (Photos: A.I. Agudo-Padrón)

For more complete and detailed information concerning the species recognized to date in the territory of the park, please contact the authors of this contribution.

Agudo[-Padrón], [A.] I. 2002a. Malacofauna continental ocorrente na Mesorregião da Grande Florianópolis, Santa Catarina, Brasil. *Resumos V Congreso Latinoamericano de Malacologia*, São Paulo: 101. http://bigmail1.lycosmail.lycos.com/Mail-bin/bigfile_down?uid=FNXtKrjx87ZBicm_MHp1yuknousD2l6

Agudo[-Padrón], [A.] I. 2002b. Malacofauna ocorrente na Ponta do Papagaio e áreas adjacentes, Mesorregião da Grande Florianópolis, Municipio Palhoça, Santa Catarina, Brasil. *Resumos V Congreso Latinoamericano de Malacologia*, São Paulo: 102. http://bigmail1.lycosmail.lycos.com/Mail-bin/bigfile_down?uid=FNXtKrjx87ZBicm_MHp1yuknousD2l6

Agudo[-Padrón], [A.] I. 2003. Ocorrência de moluscos continentais dulce-aqüícolas no Estado de Santa Catarina, SC, região sul do Brasil. *Resumos XVIII Encontro Brasileiro de Malacologia*, Rio

de Janeiro: 205. http://bigmail1.lycosmail.lycos.com/Mail-bin/bigfile_down?uid=JeiYQiReTxWdWY8Bje.jxqCOXIfn5JeQ

Agudo[-Padrón], [A.] I. 2005. Estado atual do conhecimento da malacofauna continental ocorrente na "Grande Florianópolis", estado de Santa Catarina, Região Sul do Brasil. *Resumos XIX Encontro Brasileiro de Malacologia*, Rio de Janeiro: 265. http://bigmail1.lycosmail.lycos.com/Mail-bin/bigfile_down?uid=8BtRZ-cXvDfYsU5SlB7EdisfiINwwdQc

Agudo-Padrón, A.I. 2006. *Biogeografia das doenças transmissíveis por moluscos vetores no Estado de Santa Catarina* [Biogeography of the transmissible diseases vectored by molluscan intermediate hosts in Santa Catarina's State]. Florianópolis, UDESC, Geography Dissertation, xviii + 98 p., 45 figs., 4 tabs. http://www.faed.udesc.br/userimages/TCC%20geografia2.htm

Agudo-Padrón, [A.] I. 2007a. Moluscos continentais ocorrentes no Estado de Santa Catarina, sul do Brasil: uma revisão geral. *Resumos XX Encontro Brasileiro de Malacologia*, Rio de Janeiro: 226. http://bigmail1.lycosmail.lycos.com/Mail-bin/bigfile_down?uid=-wjjduIfLhg1gX1-vKEvdB2D4ms3koiv

Agudo[-Padrón], A.I. 2007b. Continental land and freshwater molluscs in Santa Catarina State, southern Brasil: a general review of current knowledge. *Tentacle* 15: 11-14. http://www.hawaii.edu/cowielab/Tentacle.htm

Agudo[-Padrón], A.I. 2008. Occurrence of the invasive exotic freshwater snail *Melanoides tuberculatus* (Müller, 1774) in Santa Catarina State, southern Brazil, and the potential implications for the local public health. *FMCS Newsletter - Ellipsaria* 10(1): 13-18. http://bigmail1.lycosmail.lycos.com/Mail-bin/bigfile_down?uid=JlMtevKuq4_hpg2X2KB-MpbjNLsqMEPt

Agudo[-Padrón], A.I. & Bleicker, M.S. 2004. Malacofauna Recente da Baixada do Massiambú, Município Palhoça, Santa Catarina – SC. *Resumos XXV Congresso Brasileiro de Zoologia*, Brasília: 284-285. http://bigmail1.lycosmail.lycos.com/Mail-bin/bigfile_down?uid=TUhKlFtwkcbQzbdJ9nEh7OLfetUXzpNK

Agudo[-Padrón], [A.] I. & Bleicker, M.S. 2005. Inventário preliminar dos moluscos marinhos ocorrentes no estado de Santa Catarina, SC, Região Sul do Brasil. *Resumos XIX Encontro Brasileiro de Malacologia*, Rio de Janeiro: 257. http://bigmail1.lycosmail.lycos.com/Mail-bin/bigfile_down?uid=8BtRZ-cXvDfYsU5SlB7EdisfiINwwdQc

Agudo[-Padrón], A.I. & Bleicker, M.S. 2006. First general inventory of the malacological fauna of Santa Catarina State, southern Brasil. *Tentacle* 14: 8-10. http://www.hawaii.edu/cowielab/Tentacle.htm

Agudo[-Padrón], [A.] I. & K. Saalfeld. 2003. Registro da ocorrência de chitons (Mollusca: Polyplacophora) no litoral do Estado de Santa Catarina, SC, região sul do Brasil. *Resumos XVIII Encontro Brasileiro de Malacologia*, Rio de Janeiro: 195. http://bigmail1.lycosmail.lycos.com/Mail-bin/bigfile_down?uid=JeiYQiReTxWdWY8Bje.jxqCOXIfn5JeQ

Agudo[-Padrón], A.I. & Saalfeld, K. 2004. Registro da Ocorrência de Escafópodes (Mollusca: Scaphopoda) no Litoral do Estado de Santa Catarina – SC. *Resumos XXV Congresso Brasileiro de Zoologia*, Brasília: 295. http://bigmail1.lycosmail.lycos.com/Mail-bin/bigfile_down?uid=TUhKlFtwkcbQzbdJ9nEh7OLfetUXzpNK

Agudo-Padrón, [A.] I., Bleicker, M.S. & Saalfeld, K. 2007. Moluscos marinhos ocorrentes no Estado de Santa Catarina, região Sul do Brasil: uma revisão geral. *Resumos XX Encontro Brasileiro de Malacologia*, Rio de Janeiro: 217. http://bigmail1.lycosmail.lycos.com/Mail-bin/bigfile_down?uid=-wjjduIfLhg1gX1-vKEvdB2D4ms3koiv

Bigarella, J.J. 1949. Contribuição ao estudo da planície sedimentar da parte Norte da Ilha de Santa Catarina. *Arquivos de Biologia e Tecnologia, Instituto de Biologia e Pesquisas Tecnológicas (IBPT)*, Curitiba 4: 107-140.

Caruso Júnior, F. 1992. Geologia dos depósitos de conchas calcárias no Estado de Santa Catarina. *Geosul*, Florianópolis, 7(14): 101-136.

Caruso Júnior, F. 1995. Mapa geológico e de recursos minerais do sudeste de Santa Catarina. MME/DNPM, Brasília. 52 p., 1 map.

Marterer, B.T.P. & Cimardi, A.V. 2003. Fauna. In: *A natureza do Parque Estadual da Serra do Tabuleiro* (coord. Rosário, L.A. do), p. 55-68. Fundação do Meio Ambiente – FATMA, Florianópolis.

Morretes, F.L. 1949. Ensaio de Catálogo dos Moluscos do Brasil. *Arquivos do Museu Paranaense*, Curitiba, 7(1): 5-216.

Morretes, F.L. 1953. Addenda e Corrigenda ao Ensaio de Catálogo dos Moluscos do Brasil. *Arquivos do Museu Paranaense*, Curitiba, 10(2): 37-76.

Rios, E. de C. 1994. *Seashells of Brazil*. Second edition. Fundação Universidade do Rio Grande, Museu Oceanográfico, Rio Grande. 329 p., 102 pl.

Rosário, L.A. do. 2003. *A natureza do Parque Estadual da Serra do Tabuleiro.* Fundação do Meio Ambiente - FATMA, Florianópolis. 128 p.

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

Thomé, J.W., Arruda, J.O. & da Silva, L.F. 2007. Moluscos terrestres no Cone Meridional da América do Sul, diversidade e distribuição. *Ciência & Ambiente*, Santa Maria 35: 9-28.

A. Ignacio Agudo-Padrón ignacioagudo@gmail.com
Mário Saraiva Bleicker msbleicker@terra.com.br
Project "Avulsos Malacológicos", PO Box 010, 88010-970 Centro, Florianópolis, Santa Catarina - SC, Brasil.
www.malacologia.com.br

LAND SNAILS AS INDICATOR SPECIES: EXAMPLES FROM SEVEN BIOBLITZES IN THE EASTERN UNITED STATES

By Timothy A. Pearce

In complex environments, monitoring environmental changes such as disturbance over time presents challenges because many factors can change simultaneously. Monitoring indicator taxa that integrate a combination of factors can be a practical and economical surrogate for measuring the many factors contributing to disturbance.

Disturbance changes a system from one ecological state to another, usually farther from equilibrium. Disturbance can occur over a large range of time and size scales and may be due to human or non-human causes. Human-mediated factors contributing to disturbance might include logging or clearing, mining, fire, roads, trampling by foot or recreational vehicles, livestock grazing, refuse dumping, invasive species and air-borne pollution from industry or agriculture.

Many taxa, including plants, vertebrates and invertebrates have been examined as potentially useful indicator taxa (Kremen *et al.*, 1993; Dufrêne & Legendre, 1997; McGeoch, 1998; Davis, 2001; Godefroid & Koedam, 2008), but few studies have evaluated land snails as indicators. Advantages of land snails as environmental indicators include their readily identifiable shells that persist for months or years after they die, easy to sample diversity and abundance typically in a suitable range for monitoring changes, sensitivity to changes in moisture, temperature, and physical characteristics of the substrate, small

body sizes and sedentary habits ensuring that individuals integrate local conditions over their lifetimes, and lack of migration or metamorphosis allowing detection throughout the year (Strayer *et al*., 1986; Prezio *et al*., 1999; Ovaska & Sopuck, 2003; Pearce, 2008). Invertebrates tend to perform better as indicators than vertebrates (Landsberg *et al*., 1999) and since land snails usually have finer-scale distribution patterns and greater local endemism than vertebrates and plants, land snails might be superior indicators (Moritz *et al*., 2001).

How well suited are land snails as indicators of environmental disturbance? This study compares land snails with disturbance at seven parks in eastern USA sampled during BioBlitzes. A BioBlitz is a publicity-generating event to discover as many species as possible in a certain period of time in a circumscribed area, usually within 24 hours in a park. I examined whether species richness, abundance, and the proportion of non-native species correlated with my subjective ranking of disturbance among the seven parks.

I subjectively ranked the seven parks (Table 1) from least to most disturbed, avoiding being influenced by knowledge of mollusc search results. Factors I considered in my ranking included whether the parks were urban, the amount of construction, trampling, refuse, and dumping I observed, and tree size as an indication of how long ago the area was cleared. The three aspects of mollusc results I considered as potentially useful indicators were the diversity (total number of species), the proportion of the species richness made up by native species, and abundance (individuals per litre of leaf litter).

Table 1. Study areas ranked by disturbance. Search effort (number of stations, number of leaf litter samples, and litres of litter) did not differ among study areas.

Disturbance rank	Park Lat & Long	Year	No. of stations	No. of samples	Litres of litter
1	Erie Bluff St Pk 42.01°N 80.39°W	2004	12	10	16.4
2	Potomac Gorge 38.99°N 77.24°W	2006	12	5	5.7
3	Murphys Bottom 40.69°N 79.64°W	2006	11	11	11.0
4	Duff Park 40.42°N 79.68°W	2008	7	7	9.7
5	Highland Park 40.48°N 79.91°W	2002	11	9	9.0
6	Twin Hills Park 40.39°N 80.05°W	2005	12	12	13.3
7	Bird Park 40.36°N 80.05°W	2003	8	8	9.1

Search effort (combination of visual search and leaf litter sampling) was similar at each park as assessed by three measures. Number of stations at each park was 7-12, number of leaf litter samples was 5-12, and total litres of leaf litter was 5.7-16.4. None of these measures correlated significantly with my subjectively assessed disturbance rank (Spearman Rank Correlation r_s = -0.449, 0.143 and -0.179, respectively, with p-values of >0.2, >0.5 and >0.5 respectively).

Two of the three mollusc measures correlated significantly with my subjective disturbance order for the seven parks (Fig. 1). Diversity was greater in more pristine parks (Spearman Rank Correlation, r_s = 0.991, p<0.005) and native species were

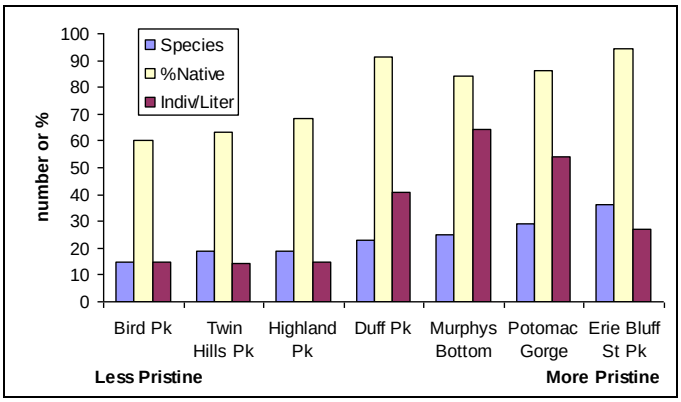


Fig. 1. Land snail responses at seven parks, arranged from least (left) to most (right) pristine. Species richness and proportion of native species was greater in more pristine parks. The tendency for greater abundance (individuals/litre) in more pristine parks was not significant.

a greater proportion of the fauna in more pristine parks (r_s = 0.893, p = 0.02). Snails tended to be more abundant in more pristine parks, but the relationship was not significant (r_s = 0.714, p = 0.1).

The greater diversity and greater proportion of native species in more pristine parks is not a surprising result and supports the idea that land snails as a group can function as bioindicators. The result that abundance did not correlate significantly with disturbance might indicate that abundance is a poor surrogate for measuring disturbance or that the sample size of parks was too small to show a significant relationship. Although abundance of land snails has been found to correlate with disturbance in some studies (Prezio *et al*., 1999; Ovaska & Sopuck 2003), it does not always do so (Strayer *et al*., 1986).

In contrast to monitoring individual species, monitoring a group of species, such as the entire land snail fauna, would probably yield a more robust indication of the ecological state of the environment. Because individual species probably respond to different aspects of the environment, the response of a suite of species should yield more confidence (McGeoch *et al*., 2002).

This study suggests that these measures (species richness, proportion native) of land snails might provide the simplicity and efficiency needed by non-experts. While invertebrates have been recognized by the scientific community as effective bioindicators, their unfamiliarity and taxonomic challenges have tended to make them unattractive and inaccessible to land managers (Anderson *et al*., 2002). The potential of land snails as bioindicators is highlighted by this finding that relatively easily gathered data, such as that acquired during BioBlitzes, appear useful for evaluating levels of disturbance. With regard to data quality, note that sufficient sampling should occur so the species richness estimate approaches an asymptote (McGeoch *et al*., 2002).

This result, showing that land snail faunas might be useful surrogates for estimating relative disturbance among parks, sets the stage for future studies. More detailed studies (Dufrêne & Legendre, 1997; McGeoch, 1998; Anderson, 1999; Hilty & Merenlander, 2000; McGeoch *et al*., 2002)

could evaluate land snails, including individual species, for their utility regarding particular aspects of environmental monitoring.

Andersen, A.N. 1999. My bioindicator or yours? Making the selection. *Journal of Insect Conservation* 3: 61-64.

Andersen, A.N., Hoffmann, B.J., Müller, W.J. & Griffiths, A.D. 2002. Using ants as bioindicators in land management: simplifying the assessment of ant community responses. *Journal of Applied Ecology* 39: 8-17.

Davis, A.J. 2001. Dung beetles as indicators of change in the forests of northern Borneo. *Journal of Applied Ecology* 38: 593-616.

Dufrêne, M. & Legendre, P. 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecological Monographs* 67: 345-366.

Godefroid, S. & Koedam, N. 2008. Using high resolution mapping of disturbance indicator species to assess the sustainability of silviculture activities. *Forest Ecology and Management* 255: 3416-3423.

Hilty, J. & Merenlander, A. 2000. Faunal indicator taxa selection for monitoring ecosystem health. *Biological Conservation* 92: 185-197.

Kremen, C., Colwell, R.K., Erwin, T.L., Murphy, D.D., Noss, R.F & Sanjayan, M.A. 1993. Terrestrial arthropod assemblages: their use in conservation planning. *Conservation Biology* 7: 796-808.

Landsberg, J., Morton, S. & James, C. 1999. A comparison of the diversity and indicator potential of arthropods, vertebrates and plants in arid rangelands across Australia. In: *The Other 99 %. The Conservation and Biodiversity of Invertebrates* (eds. Ponder, W. & Lunney, D.), p. 111-120. Transactions of the Royal Zoological Society of New South Wales, Mosman, Australia.

McGeoch, M.A. 1998. The selection, testing and application of terrestrial insects as bioindicators. *Biological Reviews* 73: 181-201.

McGeoch, M.A., Van Rensburg, B.J. & Botes, A. 2002. The verification and application of bioindicators: a case study of dung beetles in a savanna ecosystem. *Journal of Applied Ecology* 39: 661-672.

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

Ovaska, K. & Sopuck, L. 2003. *Terrestrial gastropods as indicators for monitoring ecological effects of variable-retention logging practices. Pre-disturbance surveys at experimental sites, May-October 2002*. Annual Progress Report for Weyerhaeuser Company Limited, Nanaimo Office, British Columbia. ix + 55 p. http://www.for.gov.bc.ca/hfd/library/FIA/2003/FIA2003MR072.pdf [accessed 31 December 2008].

Pearce, T.A. 2008. When a snail dies in the forest, how long will the shell persist? Effect of dissolution and micro-bioerosion. *American Malacological Bulletin* 26: 111-117.

Prezio, J.R., Lankester, M.W., Lautenschlager, R.A. & Bell, F.W. 1999. Effects of alternative conifer release treatments on terrestrial gastropods in regenerating spruce plantations. *Canadian Journal of Forest Research* 29: 1141-1148.

Strayer, D., Pletscher, D.H., Hamburg, S.P. & Nodvin, S.C. 1986. The effects of forest disturbance on land gastropod communities in northern New England. *Canadian Journal of Zoology* 64: 2094-2098.

Timothy A. Pearce, Mollusc Specialist Group Member, Carnegie Museum of Natural History, 4400 Forbes Avenue, Pittsburgh, Pennsylvania 15213, USA. PearceT@CarnegieMNH.org

WILL ASSISTED COLONIZATION BE A VIABLE OPTION TO SAVE TERRESTRIAL GASTROPODS THREATENED BY CLIMATE CHANGE?

By Aydın Örstan

Assisted colonization (or assisted migration) has been proposed as a potential solution for the conservation of the species threatened by global warming (McLachlan *et al*., 2007; Hoegh-Guldberg *et al.*, 2008). The underlying premise is simple: individuals of a threatened species will be collected and moved to a suitable habitat further north where they are less likely to be affected by climate change.

Hunter (2007) listed three criteria to determine if a threatened species is a suitable candidate for assisted colonization: the probability of extinction of the species due to climate change; its vagility; its ecological role. Because of their relatively slow dispersal rates, all terrestrial gastropod species would qualify under the second criterion. But we cannot predict the potential effects of global warming on individual gastropod species with any degree of certainty and we are quite ignorant of the ecological interactions of most terrestrial gastropod species. Therefore, we would be hard pressed to form a confident opinion on the candidacy of a given species under Hunter's first and second criteria. The probability of extinction of a species would be influenced by several factors, including the physiological effects of temperature and the rate of evolution of new traits that may adapt the species to climate change. For example, some terrestrial gastropod species may require vernalization (cold-induced triggering of reproduction) and if global warming trends continue, the extinction probabilities of such species may increase (Örstan, 2008a). We certainly need to learn more about the basic biology and ecology of as many terrestrial gastropods as possible in a short time frame before we can make productive conservation decisions.

Starting from the framework of Hoegh-Guldberg *et al*. (2008), I can envisage three possible assisted colonization scenarios involving terrestrial gastropods (Fig. 1) (Örstan, 2008b).

1. Species A has a continuous range extending from the southern to the northern U.S. An example is the widespread land snail *Haplotrema concavum* distributed from Florida to Maine (Hubricht, 1985). The southern (A_s) and the northern populations (A_n) may be genetically differentiated and the former may be adapted to warm climates better than the latter. Therefore, the transplantation of individuals from the south to the north may increase the likelihood of adaptation of the resulting mixed northern population as the climate changes.

2. Species B exists in two disjunct populations, one in the south (B_s) and the other in the north (B_n). The intervening populations may have disappeared a long time ago as a result of vicariance events or changes in habitat or climate arising from natural events or recently from habitat destruction by humans. A land snail with a disjunct distribution pattern is *Hendersonia occulta*, occurring in two regions along a northwest to southeast diagonal separated by about 800 km (Hubricht, 1985). The relevant proposal of Hoegh-Guldberg *et al*. (2008) is that assisted colonization may be used to

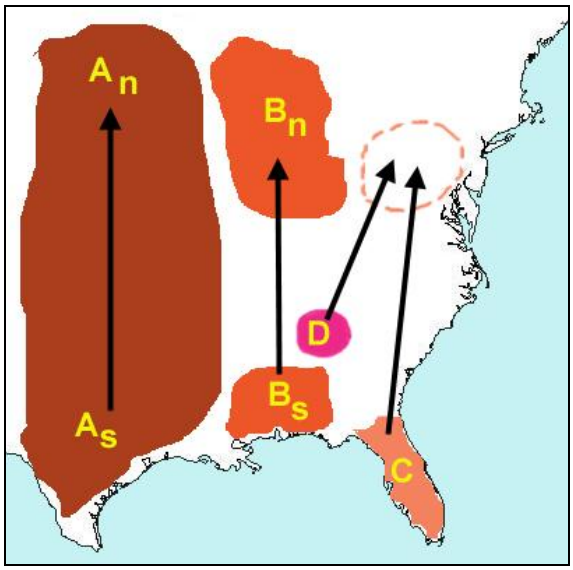


Fig. 1. Although my discussion is applicable to any part of the world, for the sake of argument, I am using a map of North America. The ranges are hypothetical and do not necessarily correspond to those of the species discussed in the text.

reconnect such separate populations. The ultimate aim is to help a species migrate northward on its own should its southerly populations become threatened.

3. Species C has always been endemic to the south without native populations in the north. An example is the carnivorous snail *Euglandina rosea*, whose endemic range covers the southeast U.S. and a few disjunct counties in Texas (Hubricht, 1985). Although such southerly species are adapted to life in warm climates, global warming may still push them to the upper limits of their temperature tolerances. Montane species of temperate latitudes are also in this category (species D). Since the latter cannot undertake latitudinal migration, global warming may drive them toward cooler and higher elevations until they have no place left to go (Colwell *et al*., 2008). To save such species with climate-restricted ranges from extinction, Hoegh-Guldberg *et al*. (2008) recommend their introduction to suitable locations outside their endemic ranges.

The second and the third scenarios both involve the introduction of a species to places where it has not existed before. To implement either one it is necessary to accomplish two difficult tasks. First, for each species one or more physically suitable habitat hundreds of kilometers away from its native (donor) community would have to be located. In most cases, however, reconnections of disjunct habitats separated by a varying terrain interjected with rivers, roads, populated areas and other unsuitable habitats would not be feasible. Second, to prevent the development of destructive ecological interactions in the receiver community, the potential biological interactions between the introduced species and the native inhabitants of the receiver community would have to be evaluated thoroughly (McLachlan *et al*., 2007; Hunter, 2007).

Intentional and unintentional introductions of terrestrial gastropods have already taken place many times and in some cases without apparent detrimental results. For example, several introduced European slugs coexist, seemingly peacefully, with the native fauna in eastern North American forests. A more intriguing example is the snail *Opeas pyrgula*, a member of a genus whose original range is said to be tropical and subtropical (Pilsbry, 1946). This species has had long lasting introduced colonies at least as far north as Philadelphia (Pilsbry, 1946) and Maryland (Örstan, unpublished). The ability of *O. pyrgula* to survive the northern winters, despite its having originated in warmer climates, is a relevant piece of information for assisted colonization research.

Ironically, however, it has usually been the intentional introductions of species that ended in disaster or failure. A famous case is the near-destruction of the *Partula* snails of the Society Islands by the intentionally introduced carnivorous snail *E. rosea* (Murray *et al*., 1988). In contrast, the well-planned introductions of threatened snail species to seemingly suitable habitats to establish self-sustaining colonies have often failed for inexplicable reasons (for a recent example, see Stringer & Parrish, 2008). These cases illustrate the difficulty of predicting the outcomes of assisted colonization events correctly.

Of course, the best solution to save a threatened species would involve measures applied to conserve the species in its native habitat. But sadly, that's not always possible. Hoegh-Guldberg *et al*. (2008) proposed two last ditch resorts to save a species if everything else fails or is impractical. The first is the storage of frozen gametes with the hope that the species may be re-created, so to speak, in the future if and when the environmental conditions improve. There is no guarantee, however, that the future world will be more hospitable to those species that are on the verge of extinction today. Even assuming that it would be, one would still need to save enough genetic variety to assure the establishment of viable populations in the wild. Hence, the second option, assisted colonization, may appear to be the only way out. However, we know very little about the biology and the ecology of most terrestrial gastropods species to be confident that transplanted species will survive indefinitely in their new homes and will not create unintended traumas in the receiver communities.

Colwell, R.K., Brehm, G. Cardelús, C.L., Gilman, A.C. & Longino, J.T. 2008. Global warming, elevational range shifts, and lowland biotic attrition in the wet tropics. *Science* 322: 258-261.

Hoegh-Guldberg, O., Hughes, L., McIntyre, S., Lindenmayer, D.B., Parmesan, C., Possingham, H.P., Thomas, C.D. 2008. Assisted colonization and rapid climate change. *Science* 321: 345-346.

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

Hunter, M.L. 2007. Climate change and moving species: furthering the debate on assisted colonization. *Conservation Biology* 21: 1356-1358.

McLachlan, J.S., Hellmann, J.J. & Schwartz, M.W. 2007. A framework for debate of assisted migration in an era of climate change. *Conservation Biology* 21: 297-302.

Murray, J., Murray, E., Johnson, M.S. & Clarke, B. 1988. The extinction of *Partula* on Moorea. *Pacific Science* 42: 150-153.

Örstan, A. 2008a. Vernalization requirements of terrestrial gastropods and global warming. *Tentacle* 16: 17-18. http://www.hawaii.edu/cowielab/Tentacle.htm

Örstan, A. 2008b. Assisted colonization? Let's hope that will not be our last hope. *Snail's Tales*. 22 July 2008. http://snailstales.blogspot.com/2008/07/assisted-colonization-lets-hope-that.html

Pilsbry, H. 1946. *Land Mollusca of North America (North of Mexico)*, Vol. 2, part 1. The Academy of Natural Sciences of Philadelphia, Philadelphia.
Stringer, I.A.N. & Parrish, R. 2008. Transfer of captive-bred *Placostylus hongii* snails to Limestone Island. *DOC Research & Development Series* 302: 18 p. http://www.doc.govt.nz/upload/documents/science-and-technical/drds302.pdf

Aydın Örstan, Section of Mollusks, Carnegie Museum of Natural History, 4400 Forbes Ave., Pittsburgh, Pennsylvania 15213-4080 USA. pulmonate@earthlink.net

CONSERVATION STATUS OF THE ENDEMIC LAND SNAIL *POLYMITA VENUSTA* (XANTHONYCHIDAE) IN THE COASTAL TERRACES SOUTH OF THE SIERRA MAESTRA MOUNTAIN RANGE, CUBA

By David Maceira Filgueira, Alexander Pupo Sánchez & Beatriz Lauranzón Meléndez

The Cuban terrestrial mollusc fauna is characterized by its high number of species and marked endemism (Espinosa & Ortea, 1999). The genus *Polymita* Beck is endemic to Cuba and is distributed in the Eastern, Central-Eastern and Sabana-Camagüey Regions (Maceira *et al*., 2005). All the species are threatened (Berovides, 1994; Berovides *et al*., 1997) so it is very important to investigate the current state of their populations.

It is necessary to guarantee connectivity among the areas so that gene flow is conserved among the populations and the diversity of genes controlling the colour polymorphism, so attractive in the genus, is maintained. At present the extent of protected areas guarantees the preservation of some populations; but it is inadequate for conservation of the evolutionary processes that are more important. The lack of connectivity among populations has been caused by a long process of destruction and fragmentation of habitat.

Because of the beauty of these molluscs they have suffered major impacts from collectors and commercial exploitation for production of handmade articles or for exhibitions.

The study was carried out in the area of coastal terraces south of the Sierra Maestra mountain range between the Santiago de Cuba bay and the eastern border of the Siboney-Juticí ecological reserve. This area includes the terrace of Santiago de Cuba, terrace of Aguadores, terrace of El Sardinero and terrace of Siboney. According to Núñez (1989) these areas are part of the Eastern Region. Sampling was undertaken between 07.00 and 12.00 from March to September 2007. Sampling was by direct observation of individuals in semideciduous forest and xeromorphic shrubland on plants or the ground surface.

Polymita venusta (Gmelin, 1792) (Fig. 1) historically was very abundantly distributed in the terraces of Santiago de Cuba, de Aguadores, El Sardinero and Siboney. Now, many populations are extinct primarily because of major human modification of habitat and only one population was found, in the semideciduos forest of the terrace of Santiago de Cuba that covers an area of 255,000 m^2. The snails in this population were using *Leucaena leucocephala* (Caesalpiniaceae) as the only substrate on which to rest, at a height above ground of 0.75-1.80 m.

No *Polymita venusta* were observed in the terraces of Aguadores, El Sardinero and Siboney, and we may now consider the populations in those areas probably extinct. In the terrace of Aguadores and Siboney the last live individuals were observed during September 2000. The population in the terrace of El Sardinero was studied for a decade (1994-2004) by Maceira Filgueira *et al*. (2005), who documented the decline and extinction of *Polymita venusta* in this location.

Threats to the conservation of *Polymita venusta* include invasive plants, illegal extraction of wood for craft and firewood, alteration of the vegetation by domestic animals, coal ovens, fragmentation and destruction of habitat, existence of wide roads, uncontrolled entrance to the forest for local residents or visitors from other places, trade of mascots, poaching, anthropogenically originated fire, illegal extraction of sand, dumping of solid waste, and the lack of material and financial resources for the care of the forest. In the terraces of Santiago de Cuba, Aguadores and El Sardinero the forest is not included in any protected area category.

Fig. 1. *Polymita venusta*.

The populations of *Polymita venusta* that survive in the semideciduous forest in the terrace of Santiago de Cuba and in the semideciduous forest and xeromorphic shrub of the coastal terraces in the south of the Sierra Maestra mountain range, are the subject of a management plan of the Ecological Station of the Centro Oriental de Ecosistemas y Biodiversidad (BIOECO) in the terrace of Siboney. The research and monitoring program includes:

- Determine the distribution of *Leucaena leucocephala* in the terrace of Santiago de Cuba.
- Evaluate the populational densities of *Polymita venusta* and the resources that it uses in the semideciduous forest in the terrace of Santiago de Cuba.
- Propose that the semideciduos forest of the terrace of Santiago de Cuba be designated a conservation area.

- Reforest the area of the coastal terraces south of the Sierra Maestra mountain range using native plant species from the semideciduous forest.
- Undertake a captive breeding program for *P. venusta*.
- Undertake a program of reintroduction of *P. venusta* in the field after the reforestation plan.
- Undertake genetic studies of populations that potentially could be used for the captive breeding and subsequent reintroduction programs in the coastal terraces south of the Sierra Maestra mountain range.

We thank Sibylle Maurer-Wohlatz of the German non-governmental organization BUND (Bund für Umwelt und Naturschutz Deutschland) and the Centro Oriental de Ecosistemas y Biodiversidad (BIOECO, Cuba) for support of the field work.

Berovides, V. 1994. Estado de conservación de *Polymita picta* (Mollusca: Pulmonata) en Maisí, Guantánamo. *Cocuyo* 1: 2-3.

Berovides, V., Bidart, L. & Fernández, A. 1997. *Polymita*. Hoja de datos del taxón. *Memorias del Taller para la conservación, análisis y manejo planificado, una selección de especies cubanas II*. Havana.

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

Maceira Filgueira, D., Reyes-Tur, B., Fernández, A. & Lauranzón Meléndez, B. 2005. Estado de poblaciones de las especies del género *Polymita* Beck, 1837. Unpublished report. Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), Santiago de Cuba. 60p., 10 figs., 7 tables, 42 photos.

Núñez, A. 1989. *Nuevo Atlas Nacional de Cuba*. XII. Paisajes. Instituto de Geografía e ICGC. Havana.

David Maceira Filgueira and Beatriz Lauranzón Meléndez, Centro Oriental de Ecosistemas y Biodiversidad (BIOECO). Enramadas # 601 esquina Barnada, Santiago de Cuba 90 100, Cuba.
davidmaceira@yahoo.es
Alexander Pupo Sánchez, Universidad de Las Tunas, Las Tunas, Cuba.

THE GIANT PEARL MUSSEL: A NEW LOCATION DISCOVERED IN FRANCE INCREASES SIGNIFICANTLY THE KNOWN NUMBER OF LIVING INDIVIDUALS

By Vincent Prié

The giant pearl mussel, *Margaritifera auricularia*, is probably among the most threatened invertebrate species in the world. Previously known to occur in most European rivers from Denmark to Spain, in the 20th century it was thought to be nearly extinct with a few individuals known from Spain (Altaba, 1990), followed by its rediscovery in France in 1999 (Cochet, 1999). It is categorized as critically endangered and listed in appendix IV of the EU Habitats Directive (92/43/EEC 1992).

Living up to 120 yr, the giant pearl mussel needs a stable environment and free running rivers and cannot cope with the permanent changes of river channels that come from management of slow flowing rivers in lowland areas. The main causes of its decline are thought to be 1) river management, including realignment of river channels, dredging, dam building and subsequent hydrological changes and 2) rarity of the presumed fish host, the European sturgeon, which is also in decline in Europe.

In 2006, its global population was thought to be restricted to four locations: one in Spain in the Ebro river (estimated at several thousand living individuals) and three in France in the Loire river and two tributaries (estimated at a few hundred living individuals).

In 2007, during an environmental impact study for a major canalisation project for barge transport, we discovered that a population had become extinct very recently in the Oise river (Prié *et al*., 2008a). The same year, during another environmental impact study for a dredging project, we discovered a major population in the Charente river (Fig. 1), estimated to about 20,000 living individuals (Prié *et al*., 2008b).

Fig. 1. A hopeful sight from the Charente: healthy living giant pearl mussels in a preserved environment.

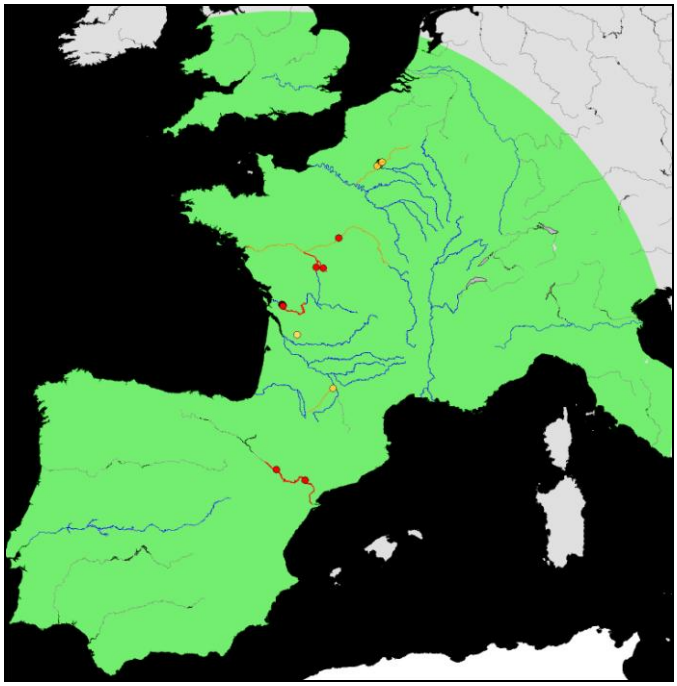


Fig. 2. Distribution map of the known populations of the giant pearl mussel. Red dots: living populations; yellow dots: recently extinct or known from shells only; green: historical area of occurrence.

The striking fact is that most of the known populations (Fig. 2) have already been impacted by development projects: a bridge for two populations of the Loire basin, dredging for the Charente population, a canalisation project for the recently extinct Oise population. It is therefore urgent to survey for any remaining populations in France before development projects impact them, and so that conservationists are aware of their presence and can advise on planning for development of the river systems in ways that do not impact the species.

Considering the threatened status of the species, funds have been allocated by the French government for the study of these last known populations, including implementing proposed action plans to improve their status. Nevertheless a global plan is still urgently needed to counter the giant pearl mussel's global decline. A European action plan was proposed by the Council of Europe in 2000 but it has never been implemented.

Biotope, a consultancy agency specialising in ecology, is planning to fundraise for a European restoration plan that should include 1) further investigatory surveys to estimate the global living populations, 2) ex-situ conservation breeding programmes and 3) advising on practical environmental measures in known river systems. Biotope has already been charged in 2008 by the French government to set up a national conservation plan.

Altaba, C. R. 1990. The last known population of the freshwater mussel *Margaritifera auricularia* (Bivalvia, Unionoida): a conservation priority. *Biological Conservation* 52: 271-286.

Cochet, G. 1999. Le statut des Margaritiferidae de France. *Vertigo* 6 [1996]: 27-31.

Prié, V., Cochet, G. & Philippe, L. 2008a. La grande mulette *Margaritifera auricularia* dans l'Oise – chronique d'une mort annoncée. *Le Courrier de la Nature* 239: 20-24.

Prié, V., Cochet, G., Philippe, L., Rethoret, H. & Filali, R. 2008b. Une population majeure de la très rare grande mulette *Margaritifera auricularia* (Spengler, 1793) (Bivalvia : Margaritiferidae) dans le fleuve Charente (France). *MalaCo* 5: 230-239.

Vincent Prié, Biotope - pôle R&D, BP 58, 22 Boulevard Maréchal Foch, 34140 Mèze, France. Tel. +33 (0)6 72 32 00 43, vprie@biotope.fr

UK SLOW TO IMPLEMENT PROTECTION OF THE LITTLE WHIRLPOOL RAMSHORN SNAIL (*ANISUS VORTICULUS*)

By Matt Shardlow

On 1 May 2004 the EU Habitats Directive (92/43/EEC 1992) was amended to incorporate species and habitats relevant to the new EU members: Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and Slovakia. One of the species added was the little whirlpool ramshorn snail (*Anisus vorticulus*). Being on the Annex II list means that it is a species that member states are required to protect through the designation of Special Areas of Conservation (SACs). The newly listed little whirlpool ramshorn snail (*Anisus vorticulus*) occurs in the UK and the Government had until May 2007 to propose SACs in UK to secure the conservation of the species; however, they failed to complete this work. Buglife – The Invertebrate Conservation Trust – has now secured a commitment from the UK Government's Department of Environment, Food and Rural Affairs (DEFRA) that it intends to submit a list of candidate SACs for the *Anisus vorticulus* in August 2009.

Anisus vorticulus occurs throughout central and southern Europe and is local or rare throughout its range. It is known to be rare in France, Germany, Czech Republic, Netherlands and Poland, and it is on the national Red Data Books in Austria, Germany (four regions), Sweden, Switzerland and the UK. In the recent Article 17 report on the status of Habitats Directive listed species the status of *Anisus vorticulus* was described as 'Bad' by six EU states, 'Poor' by three, 'Unknown' by four and 'Good' by one (Hungary).

In the UK this snail has been almost certainly lost from two key areas: Staines (site near River Thames) and Ouse valley (Lewes Brooks), East Sussex (Killeen & Willing, 1997). And its range has retracted in other areas. At its former stronghold of Amberley Wildbrooks in the Arun valley there has been a substantial loss of the species between 2000 and 2006, with disappearance from all 12 of the ditches once known to support it; it is close to extinction on Amberley Wildbrooks (Willing, 2005, 2006, 2007). The UK populations of *Anisus vorticulus* are in desperate need of positive conservation action, and, despite the snail being listed on the UK's Biodiversity Action Plan Priority list, the action has not been sufficiently forthcoming (Willing & Killeen 1999). Although there have been promising reintroduction attempts (Willing 2007), the management of the three key ditch systems in terms of frequency of clearing, techniques, and timing remain sub-optimal.

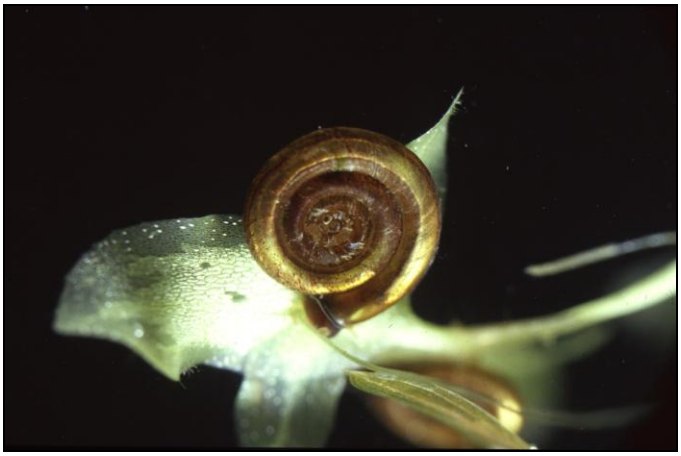


Fig. 1. *Anisus vorticulus* © Paul Sterry - Nature Photographers.

In addition to being listed on Annex II of the Habitats Directive, *Anisus vorticulus* is also listed on Annex IV and is thereby the only UK mollusc requiring 'strict protection' – this means that taking snails from the wild or destroying wild snails is illegal, as is any trade in the species. The UK finally brought in measures to implement the Directive in relation to the strict protection of *Anisus vorticulus* in 2008 after Buglife pointed out that the first legislative attempt to achieve this in 2007 failed to provide any protection for the species. The strict

protection does affect site management as the dredging of a ditch containing the snail will 'disturb' it and 'damage or destroy breeding sites' both offences under the UK legislation. Management of ditches containing *Anisus vorticulus* should now be subject to licensing but there is no evidence that the UK authorities have taken action to inform landowners and managers about the new legal situation. Again, the implementation of SACs for the species should help to bring these activities under control.

The SAC selection guidance indicates that for species that are very rare and highly endangered the SAC network should contain a high proportion of the national population. Buglife believes that there is an urgent need to designate a series of SACs for *Anisus vorticulus* so that both range and population size can be conserved. Each SAC should include both inhabited ditches and ditches in the wider area so that the naturally dynamic populations can be sustainably managed into the future. The sites that we believe require designation are:

- Pevensey Levels – already a RAMSAR site and the profile mentions *Anisus vorticulus*.
- Arun Valley Wetlands from Pulborough Brooks, through Amberley Wildbrooks to North Stoke – much is already a RAMSAR site and the profile mentions *Anisus vorticulus*.
- The Broads – in part already an SAC – but would need an extension of the current boundary to include important sites for *Anisus vorticulus* in the Lowestoft area.

The establishment of an SAC network on which the snail is a named interest feature should help focus resources and Government action on halting and reversing the current declines.

In frustration at the lack of apparent progress, Buglife recently wrote to the UK Government to inquire what plans were afoot for establishing SACs to protect the species. The response from DEFRA acknowledged that the UK had failed to put forward the necessary SACs before the deadline of 1 May 2007 but reassured Buglife that Natural England was undertaking work to identify the most suitable 'site/s' for designation as SACs and that it was hoped that 'candidate sites' would be submitted to the EU in the August 2009 tranche.

Buglife would be very interested to hear about any similar issues relating to the designation of SACs for invertebrates in the EU, please contact matt.shardlow@buglife.org.uk.

Thank you to Martin Willing for helpful comments on this article.

Killeen, I.J. & Willing, M.J. 1997. Survey of ditches in East Anglia and south east England for the freshwater snails *Segmentina nitida* and *Anisus vorticulus*. *English Nature Research Report* 229: 69 p.

Willing, M.J. & Killeen, I.J. 1999. *Anisus vorticulus* – a rare and threatened water snail. *British Wildlife* 10: 412-418.

Willing, M.J. 2005. Monitoring populations of the little whirlpool ram's-horn snail *Anisus vorticulus* at Pulborough Brooks, Amberley Wildbrooks and North Stoke June - September 2004. Unpublished report to the Royal Society for the Protection of Birds and the Environment Agency.

Willing, M.J. 2006. Monitoring, survey and translocation of populations of the little whirlpool ram's-horn snail *Anisus vorticulus* at Pulborough Brooks, Amberley Wildbrooks and North Stoke: June - November 2005. Unpublished report to the Royal Society for the Protection of Birds and the Environment Agency.

Willing, M.J. 2007. The survey and monitoring of populations of the little whirlpool ram's-horn snail *Anisus vorticulus* on (a) the SWT Pevensey Levels Reserve and (b) Amberley Wildbrooks and Pulborough Brooks: May - June 2006. Unpublished report to The Sussex Biodiversity Records Centre Survey Unit, Henfield, West Sussex.

Matt Shardlow, Director, Buglife – The Invertebrate Conservation Trust, First Floor, 90 Bridge Street, Peterborough, Cambridgeshire PE1 1DY, UK. +44 (0)1733 201210, +44 (0)7921 700151, www.buglife.org.uk

THE EXTINCTION OF *THEODOXUS PREVOSTIANUS* (C. PFEIFFER, 1828) (MOLLUSCA: GASTROPODA: NERITIDAE) IN ROMANIA

By Ioan Sîrbu & Ana Maria Benedek

The range of the relict snail *Theodoxus prevostianus* (C. Pfeiffer, 1828) (Fig. 1) is limited to a few small and scattered spots in eastern and central Europe. The species is included in Annex IV of the EU Habitats Directive (92/43/EEC 1992) and listed as endangered (EN) according to IUCN categories (Sólymos & Fehér, 2007). Its habitat is springs and brooks of thermal or mesothermal freshwater. The range of the species comprised a few locations in Austria, Croatia, Bosnia-Herzegovina, Slovenia, Hungary, Romania (M. Zettler, pers. comm.) and presumably also Bulgaria (Grossu, 1936). By now, most of the populations are extinct or on the brink of extinction in these countries, and thereby *T. prevostianus* is a highly endangered species. In Romania it was still present in 2005 in two short rivulets at Răbăgani village, Bihor County, in the north-western part of the country.

Fig. 1. *Theodoxus prevostianus* (C. Pfeiffer, 1828), a relict, thermal and highly endangered species of freshwater gastropod. Some of the last living individuals found during 2005 in the only Romanian population.

T. prevostianus seems to have been discovered in Răbăgani by Mauritius von Kimakowicz, as attested by a sample (without date, but probably from the end of the 19th century) found by us in his collection. Thereafter, the presence of this species here was confirmed by Soós (1943), Jurcsák (1967), Grossu (1986, 1993) and others. In the literature there have also been erroneous records of *T. prevostianus* from other localities in Romania, some resulting from confusion with melanistic forms of other *Theodoxus* species. But even if the species occurred

Fig. 2. Despite the declaration of some of the thermal freshwater area of Răbăgani as a nature reserve, and also the last habitat of *Theodoxus prevostianus* in Romania, the lack of proper management and law enforcement were responsible for damming, water capture and household use by local people. In the very heart of the formally declared reserve a swimming pool was built, without being noticed by any responsible public institution, leading to the population's decline.

previously in other areas of Romania, by 2000 it survived only in Răbăgani. Here it inhabited stretches a few hundred meters long of the nearby Băii and Tina cea Rea mesothermal rivulets. Some other remarkable species were also found in the same waters, notably a melanistic form of the relict *Esperiana* (*Microcolpia*) *daudebartii acicularis* (Férussac, 1823). Jurcsák (1967) reported an exceptionally abundant population of *T. prevostianus*, especially along the upper reach of the first brook, where later a nature reserve was declared. But, other than the mere declaration, no other steps were taken to preserve this outstanding place. Instead, the Băii rivulet was dammed and a swimming pool was established, probably during the 1980s, within the reserve area (Fig. 2). Sîrbu & Benedek (2005) wrote, based on research done prior to 2004, that

> "the present-day state is in opposition with the past data, because of habitat debasement and households' capture of the thermal water. The spring is flowing both in pipes and a swimming pool; thus *Theodoxus prevostianus* does no longer inhabit the former stretch, until the village. It can still be found downstream the village, in some hundred meters stretches, down to the flowing into Holod River of the two rivulets. In this two sectors it is outnumbered by *E. daudebartii acicularis*, and the former species is to be considered as threatened to become extinct, because of both capture and use of the thermal water in household works".

During the field investigation in September 2005 we ascertained that the species was already extinct in the first rivulet (Băii brook), but it still lived in the second one (Tina cea Rea brook) downstream of the village. The GPS location of this spot where *T. prevostianus* was last found alive in 2005 is 46º45'11" N and 22º12'35" E, elevation 137 m a.s.l. At that time we collected a few individuals for phylogenetic studies at the request of Dr. Zoltán Fehér (Hungarian Natural History Museum, Budapest) and Dr. Michael L. Zettler (Baltic Sea

Fig. 3. The end of the last population of *Theodoxus prevostianus* in Romania. Without legal permission, except that of the local town hall, the firm S.C. D.R. Mayer Impex SRL excavated and captured the last thermal rivulet in order to build fishponds. Nothing was done to prevent, stop or recover the damage, and no official responsibility was acknowledged.

Research Institute, Rostock). Then the population of the Tina cea Rea brook still numbered some thousand individuals.

On June 8, 2007, during a sampling and research field campaign in Crişana (the Criş Rivers Basin area), carried out together with a museologist from the Ţării Crişurilor Museum (Oradea) and a biologist from the Bihor Environmental Protection Agency (Oradea), we visited Răbăgani in order to assess the status of the last *T. prevostianus* population in Romania. To the great dismay of the research team, we could only witness that this last habitat had been completely destroyed by excavations (Fig. 3). Thus, with the disappearance of this last population, *T. prevostianus* has to be considered extinct in Romania.

The discovery of the destruction lead to a long chain of paperwork that ended with the complete hushing up of this matter. Two weeks later the local Environmental Protection Agency informed the Environmental Guard about the illegal enterprise of S.C. D.R. Mayer Impex S.R.L. which, as it turned out, had no environmental or other legal permit for the project. The reports were advanced hierarchically through official channels, but to no avail. No fine was imposed, or even suggested, and the firm was allowed to continue its illegal activity. In fact, nobody at any official level seemed to be impressed by the extinction of this mollusc species or the events behind it. Incidentally, the head of the firm turned out to be a person of high political and financial profile, who was advised in this enterprise by a professor from Bucharest.

As it turned out, in June 2006 the firm S.C. D.R. Mayer Impex S.R.L. began capturing the Tina cea Rea mesothermal rivulet and digging in order to establish fishponds for breeding sturgeons. The company had permission from the local town hall to which the land belonged, but none of the other legally required permits.

The official procedure ended suddenly with harassment letters from Dumitru Maereanu, administrator of S.C. D.R. Mayer Impex S.R.L., addressed to the Museum and the

Environmental Protection Agency of Oradea. Menaced by the influence of this person, conveyed through intimidation of their directors, the two researchers from Oradea who participated in the 2007 field investigation were reduced to silence and made to fear for their jobs. Although everybody recognized that the firm acted illegally, the matter was settled through intimidation, obscure excuses and without enforcing the law.

Regarding the above objective facts, we note that *T. prevostianus* has been mentioned as a species threatened with extinction in several papers, the last of which was published in 2005 (Sîrbu & Benedek, 2005). This latter publication was sent to a wide range of experts and institutions, but received little attention, despite the fact that it concerns a species on Annex IV of the Habitats Directive, also known as Natura 2000, listing taxa that require special protection in Romania. With just a little more attention, the last population of this snail could have easily been preserved. The extinction of *T. prevostianus* underlies that, unfortunately, institutions and even biologists tend to pay more attention to vertebrates than invertebrates, which are usually ignored or under-valued.

The official papers voiced the criticism that local authorities were not informed of the natural values of the Răbăgani site. This is (maybe) true for the town hall, but not for other institutions and persons. They received our 2005 paper, which has been widely distributed among environmental experts and is also available through the internet. But, as the present case illustrates, conservation is not so much a matter of science as it is of political and economic interest. This needs to be considered by those who are concerned about the conservation of natural values, at least for the time being.

North of the Răbăgani village lies another unique habitat, the thermal lake "Ochiul Mare" on the Peţea River, in 1 Mai Baths, close to the town of Oradea. Here lives a local endemic, relict gastropod, namely *Melanopsis parreyssii* (Philippi, 1847). Although the lake and surroundings are declared both nature reserve and Natura 2000 site, and direct involvement of the regional authorities is apparently securing this habitat, the main menace is represented by thermal underground water capture from the growing tourist industry associated with the newly built hotels. This fact could lead in the future to such a low level of phreatic thermal water, that the existence of the thermal lake itself could be threatened.

In the particular case of *T. prevostianus*, action (strict protection of the rivulet sector harbouring the last population) should have been taken before S.C. D.R. Mayer Impex S.R.L. showed interest in the area. Right now the company seems to operate with full official support, and has a series of fishponds at the place that once was the last shelter of a relict species in Romania. Who knows how many populations, or even unknown species, have also been destroyed, as also happened to a relict population of *E. daudebartii acicularis*. All the above facts and remarks highlight how lack of competence can lead to the extinction of species, especially when it affects science, legislation, law enforcement, public and governmental institutions and serves short-sighted economic interests.

Grossu, A.V. 1936. O specie de gasteropod nouă pentru România, *Theodoxus prevostianus* Pf. 1828. *Buletinul Societatii Naturalistilor din Romania, Bucureşti* 9: 10.

Grossu, A.V. 1986. *Gastropoda Romaniae, 1. I. Caractere generale, istoricul şi biologia gastropodelor. II. Subclasa Prosobranchia şi Opisthobranchia*. Editura Litera, Bucureşti.

Grossu, A.V., 1993. The catalogue of the moluscs from Romania. *Travaux du Museum National d'Histoire Naturelle "Grigore Antipa", Bucharest* 33: 291-366.

Jurcsák, T. 1969. Contribuţii la cunoaşterea faunei malacologice de la Răbăgani (jud. Bihor). *Sesiunea muzeelor, decembrie 1964; Ştiinţele naturii* (*Editura Ştiinţifică, Bucureşti*) 1: 37-39.

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

Sólymos, P. & Fehér, Z. 2007. Assessment of six Hungarian mollusc species according to the IUCN Red List categories. Unpublished report submitted to IUCN.

Soós, L., 1943. *A Kárpát-medence Molluska faunája.* Magyar Tudományos Akadémia, Budapest.

Ioan Sîrbu and Ana Maria Benedek, Department of Ecology and Environmental Protection, "Lucian Blaga" University of Sibiu, 31 Oituz St., 550337 Sibiu, Romania, meosirbu@yahoo.com

PROPOSED PROTOCOL FOR MONITORING *VERTIGO* (MOLLUSCA: GASTROPODA: VERTIGINIDAE) SPECIES IN HUNGARY

By Zoltán Fehér

The EU Habitats Directive (92/43/EEC 1992) lists several species that require special attention in the member states of the European Union. Wether or not the most appropriate species have been selected for this purpose (see e.g. Bouchet, *et al*., 1999, Sólymos 2004, 2006), the member states are obliged to follow up and to report on their conservation status. In order to provide methodological principles for the monitoring and reporting obligation, the Hungarian Ministry of Environment and Water launched a project in 2008, entitled "Development of monitoring protocols to comply with the reporting requirements set out in Council of Europe Directive 79/409/EC on the conservation of the wild birds and the Directive 92/43/EC on the conservation of natural habitats and of wild fauna and flora".

As *Vertigo* species have an important place in the Habitats Directive, an increasing number of studies are dealing with them all over Europe (e.g. Cameron *et al*., 2003; Falkner, 2003; Jueg, 2004; Killeen, 2003; Książkiewicz, 2008; Manganelli *et al*., 2001; Pokryszko, 2003; Proschwitz, 2003; Vavrova & Šteffek, 2007). One of the actions of the above project focused on the two *Vertigo* species that occur in Hungary and are listed on Annex II of the Habitats Directive, i.e. the narrow-mouthed whorl snail (*Vertigo angustior* Jeffreys, 1830) and Desmoulin's whorl snail (*Vertigo moulinsiana* (Dupuy, 1849)). This *Vertigo* action had three main objectives: 1) to compile a gap analysis based on the literature and the collections of the Hungarian Natural History Museum in order to accumulate all available data on these

species' distributions; 2) to perform population estimates in 30 varied localities, 3) to test different collecting methods and to propose a monitoring protocol.

For population estimates, localities were chosen on the basis of the gap analysis. In 20 of the sites, there were records of both *Vertigo* species, in the remaining 10, only *V. angustior* was recorded. Among the 30 selected localities, old and new records (to test the reliability of old data), small and large populations, and disturbed and undisturbed habitats were equally represented. Of these, 22 localities were within Natura 2000 sites of community interest (SCI), and an additional four were within areas protected on a national level. Sampled biotopes were mainly wetlands, i.e. fens, alluvial meadows, tall-herb humid meadows, alluvial forests and bog woodlands (several of these habitats are listed on Annex I of the Habitats Directive). Two of the 30 localities (Naplás-tó and Merzse-mocsár), both within the territory of Budapest, were selected as test areas. In the remaining 28 sites, 4-7 biomass samples were taken on two occasions between March and October 2008. These samples were collected from quadrats of 25 cm x 25 cm (= 6.25 dm^2) and contained leaf litter, some live plants and the uppermost layer of the soil. The two test localities were visited several times and other collecting methods were tested there, namely hand-searching targeted at microhabitats known to be suitable for the study species (30 min) and sweep netting (30 min). Biomass samples were immersed in water and the fraction that floated was decanted and dried; other samples were just dried. Dried samples were then sieved through a series of four sieves of mesh densities 22, 29, 55 and 100 holes per 10 cm. As *V. angustior* and *V. moulinsiana* specimens are mainly found in the 55-100 and 29-55 fractions, respectively, it was sufficient to sort these two fractions only.

Population sizes were estimated by extrapolating the average number of specimens in the samples, following Moorkens & Gaynor (2003), but 95 % confidence intervals were also calculated:

$$N = n \cdot \frac{T}{t} \quad \text{and} \quad CI_{95} = N \pm 1.96 \cdot \frac{s}{\sqrt{m}}$$

where N is the estimated population size, n is the number of sampled specimens, T is the total area of the biotope, t is the sampled area, CI_{95} is the 95 % confidence interval, s is the standard deviation and m is the number of samples.

Gap analysis resulted in 133 *V. moulinsiana* and 453 *V. angustior* records from 76 and 154 10 km x 10 km UTM grid cells, respectively. There were 14 cells with data older than 30 yr for *V. moulinsiana* and 13 for *V. angustior*, whereas recent records (found or confirmed after 2000) came from 20 and 37 cells, respectively (Fig. 1). Considering the inadequate exploration of the Hungarian mollusc fauna (Sólymos, 2007), and although the known records are based partly on material collected from plant debris floating in rivers, streams and lakes, and some of the old records might refer to populations that are now extinct, these values are probably underestimates. Based on the grid cell analysis, one can presume that there are 100-150 and 160-300 UTM grid cells in Hungary where *V. moulinsiana* and *V. angustior* occur, respectively. Population estimates performed during this study confirmed the presence

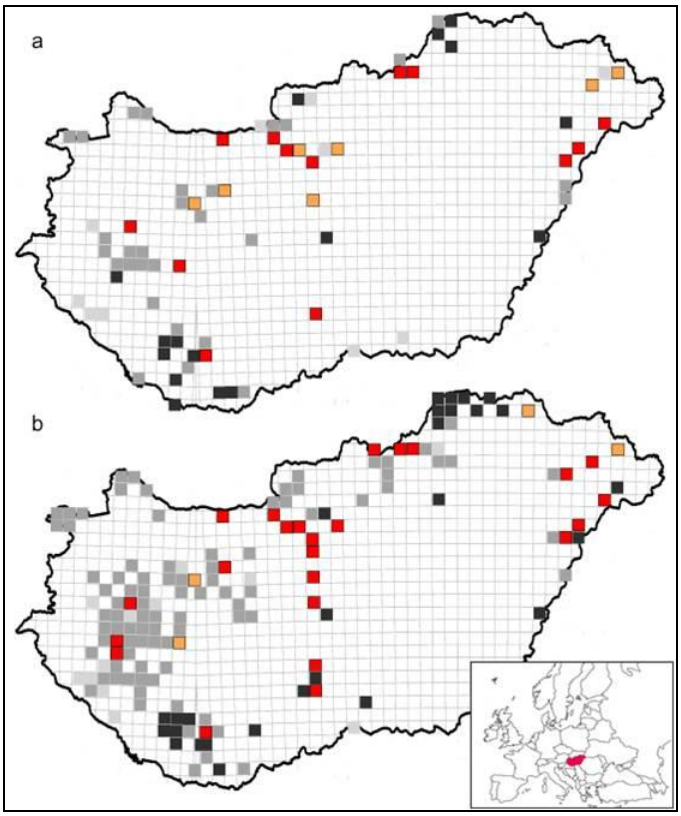


Fig 1. Results of the gap analysis and the stock assessment for (a) *Vertigo moulinsiana* and (b) *Vertigo angustior*. Light grey: data from before 1974; medium grey: data from 1974-1999; dark grey: data after 2000; orange: data not confirmed by the present population estimate; red: data confirmed by the present population estimate.

of *V. angustior* in 25 of the 30 localities and of *V. moulinsiana* in 12 of the 20 localities. Also, a new population of the latter species was discovered in a locality that was initially included as a *V. angustior* site.

All records are entered in the Hungarian Nature Conservation Information System and will soon be partly accessible to the public (http://geo.kvvm.hu/tir_en/viewer.htm). Some observations regarding the spatial and temporal distribution of the *Vertigo* species studied in the test areas are particularly noteworthy. Table 1 shows an example of the observed patchy distribution of *V. angustior* in the Merzse-mocsár (Fig. 1). The extremely large 95 % confidence interval of the mean indicates that the results are hardly usable for accurate population size estimation but really only for presence/absence. Table 2 illustrates the temporal variability (caused by seasonal trends and/or non-seasonal fluctuations) of the number of specimens sampled at a particular sampling location (Naplás-tó) on different occasions. It is notable that following heavy rain on 12 June 2008, *V. moulinsiana* climbed up on sedge (*Carex* sp.) leaves in large numbers in the vicinity of the sampling location, but hardly any of them were found on reeds (*Phragmites* sp.). Although *V. angustior* also occurred in the same site, it was not observed to climb up any plant species (see also Hornung *et al.*, 2003). This occasion provided a good opportunity to get an idea of the microscale pattern of the density of *V. moulinsiana* in that locality. *Vertigo moulinsiana* abundance was highest in the 2-3 m wide zone by the lake shore, while farther from the shore it decreased drastically. It

Table 1. Number of *Vertigo* specimens found in eight biomass samples, collected in the same locality and on the same date (Budapest, Merzse-mocsár, 26 April 2008). Sample locations are shown in Fig. 2. Means and 95 % confidence intervals are calculated both for one sample and for 1 ha.

Sample location	*V. angustior*	*V. pygmaea*	*V. antivertigo*
55A	0	0	0
55B	0	0	1
55C	0	0	0
55D	0	0	0
56	0	1	0
57	31	5	0
57B	81	7	5
57C	4	5	0
Mean (95 % CI) per sample	15 (-6-35)	2 (0-4)	1 (0-2)
Mean (95 % CI) per ha (million specimens)	2.3 (-1.0-5.6)	0.4 (0-0.7)	0.1 (-0.1-0.3)

Fig. 2. Satellite view of the first test area (Budapest, Merzse-mocsár). Red dots indicate the sampling points (see Table 1), yellow line indicates the boundary of the wetland habitat (ca. 18 ha), surrounded by agricultural areas and planted woods. (Source: Google Earth)

Table 2. Number of *Vertigo angustior* and *V. moulinsiana* specimens found in biomass samples (ca. 6.25 dm^2) or by visual search (30 min) at the same sampling location at Naplás-tó, Budapest, on four dates.

	V. angustior / V. moulinsiana				Weather during the day prior to taking the samples
Method	Biomass sample			Hand searching	
State	dead	live adult	live juvenile	live adult + juv.	
28.02.2008	1 / 1	2 / 0	0 / 0	0 / 0	partly cloudy, dry
12.06.2008	1 / 1	11 / 6	0 / 2	0 / 260	heavy rain
05.08.2008	48 / 2	296 / 2	32 / 1	0 / 11	light showers
05.11.2008	10 / 5	440 / 17	18 / 1	0 / 0	sunny, dry
Mean (95 % CI) per sample	215 (-28 – 457) / 10 (0 – 19)			0 / 68 (-60–196)	
Mean (95 % CI) per ha (million specimens)	34,4 (-4,4 – 73,1) / 1,5 (0 – 3,1)			—	

is also notable that counts of snails sampled by visual collection of individuals and of those recovered from biomass samples are not proportional (Table 2).

Because of their small size, it is very difficult to find *Vertigo* on the ground surface or among the leaf litter by hand searching, unless their density is very high. Visual collection from plants as well as sweep netting is an appropriate method only if the snails climb up plants in large numbers. Their tendency to climb up plants seems to be highly weather dependent and therefore both visual collecting and sweep netting are very difficult to standardize. Consequently, any of these methods can only be used for presence/absence surveys. If these methods fail to detect the target species, or more information is needed in addition to simple confirmation of its presence, ground surface biomass samples should be analysed. Although this method provides a count per unit of surface area, and therefore, theoretically, can be extrapolated to the whole area of the habitat, it should be used very cautiously for population estimates. This study has shown that even at the same sampling location counts are highly influenced by seasonal and non-seasonal weather variation (Table 2), and within a habitat – even if the vegetation seems to be homogenous – *Vertigo* species might be distributed very unevenly (Table 1, Fig. 2). Because of the temporal and spatial unevenness of population densities, the proposed sampling method (five samples on each of two occasions per year) provides a population estimate with a very large confidence interval (Tables 1, 2). This confidence interval could be reduced to an acceptable level by increasing the number of samples both in time and space by one or two orders of magnitude. This, however, considering the number of known *V. angustior* and *V. moulinsiana* populations in Hungary, is hardly feasible in practice. Beyond the confirmation of the presence of a species, the above method provides semi-quantitative information about the population; e.g. constancy (the proportion of samples in which the species occurs) can be a useful parameter for long-term population trend assessment. If the presence of a species is not confirmed by 10 samples in a certain habitat per year, further samples might be taken to decrease the possibility of recording pseudo-absence.

This study suggests that both *V. moulinsiana* and *V. angustior* are widely distributed in Hungary and their future prospects seem favourable. In my opinion, it is sufficient to measure grid square map area covered by recorded occurrences of these species (European Commission, 2006) to satisfy the monitoring and reporting obligations regarding their conservation status. During each reporting cycle at least one known population per UTM grid cell should be monitored, and whenever possible further habitats should be studied within unexplored cells. The suggested method is biomass sample collecting, outlined above, which provides semi-quantitative information about the population sizes and their trends. More precise investigation seems unnecessary and financially unrealistic. Scarce financial resources, if any, should be expended on researching, monitoring and protecting those mollusc species that are really threatened in our region, first of all *Theodoxus prevostianus* (Sîrbu & Benedek, 2005, Sólymos *et al.*, 2006).

Bouchet, P., Falkner, G. & Seddon, M.B. 1999. Lists of protected land and freshwater molluscs in the Bern Convention and European Habitats Directive: are they relevant to conservation? *Biological Conservation* 90: 21-31.

Cameron, R.A.D., Colville, B., Falkner, G., Holyoak, G., Hornung, E., Killeen, I., Moorkens, E., Pokryszko, B.M., Tattersfield, P., Valovirta, I. & von Proschwitz, T.. 2003. Species accounts for snails of the genus *Vertigo* listed in Annex II of the Habitats Directive: *V. angustior*, *V. genesii*, *V. geyeri* and *V. moulinsiana* (Gastropoda: Vertiginidae). *Heldia* 5: 151-170.

European Commission 2006. Assessment, monitoring and reporting under Article 17 of the Habitats Directive: explanatory notes & guidelines. Draft 3 – April 2006.

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

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

Jueg, U. 2004. Die Verbreitung und Ökologie von *Vertigo moulinsiana* (Dupuy, 1849) in Mecklenburg – Vorpommern (Gastropoda: Stylommatophora: Vertiginidae). *Malakologische Abhandlungen Staatlilches Museum für Tierkunde Dresden* 22: 87-124.

Killeen, I.J. 2003. A review of EUHSD *Vertigo* species in England and Scotland (Gastropoda, Pulmonata: Vertiginidae). *Heldia* 5: 73-84.

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

Manganelli, G., Cianfanelli, S., Brezzi, M. & Favilli, L. 2001. The distribution and taxonomy of *Vertigo moulinsiana* (Dupuy, 1849) in Italy (Gastropoda: Pulmonata: Vertiginidae). *Journal of Conchology* 37: 267-280.

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

Pokryszko, B.M. 2003. *Vertigo* of continental Europe – autecology, threats and conservation status (Gastropoda, Pulmonata: Vertiginidae). *Heldia* 5: 13-25.

Proschwitz, T. von 2003. A review of the distribution, habitat and conservation status of the species of the genus *Vertigo* in Scandinavia (Denmark, Norway and Sweden) (Gastropoda, Pulmonata: Vertiginidae). *Heldia* 5: 27-50.

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

Sólymos, P. 2004. The assessment of the Hungarian land molluscs based on their rarity, and its applications. *Természetvédelmi Közlemények* 11: 349-358 [Hungarian with English abstract].

Sólymos, P. 2006. Are current protections of land snails in Hungary relevant to conservation? *Biodiversity and Conservation* 16: 347-356.

Sólymos, P. 2007. Geographic and taxonomic bias in land snail distribution data of Hungary. *Community Ecology* 8: 239-246.

Sólymos, P., Fehér, Z. & Varga, A. 2006. Mollusc conservation in Hungary: rarity, regionality and responsibility. *Tentacle* 14: 13-14.

Vavrova L. & Šteffek J. 2007. Favourable conservation status of European important species of genus *Vertigo* spp. in Slovakia – categories and criteria. *Linzer Biologische Beiträge.* 39/1: 667-676.

Zoltán Fehér, Hungarian Natural History Museum, Department of Zoology, Mollusca Collection, H-1088, Baross u. 13, Budapest, Hungary. Tel +36 1 267 7100, feher@nhmus.hu

MANAGEMENT POLICIES ON BIOINVASIONS IN CONTINENTAL WATERS OF THE SOUTH OF THE NEOTROPICAL REGION – DO THEY EXIST?

By Gustavo Darrigran

The effects of global change (Mooney & Hobbs, 2000) and globalization of trade on the biosphere spur an increase in bioinvasions and their subsequent impact (Darrigran & Damborenea, 2005). Biological invasions became a popular area of research and an increasingly controversial topic of debate during the 1990s, resulting in a flood of publications, both scholarly and popular, that continues to this day (Davis, 2006).

Even though the word bioinvasion was used for the first time in the 1950s (Elton, 1958), this word, as above mentioned, has been profusely used during recent decades. In many scientific meetings related one way or another to the topic of biological diversity, biological invasions are the focus of much attention. In this vein, on 6 November 2008, in Valdivia, Chile, during the VII CLAMA (Latin American Congress on Malacology) I had the honour of organizing and coordinating a Symposium on "Mollusks as Bioinvaders", in which Latin American malacologists addressed the following issues:

- Dr. Carlos E. Belz. Risk analysis as a tool for the prevention of bioinvaders
- Dr. Claudia T. Callil. Chronology of invasion. New records of occurrence of Corbiculidae in South America: a way to follow the dispersion of the golden mussel
- Lic. Eduardo Colley. The "giant African caramujo" *Achatina fulica* Bowdich, 1822: panorama to date of the invader land gastropods of Brazil
- Dr. Maria Cristina Dreher Mansur. The golden mussel in Brazil: environmental damage, economical injury, behavior and control

According to my experience as a researcher and consultant on bioinvasions, and to what we heard in this and other symposia in which I have participated, I am taking as a model of bioinvasion in the Neotropical region the case of invasion by *Limnoperna fortunei*, the golden mussel (Bivalvia: Mytilidae). The golden mussel is native to rivers and creeks in China and southeast Asia. It invaded Hong Kong in 1965, and Japan and Taiwan in the 1990s (Darrigran, 2002). It was found for the first time in the Americas in 1991 in the Argentine pampas at Bagliardi Beach, Río de la Plata estuary (35º55'S-57º49'W) (Pastorino *et al*., 1993). Darrigran & Pastorino (1995) suggested that the non-intentional introduction of this species into the Americas in 1991 was via ballast water of ocean vessels.

The rapid increase in density and distribution of this bivalve added a widespread and abundant epifaunal mussel to freshwater benthic communities of the Plata basin. Dense populations of golden mussels create new habitats that can be colonized by other taxa, thereby modifying the specific richness and composition of the native benthic communities.

In 1988, at Bagliardi Beach, before the introduction of *Limnoperna fortunei*, three gastropods were common in the rocky environment: *Heleobia piscium* (d'Orbigny, 1835), *Chilina fluminea* (Maton, 1809) and *Gundlachia concentrica* (d'Orbigny, 1835). Among the problems related to the presence of the invasive bivalve were the quick change in the benthic community, favoring the presence of Oligochaeta and Hirudinea, as well as the displacement of indigenous species of molluscs. Since the introduction of the golden mussel in Bagliardi Beach, *C. fluminea* and *G. concentrica* have become rare (Darrigran *et al*., 1998).

The most direct and severe ecological impact has been the epizoic colonization of native bivalves (Hyriidae and Mycetopodidae) by *L. fortunei*, similar to the impact of *Dreissena polymorpha* on native bivalves in North America. Displacement of the native bivalves resulted from their inability to open and shut their valves because of the byssally-attached mussels on their shells. Golden mussels also settle on other native molluscs, such as *Pomacea canaliculata* (Lamarck, 1822) (Gastropoda, Ampullariidae), as well as on the introduced *Corbicula fluminea* (Bivalvia, Corbiculidae) (Darrigran, 2002).

The invasion of *Limnoperna fortunei*, the golden mussel, leads me to think that we are in the middle of a crisis relating to management policies for bioinvasions. This is evident from:

- a global point of view in which government actions tend to minimize their responsibilities for vectors of invaders and maximize their concern about not being recipients of invasive species;
- a regional point of view in which the potential impact on the human, as well as the natural environments of a bioinvasion process, are unknown or downplayed.

Considering the problem from a regional point of view, for instance, 17 years after the first record (in 1991) of the invasion of the golden mussel into South America (Darrigran & Pastorino, 1995), we are still confronted with freshwater macrofouling (incrustations greater than 1 mm in size) caused by the mussel, as a novel economic/environmental problem for South American freshwater systems. This fact arises from:

- Scientific policies, e.g. of member countries of MERCOSUR, are subject to unstable socioeconomic policies. Thus, policies generating rules for freshwater macrofouling control are implemented on a short-term local basis by private/state enterprises that tend to stick to economic and individual objectives, rather than searching for sustainable and regional solutions.
- Research on biology of invasions in this region is in general still at a basic stage of bioinvasion description. From the scientific point of view we are trying to initiate the next two necessary stages for sustainable management of bioinvasions: prediction and risk analysis of invasion. If we are successful in achieving this, the result would be a well ordered research system generating potential solutions to bioinvasions rather than a governmental system of ill-informed management of bioinvasions, or worse, a system unaware of the problems causing bioinvasions.

The scientific system devoted to invasion biology in the south of the Neotropical region is progressing and is beginning to address prediction and analysis of invasion risk. This progress then must necessarily be accompanied with a policy integrating this scientific system into the economical-social system of the region.

Darrigran, G. 2002 Potential impact of filter-feeding invaders on temperate inland freshwater environments. *Biological Invasion*s 4: 145-156.

Darrigran G. & Pastorino, G. 1995. The Recent introduction of a freshwater Asiatic bivalve, *Limnoperna fortunei* (Mytilidae) into South America. *The Veliger* 38: 171-175.

Darrigran, G. & Damborenea, M.C. 2005. A South American bioinvasion case history: *Limnoperna fortunei* (Dunker, 1857), the golden mussel. *American Malacological Bulletin* 20: 105-112.

Darrigran, G., Martin, S.M., Gullo, B. & Armendariz, L. 1998. Macroinvertebrates associated with *Limnoperna fortunei* (Dunker, 1857) (Bivalvia, Mytilidae). Río de la Plata, Argentina. *Hydrobiologia* 367: 223-230.

Davis, M.A. 2006. Invasion biology 1958-2005: the pursuit of science and conservation. In: *Conceptual Ecology and Invasion Biology: Reciprocal Approaches to Nature* (eds. Cadotte, M.W., McMahon, S.N. & Fukami, T.), p. 35-64. Springer, Dordrecht.

Elton, C.S. 1958. *The Ecology of Invasions by animals and plants*. Methuen, London.

Mooney, H. & Hobbs, R.J. 2000. *Invasive Species in a Changing World*. Island Press, Washington.

Pastorino, G., Darrigran, G., Martin, S.M. & Lunaschi, L. 1993. *Limnoperna fortunei* (Dunker, 1857) (Mytilidae), nuevo bivalvo invasor en aguas del Río de la Plata. *Neotropica* 39: 34.

Gustavo Darrigran, Grupo de Investigación sobre Moluscos Invasores/Plagas (GIMIP), División Zoología Invertebrados, Facultad de Ciencias Naturales y Museo, UNLP, Paseo del Bosque, La Plata (1900) Argentina. CONICET. invasion@fcnym.unlp.edu.ar www.malacologia.com.ar

HOW MANY *DREISSENA* SPECIES ARE LIVING IN THE SEYHAN LAKE NEAR BALCALI-ADANA, TURKEY?

By Henk K. Mienis & Cem Çevik

The day after the 2nd National Malacology Congress of Turkey, held 8-10 October 2008 at the Çukurova University in Balcali-Adana, we made a brief visit to Lake Seyhan adjacent to the university campus. This lake is a reservoir, created by damming the river Seyhan (formerly Sarus) near the town.

We walked along the edge of the lake from the marina annex restaurant of the university towards a cove about 500 m north-east of the marina. This cove is formed by an inundated valley. The banks were very steep and covered with boulders, while former lake levels were clearly indicated by dense monotypic stands of a cocklebur (*Xanthium* sp.). These stands were present as bands growing at different heights, indicating recent changes in water levels. One such band, consisting of small plants 5-10 cm high, was covered by the lake's water, a sign that the water level had recently increased.

Because of this elevation in water level almost all the submerged stones were devoid of molluscs. Here and there we

collected some aquatic plants belonging to two species of *Potamogeton*. Tiny juvenile specimens of *Dreissena* were adhering to their stems. However, here and there we also found some empty, but recent valves of adult mussels among the stones near the water's edge.

We were able to divide these shells into three morphological groups:

- slender, slightly curved specimens with a well developed carina,
- rather broad, triangular specimens with a well developed carina, and
- almost smooth, convex specimens with a weak indication of a crest-like carina running in the middle over its entire length.

With the help of the monograph of Schütt (1993) we were able to identify them as, respectively, *Dreissena polymorpha anatolica* (Locard, 1893), *Dreissena caputlacus* Schütt, 1993 and *Dreissena iconica* Schütt, 1991.

The first two had recently been recorded from the lake by May *et al*. (2006) and indeed were considered to represent two different taxa. However, the discovery of *Dreissena iconica* was a real surprise. Schütt (1991) based the description of this species on fossil material from the Burdur Valley and the former Konya-Ereğli Lake, 10 km south of Konya, and considered it extinct. More fieldwork in the near future aims to determine whether Seyhan Lake is indeed inhabited by three species of *Dreissena*. Another question to be resolved is whether these species occur in mixed colonies or form more or less separate colonies confined to particular depth ranges.

The genus *Dreissena* is well-known for its speciation in Turkey (Schütt, 1993; Schütt & Şeşen, 2007). However, most lakes or streams are inhabited by a single species. *Dreissena* is a fouling organism of economic importance in Turkey (Bobat *et al*., 2004, 2005). Since the water of Lake Seyhan is used for producing hydroelectric power and for irrigation, these mussels could therefore easily become an economic problem in Lake Seyhan.

Yet the presence of at least two *Dreissena* species, and probably a third one that until recently had been known only as a fossil, calls for some kind of conservation measures to protect this unusual situation in Lake Seyhan.

The senior author thanks the organizers of the 2nd National Malacology Congress of Turkey for inviting him to participate and for giving him the opportunity to have a first look at the mollusc fauna of Seyhan Lake.

Bobat, A., Altinayar, G., Üstündağ, S. & Çevlík, H. 2005. Hidroelektrik santrallarda Zebra midye sorunu ve savaşimi. *Eğitím ve bilgí işlem daíresí başkanliği yayin* [Ankara] 2: 72 p.

Bobat, A., Hengirmen, M.O. & Zapletal, W. 2004. Zebra mussel and fouling problems in the Euphrates basin. *Turkish Journal of Zoology* 28: 161-177.

May, G.E., Gelembiuk, G.W., Panov, V.E., Orlova, M.I. & Lee, C.E. 2006. Molecular ecology of zebra mussel invasions. *Molecular Ecology* 15: 1021-1031.

Schütt, H. 1991. Fossile Mollusken dreier anatolischer Ovas. *Archiv für Molluskenkunde* 120: 131-147, 1 pl.

Schütt, H. 1993. Die Gattung *Dreissena* im Quartär Anatoliens (Bivalvia: Eulamellibranchiata: Dreissenacea). *Archiv für Molluskenkunde* 122: 323-333.

Schütt, H. & Şeşen, R. 2007. The freshwater mussel *Dreissena siouffi* (Locard) in the river Euphrates. *Triton* 16: 1-4.

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
Cem Çevik, Su Ürünleri Fakültesi, Temel Bilimler Bölümü, Çukurova Üniversitesi, 01330 Balcali-Adana, Turkey.
cem95@cu.edu.tr

BIG RANGES FROM SMALL PACKAGES: NORTH AMERICAN VERTIGINIDS MORE WIDESPREAD THAN THOUGHT

By Jeffrey C. Nekola

More thorough field surveys, in conjunction with reanalysis of existing museum collections and analysis of mtDNA sequences are demonstrating that in North America, minute land snails such as vertiginids do not tend to develop local endemism.

Fig. 1. Species of *Vertigo* mentioned in the text.

Take for example what were believed to be the two most narrow range *Vertigo* species in eastern North America, *V. perryi* and *V. clappi* (Fig. 1). The former was thought to be limited to a 550 km stretch of the New England coast, while the latter was known only from a 650 km extent in the Southern Appalachians from western Tennessee to northern West Virginia. In the fall of 2004, Brian Coles of the Welsh National Museum and I discovered that *V. perryi* ranges at least as far west as central Wisconsin, a range extension of roughly 1500 km. This fall (2008), my reanalysis of half-century-old collections in the University of Michigan Museum of Zoology and the Royal Ontario Museum, as part of a Committee on the Status of Endangered Wildlife in Canada (COSEWIC) project to prioritize the conservation status of land snails of Ontario and Quebec, documented that the range of *V. clappi* is actually double what it had been thought to be, extending as far north as the northern shores of Lake Erie and Lake Ontario. These specimens had been misidentified as another common *Vertigo* species, thereby escaping detection.

Only in the midwest and desert southwest are some *Vertigo* species, such as *V. arizonensis*, *V. inserta* and *V. meramecensis*, limited to ranges of 500 km or less. Yet, even in these cases, none are narrow range endemics, with populations occurring across multiple river basins or mountain

ranges. It thus appears that like *Balea* from the western Atlantic, small snails such as *Vertigo* have an immense capacity for passive long-range dispersal, and tend to exhibit ranges of 1000 km or greater, with some (like *V. arthuri*) extending across the entire continent from Newfoundland to Alaska, south to northern New Mexico. Endemicity appears more apt to occur in large sized species (e.g. polygyrids, urocoptids, helminthoglyptids), presumably because of their more limited long-range dispersal ability.

Jeffrey C. Nekola, Biology Department, University of New Mexico, Albuquerque, New Mexico, 87131, USA. Tel. +1 505 277 6270, jnekola@unm.edu, http://sev.lternet.edu/~jnekola

CONSERVATION STATUS OF FRESHWATER SNAILS IN WISCONSIN

By Joan P. Jass

Conservationists seeking to present a case in support of the need for research on the smaller and less charismatic members of their local fauna may be stymied by an absence of even the most basic data to use in providing evidence for the relative stability or lack of it in these populations. The State of Wisconsin for example was able to identify a list of 527 invertebrate species of greatest conservation need in formulating its most recent Wildlife Action Plan (http://dnr.wi.gov/org/land/er/wwap). However, only four of these are freshwater snails, with the vast majority of the aquatic gastropods recorded from the state (64/68, 94 %) by Jass (2004) being relegated to the category of those for which so little information was available that their conservation status could not be assessed.

Fig. 1. *Promenetus exacuous*, a planorbid widely distributed in the eastern United States but recorded from only eight Wisconsin counties and under review (SU) for determination of its conservation status in the state (Milwaukee Public Museum Mollusk lot 19659, collected marshy pond, 3 miles [5 km] SW of Eagle, Waukesha County, Wisconsin, 8 June 1972, shell diameters < 5 mm).

This need for additional basic biological and zoogeographic data can scarcely be exaggerated, as the following figures may illustrate. One quarter of Wisconsin's counties are without even a single record for any aquatic gastropod species. More than half of those 68 snails (54 %) were reported from a total of seven or fewer of the counties in the state (7/72, < 10 %). Moreover, many of those reported records are from the fairly distant past, leaving the current relevance of such distribution data open to considerable question. Dates associated with the records reported by Jass (2004) were broken down into three categories: reports before 1928, 1929-1968, 1969-2004. Slightly more than 35 % (24/68) of the county records were from the earliest category, and only 38 % of them were reported in the most recent time span. Even though county records are lacking in zoogeographic significance, the absence of them, especially for species thought to be of generally wide distribution (Fig. 1), may be useful to indicate the location of gaps in collecting.

Jass, J.P. 2004. Distributions of gastropods in Wisconsin. *Milwaukee Public Museum Contributions in Biology and Geology* 99: 1-28.

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

FRESHWATER BIVALVES IN NORTH AMERICA

Mortality of native freshwater mussels associated with increased populations of *Dreissena polymorpha*, 15-18 years after its introduction to the upper Rideau River, Ontario, Canada

By Frederick W. Schueler & André L. Martel

Three years ago in *Tentacle* we reported (Martel *et al*., 2006) on conditions in the Rideau River, in eastern Ontario, Canada, where increasing numbers of *Dreissena polymorpha* (the zebra mussel) were, in 2005, beginning to cause mortality in upstream "hot spots" of unionid diversity and abundance, 15 years after the species' initial discovery in the river (1990) and 5 years after it had affected almost the entire downstream half of the river. At the foot of the Andrewsville Flats **(**44.95017° N 75.81949° W, WGS 84), in lock-bypass riffles over limestone rubble and bedrock, in this clear-water canal-river, no *D. polymorpha* were found until 1998, though they had been present in upstream lakes at least since 1993. From 1999 to 2002 they were found here at a rate of about 1.25 individuals per hour of searching and then with increasing abundance each year through 2003-2005 (Martel *et al*., 2006).

We now report on the three subsequent field seasons, despite the non-quantitative character of our observations, because they complete the series from the onset of mortality, to the elimination of all living unionids, except a few of the hardy *Elliptio complanata* (eastern elliptio), which was previously a minority species at this site.

On 25 July 2005, there were about 150 zebra mussels per square metre on the bedrock bottom of the Andrewsville Flats. On 25 September 2005, for the first time, there seemed to be an increase in the mortality of the big old unionids that lived on the largely bare bedrock bottom here. Most of the shells were *Lampsilis cardium* (plain pocketbook; 71 shells, mostly adults, including one individual with a shell measuring 172 x 96 x 70 mm –it had possibly been the largest invertebrate in eastern Ontario) and *Lasmigona costata* (fluted shell; 11

shells, some of which were large adults). It is now recognized that even a few large zebra mussels can kill a unionid by restricting normal valve action or, especially here where the riverbed is largely flat bedrock, by increasing hydrodynamic drag. Among the unionids were also *Lasmigona compressa* (creek heelsplitter; one old pair of valves, plus a doubtful old pair and fragment), *Ligumia recta* (black sandshell; three shells and one adult) and *Elliptio complanata* (eastern elliptio; 12 shells and many adults). Many of the living *Elliptio* were under rocks not heavily fouled by zebra mussels, suggesting that this was a refuge for this species.

On 28 June 2006, at the foot of the flats, where living mussels had previously been found accumulated in the spring, almost all the unionids were dead and all heavily fouled by *Dreissena*. On 6 May 2007, there was a large pile of new shells at the foot of flats; many with attached *D. polymorpha*. On 9 July 2007 (Fig. 1) the bottom was littered with unionid shells, which were also densely piled at the foot of the flats, including four large living *Elliptio complanata* (eastern elliptio) and one small *Lampsilis* sp., all with attached *D. polymorpha*. Everywhere the river bottom was dark and crunchy with a thick layer of small zebra mussels.

Fig. 1. General view of the bottom of the Rideau River at Andrewsville, taken while snorkelling during July 2007 (water depth approximately 1m). Several large dead unionids, including *Lasmigona costata* (fluted shell) and *Lampsilis cardium* (plain pocketbook) can be seen among a large number of zebra mussels (*Dreissena polymorpha*), both alive and dead.

On 3 August 2007, we saw no living unionids at the foot of the flats, where the bedrock had a scattering of tiny zebra mussels, with larger zebra mussels more densely covering the sediment bottom and where *Vallisneria americana* plants were rooted. At the head of the flats in a place where drifts of small shells accumulate, these were about 65 % small *D. polymorpha* shells, 25 % mostly old shells of *Bithynia tentaculata* and 5 % *Viviparus georgianus*, where the shells formerly were predominantly fresh *B. tentaculata*, with fewer *V. georgianus*. Under flat rocks (about 2 m^2 total area) we saw medium-size zebra mussels, at a density of about 1000/m^2 (estimated as 10 individuals in a typical 10 x 10 cm square). Nearby bedrock bottom had at least 10,000 zebra mussels per square metre. This kind of density extended into beds of *Myriophyllum* sp. (water milfoil). During this visit, the only living unionid we saw was a 5 cm juvenile *Lampsilis* sp., which we cleaned of several *D. polymorpha*.

On 5 September 2008 (the visit referenced in Farr's (2008) popular account of unionid decline in Ontario) we estimated that zebra mussels covered about 50 % of the entire bottom bedrock of the flats. Only two *Elliptio complanata* were found alive and there was no longer a concentration of empty unionid shells at the foot of the flats.

The increase in *Dreissena polymorpha* since 2005 has effectively extirpated the diverse unionid fauna here and this has been accompanied by steep declines in the formerly dominant filter-feeding introduced snail *Bithynia tentaculata* (Schueler, in prep.). Conservation concern for unionids in the upper Rideau must now switch from anxiety for populations composed of big old individuals to the questions of which species will survive in equilibrium with *D. polymorpha* and which will survive in the few small tributaries of this stretch of the river.

While we are not sure what triggered the increase of *D. polymorpha* in the Rideau, events here can serve as a cautionary tale for other streams, in eastern Ontario and elsewhere, where zebra mussels are "present but not dominant". It is possible that any factor that favours *D. polymorpha* – reduced flow, increased impoundments, or increased calcium or food organisms – may trigger a population explosion.

Farr, M. 2008. The Mussel Crisis. *ON Nature* 48(4): 36-39. http://www.ontarionature.org/onnature/themusselcrisis.html

Martel, A.L., Madill, J. & Schueler, F. 2006. Apparent refugia of native freshwater mussels in the upper Rideau River threatened by increased *Dreissena* 15 years after its introduction. *Tentacle* 14: 31-32.

Frederick Schueler, Bishops Mills Natural History Centre, RR2 Bishops Mills, Ontario K0G 1T0, Canada. bckcdb@istar.ca
André L. Martel, Life Sciences, Malacology, Canadian Museum of Nature, P.O. Box 3443, Station D, Ottawa, Ontario K1P 6P4, Canada. amartel@mus-nature.ca

PACIFIC ISLAND LAND SNAILS

Impacts of alien predators on endemic land snails of the oceanic Ogasawara Islands

By Shinji Sugiura

The Ogasawara (Bonin) Islands are oceanic islands located in the northwestern Pacific Ocean, about 1000 km south of the mainland of Japan. The islands support relatively more endemic land snail species, despite their small total area (ca. 110 km^2), than other island groups. More than 100 species of land snails have been recorded from the islands: 98 endemic, 6 indigenous, 21 introduced and 5 status-unknown (excluding fossil species; Chiba, 2009). Like other oceanic islands, several groups of endemic land snails, such as the genera *Mandarina* and *Hirasea*, have undergone extensive adaptive radiation within the islands (Chiba, 1999). However, at least

24 endemic species have become extinct and many species have been declining since human colonization of the Ogasawara Islands in the 19th Century (Chiba, 2009). Feral goats and human activities have impacted habitats of the endemic snails (i.e. forests). Introduced predators such as the rat *Rattus rattus* Linnaeus and the snail-eating flatworm *Platydemus manokwari* De Beauchamp have recently impacted the endemic snails.

The rat *R. rattus* has invaded almost all the islands of the Ogasawara archipelago (Hashimoto, 2009). On an uninhabited island (Anijima), where many endemic species are well preserved, rat predation has recently impacted populations of the endemic *Mandarina anijimana* Chiba (Chiba, 2007; Fig. 1). *Mandarina* shells broken by rats are also frequently found on other islands, suggesting that the relatively large species such as those in *Mandarina* have been heavily impacted by rat predation.

Fig. 1. *Mandarina anijimana* Chiba preyed upon by rats.

Several species of snail-eating flatworms have impacted various species of endemic land snails (Okochi *et al*., 2004). Among them, the largest species, *Platydemus manokwari* (Fig. 2), has been accidentally introduced to the largest island, Chichijima, where it has caused the extinction and rapid decline of endemic snail species (Sugiura *et al*., 2006; Ohbayashi *et al*., 2007). Land snails are rarely found in areas where *P. manokwari* has invaded. When live land snails were experimentally placed in areas where snails had been absent since its invasion, over 90 % of the snails were eaten by *P. manokwari* over a period of 7-11 days (Sugiura *et al*., 2006; Sugiura & Yamaura, 2009). *Platydemus manokwari*, which usually feeds on ground-dwelling snails, climbs trees to attack arboreal snail species (Sugiura & Yamaura, 2009), and several arboreal snail species, such as *Boninosuccinea punctulispira* (Pilsbry) (Fig. 3), have become extinct on Chichijima as a result (Chiba, 2009). Thus, *P. manokwari* has impacted land snail species of various sizes and in various habitats.

To mitigate the impacts of introduced predators on endemic land snails, the predators should be eradicated or their further expansion prevented. Several research teams have recently tried to mitigate the impacts of introduced predators on the native biota (including land snails). In 2008, a research project funded by the Japanese Environment Ministry successfully

Fig. 2. The snail-eating flatworm *Platydemus manokwari* De Beauchamp.

eradicated the population of *R. rattus* using poison baiting in a small island of the Ogasawara archipelago (Hashimoto, 2009), and the Ministry has been conducting eradication programs on other islands (Hashimoto, 2009). Unlike rats, it is difficult to eradicate flatworms because no method for control or eradication of flatworms has been developed. Therefore, another research project has been trying to prevent further expansion of the distribution of flatworms as a first step. *Platydemus manokwari* can be readily transported in soil attached to various materials such as potted plants, shoes and construction machinery. Therefore, researchers have proposed restriction of transport of soil-containing materials to other islands (Okochi *et al*., 2004) and to quarantine such materials in order to kill flatworms (Sugiura, 2008). Furthermore, captive breeding as an approach to avoiding extinction of endemic species has started for endangered endemic snails such as species of *Mandarina*, *Hirasea* and *Boninosuccinea* (Chiba, 2009), although the problem of captive breeding and reintroduction into original habitats has been discussed already in *Tentacle* (Chiba, 2003).

Fig. 3. *Boninosuccinea punctulispira* (Pilsbry).

Chiba, S. 1999. Accelerated evolution of land snails *Mandarina* in the oceanic Bonin Islands: evidence from mitochondrial DNA sequences. *Evolution* 53: 460-471.

Chiba, S. 2003. Extinction and conservation of the endemic land snails of the Ogasawara Islands. *Tentacle* 11: 13-14. http://www.hawaii.edu/cowielab/Tentacle.htm

Chiba, S. 2007. Morphological and ecological shifts in a land snail caused by the impact of an introduced predator. *Ecological Research* 22: 884-891.
Chiba, S. 2009. Paradise on the edge: current status and conservation of endemic land snail fauna on the Ogasawara Islands. *Global Environmental Research* 14: in press [in Japanese].
Hashimoto, T. 2009. Eradication and ecosystem impact of rats in the Ogasawara Islands. *Global Environmental Research* 14: in press [In Japanese].
Ohbayashi, T., Okochi, I., Sato, H., Ono, T. & Chiba, S. 2007. Rapid decline of endemic snails in the Ogasawara Islands, Western Pacific Ocean. *Applied Entomology and Zoology* 42: 479-485.
Okochi, I., Sato, H. & Ohbayashi, T. 2004. The cause of mollusk decline on the Ogasawara Islands. *Biodiversity and Conservation* 13:1465-1475.
Sugiura, S. 2008. Hot water tolerance of soil animals: utility of hot water immersions for biological invasions of soil animals. *Applied Entomology and Zoology* 43: 207-212.
Sugiura, S. & Yamaura, Y. 2009. Potential impacts of the invasive flatworm *Platydemus manokwari* on arboreal snails. *Biological Invasions* 11: in press. (doi:10.1007/s10530-008-9287-1)
Sugiura, S., Okochi, I. & Tamada, H. 2006. High predation pressure by an introduced flatworm on land snails on the oceanic Ogasawara Islands. *Biotropica* 38: 700-703.

Shinji Sugiura, Forestry and Forest Products Research Institute (FFPRI), 1 Matsunosato, Tsukuba, Ibaraki 305-8687, Japan. ssugiura@ffpri.affrc.go.jp (Current address: Center for Conservation Research and Training, Pacific Biosciences Research Center, University of Hawaii, 3050 Maile Way, Gilmore 408, Honolulu, Hawaii 96822, USA. ssugiura@hawaii.edu)

Conservation status update on Society Island Partulidae

By Diarmaid Ó Foighil

Oceanic islands hold particular interest for both evolutionary and conservation biologists. Native plants and animals evolved in isolation on these islands and their study often provides detailed insights into fundamental evolutionary processes (Wagner & Funk, 1995; Baldwin & Sanderson, 1998). However, they characteristically lack well-developed defense mechanisms and are extremely vulnerable to introduced continental predators (Paulay, 1994; Vermeij, 1999).

The rich endemic partulid tree snail fauna of the Society Islands (French Polynesia) has attracted considerable scientific interest for two very different reasons. For most of the last century, it was primarily viewed as an influential example of an evolutionarily rapid endemic species radiation. Although the predominantly arboreal land snail family Partulidae ranges over 10,000 km of Oceania from Belau and the Marianas in the west to the Marquesas in the east (Cowie, 1992), of the family's nominal species diversity, half (61 species: 4 *Samoana* and 57 *Partula*) is endemic to this one hot spot archipelago and a quarter (33 species) is endemic to a single constituent island, Raiatea (Kondo, 1968). It is unsurprising therefore, that this archipelagic malacofauna has been the subject of classic studies in zoology, population biology and evolutionary ecology for over a century (Garrett, 1884; Crampton, 1916, 1932; Murray & Clarke, 1980; Murray *et al*., 1993; Johnson *et al*., 1993a, b).

Unfortunately, this endemic fauna is now best known as the victim of a misguided biological control experiment: introduction of the predatory snail *Euglandina rosea* in the mid 1970s (Clarke *et al*., 1984; Cowie, 1992, 2001). Until recently, only 6 of the original 61 endemic species of the Society Islands were thought to persist in the wild, 5 on Tahiti (Coote & Loève, 2003). Prescient emergency interventions lead to the successful establishment of international captive populations for 15 Society Island species of *Partula* (Murray *et al*., 1988; Tonge & Bloxham, 1991; Pearce-Kelly *et al*., 1997) that are coordinated by the Partulid Global Species Management Programme (Fig. 1). However, experimental efforts to reestablish captive-reared partulid populations in a protected Moorean field reserve had to be terminated after repeated predator incursions (Coote *et al*., 2004).

Fig. 1. Maintenance of Partulid Global Species Management Programme captive populations. (Photo: courtesy of P. Pearce-Kelly)

For the past three years, a group of researchers at the University of Michigan's Museum of Zoology (UMMZ; Taehwan Lee, John B. Burch and Diarmaid Ó Foighil) have engaged in an international collaboration that is re-assessing the conservation status of Society Island partulids. The initial impetus for this study stemmed from a remarkable collection of freeze-dried museum samples collected by Burch in 1970. He spent three months on Tahiti (Fig. 2), with short trips to other Society Islands, while engaged in a collaborative study of endemic tree snails with partulid specialist Yoshio Kondo (Bishop Museum, Honolulu). Their aim was to produce a comprehensive monograph of the Tahitian taxa, featuring a detailed comparison of anatomical characters. Unfortunately, Kondo died before the substantially completed monograph could be published. While in the Society Islands, Burch airmailed hundreds of specimens alive to the UMMZ, where they were lyophilized and placed in the collection. Although he could not have anticipated the impending mass-extirpation of Society Island partulids, thanks to Burch's collecting efforts we have at hand a comprehensive sampling of Society Island partulids (especially Tahitian) that predates the introduction of *Euglandina*.

It occurred to us that Burch's museum specimens, through their preserved genomes, provided in effect a time portal that could be used to assemble a genetic profile of a largely extirpated malacofauna. This in turn would allow us to place the remnant wild and captive populations into their proper evolutionary context – that of the previously intact fauna – by obtaining DNA profiles of extant wild and captive populations that could be referenced with our historical database. Results could therefore provide a genealogical perspective on lineage survival and might have practical value in helping to prioritize on-going conservation and rehabilitation efforts.

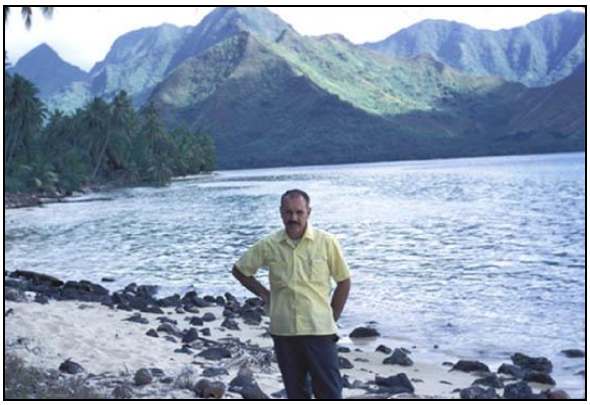


Fig. 2. John B. Burch in Tahiti in 1970. This view shows Tahiti-Nui (background) from the foreshore of Tahiti-Iti. (Photo: courtesy of John B. Burch)

An important step toward achieving this goal was the organization of a symposium entitled "Pacific Island Land Snail Diversity – Origins and Conservation" during the 2005 American Malacological Society/Western Society of Malacologists meeting in Asilomar, California, previously reported in *Tentacle* (Ó Foighil, 2006). This greatly facilitated the establishment of collaborative agreements with colleagues working on captive populations and/or field surveys, including Trevor Coote and Paul Pearce-Kelly (Partulid Global Species Management Programme), Jean-Yves Meyer (Délégation à la Recherche, Papeete), Benôit Fontaine and Olivier Gargominy (Muséum national d'Histoire naturelle, Paris) and Carole Hickman (University of California, Berkeley).

Choice of appropriate molecular markers was complicated by the incongruence of Society Island partulid morphological, mitochondrial (mt) and nuclear datasets (Clarke *et al*., 1996; Goodacre & Wade, 2001a). Available nuclear markers provide relatively poor phylogenetic resolution (Goodacre & Wade, 2001a) and we chose to work primarily with a mt gene because these have provided the best phylogenetic resolution for within- and among-island partulid relationships (Goodacre, 2001, 2002; Goodacre & Wade, 2001b). Our mt assessments of Society Island partulid survival come with an obvious caveat concerning their broader utility; do these results have relevance to understanding whole organism genealogies, and their present day conservation status? Two lines of indirect data indicate that our mt genealogies do have broader biological and conservation significance. First, the taxonomic composition of mt clades are in good agreement with the results of Moorean partulid breeding experiments (Murray & Clarke, 1980). Second, the ability of *Partula* spp. populations to persist on Moorea and in Tahitian valleys in the long-term presence of *Euglandina rosea* appears to be correlated with both taxonomy and mt lineages.

Our primary findings to date are that a larger fraction of endemic phylogenetic diversity has survived in tiny remnant wild populations than was previously suspected (although each island exhibits distinctive patterns of persistence), that a multi-island perspective is required to fully comprehend survival patterns and that one species, which attained its uniquely multi-archipelagic distribution through prehistoric anthropogenic introduction, carries an implicit, though controversial, present day conservation lesson. These issues are briefly discussed in turn below.

Tahiti

Survival of Society Island partulids in the wild is correlated with a number of extrinsic (geographic/ecological) and intrinsic (lineage specific) factors. Wherever the former factors are most important, all lineages originally present in a particular location/habitat should have a heightened likelihood of survival. Correspondingly, wherever the latter factors predominate, snail survival is more likely to be lineage specific. In Tahiti, we see evidence for both extrinsic (montane populations) and intrinsic (valley populations) patterns of survival and, remarkably, all five primary mitochondrial clades present in the historical samples have maintained some representation among surviving populations (Lee *et al.*, 2007a). Tahitian survivors minimally possess one of three attributes: 1) presence in montane forest refuges >1000 m in elevation; 2) off-island captivity; 3) membership of a differentially resistant valley lineage (Fig. 3).

Fig. 3. Surveying remnant *Partula hyalina* Tahitian valley populations with Trevor Coote (on left).

Our molecular data revealed the latent potential conservation value of montane nominal *Partula otaheitana* populations, e.g. they harbour four or five historical Tahitian mt clades now extirpated from valley populations, and captive Mount Marau snails alone collectively encompass almost half of Tahitian *Partula* mt phylogenetic tree space (Lee *et al.*, 2007a). However, it is not clear at present whether they also embody an equivalent fraction of historical nuclear gene diversity. Based on laboratory behavioral studies of the effect of temperature on *Euglandina rosea* movement, Gerlach (1994) hypothesized that an altitudinal refuge above 600-700 m would exist for Society Island partulids. Although living predators have been observed on Tahiti at elevations up to

1420 m (J.-Y. Meyer, pers. comm.), Mount Marau *P. otaheitana* populations above 1000 m elevation have persisted in the presence of *E. rosea* for a decade and may be capable of at least short term persistence in the wild (Lee *et al.*, 2007a). Conservation of the island's remnant tree snail diversity is likely to require proactive maintenance of these threatened montane populations.

Although the predominant pattern on Tahiti is one of valley extirpation and montane persistence, ongoing field surveys have encountered remnant micro-populations of two nominal species, *Partula clara* and/or *P. hyalina*, in a growing number of Tahitian valleys (Coote, 2007), the latest estimate being 33 valleys (T. Coote, pers. comm.). This encouraging result is somewhat surprising because these two taxa collectively represented only 5% of historical Tahitian valley tree snail populations (Crampton, 1916), they lack montane refuge populations, and predation models predict extirpation within three years of initial *Euglandina rosea* contact (Gerlach, 2001). Our phylogenetic data show that *P. clara* and *P. hyalina* genotypes form an exclusive mt clade on Tahiti and share numerous haplotypes, indicating that they represent a single conchologically variable lineage that has differentially survived up to 30 years of *E. rosea* predation pressure in Tahitian valleys.

The near-extirpation of Tahitian partulid populations has resulted in an extensive winnowing of historical Tahitian partulid genetic diversity. Nevertheless, montane populations of *Partula otaheitana* and valley populations of *P. clara*/*hyalina* still persist in the wild and contain representatives of all major historical Tahitian mitochondrial clades. It may still be possible to preserve a representative sub-sampling of Tahiti's tree snail diversity on the island.

Raiatea

Prior to the deliberate introduction of *Euglandina rosea* in 1986, the island of Raiatea supported 34 partulid species, including 33 single island endemics (Kondo, 1968). No living partulids were encountered in a 2000 Partulid Global Species Management Programme survey of the island, leading to the conclusion that only four taxa, all maintained in off-island captivity, remained extant (Coote & Loève, 2003). It was therefore a pleasant surprise that a subsequent (February 2006) botanical and entomological field expedition to Raiatea, led by Jean-Yves Meyer, encountered two relict populations of partulid land snails on Mount Tefatua, the highest (1017 m) peak on the island (Fig. 4).

Voucher specimens were forwarded to the University of Michigan for identification using diagnostic morphological characters as well as molecular phylogenies, the latter including genotypes from a limited number of Raiatean lyophilized museum samples collected by J.B. Burch in 1970, and also from captive Raiatean snails (Lee *et al.*, 2008). One population, present at 750 m elevation, was unambiguously identified as *Samoana attenuata*, one of only two Society Island partulids with a multi-island distribution (Kondo, 1973). Surviving populations of *S. attenuata* persist also on Tahiti and Moorea (Coote, 2007). The second surviving Raiatean partulid population, located just below the summit at 950 m, was more enigmatic. Conchologically, it was distinct from all other described Raiatean partulids, including the now extinct (Cunningham & Daszak, 1998) Raiatean congener *Partula turgida*, with which it shares a thin and partially transparent shell (Fig. 4) more typically found in *Samoana* spp. (Pilsbry, 1909-1910). Nuclear and mitochondrial gene trees unambiguously placed it in the *Partula* clade (Lee *et al.*, 2008) and it has been formally described as *P. meyeri* (Burch, 2007). Discovery of a new species belonging to an ostensibly extirpated fauna may seem surprising, but given the almost inaccessible Mount Tefatua location, it is unlikely that *P. meyeri* was ever observed by previous researchers.

Fig. 4. Summit of Mount Tefatua (left), the highest point on Raiatea, where surviving micro-populations of a new species, *Partula meyeri* (right), were discovered in 2006. (Photos: Jean-Yves Meyer)

It is unclear at present if a stable altitudinal refuge from *E. rosea* predation exits on Mount Tefatua, but the unexpected discovery of these two surviving montane populations raises the possibility of preserving some fraction of Raiatea's endemic tree snail diversity in the wild. The Mount Tefatua summit area is officially deemed to be an area of high ecological interest but, because of its relative inaccessibility, it is not considered to be under immediate anthropogenic threat. Our documentation of these remnant tree snail populations is significant in that they represent the only known extant partulids in the "Leeward Islands/Îles sous le vent" of the Society archipelago. This status alone qualifies the Mount Tefatua survivors for proactive conservation measures, and their continuing vulnerability to *E. rosea* predation may prompt an official upgrading of the conservation status of their isolated montane habitat.

Moorea

Euglandina rosea's devastating effect on Society Island endemic tree snail populations is best documented for the island of Moorea (Clarke *et al*., 1984; Murray *et al*., 1988). Off-island captive populations were quickly established for most of the island's *Partula* species (Murray *et al*., 1988; Tonge & Bloxham, 1991; Pearce-Kelly *et al*., 1997) but by 1987 all Moorean partulid species were thought to be extirpated in the wild (Murray *et al*., 1988). Fortunately, intensive on-going field surveys have recently detected multiple surviving micro-populations of *Samoana attenuata*, *Partula taeniata*, and, most recently, putative *S. diaphana* (Fig. 5). However, Moorea has a much smaller montane (>1000 m) habitat than Tahiti and nowhere on the island does a representative sample of the original *in situ* diversity survive.

We are currently interested in assessing these surviving wild Moorean populations in comparison with captive and Burch 1970 historical material, but a single island phylogenetic

perspective is insufficient because both *Samoana* species also occur on Tahiti (Kondo, 1973) and *Partula taeniata* contains divergent mt lineages that collectively form robust polyphyletic clades with different subsets of Moorean and Tahitian congeners (Murray *et al*., 1991; Goodacre & Wade, 2001b). Moorea and Tahiti are neighboring islands separated by a mere 17 km of ocean and they collectively support all of the partulid populations of the Society Island archipelago's eastern "Windward Islands/Îles du vent" sub-grouping. Thanks to the Burch 1970 collections and to the Partulid Global Species Management Programme captive specimens, we have almost complete nominal species taxonomic representation at hand, including extinct taxa: 17 of the 18 Windward Island partulid taxa (Coote & Loève, 2003) plus the endemic Tahitian *Samoana burchi*. The missing species, *Partula cytherea*, has not been seen since its discovery in the 1920s on a remote Tahitian interior mountain slope (Cooke & Crampton, 1930) and it is now presumed extinct (Coote & Loève, 2003).

Fig. 5. Recently discovered surviving wild partulids on Moorea. Left: *Partula taeniata*; center: *Samoana attenuata*; right: a suspected specimen of *Samoana diaphana*. (Photos: T. Coote, left; C. Hickman, center; Jean-Yves Meyer, right)

To briefly summarize our Moorean molecular results, seven of eight (six *Partula*, two *Samoana*) partulid tip clades remain extant; the extinct mtDNA clade occurred predominantly in the *P. suturalis* species complex. Extant Moorean mtDNA clades exhibited a complex spectrum of persistence on Moorea, in captivity, and (in the form of five phylogenetically distinct sister lineages) on Tahiti. Most notably, three *Partula* taxa, bearing two multi-island mtDNA lineages, have survived decades of *E. rosea* predation on Moorea (*P. taeniata*) and in the valleys of Tahiti (*P. hyalina* and *P. clara*). Their differential persistence was correlated with intrinsic attributes, such as taxonomy and mt lineages, rather than with their respective within-island distribution patterns. Future conservation efforts directed towards Moorean and Tahitian partulids should ideally have a multi-island frame of reference and could benefit from detailed genetic and ecological analyses of the resistant lineages.

The multi-archipelago distribution of *Partula hyalina*

Individual partulids rarely disperse more than a few metres during their lives (Murray & Clarke, 1984) and most species, including 59 of the 61 Society Islands taxa (Pilsbry, 1909-10), are restricted to single islands (Cowie, 1992). *Partula hyalina*, a distinctive white-shelled species (Fig. 6), is the only partulid with a multi-archipelago distribution (Garrett, 1880; Pilsbry, 1909-10; Crampton, 1916). It occurs on seven islands distributed among three neighboring south-central Pacific island groups: Society Islands (Tahiti only), Austral Islands (Rurutu, Tubuai, Raivavae and Rimatara) and southern Cook Islands (Mangaia and Mauke).

Fig. 6. Austral Island *Partula hyalina*. The living specimen (left) is from Raivavae; the shell *lei* (right), bearing a large number of dead shells (larger white specimens), was produced for sale on Rurutu in 2002. (Photos: Olivier Gargominy)

Partula hyalina's multi-archipelago distribution generated considerable interest and speculation among early Pacific island malacologists and was variously attributed to convergent evolution (Garrett, 1880), a now untenable (Duncan & McDougall, 1976) sunken continent hypothesis (Garrett, 1880; Pilsbry, 1909-10; Crampton, 1916, 1932) and prehistoric human transfer (Pilsbry 1909-10; Crampton, 1916) from "its headquarters" in the Australs to the other three islands (Crampton, 1932). In a recent publication (Lee *et al.*, 2007b) we aimed to provide a genealogical perspective on *Partula hyalina*'s multi-archipelago distribution in order to gain new insights into the genesis of its most unusual biogeography. This required genotyping a comprehensive sampling of *P. hyalina* and *P. clara* genetic diversity in Tahiti (using extant wild, captive and museum samples) as well as samples of *P. hyalina* from all six island populations in the Cooks and Australs.

Our genetic data unambiguously established Tahiti as the source island. Of the 23 Cook and Austral Island *P. hyalina* genotyped, 19, collectively distributed among all 6 founder island populations, exhibited genotypic identity with one of three Tahitian *P. hyalina/clara* haplotypes. These data, in conjunction with archaeological evidence for a prehistoric multi-archipelago distribution (Kirch *et al*., 1995; Orliac, 1997), provide a compelling case for the introduction of this snail from Tahiti to the Australs and Cooks by prehistoric Polynesians. The source lineage is polymorphic in shell coloration and contains a second nominal species, the dark-shelled *P. clara*, in addition to the white-shelled *P. hyalina*. Most intriguingly, prehistoric inter-island introductions were non-random: they involved white-shelled snails only and they were exclusively inter-archipelago. Partulid shells were commonly used in regional Polynesian jewelry and we proposed that the white-shelled *P. hyalina*, originally restricted to Tahiti, had aesthetic value throughout these archipelagoes. Demand within the Society Islands could be best met by trading dead shells, but a low rate of inter-archipelago exchange may have prompted the establishment of multiple founder populations in the Australs and southern Cooks.

Inter-archipelago exchange networks were an important aspect of prehistoric Polynesian societies (Irwin, 1992). Our *Partula hyalina* results provide qualitatively new material evidence of directional interaction that complements and reinforces earlier material reconstructions of Cooks/Societies/Australs regional interaction spheres inferred from geochemically-sourced stone tools (Weisler 1998; Collerson & Weisler, 2007).

Conservation implications of new results

Until recently, the outlook for Society Island Partulidae was far from encouraging (Coote & Loève, 2003). There seemed little prospect for survival in the wild and experimental reintroduction efforts using snails raised in captivity met with, at best, limited success (Coote *et al*., 2004). Our novel results qualify that bleak conservation outlook to a limited degree by identifying a number of extant wild populations that offer some possibility of at least medium-term persistence in the presence of the *Euglandina rosea*.

It is unclear at the moment what wider conservation significance these surviving micro-populations hold. Nevertheless, the persistence of genetically diverse *Partula otaheitana* in montane Tahitian refuges in one instance, and the differential survival of genealogically-linked P. *hyalina* and *P. clara* (Tahitian valleys) and *P. taeniata* (Moorea) in another, apparently reflect the influence of qualitatively distinct ecological/genetic variables on predator performance. Understanding what these genetic and ecological factors are will require detailed follow-up studies, but these may well provide important clues toward developing a viable long-term conservation plan for Society Island partulid tree snails.

One of the outstanding questions in partulid conservation concerns the ultimate fate of the captive populations. The goal is reintroduction of course, but initial attempts imply that indefinite high maintenance (and expensive) predator-proof enclosures will be required (Coote *et al*., 2004) – a distinctly unattractive proposition. Identifying conditions in which successful reintroductions might be attained with a lowered investment in protective measures could significantly increase the viability and scale of future reintroductions. Our initial results suggest two such possible scenarios: reintroducing captive *Partula otaheitana* to montane Tahitian habitats; reintroducing captive *P. hyalina* and *P. clara* to Tahitian valleys and, perhaps, *P. taeniata* to Moorea.

The logic of reintroducing captive populations to an environment still containing the extinction agent is of course open to question in terms of effectiveness. A potentially more viable, though clearly much more controversial, reintroduction strategy is suggested by the unique history of *Partula hyalina*. Southern Cook and Austral Island anthropogenic founder populations of *P. hyalina* (Lee *et al.*, 2007b) now represent the only unscathed wild populations remaining of the once spectacular Society Island partulid radiation, a default benefit of their uniquely multi-archipelago range. Introducing carefully selected subsets of captive Society Island partulids to Austral Islands that are free of the predator might be the most viable method of ensuring their long-term survival in the wild. For instance, the extirpated Tahitian endemic *P. nodosa* is genetically distinct from its fellow Tahitian native *P. hyalina* (Lee *et al.*, 2007b), the only congener present on the Australs, and the pros and cons of transplanting captive *P. nodosa* to the Australs deserve dispassionate and thorough consideration. It may be germane to recall the evolutionary history of partulids as Pacific high-island endemics. Hot-spot archipelago high-islands typically have an effective geological lifespan of 4-6 million years (Menard, 1986; Craig, 2003) and their endemic biotas *must* island-hop to survive. With the introduction of *Euglandina rosea* to the Society Islands, the survival time window for successful island-hopping has unfortunately been shortened to decades at most for many endemic partulids.

Baldwin, B.G. & Sanderson, M.J. 1998. Age and rate of diversification of the Hawaiian silversword alliance. *Proceedings of the National Academy of Sciences of the United States of America* 95: 9402-9406.

Burch, J.B. 2007. A new species of land snail (Stylommatophora: Partulidae) from Raiatea, French Polynesia, Oceania. *Occasional Papers of the University of Michigan Museum of Zoology* 740: 1-8.

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

Clarke, B., Johnson, M.S. & Murray, J. 1996. Clines in the genetic distance between two species of island land snails: how "molecular leakage" can mislead us about speciation. *Philosophical Transactions of the Royal Society B* 351: 773-784.

Collerson, K.D. & Weisler, M.I. 2007. Stone adze compositions and the extent of ancient Polynesian voyaging and trade. *Science* 317: 1907-1911.

Cooke, C.M., Jr. & Crampton, H.E. 1930. New species of *Partula*. *Bernice P. Bishop Museum Occasional Papers* 9(11): 1-9.

Coote, T. 2007. Partulids on Tahiti: differential persistence of a minority of endemic taxa among relict populations. *American Malacological Bulletin* 22: 83-87.

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

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

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

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

Craig, D.A. 2003. Geomorphology, development of running water habitats, and evolution of black flies on Polynesian islands. *BioScience* 53: 1079-1093.

Crampton, H.E. 1916. Studies on the variation, distribution and evolution of the genus *Partula*. The species inhabiting Tahiti. *Carnegie Institute of Washington Publication* 228: 1-311.

Crampton, H.E. 1932. Studies on the variation, distribution and evolution of the genus *Partula*. The species inhabiting Moorea. *Carnegie Institute of Washington Publication* 410: 1-335.

Cunningham, A.A. & Daszak, P. 1998. Extinction of a species of land snail due to infection with a microsporidian parasite. *Conservation Biology* 12: 1139-1141.

Duncan, R.A. & McDougall, I. 1976. Linear volcanism in French Polynesia. *Journal of Volcanology and Geothermal Research* 1: 197-227.

Garrett, A. 1880. List of land shells inhabiting Rurutu, one of the Austral Islands, with remarks on their synonymy, geographical range, and descriptions of new species. *Proceedings of the Academy of Natural Sciences of Philadelphia* 31: 17-30.

Garrett, A. 1884. The terrestrial Mollusca inhabiting the Society Islands. *Journal of the Academy of Natural Sciences of Philadelphia* (Series 2) 9: 17-114.

Gerlach, J. 1994. *The ecology of the carnivorous snail* Euglandina rosea. D. Phil. thesis, Oxford University.

Gerlach, J. 2001. Predator, prey and pathogen interactions in introduced snail populations. *Animal Conservation* 4: 203-209.

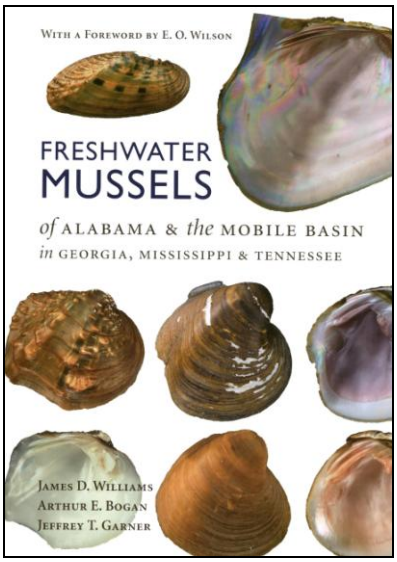
Goodacre, S.L. 2001. Genetic variation in a Pacific island land snail: population history versus current drift and selection. *Proceedings of the Royal Society of London B* 268: 121-126.
Goodacre, S.L. 2002. Population structure, history and gene flow in a group of closely related land snails: genetic variation in *Partula* from the Society Islands of the Pacific. *Molecular Ecology* 11: 55-68.
Goodacre, S.L. & Wade, C.M. 2001a. Molecular evolutionary relationships between partulid land snails of the Pacific. *Proceedings of the Royal Society of London B* 268: 1-7.
Goodacre, S.L. & Wade, C.M. 2001b. Patterns of genetic variation in Pacific island land snails: the distribution of cytochrome b lineages among Society Island *Partula*. *Biological Journal of the Linnean Society* 73: 131-138.
Irwin, G. 1992. *The Prehistoric Exploration and Colonisation of the Pacific.* Cambridge University Press, Cambridge.
Johnson, M.S., Murray, J. & Clarke, B. 1993a. The ecological genetics and adaptive radiation of *Partula* on Moorea. *Oxford Surveys in Evolutionary Biology* 9: 167-236.
Johnson, M.S., Murray, J. & Clarke, B. 1993b. Evolutionary relationships and extreme genital variation in a closely related group of *Partula*. *Malacologia* 35: 43-61.
Kirch, P.V., Steadman, D.W., Butler, V.L., Hather, J. & Weisler, M.I. 1995. Prehistory and human ecology in eastern Polynesia: excavations at Tangatatau rockshelter, Mangaia, Cook Islands. *Archaeology in Oceania* 30: 47-65.
Kondo, Y. 1968. Partulidae: preview of anatomical revision. *Nautilus* 81: 73-77.
Kondo, Y. 1973. *Samoana* of the Society Islands (Pulmonata: Partulidae). *Malacological Review* 6: 19-33.
Lee, T., Burch, J.B., Jung, Y., Coote, T., Pearce-Kelly, P. & Ó Foighil, D. 2007a. Tahitian tree snail mitochondrial clades survived recent mass-extirpation. *Current Biology* 17: R502-R503.
Lee, T., Burch, J.B., Coote, T., Fontaine, B., Gargominy, O., Pearce-Kelly, P. & Ó Foighil, D. 2007b. Prehistoric inter-archipelago trading of Polynesian tree snails leaves a conservation legacy. *Proceedings of the Royal Society of London B* 272: 2907-2914.
Lee, T., Meyer, J.-Y., Burch, J.B., Pearce-Kelly, P. & Ó Foighil, D. 2008. Not completely gone: two partulid tree snail species persist on the highest peak of Raiatea, French Polynesia. *Oryx* 42: 615-619.
Menard, H.W. 1986. *Islands*. Scientific American Library, New York.
Murray, J. & Clarke, B. 1980. The genus *Partula* on Moorea: speciation in progress. *Proceedings of the Royal Society of London B* 211:83-117.
Murray, J. & Clarke, B. 1984. Movement and gene flow in *Partula taeniata*. *Malacologia* 25: 343-348.
Murray, J., Murray, E., Johnson, M.S. & Clarke, B. 1988. The extinction of *Partula* on Moorea. *Pacific Science* 42: 150-153.
Murray, J., Stine, O.C. & Johnson, M.S. 1991. The evolution of mitochondrial DNA in *Partula*. *Heredity* 66: 93-104.
Murray, J., Clarke, B. & Johnson, M.S. 1993. Adaptive radiation and community structure of *Partula* on Moorea. *Proceedings of the Royal Society of London B* 252: 205-211.
Ó Foighil, D. 2006. Report on the joint American Malacological Society and Western Society of Malacologists 2005 symposium: Pacific island land snail diversity – origins and conservation. *Tentacle* 14: 24-25.
Orliac, M. 1997. Human occupation and environmental modifications in the Papenoʻo Valley, Tahiti. In: *Historical Ecology in the Pacific Islands* (eds. Kirch, P.V. & Hunt, T.L.), p. 200-229. Yale University Press, New Haven.
Paulay, G. 1994. Biodiversity on oceanic islands: its origin and extinction. *American Zoologist* 34: 134-144.
Pearce-Kelly, P., Clarke, D., Walker, C. & Atkin, P. 1997. A conservation programme for the partulid tree snails of the Pacific Region. *Memoirs of Museum Victoria* 56: 431-433.
Pilsbry, H.A. 1909-1910. *Manual of Conchology, Structural and Systematic. With Illustrations of the Species. Second series: Pulmonata.* Vol. XX. *Caecilioides, Glessula* and Partulidae. Index to Vols. XVI-XX. Academy of Natural Sciences, Philadelphia. viii + 336 p., 43 pls.
Tonge, S. & Bloxham, Q. 1991. A review of the captive-breeding programme for Polynesian tree snails *Partula* spp. *International Zoo Yearbook* 30: 51-59.
Vermeij, G.J. 1999. Inequality and the directionality of history. *American Naturalist* 153: 243-253.
Wagner, W.L. & Funk, V.A. 1995. *Hawaiian Biogeography: Evolution on a Hot Spot Archipelago*. Smithsonian Institution Press, Washington, DC.
Weisler, M.I. 1998. Hard evidence for prehistoric interaction in Polynesia. *Current Anthropology* 39: 521-532.

Diarmaid Ó Foighil, Museum of Zoology and Department of Ecology and Evolutionary Biology, University of Michigan, 1109 Geddes Avenue, Ann Arbor, Michigan 48109-1079, USA.
diarmaid@umich.edu

RECENT PUBLICATIONS RELEVANT TO MOLLUSC CONSERVATION

Freshwater mussels of Alabama and the Mobile Basin in Georgia, Mississippi and Tennessee

By James D. Williams, Arthur E. Bogan & Jeffrey T. Garner
University of Alabama Press, Tuscaloosa. 2008. xv + 908 p.
ISBN 0-8173-1613-2. US$70.00. Cloth.



The following is taken directly from the University of Alabama Press website, where the book can be ordered: http://www.uapress.ua.edu/

A comprehensive accounting of the richest mussel fauna in the United States

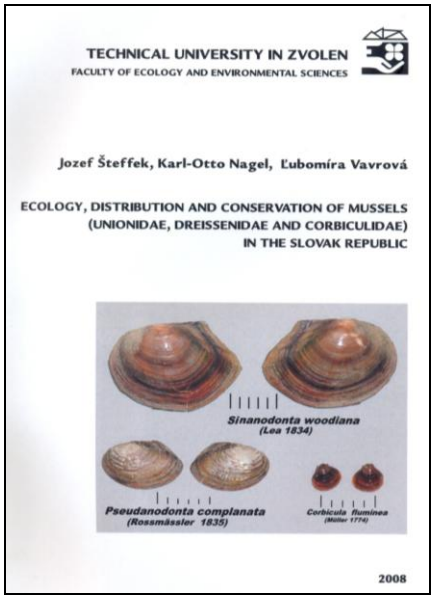
Alabama rivers and waterways are home to the largest and most diverse population of freshwater mussel species in the

nation, roughly 60 % of the United States mussel fauna. The Mobile River Basin, which drains portions of Tennessee, Georgia and Mississippi waterways, also contains diverse mussel populations. However, many of these species have been significantly depleted in the last century due to habitat alteration (river damming, channelization, siltation), pollution and invasive species, and many more are in imminent danger of extinction.

The authors offer encyclopedic entries on each of the 178 mussel species currently identified in Alabama and the Mobile River Basin: the scientific and common names; a morphological description as well as color photographs of the shell appearance; analysis of the soft anatomy; information about ecology, biology and conservation status; and a color distribution map. With an extensive glossary of terms and full index, plus additional material on the archaeological record, a history of commercial uses of mussels, and the work of significant biologists studying these species, this volume is a long overdue and invaluable resource, not only for scholars of aquatic biology and zoology but also conservationists interested in the preservation of ecological diversity and protection of inland environments.

Ecology, distribution and conservation of mussels (Unionidae, Dreissenidae and Corbiculidae) in the Slovak Republic

By Jozef Šteffek , Karl-Otto Nagel & Ľubomíra Vavrová



Large freshwater mussels of the Slovak Republic are represented by seven species of Unionidae (*Unio crassus*, *U. pictorum*, *U. tumidus*, *Anodonta anatina*, *A. cygnea*, *Pseudanodonta complanata*, *Sinanodonta woodiana*); by one species of Corbiculidae (*Corbicula fluminea*) and by one species of Dreissenidae (*Dreissena polymorpha*). This monograph brings together recent knowledge on ecology, distribution and conservation of the species in Slovakia. It is divided into several chapters, starting with an overview of the history of research on large freshwater mussels in Slovakia. Before 1982 little attention was paid to the mussels of Slovakia and only 46 papers were published. The only one to date with comprehensive distribution data for the freshwater mussels of Slovakia is by Brabenec (1952). From 1983 to 2005 the number of papers and articles increased significantly. One of the reasons was the need to update information on the distributions of mollusc species listed in the Annexes of the EU Habitats Directive (92/43/EEC 1992), in which large freshwater mussels are represented by *U. crassus*. This overview chapter is followed by a detailed description of the biology and life cycle of species in each of the families, including a list of host fish species. A key allows identification to the subspecies level and includes drawings of the species focussing on features specific to each of them. Lists of localities with records of the occurrence of the species includes both published and unpublished data, with fossil and recent records listed separately. The data are also presented in distribution maps for each species that show the species' distribution per square according to the Databank of Fauna of Slovakia. Differentiation of the distribution before 1982 and after 1983 indicates increasing numbers of records obtained after 1983. As explained above, this was a result of the growing interest of malacologists in the species' distributions in Slovakia, as well as intensive research of river ecosystems undertaken by experts from Slovakia, Germany and the Czech Republic between 2000 and 2005. Information on the species' habitat preferences and their potential as bio-indicators of water quality is given in the second part of the monograph. Recently, the large freshwater mussel populations are being negatively impacted by the changing characteristics of water ecosystems (e.g. water quality, sedimentation, flow speed, etc.). The major threats, as well as conservation and management measures, are discussed in the chapter on threats and protection. Also, the status of the species according to national and international legislation as well as to the categories and criteria of IUCN is given.

Last but not least, pictures of the large freshwater mussels are also provided. The list of references (more than 180) provides access to most of the important papers and studies of freshwater mussels in Slovakia and the former Czechoslovakia.

The monograph was published in Slovak in 2006. On behalf of the authors I am pleased to inform you that it is now also available in English. This would not have been possible without the help of our colleagues Sue Wells and Vicky Myers, to whom we express our thanks.

Since only a limited number of hard copies is available I hope soon to also make it downloadable from a web page. For more information about the monograph please contact Lubomira Vavrová.

Brabenec, J. 1952. Vodní měkkýši Československa a jejich systematické zařazení. [Aquatic molluscs of Czechoslovakia and their taxonomy]. *Prírodovědecký sborník Ostravského kraje*, Opava 13: 135-165.

Lubomira Vavrová, Mollusc Specialist Group Member, 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

MalaCo – an online journal

Most of the articles in this relatively new journal are related to mollusc conservation. In the most recent issue, Mollusc Specialist Group member Philippe Bouchet, in the editorial, reflects on his perception of the resurgence of *species* as a focus of conservation at the recent World Conservation Congress in Barcelona.

Journal home: http://www.journal-malaco.fr
Latest issue: http://www.journal-malaco.fr/page-31.html

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

Freshwater Mollusk Conservation Society 2007 symposium

Papers from the 2007 symposium of the Freshwater Mollusk Conservation Society, with the theme "Directions in Freshwater Mollusk Conservation: Molecules to Ecosystems", appeared in the *Journal of the North American Benthological Society*, volume 27, issue 2, June 2008, as follows:

Christian, A.D. & Harris, J.L. An introduction to directions in freshwater mollusk conservation: molecules to ecosystems. 345-348.

Bogan, A.E. & Roe, K.J. Freshwater bivalve (Unioniformes) diversity, systematics, and evolution: status and future directions. 349-369.

Barnhart, M.C., Haag, W.R. & Roston, W.N. Adaptations to host infection and larval parasitism in Unionoida. 370-394.

Berg, D.J., Levine, T.D., Stoeckel, J.A. & Lang, B.K. A conceptual model linking demography and population genetics of freshwater mussels. 395-408.

Vaughn, C.C., Nichols, S.J. & Spooner, D.E. Community and foodweb ecology of freshwater mussels. 409-423.

Newton, T.J., Woolnough, D.A. & Strayer, D.L. Using landscape ecology to understand and manage freshwater mussel populations. 424-439.

Christian, A.D., Crump, B.G. & Berg, D.J. Nutrient release and ecological stoichiometry of freshwater mussels (Mollusca: Unionidae) in 2 small, regionally distinct streams. 440-450.

Cope, W.G., Bringolf, R.B., Buchwalter, D.B., Newton, T.J., Ingersoll, C.G., Wang, N., Augspurger, T., Dwyer, F.J., Barnhart, M.C., Neves, R.J. & Hammer, E. Differential exposure, duration, and sensitivity of unionoidean bivalve life stages to environmental contaminants. 451-462.

Lysne, S.J., Perez, K.E., Brown, K.M., Minton, R.L. & Sides, J.D. A review of freshwater gastropod conservation: challenges and opportunities. 463-470.

Perez, K.E. & Minton, R.L. Practical applications for systematics and taxonomy in North American freshwater gastropod conservation. 471-483.

Brown, K.M., Lang, B. & Perez, K.E. The conservation ecology of North American pleurocerid and hydrobiid gastropods. 484-495.

Other publications of interest

Araujo, R., Toledo, C., Van Damme, D., Ghamizi, M. & Machordom, A. 2009. *Margaritifera marocana* (Pallary, 1918): a valid species inhabiting Moroccan rivers. *Journal of Molluscan Studies*. Advance access published online 21 January 2009 DOI: 10.1093/mollus/eyn043.

Baur, B., Cremene, C., Groza, G., Schileyko, A.A., Baur, A. & Erhardt, A. 2007 Intensified grazing affects endemic plant and gastropod diversity in alpine grasslands of the Southern Carpathian mountains (Romania). *Biologia* 62: 438-445 .

Boeckman, C.J. & Bidwell, J.R. 2008. Status of freshwater mussels (Unionidae) in the Oklahoma section of the Verdigris River after introduction of the zebra mussel (*Dreissena polymorpha* Pallas, 1771). *American Malacological Bulletin* 25: 1-8.

Brescia, F.M., Pöllabauer, C.M., Potter, M.A. & Robertson, A.W. 2008. A review of the ecology and conservation of *Placostylus* (Mollusca: Gastropoda: Bulimulidae) in New Caledonia. *Molluscan Research* 28(2): 111-122.

Burch, J.B. 2007. A new species of land snail (Stylommatophora: Partulidae) from Raiatea, French Polynesia, Oceania. *Occasional Papers of the University of Michigan Museum of Zoology* 740: 1-8.

Carranza, A., Defeo, O. & Beck, M. 2008 [on line]. Diversity, conservation status and threats to native oysters (Ostreidae) around the Atlantic and Caribbean coasts of South America. *Aquatic Conservation* DOI: 10.1002/aqc.993
http://www3.interscience.wiley.com/journal/121471689/abstract

Clark, W.R., Henry, C.A. & Dettman, C.L. 2008. Demographic processes influencing population viability of the Iowa Pleistocene snail (*Discus macclintocki*). *American Midland Naturalist* 160: 129-139.

Čejka, T., Horsák, M. & Némethová, D. 2008. The composition and richness of Danubian floodplain forest land snail faunas in relation to forest type and flood frequency. *Journal of Molluscan Studies* 74(1): 37-45.

Chapman, E.J. & Smith, T.A. 2008. Structural community changes in freshwater mussel populations of Little Mahoning Creek, Pennsylvania. *American Malacological Bulletin* 26: 161-169.

Chiba, S. & Davison, A. 2008. Anatomical and molecular studies reveal several cryptic species of the endemic genus *Mandarina* (Pulmonata: Helicoidea) in the Ogasawara Islands. *Journal of Mollluscan Studies* 74: 373-382.

Chiba, S., Sasaki, T., Suzuki, H. & Horikoshi, K. 2008. Subfossil land snail fauna (Mollusca) of central Chichijima, Ogasawara Islands, with description of a new species. *Pacific Science* 62(1): 137-145.

Clements, R., Ng, P.K.L., Lub, X.X., Ambuc, S., Schilthuizen, M. & Bradshaw, C.J.A. 2008. Using biogeographical patterns of endemic land snails to improve conservation planning for limestone karsts. *Biological Conservation* 141: 2751-2764.

Conner, S.L., Pomory, C.M. & Darby, P.C. 2008. Density effects of native and exotic snails on growth in juvenile apple snails

Pomacea paludosa (Gastropoda: Ampullariidae): a laboratory experiment. *Journal of Molluscan Studies* 74: 355-362.
Cosgrove, P., Hastie, L. & Sime, I. 2007. Recorded natural predation of freshwater pearl mussels *Margaritifera margaritifera* (L.) in Scotland. *Journal of Conchology* 39(4): 469-472.
Cowie, R.H., Hayes, K.A., Tran, C.T. & Meyer, W.M., III. 2008. The horticultural industry as a vector of alien snails and slugs: widespread invasions in Hawaii. *International Journal of Pest Management* 54: 267-276.
Doi, H., Matsumasa, M., Fujikawa, M., Kanou, K., Suzuki, T. & Kikuchi, E. 2008 [on line]. Macroalgae and seagrass contribution to gastropods in sub-tropical and temperate tidal flats. *Journal of the Marine Biological Association of the United Kingdom* DOI 10.1017/S0025315408002683
Dourson, D.C. 2008. The feeding behavior and diet of an endemic West Virginia land snail, *Triodopsis platysayoides*. *American Malacological Bulletin* 26: 153-159.
Geist, J., Wunderlich, H. & Kuehn, R. 2008. Use of mollusc shells for DNA-based molecular analyses. *Journal of Molluscan Studies* 74(4): 337-343.
Gerlach, J. 2007. Short-term climate change and the extinction of *Rachistia aldabrae* (Gastropoda: Pulmonata). *Biology Letters* 3: 581-584.
Götmark, F., von Proschwitz, T. & Franc, N. 2008. Are small sedentary species affected by habitat fragmentation? Local vs. landscape factors predicting species richness and composition of land molluscs in Swedish conservation forests. *Journal of Biogeography* 35(6): 1062-1076.
Hayes, D.M., Minton, R.L. & Perez, K.E. 2007. *Elimia comalensis* (Gastropoda: Pleuroceridae) from the Edwards Plateau, Texas: multiple unrecognized endemics or native exotic? *American Midland Naturalist* 158: 97-112.
Horsák, M. & Cernohorsky, N. 2008. Mollusc diversity patterns in Central European fens: hotspots and conservation priorities. *Journal of Biogeography* 35(7): 1215-1225.
Keller, R.P., Drake, J.M. & Lodge, D.M. 2007. Fecundity as a basis for risk assessment of nonindigenous freshwater molluscs. *Conservation Biology* 21: 191-200.
Lee, T., Burch, J.B., Jung, Y., Coote, T., Pearce-Kelly, P. & Ó Foighil, D. 2007. Tahitian tree snail mitochondrial clades survived recent mass extirpation. *Current Biology* 17(13): R502-R503.
Lee, Y., Burch, J.B., Coote, T., Fontaine, B., Gargominy, O., Pearce-Kelly, P. & Ó Foighil, D. 2007. Prehistoric inter-archipelago trading of Polynesian tree snails leaves a conservation legacy. *Proceedings of the Royal Society B* 274: 2907-2914.
Lee, T., Meyer, J.-Y., Burch, J.B., Pearce-Kelly, P. & Ó Foighil, D. 2008. Not completely lost: two partulid tree snail species persist on the highest peak of Raiatea, French Polynesia. *Oryx* 42: 615-619.
Majoros, G., Fehér, Z., Deli, T. & Földvári, G. 2008. Establishment of *Biomphalaria tenagophila* snails in Europe. *Emerging Infectious Diseases* 14: 1812-1813.
Meyer, W.M., III, Hayes, K.A. & Meyer, A.L. 2008. Giant African snail, *Achatina fulica*, as a snail predator. *American Malacological Bulletin* 24: 117-119.
Minton, R.L., White, J.D., Hayes, D.M., Chenoweth, M.S. & Hill, A.M. 2008. Diversity and distribution of freshwater gastropods in the Bayou Bartholomew drainage, Arkansas, U.S.A. *American Malacological Bulletin* 26: 171-177.
Ohbayashi, T., Okochi, I., Sato, H., Ono, T. & Chiba, S. 2007. Rapid decline of endemic snails in the Ogasawara Islands, western Pacific Ocean. *Applied Entomology and Zoology* 42: 479-485.
Pearce, T.A. 2008. When a snail dies in the forest, how long will the shell persist? Effect of dissolution and micro-bioerosion. *American Malacological Bulletin* 26: 111-117.
Pyron, M., Beugly, J., Martin, E. & Spielman, M. 2008. Conservation of the freshwater gastropods of Indiana: historic and current distributions. *American Malacological Bulletin* 26: 137-151.
Raheem, D.C., Naggs, F., Preece, R.C., Mapatuna, Y., Kariyawasam, L. & Eggleton, P. 2008. Structure and conservation of Sri Lankan land-snail assemblages in fragmented lowland rainforest and village home gardens. *Journal of Applied Ecology* 45: 1019-1028.
Riley, L.A., Dybdahl, M.F. & Hall, R.O., Jr. 2008. Invasive species impact: asymmetric interactions between invasive and endemic freshwater snails. *Journal of the North American Benthological Society* 27(3): 509-520.
Stanisic, J. 2008. *Recovery Plan for the boggomoss snail* Adclarkia dawsonensis. Report to Department of the Environment, Water, Heritage and the Arts, Canberra. Environment Protection Agency, Brisbane. 22 p.
Sugiura, S. 2008. Hot water tolerance of soil animals: utility of hot water immersion for preventing invasions of soil animals. *Applied Entomology and Zoology* 43(2): 207-212.
Sugiura, S. & Yamaura, Y. 2008 [on line]. Potential impacts of the invasive flatworm *Platydemus manokwari* on arboreal snails. *Biological Invasions* DOI 10.1007/s10530-008-9287-1
Sugiura, S., Okochi, I. & Tamada, H. 2006. High predation pressure by an introduced flatworm on land snails on the oceanic Ogasawara Islands. *Biotropica* 38(5): 700-703.
Trewick, S.A., Walker, K.J. & Jordan, C.J. 2008 Taxonomic and conservation status of a newly discovered landsnail from Mount Augustus, New Zealand. *Conservation Genetics*. 9: 1563-1575.
Walker, K.J., Trewick, S.A. & Barker, G.M. 2008. *Powelliphanta augusta*, a new species of land snail, with a description of its former habitat, Stockton coal plateau, New Zealand. *Journal of the Royal Society of New Zealand* 38(30): 163-186.
Weaver, K.F., Perez-Losada, M., Guralnick, R.P., Nelson, A., Blatt, S. & Crandall, K.A. 2008. Assessing the conservation status of the land snail *Oreohelix peripherica wasatchensis* (family Oreohelicidae). *Conservation Genetics* 9: 907-916.
Wilmer, J.W., Elkin, C., Wilcox, C., Murray, L., Niejalkes, D. & Possingham, H. 2008. The influence of multiple dispersal mechanisms and landscape structure on population clustering and connectivity in fragmented artesian spring snail populations. *Molecular Ecology* 17: 3733-3751.

IUCN AND MOLLUSC SPECIALIST GROUP NEWS

http://www.iucn.org/

Red List news

From Mary B. Seddon

The United Nations General Assembly has now adopted a series of indicators to monitor the Millenium Development goal on the state of biodiversity; one of these is the Red List Index (Butchart *et al.*, 2007). At the Birdlife International Congress and the World Conservation Congress there were two reports on the Red List Index for 2008. The Red List

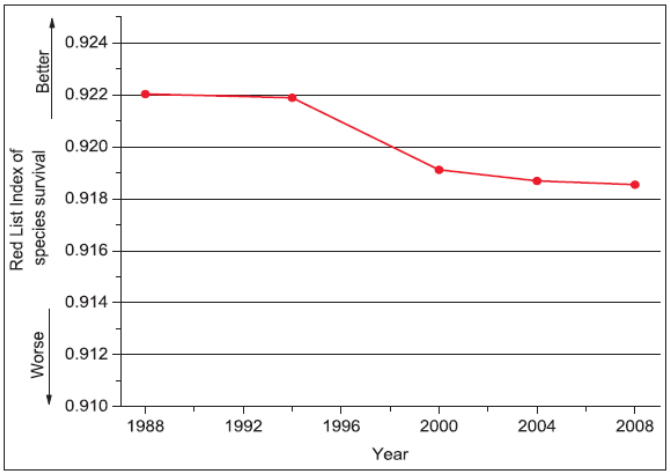


Fig. 1 The Red List Index (RLI) of species survival for bird species (n = 9798 non-Data Deficient species) shows that the world's birds are becoming more threatened. An RLI value of one equates to all species being categorized as Least Concern, and hence that none is expected to go Extinct in the near future. An RLI value of zero indicates that all species have gone Extinct. (Source: Birdlife International)

Index for birds (Fig. 1) shows a steady and continuing deterioration in the status of the world's birds between 1988 and 2008. The index is based on species moving between Red List categories and reflects the average Red List status of birds. Since 1988, 225 bird species have become more threatened, compared to just 32 species that have become less threatened.

The Red List Index uses the 'real' changes in Red List status over time for species of comprehensively assessed groups (e.g. birds, mammals, amphibians). Thus, not included are changes in status that are the result of revised evidence (range/ population) and those that result from taxonomic changes. At present the Red List Index provides a limited index of the state of degeneration of biodiversity, as only comprehensively assessed groups can be included. The taxonomic coverage of the Red List Indices will be improved in the coming years, largely through the Sampled Red List Index (SRLI). This is being developed based on a sample of species from selected taxonomic groups to provide trends in extinction risk that are more representative of global biodiversity. The information will be critical for guiding decision makers as to what conservation action is necessary. One of the Mollusc Specialist Group (MSG) goals is to identify species at risk of extinction. In the past we have submitted individual assessments to the Global Red List for these species. However, as this is not a random sample, it means that molluscs cannot be incorporated into the Red List Index. To get comprehensive assessments of the conservation status for all molluscs is clearly a mammoth task, so we have focussed on the freshwater species, as a smaller group, for which the threats are known to be high. Funding from the IUCN Freshwater Biodiversity Assessment has allowed the process to begin, with comprehensive assessments of species categorised as Least Concern, Data Deficient, Near Threatened and Threatened in some regions. Also, the Sample Red List Index project based at the Zoological Society of London is coordinating species assessments for 1500 species from each of various taxonomic groups, including freshwater molluscs. These projects are making progress towards the inclusion of lesser known groups in the Red List Index. Also, fundraising for comprehensive assessment of selected marine mollusc groups is under way, as a collaboration between the Global Marine Species Assessment, Traffic and the Mollusc Specialist Group. Abalones are the first group for which we are fundraising and future groups proposed include the giant clams, cones, cowries and volutes.

At the World Malacological Congress in 2007, we announced that the MSG was collaborating with IUCN offices to fundraise for two major projects, a Global Freshwater Mollusc Assessment and the European Red List project, as well as other minor projects. In the last 18 months IUCN staff in the Freshwater Biodiversity Assessment Unit in Cambridge have concentrated their fundraising efforts for support staff and workshop costs to enable comprehensive assessments for lesser known groups at regional or global levels. We already have funding for the African project, which includes both species assessments and some river basin case studies. The progress on these two projects is reported below in this issue of *Tentacle*.

The aim of the Red List still remains to identify and document the species most in need of conservation attention, so that others can take action. Species that are recognised as threatened on the Red List should not automatically be protected by legislation as this may not be the most appropriate conservation action. This issue was raised by scientists in Africa during the Red List evaluations for the Congo Basin system, leading to the SSC Freshwater Fish Specialist Group (through the World Association of Zoos and Aquarium – WAZA) submitting a motion to the general assembly of IUCN at the World Conservation Congress in Barcelona in October 2008. The motion was accepted and requests that IUCN produce guidelines on scientific collecting of threatened species for governments, so that it is clear that Red Listed species still need research on their life cycles, their distributions and their response to environmental stresses, and that this may require the taking of specimens.

For further information see:
http://cmsdata.iucn.org/downloads/state_of_the_world_s_species_factsheet_en.pdf

Butchart, S.H.M., Akçakaya, H.R., Chanson, J., Baillie, J.E.M., Collen, B., Quader, S., Turner, W.R., Amin, R., Stuart, S.N. & Hilton-Taylor, C. 2007. Improvements to the Red List Index. *PLoS ONE* 2(1): e140.

Mary B. Seddon, Mollusc Specialist Group Chair, Biodiversity & Systematic Biology, National Museum of Wales, Cardiff CF10 3NP, UK. Tel +44 2920 573343, Mary.Seddon@nmgw.ac.uk.

Global Freshwater Biodiversity Assessment

From William Darwall, Ian Harrison & Mary B. Seddon

Astoundingly, the "quiet crisis" in freshwater systems has failed to capture the attention of the public, of policy-makers or even of most conservationists, maybe because people are so used to taking water for granted. Or maybe people remain

unaware because the impacts, often occurring below the water's surface, are invisible to the casual observer. Numerous questions of fundamental importance remain unanswered. Which freshwater species are threatened? Where are they found? What, specifically, threatens them? What are the likely impacts of the loss of these species? What conservation actions will reduce these threats? In late 2006, the partnership for the Global Freshwater Biodiversity Assessment was initiated, with the IUCN species programme and IUCN species specialist groups (Fish, Molluscs, Odonata), Conservation International, the American Museum of Natural History, the European Invertebrate Survey – Netherlands, and others as partners. The partnership aimed to compile comprehensive assessments for all freshwater fish, molluscs, odonates (dragonflies and damselflies) and selected plant species. At present there are several regional assessments that are managed by the IUCN Freshwater Biodiversity Assessment Unit in Cambridge. These projects encompass five taxon groups: Odonata, Mollusca, freshwater crabs, freshwater fish and selected groups of freshwater plants. Since 2006, a number of other biodiversity assessments of relevance to freshwater systems have begun to pick up speed. Most notably, the European Union has provided support to IUCN to undertake Red List assessments of all African freshwater fish, dragonflies and molluscs, as well as plants. Meanwhile, NatureServe has received sponsorship from the Frankenburg Foundation to assess the status of North American species in numerous taxonomic groups.

Conservation International has provided a fundraiser for 2008-2009, who is currently compiling further grant proposals for funding regional assessments in other parts of the world, so that with time a Global Freshwater Biodiversity Assessment will provide a baseline for monitoring the status of freshwater biodiversity through the Red List Index, as mandated by the Convention on Biological Diversity.

A first analysis for birds indicates that the extinction risk facing freshwater species has increased faster than that for species in any terrestrial habitat over the last two decades (Fig. 1). Hence it is timely to extend these studies to other groups to establish if similar trends are identified, and to establish the threatening processes in each ecosystem.

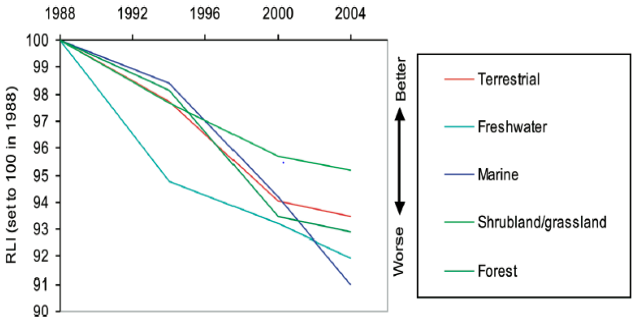


Fig. 1. Changing Red List Index for birds in different habitats over the last two decades. (Source: Birdlife International: Butchart *et al*., 2004)

For the key taxon groups (fish, odonates, crabs, molluscs and plants) this year saw the completion of the Central African assessment workshops and the North-East African assessments. For Mollusca, Dirk van Damme, Aslak Jørgensen and Dan Graf were the primary contributors to the process, with others from the African projects (Mary Seddon, Thomas Kristiansen) involved in the evaluation work.

The Central African assessment workshop was held in Cameroon, and the initial process used the expertise from local freshwater specialists in the Central African Republic, Cameroon, the Democratic Republic of Congo and Zambia to identify the major threats to the river systems in the region. Each threat was very specific to the locality, and threats varied from localized issues such as dynamite fishing, diamond mining, pollution from mining waste and commercial logging, through to major threats to river systems from large dam proposals on the Zaire river designed to provide hydropower for countries as far away as Libya and South Africa. During the Central African workshop we evaluated over 100 species assessments.

In a separate regional assessment, Dirk van Damme reviewed data on the molluscs of the North-East African region, compiling assessments for 112 species, which are currently undergoing evaluation.

These two regional assessments complete the review of mollusc species at a regional level for Africa, and the remaining job for 2009, is to bring these assessments together into a single regional assessment for Africa. This will allow a comprehensive overview of the threats to the fauna, and will contribute more species assessments with full documentation for the IUCN 2010 Red List. There are different threats emerging in each region, and as such we will be able to provide an analysis of the different status of the faunas and look at changes since David Brown's assessment of the fauna in 1996. We expect to present the overall results of this project at the Unitas Malacologica meeting in Thailand in 2010.

Butchart, S.H.M., Stattersfield, A.J., Bennun, L.A., Shutes, S.M., Akçakaya, H.R.,Baillie, J.E.M., Stuart, S.N., Hilton-Taylor, C. & Mace, G.M. 2004. Measuring global trends in the status of biodiversity: Red List Indices for birds. *PLoS Biology* 2(12): e383.

William Darwall, IUCN Freshwater Biodiversity Unit, 219c Huntingdon Road, Cambridge CB3 0DL, UK. Tel +44 (0)1223 277966, fax +44 (0)1223 277845, william.darwall@iucn.org
Ian Harrison, CI-CABS & IUCN-SSC Biodiversity Assessment Unit, Conservation International, 2011 Crystal Drive, Arlington, Virginia 22202, USA. Tel +1 703 341 2837, i.harrison@conservation.org
Mary B. Seddon, Mollusc Specialist Group Chair, Biodiversity and Systematic Biology, National Museum of Wales, Cardiff CF10 3NP, UK. Tel +44 2920 573343, fax +44 222 239829, Mary.Seddon@nmgw.ac.uk

European Red List Project 2008-2010

From Helen Temple & Mary B. Seddon

This project aims to produce European Red Lists of reptiles, amphibians, dragonflies, butterflies, saproxylic beetles, non-marine molluscs and vascular plants using the IUCN criteria at the pan-European and EU level. For European Mollusca this is an ambitious task, as there are over 3500 taxa on the Fauna Europaea list, more than many of the other proposed groups. The products of this project, when combined with existing European Red lists of mammals, birds and freshwater fish, will

give a detailed and comprehensive picture of the status of biodiversity in Europe. The products of this project will also provide a useful input into policy level processes such as the SEBI 2010 initiative (Streamlining European 2010 Biodiversity Indicators) and the conservation status assessments of species listed on the EU Habitats Directive (92/43/EEC 1992) Annexes.

For the non-marine Mollusca this project is using the existing species list from the Fauna Europaea, although we are aware that in some countries these names are not universally accepted. However, within the web database we use to capture information for assessing the conservation status of species, there is space to add comments on taxonomy, and these comments will eventually be visible on the finalized Red List database. Clearly the assessment process will be most complicated in instances in which there are conflicting opinions as to whether it is one species or several species. In cases in which there are recently published changes to the status of species, these changes can be made to the underlying list, although they have to be made by the coordinators. Nomenclatural differences are easier to deal with, as the alternative names can be captured in the synonym box, which is searchable on the Red List system. Over the last few months we have been working on transferring the data from the Fauna Europaea checklist, including the country coding, into the master Red List. We will then merge this with the existing Red List dataset before transferring it to the SIS web-based database so that more people can enter data on the status of these species in their countries. We have also started to reorganise the database to follow the higher taxonomy of Bouchet & Rocroi (2005) for the Gastropoda. Although this sounds simple, it is complicated as their Molluscan taxonomy uses over six levels of higher taxonomy, based on a mix of phylogenetic and traditional systems, which we have had to simplify to two levels for the existing database. Consequently we have had to make pragmatic decisions, usually based on existing interpretations of the Bouchet & Rocroi (2005) system, and in some cases 'superorders' and 'orders' have been merged. Bouchet & Rocroi (2005) did not assign a small number of families to an order. We therefore assigned such families to the order in which they have been most recently been placed.

For the programme of work, following consultations in Europe, we have matched our targets against two priorities: 1) freshwater species, for 2009; and 2) superfamilies Helicoidea and Pupilloidea, for 2010. This will permit parts of the dataset to be completed and analysed in 2010. Data gathering has already started on the freshwater species, and once the web-based system is available for access, country level scientists will be invited to view the records and add their comments on the draft assessments. For countries where national Red List data are available for endemic species, we have started the process of transferring data and checking that the assessments meet the IUCN categories and criteria, and have been following up with queries to local specialists on these taxa. If you have published data that you think would be valuable for threatened species assessments of endemic species in your research region, please contact us at the addresses given below.

Initially, species distribution maps attached to each species will be based on 'Extent of Occurrence' data only, although point locality data can be supplied when available. There are some groups, such as slugs, for which there may be difficulty in obtaining good verified data sets on their distributions, and consequently these groups have been given the lowest priority for data gathering. During the European project, there are two Molluscan workshops planned, in which a panel of experts will be invited to review both the draft assessments and all comments received from contributors; a finalized assessment will be visible on the web site for review in order that we assemble the best data set possible and produce an agreed Red List status at a regional level, and where the species is endemic, at a Global level.

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

Helen Temple, European Red List Coordinator, IUCN Species Programme, 219c Huntingdon Road, Cambridge CB3 0DL, UK. Tel +44 (0)1223 277966, Fax +44 (0)1223 277845, Helen.Temple@iucn.org.uk
Mary B. Seddon, Mollusc Specialist Group Chair, Biodiversity and Systematic Biology, National Museum of Wales, Cardiff CF10 3NP, UK. Tel +44 2920 573343, fax +44 222 239829, Mary.Seddon@nmgw.ac.uk

Move to the Species Information System web version

From Mary Seddon

At the World Conservation Congress in October 2008, the IUCN Species Survival Commission (SSC) announced the availability of a new way of entering data in the Red List of Threatened Species. At present, data are submitted in a variety of ways (Word documents, Excel spreadsheets or using an Access database customized by the Red List staff). Then the data have to be checked and manually transferred with additional standardized coding against threats, habitats and geographical data, so that general queries can be made of the dataset. This transfer work is done by staff in the Red List Unit or the Freshwater Biodiversity Assessment Unit. The development of the Species Information System (SIS) web-based module has been undertaken with Google development tools, and the system will have some familiarity to those of you who use iGoogle. This new database entry system will allow more specialists to enter their data directly into the database using their web browsers, rather than submitting them using the old methods of text documents, spreadsheets and databases. The species assessments will still require peer review (evaluation) before being accepted into the global Red List of Threatened Species. However, the process will be simpler, as comments on each species can be entered directly by the reviewers and are visible to them. The assessors can then modify the species accounts by incorporating the reviewers' changes (or comment on the reviewers' comments) directly on the species record. This should speed the evaluation process up and allow multiple users to work on a single dataset, reducing the likelihood of errors during the

review process. If reviewers wish to remain anonymous they may still submit their comments independently of the database entry system.

At present these tools are being used only for a few groups (e.g. beetles, selected plants), in order to test their robustness. The movement of Mollusca into the SIS web-based database will be a major test of the system, as we currently have c. 2000 species in the existing Red List system, with an additional 3000 species to be added from the European, North American and Sampled Red List Index (SRLI) assessments.

As before, the documentation requirements must be met and for each species we will need details on the nature of the threats, habitats where the species is found, as well as range data. Digital maps of the 'Extent of Occurrence' for each species are now required, and these may be submitted either as GIS shape files or Google Maps. Instructions on the meta-data required for each map will be placed on the introductory pages of the SIS web database.

I anticipate that some members of the specialist group will be using this system within two months, others will be enrolled into the system later in the year. For any geographical regions where there are species lists for countries, if you wish to complete Red List species assessments for the endemic species please send a spreadsheet of names, including family, genus, species, authority, date, common name (if applicable) and synonyms.

Mary B. Seddon, Mollusc Specialist Group Chair, Biodiversity and Systematic Biology, National Museum of Wales, Cardiff CF1 3NP, UK. Tel +44 2920 573343, fax +44 222 239829, Mary.Seddon@nmgw.ac.uk

Training opportunities

From Annabelle Cuttelod

Following the North-African IUCN members' recommendation on their interest in getting environmental training activities, the IUCN Centre for Mediterranean Cooperation is organising a regional workshop on "Applied GIS on freshwater biodiversity assessment in North Africa" that will take place in Tunis (Tunisia), 19-23 January 2009. The workshop will enable water resource managers and environmental planners in North Africa to integrate spatial information on freshwater biodiversity, especially information coming from Red List assessments (threatened species distributions), within their planning activities and development processes. In addition, this workshop will allow further development of regional expert networks as well as mobilization of existing information among decision makers.

Annabelle Cuttelod, IUCN Mediterranean Office, IUCN Centre for Mediterranean Cooperation - IUCN Species Programme, Parque Tecnológico de Andalucía, Calle Marie Curie 35, Campañillas 29590, Málaga, Spain. Tel +34 952 02 84 30 (secretariat), fax +34 952 02 81 45, mobile +34 653 98 46 13, annabelle.cuttelod@iucn.org, http://data.iucn.org/places/medoffice/index.html

MEETINGS 2009-2010

Freshwater Mollusk Conservation Society 2009

The FMC 2009 Symposium will be held at the Marriott Waterfront in Baltimore, Maryland, USA, on 19-24 April 2009, with the theme:

For more information go to the Society's website: http://ellipse.inhs.uiuc.edu/FMCS/

Molluscan Shellfish Safety Conference 2009

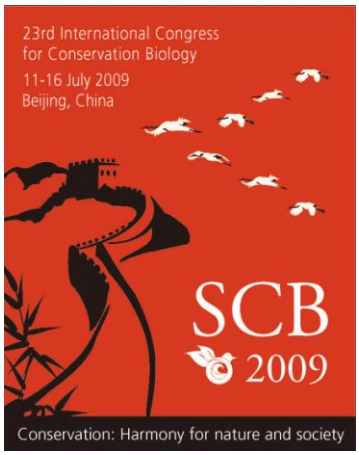
The conference dates are 14-19 June 2009. The programme will include epidemiology, risk assessment, toxin monitoring, analytical methods in microbiology and biochemistry, health consumer protection, management of farming/harvesting areas, post-harvest treatment, and the macro-economic analysis of the repercussions of shellfish-farming crises. This conference will be an exciting forum for scientists, regulators and producers, which will make an important contribution to limiting health risks associated with microbiological, toxinic and chemical contamination of coastal areas.

The conference will also address the identification of chemical contaminants and target species that represent significant risks for consumers. Finally, the conference will aim to improve the development of high performance detection tools to prevent and/or monitor contamination, and will thereby contribute to supporting existing marine environment monitoring networks.

The conference will begin with registration and a welcome reception on the evening of Sunday 14 June. From Monday 15 June to Friday 19 June there will be a full scientific programme made up of sessions of oral and poster presentations. Three round-tables will be organised to focus on 'hot topics'. Oyster farm visits together with a sightseeing tour will be organised in the Loire estuary area. A programme of social events and excursions has been designed for both delegates and accompanying persons. We look forward to seeing you in Nantes.

Full details of scientific topics, round-table discussions, abstract and poster guidelines, social events and general information are available on the conference web site: www.icmss09.com
The conference host and organiser is Patrick Lassus: icmss09@ifremer.fr

Society for Conservation Biology 2009



Society for Conservation Biology

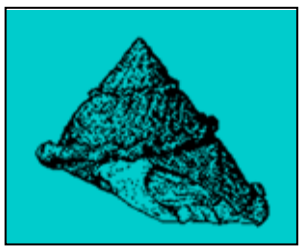
The 23rd annual meeting of the Society for Conservation Biology (SCB) will be held in Beijing, China, 11-16 July 2009, hosted by the Institute of Zoology, the Chinese Academy of Sciences.

For more information go to the conference website: http://www.conbio.org/

American Malacological Society 2009

The next annual meeting of the American Malacological Society will be held in Ithaca, New York, in July 2009. Please visit the AMS website for details: http://www.malacological.org/meetings/index.html

Western Society of Malacologists 2009



The 42nd annual meeting of the Western Society of Malacologists will take place at the California State University, Fullerton, 23-27 June 2009. For additional details see the conference website: http://www.diversiforma.com/

XXI Brazilian Malacological Meeting 2009

The Brasilian Society of Malacology (SBMa – Sociedade Brasileira de Malacologia) will hold its XXI Brasilian Malacological Meeting in Rio de Janeiro, Brasil, from 19 to 24 July 2009. The venue will be the University of the State of Rio de Janeiro (UERJ). This will be a special event because we will be commemorating the 40th anniversary of the Brazilian Malacological Society. Special sessions of poster and oral presentations as well as symposia are planned, including taxonomy, ecology, biology, evolution, distribution and conservation of terrestrial, marine and freshwater molluscs, fisheries and other topics. The major goal of the XXI Brasilian Malacological Meeting is to provide an opportunity for students and researchers to exchange information. More information after January 2009 at www.sbma.uerj.br
Sonia Barbosa dos Santos (President) and Alexandre Pimenta (Vice-President)

Malacological Society of Australasia

MOLLUSCS 2009

Brisbane, Australia—25-27 November 2009

The Malacological Society of Australasia (MSA) promotes the study of molluscs in the Australasian region and nearby areas of Asia. Molluscs are the second largest phylum of animals and comprise a quarter of all described marine organisms. Our members include amateurs, students and scientists. One of the key ways the MSA works to improve our understanding of molluscs is through conferences held every three years. Previous, very successful, conferences have been held at Rottnest Island, Western Australia (1997), Sydney (2000), Perth (as part of the World Congress of Malacology, 2004) and Wollongong, New South Wales (2006). The MSA is pleased to announce that the next conference in the series will be held at the University of Queensland, Brisbane, from Wednesday 25 November through Friday 27 November 2009. The conference will have several major symposia. Possible topics include:

- Molluscan fisheries and aquaculture
- Molluscs as pests (agricultural pests, biosecurity/invasive species etc.)
- Phylogeny and systematics
- Evolution and development

- Biogeography
- Chemical communication
- Molluscs as indicators of environmental change
- Tropical and subtropical molluscs

One-two day workshops will be held, possibly at an island laboratory, before and/or after the conference. Current suggestions include:

- Freshwater molluscs or marine micromolluscs
- Bivalves
- Analysis of development

Further information will be provided as the program develops. If you are interested in organising or participating in a particular symposium or workshop, please contact Bernie Degnan, chair of the organising committee (b.degnan@uq.edu.au), or Winston Ponder (wponder@bigpond.net.au).
We look forward to seeing you in Brisbane in November.
http://www.malsocaus.org

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, from 18 to 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 southwest 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, five symposia are planned:

- Phylogeny and biology of freshwater bivalves (Arthur Bogan and Randy Hoeh)
- The biology and evolution of limpets (Alan Hodgson)
- Bivalve evolution in conjunction with the bivalve Tree-of-Life project (Rudiger Bieler, Gonzalo Giribet and Paula Mikkelsen)
- Community ecology of tropical forest land snails (Dinarzarde Raheem and Fred Naggs)
- The last 50 years of malacology: specialization, methodological transformation and globalization (Robert Hershler and David Lindberg)

There is still room for further symposia. Please send your suggested symposium proposal to the organizer (see below). 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 (see below), 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!

A choice of four excursions is tentatively planned for Wednesday:

- Visit to Phuket Marine Biological Center
- Visit Phuket Seashell
- Tour of Ao Phang-Nga (Phang-Nga Bay) National Park with its limestone outcrops and spectacular caves (hongs) and islands
- Excursion to the Phang-Nga Mangrove area

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: http://www.wcm2010.com. Information can also be obtained from the conference organizer: somsakp@sc.chula.ac.th.

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 any of the following addresses, which all take you to the same website:
www.redlist.org www.redlist.net www.iucnredlist.org

Invasive Species Specialist Group

Includes details of the Aliens-L listserver and the ISSG newsletter, *Aliens*.
www.issg.org/index.html

CITES

CITES-L is a Bulletin board restricted to trade issues for endangered species, which is managed from 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*.
www.ucd.ie/cobid/unitas/index.html

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>

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.
www.ucmp.berkeley.edu/mologis/mollia.html

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.
http://ellipse.inhs.uiuc.edu/FMCS/

The FMCS now publishes the journal *Walkerana*
www.ummz.lsa.umich.edu/mollusks/publications/walkerana/

American Malacological Society

The homepage of the Society carries a link to its conservation policy.
www.malacological.org/

Malacological Society of Australasia

The Society 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. www.malsocaus.org/

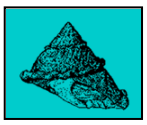
The Malacological Society of London

One of my favourite logos, *Pomacea canaliculata* by David Reid, modified from the original Malacological Society logo.
www.malacsoc.org.uk/

Conchologists of America

The homepage of the COA carries a link to a number of pages dealing with its conservation policy and conservation issues.
www.conchologistsofamerica.org/home/

Western Society of Malacologists



The home page carries links to membership, conferences, grants, and other news.
http://biology.fullerton.edu/wsm/society.html

Field Museum land snails

Information for over 158,000 lots (a lot is a collection of a single species taken from a single locality on a single occasion), including over 2500 type lots, of land snails in the Field Museum (Chicago) collections is accessible at
http://fm1.fieldmuseum.org/collections/search.cgi?dest=inverts

The National Museum Wales – Mollusca

Provides information on the global projects on molluscs underway based in Cardiff.
www.amgueddfa-cymru.org/en/biosyb/mollusca/

Haus der Natur – Cismar

The homepage carries a link to a page on mollusc conservation in Germany, as well as other links.
www.hausdernatur.de/

Illinois Natural History Survey

This site has much information on the mussels of North America, with links to other mussel sites.
www.inhs.uiuc.edu/cbd/collections/mollusk/molluskintro.html

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.
http://hbs.bishopmuseum.org/hbs1.html

Tropical land snail project at the Natural History Museum, London

This site provides access to the Sri Lankan and South and Southeast Asian snail projects of Fred Naggs, Dinarzarde Raheem and colleagues. There are some marvellous photos of brightly coloured snails.
www.nhm.ac.uk/jdsml/research-curation/projects/tropical-land-snails/

Jamaican land snail project

A key to Jamaican land snails is now online, on the DiscoverLife website:
http://pick4.pick.uga.edu/mp/20q?guide=Molluscs
The key, with many excellent photographs, is part of Gary Rosenberg's work on the Jamaican fauna:
http://data.acnatsci.org/jamaica/
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,
http://clade.acnatsci.org/rosenberg/

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.
www2.bishopmuseum.org/PBS/samoasnail/
It is part of the Bishop Museum's Pacific Biological survey.
www.bishopmuseum.org/research/pbs/pbs.html

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, is available in html at
www.amonline.net.au/invertebrates/marine_overview/
and pdf at
www.amonline.net.au/invertebrates/pdf/marineoverview.pdf

MUSSEL database project

http://clade.acnatsci.org/mussel/

CLEMAM: Check List of European Marine Mollusca

This database provides a list of taxonomic references concerning all molluscan taxa living in marine waters of Europe.
http://www.somali.asso.fr/clemam/index.clemam.html

Hilton Pond Center for Piedmont Natural History

From time to time photo essays about some molluscs encountered at the Center are posted on-line, for example:
www.hiltonpond.org/ThisWeek011022.html
www.hiltonpond.org/ThisWeek030401.html
www.hiltonpond.org/ThisWeek000608.html

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, Biodiversity and Systematic Biology, National Museum of Wales, Cardiff CF1 3NP, UK. Tel +44 2920 573343, fax +44 222 239829, Mary.Seddon@nmgw.ac.uk

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

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

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

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

Jackie van Goethem, Institut royal des sciences naturelles de Belgique, Rue Vautier 29, B-1000, Bruxelles, Belgium. Tel +32 2 627 4343, fax +32 2 627 4141, jackie.vangoethem@naturalsciences.be www.kbinirsnb.be/

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, Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia Pennsylvania 19103, USA. graf@acnatsci.org http://clade.acnatsci.org/graf/

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

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

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

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 St., Sydney NSW 2000, Australia. Tel. +61 2 9320 6120, fax +61 2 9320 6050, wponder@bigpond.net.au

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

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, College of Life Sciences, Hebei University, 071002 Hezuo Rd. 1, Baoding, Hebei Province, P. R. China. minwu@mail.hbu.edu.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

Application for Unitas Malacologica membership

Herewith I apply for membership in UNITAS MALACOLOGICA and accept the current rules.
Title and full name (family name in CAPITALS)……
Full address for correspondence (private or business). If business, please give full details (Department, etc.) .

……

……

……

Telephone …… Fax …….
E-mail …….

I intend to pay my subscription in the following way:

- remittance in EURO to **Belgian Postcheque Bank, Koloniënstraat 56, B-1100 Brussels,** in favour of **account nr. 000-1539068-66** of Unitas Malacologica, c/o RBINS, Vautierstraat 29, B-1000 Brussels. **For international transactions use IBAN code: BE07 0001 5390 6866 (for the account number) and BIC or SWIFT code: BPOTBEB 1 (to characterize the Belgian Postcheque Bank)**,
- International Postal Money Order in EURO (you can obtain forms from your Post Office),
- credit card: VISA, MASTERCARD or EUROCARD (please fill in carefully),
- remittance to a Belgian Bank in EURO,
- cash (in this case only you will receive a receipt),
- through the intermediary of my colleague ...…….
  address: ……..
  ……

Signature ……..…….. Date ……...

Current membership fee is 48 EURO for a three years period.

Please send the application form to the Treasurer:
Dr J. Van Goethem
Royal Belgian Institute of Natural Sciences
Vautierstraat 29 B–1000 BRUSSELS (Belgium) FAX: +32 2 627 41 41

IF PAYMENT BY CREDIT CARD, PLEASE COMPLETE THIS AUTHORISATION
(Visa, MasterCard or EuroCard ONLY)

Name .....……..

Address .....……..

……

VISA O MASTERCARD O EUROCARD O (Please tick the appropriate card)

Card number | | | | | | | | | | | | | | | | |

Name on card:.....…….. **Expiry date:** ..…...../....…....

Amount for annual dues ..... EURO
Credit card transaction cost ……... EURO [cost for Unitas is in fact around 3 EURO]
Donation to Trust Fund ..... EURO

TOTAL AMOUNT [ ] EURO

Signature .....