September 2011 Vol. 98

froglog

www.amphibians.org

News from the herpetological community

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Mainland Asia

Regional updates and latests research.

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FrogLog

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Editorial

I would like to begin this edition by thanking all those people that have been involved in making the new FrogLog format such a great success. Over the last two months FrogLog 97 has received our highest number of online readers yet, with almost 8000 people accessing the Issuu version alone and of course many copies being downloaded from our web site. With your help we look forward to continuing to develop FrogLog into a publication that is both informative and enjoyable to read.

As we outlined In FrogLog 96, the new FrogLog format was phase 1 of our efforts to provide communication opportunities for our community. The next step was the development of a new web site which we are pleased to announce will be going live in the next couple weeks. This web site has been developed in consultation with Regional Chairs in order to produce a tool that we hope will be utilized in a similar fashion to FrogLog. Like FrogLog, the web site is aimed to showcase the incredible work being undertaken on a daily basis by individuals and groups dedicated to preserving amphibians. The web site will continue to develop to meet the needs of our members and we are always open to hearing about what resources and tools you would like made available.

Finally I would like to thank the many contributors to this edition which focuses on Mainland Asia. This incredibly diverse region continues to provide us with amazing discoveries such as the 12 new frog species and three lost species recently found in the Western Ghats and reported last week in the world's media. Efforts such as the Lost Amphibians of India campaign, spearheaded by Prof. S.D. Biju, help to draw public attention to the issues facing global amphibian populations and we look forward to hearing of more discoveries from this inspiring team and others like it. We hope you enjoy reading about these and other efforts under way in Mainland Asia.

James P. Lewis
ASG Program Coordinator

Froglog

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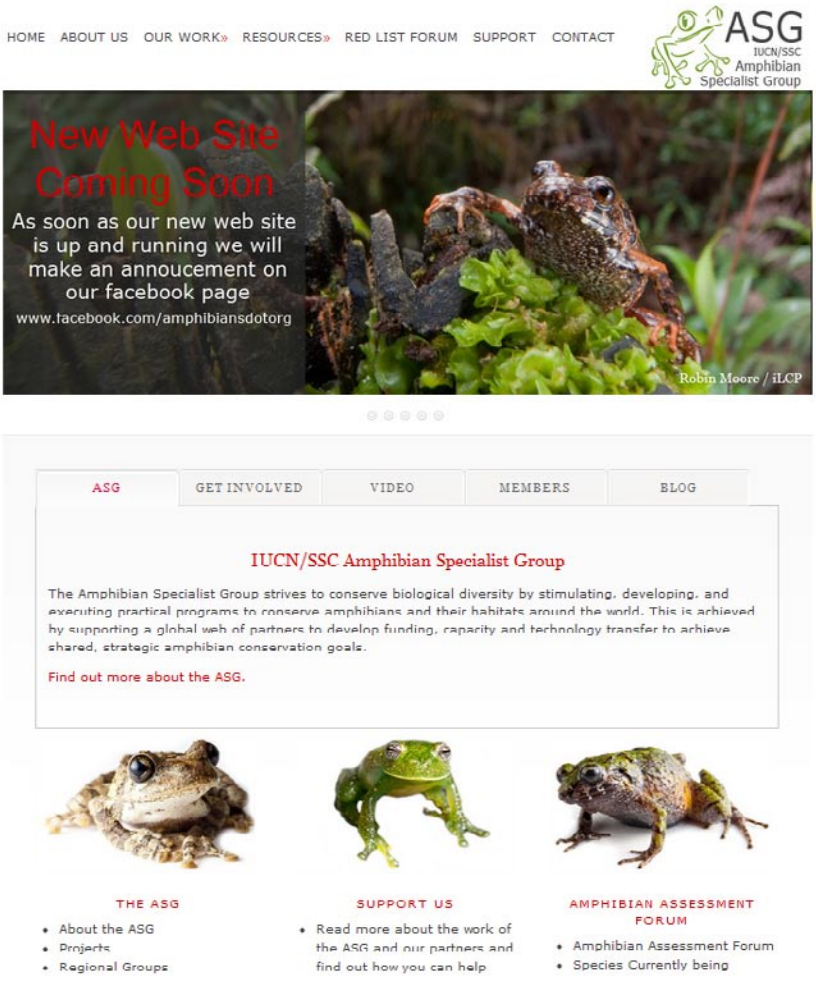
New Web Site Coming Soon

In the next couple of weeks, the ASG will be launching its new website. Still located at www.amphibians.org, this new website will use a number of new technologies and social media tools to forward the ASG's mission and facilitate communication amongst our members. The structure of the website is not designed to be static but to evolve with the needs of our members. For this reason, we are eager to hear your feedback.



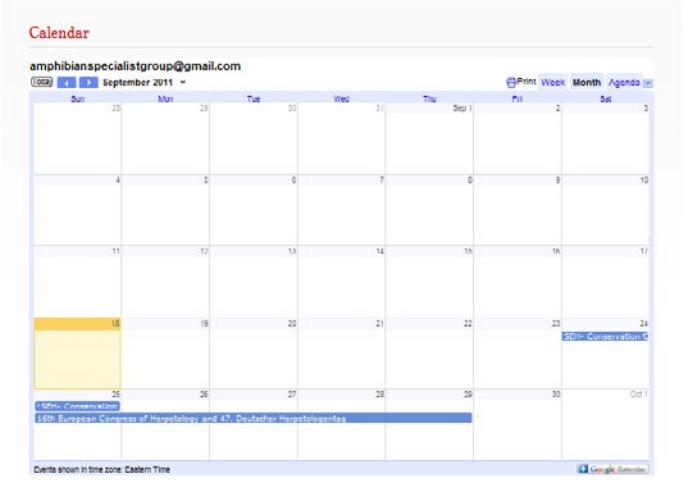
The website will feature three main sections: (1) "Our Work;" (2) "Resources;" and (3) the "Red List Forum," the global amphibian assessment forum designed to help update the IUCN amphibian database.

The "Our Work" section will deliver blog posts, details of ASG partnerships and projects and information on current campaigns such as the "Search for Lost Frogs" and the "Global Amphibian BioBlitz" (GAB) a citizen-science effort to collect distribution data on amphibians from the public. Although this section will be of interest to members, it will be focused more towards the general public, helping to provide an insight into activities being undertaken around the world to conserve amphibian populations. Project partners will be able to provide updates on activities to highlight their achievements and the challenges they face.

The "Resources" section will be designed specifically for our members. This section will showcase publications, where you will find the FrogLog archive along with other ASG and non-ASG publications. Over time, one of our goals is to develop a comprehensive library of regional amphibian action plans. If you would like a publication to be featured on the website, please contact James Lewis at jplewis@amphibians.org.

The new publications display format.

An interactive Google calendar will also be available within the "Resources" section. Each Regional Chair will have access to the calendar to be able to include any upcoming regional or international events. Members and the general public will have the ability to add specific events from the ASG calendar to their personal Google Calendar. If you would like to publicize an event on the ASG calendar, you can either contact James Lewis at jplewis@amphibians.org or your Regional Chair.



Interactive Google calendar.

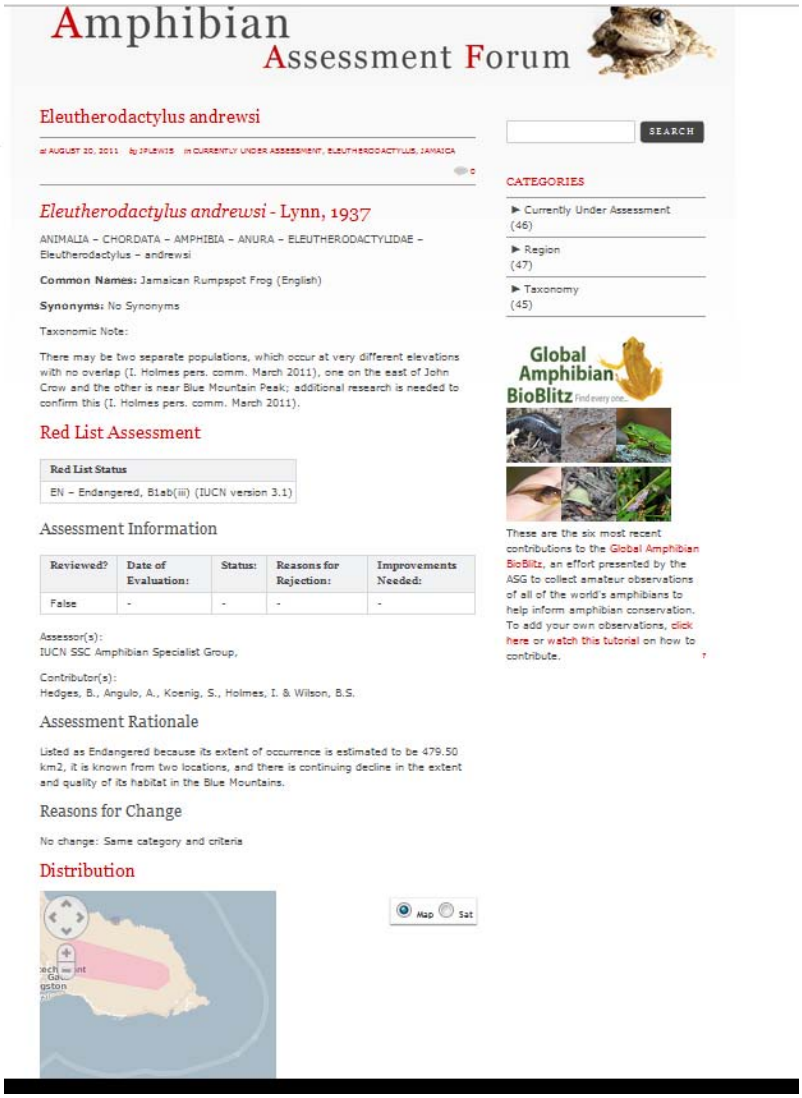
Members Page. Details of all Regional and Country Chairs will be included along with a list of members.

Within the "Resources" section will also be a list of all current members and Regional Chairs separated by broad geographical zones as outlined in FrogLog 96. This comprehensive list will include contact emails for all Regional Chairs, similar to the format on the current website.

The third section, the "Red List Forum," is in collaboration with the IUCN SSC Amphibian Red List Authority (Amphibian RLA) and the GAB. In an effort to address amphibian reassessments and engage with a wider spectrum of experts in the assessment process, the Amphibian RLA is trialing an online assessment forum. At first, a selection of draft assessments from a recent workshop in the Dominican Republic will be open for feedback, and other assessments will continue to be added to the forum as they reach the assessment consultation process. Assessments will be available for feedback for a specified period of time, after which feedback will be considered/incorporated and the updated assessment will be sent out for external review. The distribution maps in these assessments show either new modified draft range maps or previously published maps (where there are no changes to distribution) alongside contributions from the GAB.

The GAB uses expert verified amateur photos to confirm the occupancy of a species in places overlapping the range map. By contributing observations to the GAB and commenting on occupancy within places, the public can verify and provide feedback on species distributions. For example, a photo might confirm that a species indeed persists in a state. Another contribution might reveal that a population persists in a county outside the range map. Lastly, if a contributor suspects a species is absent from a county overlapping the range map, this can be expressed on the map by leaving comments on the occupancy within that place. The resulting data are made available to the expert community to include in assessments at their discretion. To contribute to the GAB, click the 'Add Observation' button on the GAB home page which will be located at: http://www.amphibians.org/redlist/gab .

We hope that you find the resources both interesting and useful, and we welcome your feedback on how we can further develop the website to meet your needs.



The Amphibian Assessment Forum, a collaboration with the IUCN / SSC Amphibian Red List Authority and the GAB to engage a wider spectrum of experts in the assessment process.

ASG International Seed Grant Award Winners 2011

We are pleased to announce the second round of recipients of the 2011 ASG International Seed Grants. The Seed Grant program, founded by the Declining Amphibian Populations Task Force, continues to be a hugely popular mechanism for kick-starting research and conservation programs that often develop into larger or longer-term projects. As always, the quality of submissions was extremely high with a wide range of projects spread across all continents on which amphibians occur. A thread running through the recipients of this round of Seed Grants is bridging the gap between research and conservation. As amphibians continue to decline and go extinct it is important that we apply our knowledge to their protection, and it is hugely encouraging to see such an interest from the research community in spearheading efforts to conserve amphibians.

Evaluation and monitoring of a newly discovered population of *Atelopus varius* in Costa Rica

By José F. González-Maya, Sarah Wyatt & Jan Schipper

Atelopus varius individual from the new population. Photo: Sarah A. Wyatt-ProCAT International.

The harlequin frog, *Atelopus varius*, is considered as Critically Endangered as result of a severe population decline. There are two known remaining populations, including a recently discovered one in southern Costa Rica with a small number of individuals with potential signs of Chytridiomycosis in some of them. This project aims to establish baseline data on population status (size, structure, and threats), develop a long term monitoring program to ensure persistence, and understand the dynamics of threats facing *Atelopus* and amphibians in general. In addition, we will be adding to our environmental education programs in the area and working with the indigenous community surrounding the population to develop site conservation strategies. The harlequin frog is a flagship species for conservation in Costa Rica and can be used to raise awareness of global amphibian declines. As expected outcomes the project will 1) collect baseline data on the population and determine the presence of chytridiomycosis fungus, 2) establish a long term monitoring and research program, 3) work with the local community to implement conservation measures to ensure habitat conservation and survival of the population, 4) develop and carry out environmental education with the local community and surrounding areas and 5) conduct surveys in neighboring watersheds to determine the area of occupancy of this population and search for other threatened amphibians such as *A. chiriquiensis*. We expect with this project to generate baseline information and provide insights related with the persistence of this population despites its previous disappearance, generating probable hope for some other species' populations in other areas of the Neotropics.

ProCAT team together and in the study site. Photo: ProCAT International

Implementation and development of local conservation strategy for *Xenopus laevis* and *Hyperolius viridiflavis* in Yala and Dunga Wetlands, Kenya

By Allai Orimba

Allai (centre) with some of the team members during one of the monitoring survey in Dunga swamp.

The project targets two unprotected Important Biodiversity Areas: Yala Swamp 0 05N, 34 11' E in, Siaya District, an area of 8000 ha on altitude of 1,160 m: and Dunga Swamp 01 10'S, 34 47'E in Kisumu District an area of 500 ha at altitude of 1,130. The two areas host numerous amphibian species, and have diverse functions values and benefits to the local communities require urgent conservation and management measures. Our proposed project addresses the need to protect and conserve African reed frog (*Hyperolius viridiflavis* and Africa clawed frog *Xenopus laevis* that exists in them. Unfortunately, their habitats are under serious anthropogenic threats, which provide the need for serious concerted efforts of conservation measures from different stakeholder groups. The proposed project is to formulate species management and conservation strategies through; i) promoting awareness and education of amphibian abundance, their needs and their importance in ecosystem balance. ii) Build capacity of local communities and other stakeholders in identification and management of natural resource. iii) Provide information about the occurrence and habitat use of resident species and enhance their survival. iv) Increase an organization strength and knowledge of the two community sites by establishing site support groups. v) Promote monitoring and evaluation activities to support paths to obtaining comprehensive indicators that bring change to amphibian conservation.

Amphibian habitat improvement after the eruption in the Gunung Merapi National Park, Indonesia

By Cahyandra T.A., K. Latifiana, D.A. Satiti, and Agus Jati

Cahyandra T.A (at the left side), Agus Jati (at the middle left side), D.A.Satiti (at the bottom left side), K. Latifiana (at the bottom right side), and our team.

In 2010, Mount Merapi erupted on a large scale. The eruption of Mount Merapi damaged 43% of 6410 hectares of national park forest. This eruption changed the structure of the Mount Merapi area and wildlife habitat because of hot clouds. It caused some water resources and vegetation cover in this location to suffer.

The effort that we will carry out included in amphibian habitat protection will be amphibian habitat improvement. This project consists of several programs that will contribute to the improvement of amphibian habitats, such as a survey of amphibians and their habitats in Gunung Merapi National Park, amphibian conservation education to local schools, and other activities according to the location. This project also recruited participants from related stakeholders i.e. Gunung Merapi National Park staff, local NGO, and local communities.

Amphibian survey after eruption will be carried out and then compared with amphibian survey before the eruption of Mount Merapi. Amphibian habitat survey will also be carried out including the ecological conditions. This result (amphibian and habitat survey) will be overlay to find out the handling of the problems faced in every location. The problems will be solved by making many water sources and securing area. The education program that will be carried out in this project aims to reinforce the love of the environment especially towards amphibians. We will visit several schools around the national park for our amphibian conservation education program. Finally this project hopes to make the understanding between any relevant stakeholders about the importance of the protection of amphibian habitat the same. This improvement for amphibian habitat will help to increase the numbers of amphibians in the Mount Merapi area and also help to increase the diversity in the area.

Regional Updates

Mainland Asia

To help ASG members around to world keep up-to-date with the activities of regional ASG's, each edition of FrogLog focuses on one of the six geographical areas as outlined in FrogLog 96 (pg 6-7). This provides local ASG's with an opportunity to showcase their conservation efforts and publicize issues of concern. In this edition we focus on Mainland Asia, a zone consisting of 10 ASG groups.

Korea

In South Korea amphibian species living in woodland areas, such as mountain frogs and several salamanders, are relatively well conserved because more than 70% of the country is made up of these habitats. On the contrary, amphibian species inhabiting lowland areas including agricultural areas, such as frogs in Ranidae and toads, are largely declining in numbers or are threatened. As a result, current national protection efforts and ecological scientific research has mainly focused on amphibians in lowland habitats.

There are 18 amphibians, in South Korea, composed of five urodeles and 13 anurans (Yang et al. 2001). Among them, the gold-spotted pond frog, *Rana plancyi chosenica* (*Pelophylax chosenicus*) and the narrow- mouthed toad (*Kaloula borealis*) have been designated as a national endangered species since 2005. Recently, the Suweon tree frog (*Hyla suweonensis*) has been added as an endangered species due to its restricted distribution ranges and small population size.

In South Korea before the 1980s most amphibian studies focused on new species identification and re-classification of existing amphibians. From the mid 1980's new evolutionary ecological approaches were taken establishing *Bombina orientalis* as an important model for studies on maternal effects and developmental plasticity (Kaplan 1987) and in the mid -1990s, molecular phylogenetic studies and several new ecological and behavioral studies were started. From this research, in 2005 the first Asian plethodontid salamander (*Karsenia koreana*) was discovered living in the middle portion of the Korean Peninsula in South Korea (Min et al. 2005). From the early 2000s, conservation and rehabilitation studies have been conducted involving mostly endangered lowland amphibians. Also from 2005, a research group began to study the Chytrid fungus and it was detected in several frog species, such as Korean tree frogs (*Hyla japonica*) and bullfrogs. Researchers are continuing their work to determine how the fungus affects amphibian field populations throughout South Korea. In 2005, the Korean Research Society of Herpetologists was established. They organize an annual conference and publish the Korean Journal of Herpetology (http://www.krsh.or.kr/).

In early 1997, the Korean Ministry of Environment started the National Natural Environment Survey and included amphibians in the survey. This year it is currently in the middle of the third round of the survey. For the survey, the National Institute of Environmental Research (http://nier.go.kr/eric/portal/kor) divided South Korea into 2 km X 2km quadrats areas and one individual surveys animals in at least two different sites twice within each quadrat. The data collected from the survey are used to develop environmental policies and provide the baseline for various ecological studies. In addition to the survey, the Korean Ministry of Environment has supported more than 100 ecologists for national Long-Term Environmental Monitoring since 2004 (http://www.knlter.net/). Amphibian populations are also being monitored in two different national parks, Woraksan and Odaesan National Parks. Some of the results were recently published (Lee et al. 2011). In addition, in 2011 the National Institute of Biological Resources (http://www.nibr.go.kr/), originally established in 2007, re-evaluated threatened levels of Korean amphibians and also published the Red Data Book of Endangered Amphibians and Reptiles in Korea.

Suweon tree frog, *Hyla suweonensis*, one of endangered frogs in South Korea. Photo: Yong-Wook Lee.

In conjunction with governmental action, non-governmental organizations (NGO) in South Korea are very active. Regional NGOs have been actively involved in protecting local amphibian populations and endangered species. For example, the Committee of Wonhungii Life and Peace successfully protected an Asian toad (*Bufo gargarizans*) population within developing city areas in Cheongju-shi, and they established an ecological park (http://wonheungi.net/main.do). The recently established Korea Network for Amphibian Conservation (http://cafe.naver.com/koreafrog/) is also actively working to determine how recent climate changes affect calling patterns and reproduction of amphibians. Most NGOs are developing and managing ecological education programs for adults and children. These programs are essential to help increase awareness about Korean amphibians, particularly for our future generations.

In South Korea, although there are a limited number of scientists focusing on amphibian research, interest about endangered amphibians and amphibian ecology is increasing among the general public. A detailed review providing the history and current efforts surrounding the conservation of amphibians in South Korea is in press (Park et al. 2012).

The following are critical to the success of protecting amphibian populations in South Korea: (1) continued development of educational programs for the general public to increase their awareness and involvement in protection efforts: (2) continued work with the South Korean government and NGOs to develop environmental policies; and (3) increased funding for scientists working on amphibians to provide baseline and ongoing data for ecological studies.

Daesik Park (Co-Chair) and Robert H. Kaplan (Co-Chair) Korean Amphibian Specialist Group

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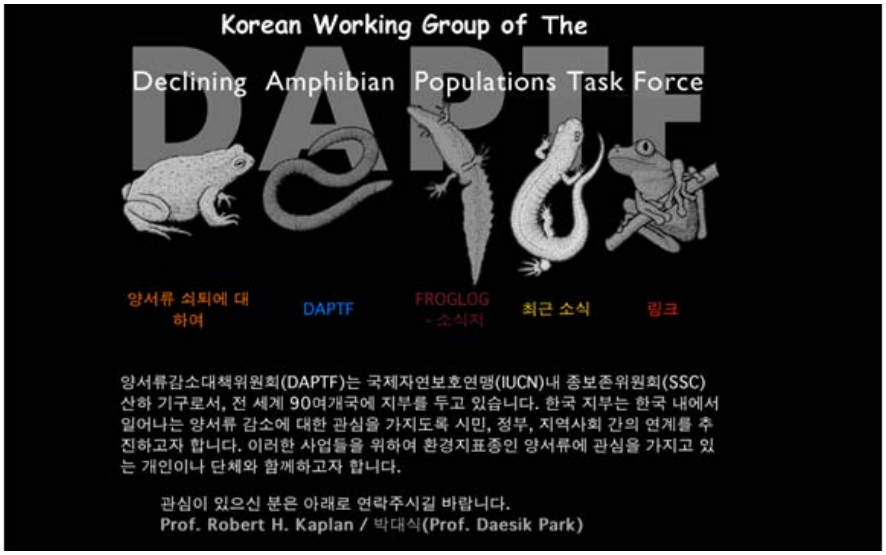

Homepage of the Korean DAPTF

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Abbreviated History of the Korean Working Group of the ASG

Sept 18, 2001 - Professor Mi-Sook Min contacted by Professor Kaplan about DAPTF and provides personal contact information with her Professor and Kaplan's former colleague.

Sept. 26, 2001 - Professor Suh-Yung Yang contacted by Professor Robert Kaplan and discussion resulted in the hiring of a Korean post-baccalaureate Gihye Kim to work on a Korean translation of the DAPTF FrogLog in Kaplan's lab at Reed College in Portland, Oregon.

December 20, 2001 - Link to first Korean language mirror page of the DAPTF FrogLog written by Gihye Kim in the laboratory of Kaplan was launched.

January 4, 2005 - Professor Daesik Park agrees to co-chair the Korean working group with Professor Kaplan and refines the Korean website. http://academic.reed.edu/biology/korea_daptf/.

July 1, 2006 - Metamorphosis of the DAPTF into the Research Section of the Amphibian Specialist Group (ASG) was launched.

August 2008 - First members of the Korean Working Group of the ASG formed. Members include: Robert Kaplan (co-chair); Daesik Park (co-chair); Mi-Sook Min (member); Jae-HwaSuh (member) and Jae-Young Song (member).

September 2010 - Professor Jim Collins visits the Columbia River Gorge in Portland, Oregon to give a lecture to the Division of Sciences at Reed College, and to talk about the ASG and increased international involvement in the Republic of Korea.

Robert H. Kaplan (Co-Chair) Korean Amphibian Specialist Group

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South Asia (minus Sri Lanka)

The Amphibian Specialist Group–South Asia (ASG–SA) regional network currently has 214 members with many involved in amphibian research part time and a few full time. The region has seen, since the setting up of the Amphibian Network of South Asia (ANSA) in 1995, a phenomenal increase in interest in the group with particular interest in taxonomic and distribution studies. Increasing numbers of young researchers have contributed significantly in new descriptions and new records of species, especially in the Western Ghats region. The hotspot has shown an increase in endemicity in species and genera, with the most recent description of a new genus of bush frogs, *Raorchestes*. Similarly, the northeastern Indian region has several new descriptions including that of caecilians.

A recent threat to the region is from the release of The African Clawed Frog *Xenophis laevis* into natural habitats by aquarium hobbyists. The species is a relatively new entrant into the South Asian market through traders as an aquarium pet. Several thousand individuals are sold in most major cities. Although quite attractive, the frog is released by hobbyists due to its aggressive nature and due to lack of knowledge on keeping them in captivity. Known for being a source for the spread of chytrid fungus, the ASG–SA is currently involved in a rapid assessment of the volume of trade, its effects, releases into the wild and developing a national policy on placing a ban on the species, import.

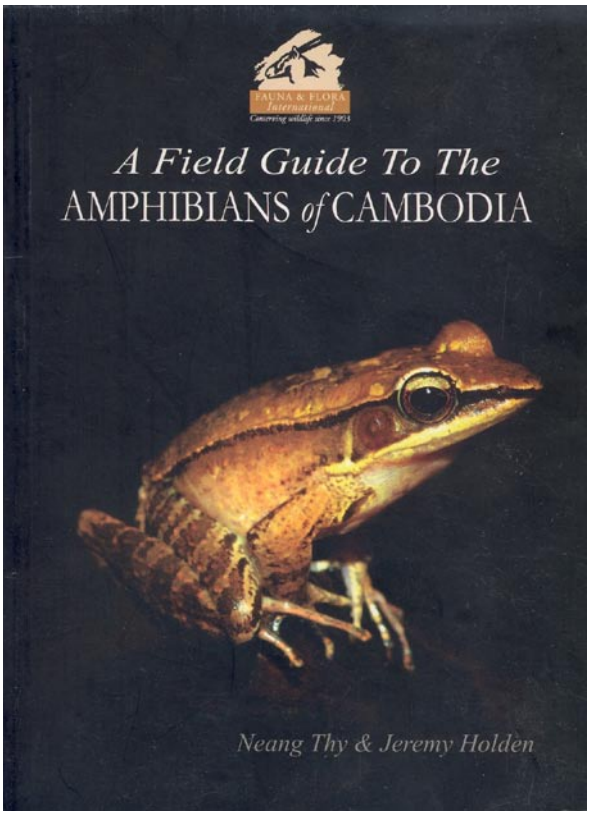
The network is updating its database on amphibian distributions in the region to revisit assessments in 2012 after a gap of 10 years when the last assessment was carried out under the Global Amphibian Assessments. Presently, 380 species are recognized in South Asia with several new species being discovered or reviewed for their taxonomic position.

Sanjay Molur (Co-Chair) South Asia Amphibian Specialist Group

Laos and Cambodia

The amphibian faunas of Laos and Cambodia have long been poorly known, primarily because these two countries have never had national herpetologists and all previous work done there has been by visiting foreign scientists. I am pleased to report that this has changed.

Mr. Neang Thy, a biologist with the Ministry of Environment, Phnom Penh, and the non-governmental organization Fauna & Flora International, began training on field surveys of amphibians in Cambodia with me in 2003, and has since worked extensively with L. Lee Grismer (La Sierra University, USA) and Jodi J. L. Rowley (Australian Museum, Australia). Thy's keen interest and dedication to



documenting the amphibian fauna of his country has resulted in numerous peer-reviewed publications co-authored by him and his colleagues, and most notably, he has produced a photographic guide to the amphibians of Cambodia (Neang and Holden, 2008). This beautiful and informative guide provides a photograph, identification features, and comments on ecology and distribution within Cambodia for most of the amphibian species known to occur in the country.

Ms. Somphouthone Phimmachak was the first student to complete the new M.Sc. program in the Faculty of Sciences, Department of Biology, at the National University of Laos, with the January 2010 defense of her thesis titled "Distribution, natural history, and conservation of the Lao endemic newt, *Laotriton laoensis* (Urodela: Salamandridae)," with co-supervision by Prof. Niane Sivongxay (National University of Laos) and me. This beautiful and enigmatic species of newt was described to science only in 2002 and is endemic to a small area in northern Laos. Unfortunately it is threatened by harvesting for traditional medicine and, especially, to meet high demand for it in the international pet trade. Almost nothing was known on its biology prior to Somphouthone's thesis work, which has been summarized and accepted for publication in English in a peer-reviewed journal (Phimmachak et al., in press). In addition to her independent thesis fieldwork, she has worked with me on eight field surveys of amphibians throughout the country since 2007 and has become very knowledgeable on amphibian species diversity of Laos. Somphouthone is now enrolled in the Ph.D. program in the Zoology Department, Kasetsart University, Bangkok, Thailand, where she continues to study amphibians of Laos for her dissertation research. Her Master's and Ph.D. programs were supported by grants from The John D. and Catherine T. MacArthur Foundation and a Seed Grant from the IUCN/SSC Amphibian Specialist Group.

Bryan Stuart (Deputy Chair) Laos and Cambodia Amphibian Specialist Group

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India - Chalazodes Bubble-nest Frog (*Raorchestes chalazodes*) © SD Biju

2012 Amphibian Ark calendars are now available!

The twelve spectacular winning photos from Amphibian Ark's international amphibian photography competition have been included in Amphibian Ark's beautiful 2012 wall calendar. The calendars are now available for sale, and proceeds from sales will go towards saving threatened amphibian species.

Pricing for calendars varies depending on the number of calendars ordered – the more you order, the more you save! Orders of 1-10 calendars are priced at **US$15 each**; orders of between 11-25 calendars drop the price to US$12 each; and orders of 26-99 are priced at just US$10 each. (These prices do not include shipping).

As well as ordering calendars for yourself, friends and family, why not purchase some calendars for re-sale through your retail outlets, or for gifts for staff, sponsors, or for fund-raising events?

Order your calendars from our web site:
www.amphibianark.org/calendar-order-form/

Remember – as well as having a spectacular calendar to keep track of all your important dates, you'll also be directly helping to save amphibians, as all profits will be used to support amphibian conservation projects.

www.amphibianark.org

Amphibian Population Declines and Chytridiomycosis in South Korea

By Mi-Sook Min, Hang Lee, & Bruce Waldman

Korea has a diverse, but understudied, amphibian fauna comprising 18 species of which only two are considered to be of concern on the IUCN Red List. The systematics of the four species of hynobiid salamanders species have been well studied (Baek et al. 2011), but little is known about their ecology. Two endemic species, the Jeju salamander, *Hynobius quelpaertensis*, confined to Jeju Island and southern regions, and the Kori salamander, *H. yangi* , found in the southeast of the country, resemble the more widely distributed Korean salamander *H. leechii* and previously were classified as subspecies. Further work may reveal at least three additional species in this group. A lungless salamander, *Karsenia koreana*, was discovered recently and represents an enigma as the only known plethodontid in Asia, but it is not genetically close to North American *Plethodon* (Min et al. 2005).

Rana coreana. Photo: Jonathan Fong

Thirteen frog species, from five families, most of which are widely distributed in Asia, including the Asian toad, *Bufo gargarizans*, and the oriental fire-bellied toad, *Bombina orientalis*, appear not to be at risk although their populations in Korea have declined noticeably in recent years. Of special interest are the Korean water toad, *Bufo stejnegeri*, which spends much of the year in streams and rivers; the microhylid narrow-mouthed toad, *Kaloula borealis*, which although common across much of its range, is considered endangered in Korea; and the Suweon tree frog, *Hyla suweonensis*, which is restricted to small ranges and is reproductively isolated from the phenotypically similar tree frog *Hyla japonica*.

Of the 'true' frogs, the black-spotted pond frog *Pelophylax nigromaculatus* (*Rana nigromaculata*) and the gold-spotted pond frog *P. chosenicus* (*Rana chosenica*) are listed as 'near threatened' and 'vulnerable', respectively, on the IUCN Red List. *Pelophylax chosenicus* is known from fewer than 26 locations, and its remaining habitat is at risk from urban development. Other species, including the wrinkled or rough skinned frog, *Glandirana* (*Rana*) *rugosa*; the Korean brown frog, *Rana coreana*; Dybowski's brown frog, *Rana dybowskii*; and the Huanren brown frog, *Rana huanrenensis*, appear not to be at risk. The American bullfrog, *Lithobates catesbeianus (Rana catesbeiana)*, now is common throughout South Korea and may be a vector for the spread of the amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*).

Prevalence of amphibian chytrid fungus in South Korea

We are studying how the amphibian chytrid fungus affects Korean species and its possible contribution to population declines. Although no mass mortality events have been reported, nor have any individuals from the wild been observed demonstrating clinical signs of chytridiomycosis among the Korean amphibians, population sizes have declined and ranges have contracted in several species. Habitat degradation and destruction may be primary causes, as well as harvesting for food or medicine especially in rural areas, but disease also may play a role. Since 2007, we have surveyed amphibians throughout the Korean peninsula and Jeju Island for *Bd* infection using a combination of histology, immunoperoxidase staining, and PCR (Yang et al. 2009a).

Based on samples of 1,110 individuals from 81 regions, we have found amphibians infected by *Bd* throughout the country. Incheon and Busan, near coastal ports, show the highest prevalence of infected animals (16% and 26%, respectively). Prevalence ranges between 3 and 9% elsewhere, lowest in western areas of the country. American bullfrogs, *L. catesbeianus*, show the highest prevalence (18%), consistent with the hypothesis that they may be the source and vector of *Bd* spread. Surprisingly, given its limited and restricted range, the Jeju salamander, *H. quelpaertensis*, also shows a prevalence of 18%. This is followed by *G. rugosa* (11%), *H. japonica* (10%), *R. dybowskii* (9%), *B. gargarizans* (7%), *R. coreana* (5%), *B. orientalis* (5%), *H. leechii* (2%), and *P. nigromaculatus* (1%). Sample sizes of other species are still too low to allow us to draw conclusions.

Has amphibian chytrid fungus arrived only recently in South Korea?

Analysis of the haplotypes of the *Bd* lineages observed infecting Korean amphibians reveals a diversity of strains including several unique lineages that have not been found elsewhere in the world but may be closely related to those in Japan (Goka et al. 2009). Among 13 *Bd* positive sequences, six were coincident with sequences previously entered into GenBank while 3 haplotypes

from 7 sequences in South Korea were not. The possibility thus exists that although *Bd* may have been carried into Korea on introduced species such as *L. catesbeianus, Bd* may have been present in Korea prior to recent amphibian introductions. In that case, endemic *Bd* lineages may have evolved to be less virulent to their amphibian hosts, or conversely, amphibians may have evolved resistance to these lineages. We plan to further characterize the *Bd* lineages present in Korea and their relative virulence to amphibian populations.

Some anuran species which we investigated in our study. Top left: *Bufo gargarizans*. Photo: Jungbae Park. top right: *Hyla japonica*. Photo: Jungbae Park. bottom left: *Rana huanrenensis*. Photo: Jungbae Park. bottom right: *Pelophylax nigromaculatus*. Photo: Jonathan Fong.

Evolution of immunogenetic responses to amphibian chytrid fungus

The immunological response of amphibian hosts to *Bd* is a major focus of our research. We are studying the co-evolution of *Bd* lineages and the immunological responses of their Korean hosts, especially focusing on genetic variation in the major histocompatibility complex (MHC). By sequencing MHC class I and class II genes, we are examining whether particular MHC alleles confer resistance to *Bd* and thus spread in populations. Although this work still is in progress, we have compiled MHC sequences directly from Korean amphibians by the use of next-generation sequencing methodologies. This should allow us to examine the evolution of hosts' immunogenetic responses more rapidly, and in more extensive detail, than if we were to use traditional means of genetic analysis, which rely on sequence information obtained from model species such as *Xenopus laevis* (Bos and Waldman 2006). Should we find that particular MHC alleles confer resistance to *Bd*, we will develop plans for captive management of threatened species that may involve selective breeding for disease resistance (Barribeau et al. 2008).

While we have accumulated no evidence yet that *Bd* is significantly impacting Korean species, we cannot afford to be complacent. Our studies are still in the beginning stages, and although Koreans love nature and wildlife, remarkably little is known about the ecology or life history of Korean amphibians. South Korean government policy actively promotes nature restoration, for example, by releasing large number of amphibians into city reserves. But these reintroductions, even as they heighten awareness of Korean amphibians, may pose risks to population viability as genetic differentiation of source populations is not considered nor are introduced animals tested for *Bd* infection. We also are concerned that new, possibly more virulent lineages of *Bd* might be introduced into Korea through the continued unregulated importation of amphibians as pets (Yang et al. 2009b), which are not screened for *Bd* infection.

Acknowledgments

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Brief History of Long-Term Research Efforts on the Oriental Fire-Bellied Toad, *Bombina orientalis*, in the Republic of Korea

By Robert H. Kaplan

Kaplan and colleagues have been working on the evolution, ecology, development and life history of the oriental fire-bellied toad, Bombina orientalis, both in the field in South Korea and in his laboratory at Reed College since 1985. For a brief introduction to aspects of the work and access to a bibliography see: http://academic.reed.edu/biology/professors/rkaplan/index.html#RES.

The oriental fire-bellied toad, *Bombina orientalis* in Jung Bong

Since 1985, Kaplan has established two field sites in South Korea with the help of local environmentalists and merchants, and governmental agencies. Both sites are on the northeast side of the country in the Taebaek Mountain Range. The first is above the village of Munungae in the Province of Kangwon-do. The second is a short distance away in a different watershed in the Jung Bong Valley. Access to these field sites and major logistical supports have been made possible by local environmentalists, Kim Wongi and Choi Geumsook of the Munung Valley.

Over the past 25 years, approximately 13 expeditions with Reed College students were conducted during the breeding season of *Bombina* from the end of May until the end of June. Over 30 senior theses on the development, evolution and ecology of *Bombina* have been produced by Reed College students working in Kaplan's lab, many of whom have gone on to obtain university professorships.

Kaplan's initial introduction to *Bombina* at numerous field sites in Korea was made possible by Professor Suh-Yung Yang of Inha University, now deceased but remains an influential figure in Korean Zoology. Many of Professor Yang's students have continued his tradition of collaboration, including Dr. Mi-Sook Min of Seoul National University. Over the past seven years Dr. Daesik Park of Kangwon National University and his students have provided invaluable assistance and have partnered with Kaplan in articles in the older Froglog run by the DAPTF, and Professor Park is now a co-chair with Kaplan of the newly metamorphosed ASG Korean working group.

Dr. Robert Kaplan (left) and two undergraduate students, Jessie Ellington (center), and Advait Jukar (right) with the mesocosms used in experiments in Jung Bong

Kaplan and colleagues most recent research on *Bombina orientalis* focuses on the effects of daily thermal variation and extreme temperature fluctuations on early development. They are finding that diel thermal variation results in fitness related modifications to early larval morphology and performance. Their work is beginning to focus on interpopulation variation and local adaptation especially as it relates to changing agricultural practices in Korea.

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Saving the Gold-spotted Pond Frog in South Korea

By Nam-Yong Ra and Daesik Park

Figure 1. A typical habitat (above) and an amplexed pair (right) of the gold-spotted pond frog in South Korea

In South Korea, one of the biggest challenges as the country grows is how to balance environmental protection with economic demands. This is particularly critical with increasing demands for development in lowland habitats, as more than 70% of the country is mountainous and more difficult and expensive to develop. Korean frog populations that inhabit agricultural areas or wetlands in these lowland habitats have rapidly decreased since 1980s, when South Korea began its rapid development. One of the declining frog species is the gold-spotted pond frog, *Rana plancyi chosenica* (*Pelophylax chosenicus*), with two distinctive gold lines on its dorsal plate. Before the early 1980s, the frog was commonly found in agricultural areas or wetlands in lowland habitats (Yang and Yu 1978, Figure 1). Today, only several isolated populations of the species are found mostly along the west coast of the country. Due to the small number of identified field populations and its relatively restricted distribution, the gold-spotted pond frog was designated as a vulnerable species by IUCN (IUCN 2011) in 2004 and also classified as an Endangered Category II species by the Ministry of Korean Environment in 2005. Between 2006 and 2009, we conducted a series of field and captive breeding studies on the gold-spotted pond frog, supported by "an Eco-Technopia 21 project" of the ministry. The goal of the research was to elucidate the basic ecology of the species and to develop conservation and rehabilitation plans (Sung et al. 2007, Park et al. 2009).

During the study, we located 26 field populations. The altitude of the populations was below 16.7 m and vegetation surface cover in their habitats was over 74%. We also found that the presence of Bullfrogs, *Rana catesbeiana* (*Lithobates catesbeianus*), introduced in the early 1970s, was related to the absence or extinction of the local population of gold-spotted pond frogs. For example, while surveying a pond or wetland for 10 minutes, we found more than five bullfrogs and no gold-spotted pond frogs. These findings suggest that there is a causal relationship between the decline and/or extinction of the gold-spotted pond frog populations and the invasive bullfrogs in this country (Ra et al. 2010).

In addition, we conducted radio-tracking of the gold-spotted pond frog. This is the first known radio-telemetry study of amphibians in South Korea (Ra et al. 2008, Figure 2). In the study, gold-spotted pond frogs were found to be sedentary, with daily movements of only 9.8 m and did not move more than 7 m away from ponds or wetlands throughout both the breeding and non-breeding seasons. The species were found to hibernate in mountain edges or dried crop fields within 40 m of ponds or wetlands. The overall year-round home range of a field population was less than 1 ha. A small home range size is an important factor for the conservation of the gold-spotted pond frog, considering that this species inhabits areas where demand for development is significant and ever increasing.

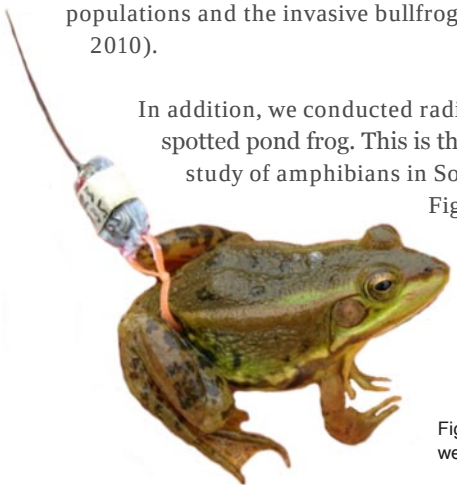

Figure 2. A male gold-spotted pond frog wearing a transmitter for radio-tracking.

Finally, we prepared a conservation plan for all of the field populations of the gold-spotted pond frog identified during this study, based on our field and captive breeding study results. For this conservation plan, we first classified all populations into three categories based on their threat levels and described in detail all factors required for management of each field population. Budget estimates for managing each population were also prepared. The total cost to conserve all the populations was estimated at about 20 billion won. Although the Korean Ministry of Environment has yet to take action for the conservation or recovery of the field populations of the gold-spotted pond frog, our study greatly increased the public's concern and awareness of decreasing frog populations in South Korea. With our findings and the increased public awareness of the gold-spotted pond frog, we are hopeful that in the near future more funding will be made available to conserve this beautiful frog in South Korea.

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Little known endemic frogs of the Andaman Islands

By S.R. Chandramouli, S. Harikrishnan & Karthikeyan Vasudevan

India has several important zones of high endemism and diversity (Myers et al., 2000). These include the Western Ghats in the peninsula, rainforests of the Northeastern frontier and the Andaman and Nicobar Islands. Of these regions, the Western Ghats and the hills of the Northeast are relatively well explored, in comparison with the Andaman and Nicobar Islands. There have been very few reports on the frogs of these islands (Sarkar, 1990). Of the eighteen species of frogs known from the islands, five (28 %) are restricted to them. As part of an ongoing study in the Andaman and Nicobar islands, we are documenting amphibian species diversity in the Andamans, following are the observations on breeding and nesting behavior in some little known endemic species.

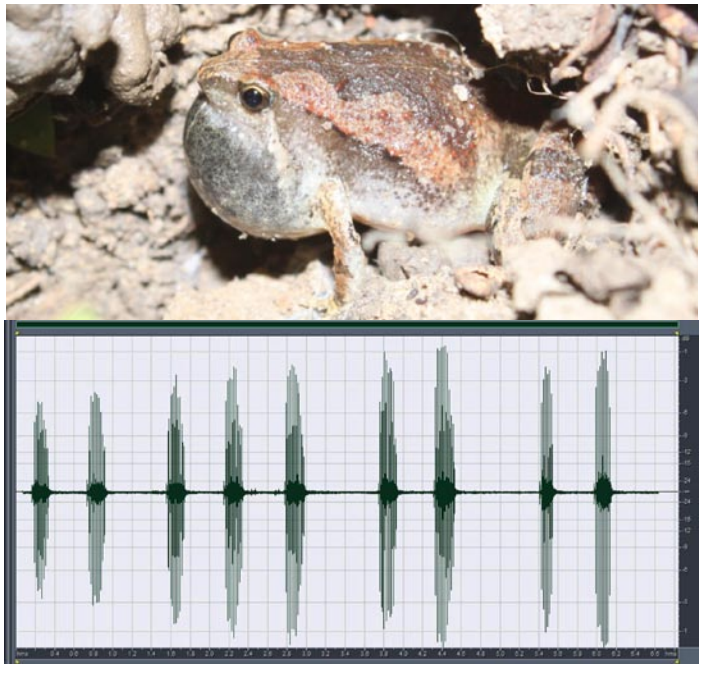
Embryos of *Ingerana charlesdarwini* seen in a water filled tree hole. Photo: S.R. Chandramouli

Ingerana charlesdarwini (Das, 1998) is an endemic dicroglossid frog described from the Andaman Islands in the recent past. Preliminary notes on the breeding habits of this endemic species were published along with its description (Das, 1998). This species has not been reported since its description almost a decade ago. As part of this ongoing study, we observed individuals of this species in courtship behavior on several occasions. Breeding takes place immediately after the onset of the monsoon in late May. Actively calling males were observed on tree trunks and on roots, especially after rainy nights. Several males assembled and started calling for seeking females, and the call resembles "*pip... pip... pip...*" The maximum amplitude of the call was a little more than -12db, with a mean amplitude of about-15 db and frequency of 937.53 Hz. The call had 23 discernible syllables within a duration of eight seconds. After mating, the female deposited dark pigmented ova in tree holes at heights ranging from <0.3 m to 1 m above ground level. Breeding pairs and freshly hatched tadpoles were seen between June and November. We observed this frog to be one of the most abundant species occurring in most of the islands sampled, with a density of 100 individuals ha^{-1}.

Adult male *Kaloula baleata ghoshi* calling. Photo: S.R. Chandramouli

Amplecting pair of *Kaloula baleata ghoshi*. Photo: S.R. Chandramouli

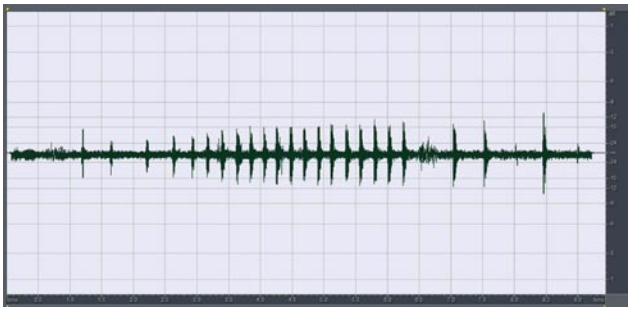
Among the microhylid frogs, *Kaloula baleata ghoshi* Cherchi, 1954 is a little known endemic subspecies restricted in distribution to Little and South Andaman Islands (Cherchi, 1954). Breeding activities were observed to commence during mid March soon after intermittent showers. We observed this species to be a communal breeder, breeding in the same pool along with *Microhyla chakrapanii*. Several males aggregated in shallow pools and started calling at about 21:00 hrs. The depth of the pool



Top: *Microhyla chakrapanii* calling. Photo: S.R. Chandramouli. Bottom: Call of *Microhyla chakrapanii*

was about 1 m and had an approximate diameter of 4 m. Males were smaller than females in size and the amplexus was axillary. Breeding continued till the end of March. Despite having observed several calling males and amplecting pairs, no egg-mass could be located. Being one of the largest frogs living in these islands, they are significantly less abundant and are seldom seen.

Another little known endemic species belonging to this family is *Microhyla chakrapanii* Pillai, 1977. Nothing is known to-date about this species since its description. It was originally reported from Mayabunder in the Middle Andaman Island. We recorded this species from Middle and South Andaman. Our observations present some basic details about breeding activities in this species. Calling males were once seen during late November in a patch of secondary forest. The call duration lasted for about 6.6 seconds and was composed of discontinuous syllables of "*treek... treek... treek...*". Maximum amplitude almost exceeded 0.4 db, with a dominant frequency of 155.42 Hz. We also observed a tadpole of this species in a shallow puddle, which was about c. 5 cm deep. On another occasion, in March 2011 during a rainy night, a male which kept calling encountered a female and the amplexus began at c. 00.00 hrs. The male frog mounted on the female and after a while, the female released ova as clumped mass consisting of black and white colored eggs. There were about 160 eggs in the clutch, which were deposited on the surface of water as the female bent its hind body downwards. This continued for a few more days till the rains subsided.



Left: *Ingerana charlesdarwini* using a phytothelm. Bottom: Call of *Ingerana charlesdarwini*

Freshwater bodies being crucial for the larval development of amphibians are unfortunately a scarcity, in the islands. This has rather compelled some of the 'terrestrial' species to exhibit a unique breeding habit of using 'phytothelms' which are the tree holes filled with rain water (Das, 1998). Surprisingly, we found freshwater stream (a rare sight) in the islands 'empty' without even any amphibian breeding activity. Apart from these limitations, they also live in a highly unstable environment, prone to natural calamities. Recent surveys revealed that the Tsunami in 2004 wiped out populations of the red-eared frog (*Hylarana erythraea*). Another major threat for these fragile organisms is the amount of anthropogenic pressure they are subjected to and possible impacts due to climate change. Further are underway to uncover the unexplored richness of these islands.

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In search of Legless amphibians at Goa and Karnataka parts of the Western Ghats

By K.P. Dinesh[1], Gopalakrishna Bhatta[2], P. Prashanth[3] and Nirmal U. Kulkarni[4]

The Western Ghats, one of the global biodiversity hotspots (Meyers et al. 2000), is known to have 167 species of amphibians; among these 23 species (Dinesh and Radhakrishnan, 2011) are legless amphibians placed in the families Ichthyophiidae and Caeciliidae systematically under the order Gymnophiona. Although apodans are secretive, new species descriptions and range extensions for the already described species are being reported from Goa and Karnataka states periodically due to concerted efforts of researchers.

Figure 1: Search for Caecilians at Sirsi, Karnataka

In the Western Ghats part of Goa and Karnataka seven new species of caecilians have been described since the year 1999. *Gegeneophis krishni* (from Karnataka) was described in the year 1999; *Gegeneophis madhavai* (from Karnataka) and *Gegeneophis nadkarnii* (from Goa) were described in the year 2004 with two animals each; *Gegeneophis goaensis* (from Goa), *Gegeneophis mhadeiensis* (from Karnataka) and *Ichthyophis kodaguensis* (from

Figure 2: Homestead areas next to forests of Western Ghats at Castle Rock, Karnataka

Figure 3: Caecilian habitat at organic areca orchards

Karnataka) were described in the year 2007 with three, three and seven animals respectively. Very recently *Gegeneophis pareshi* (from Goa in the year 2011) was described with 16 animals. Subsequently, additional collections were added to the national repositories for a few of the above mentioned species to understand the intraspecific variation in metric and meristic data. However, very little information is available on the natural history of most of the species of caecilians in the Western Ghats and for all the seven species cited above.

In order to have additional collections and to understand the breeding habit of caecilians in the bordering villages of Goa and Karnataka, an expedition was undertaken recently (August 2011) by the authors at Chorla Ghats of Goa and Kungini village, Dhobi vadda village, and Kalambuli village of Castle Rock in Karnataka. Searches were also made at Manchikere village, Honnalli village, surrounding of Siddhi settlements in Yellapur area and Kallavae village adjacent to Sirsi in Karnataka.

Searches (Fig 1) were made near the homestead areas adjacent to forest patches (Fig 2) and areca, coconut and banana plantations (Fig 3). Interestingly, we collected individuals belonging to the genera *Gegeneophis* and *Ichthyophis* from the areca plantations where only organic cultivation is practiced and near homestead areas animals were traced below the household kitchen and straw garbage (Fig 4).

Figure 4: Caecilian habitat below the household waste and straw garbage

Since caecilians are difficult to identify in the field, representative collections were made for identification and publication. Our present expedition has proved that caecilians are not very rare as conceived, but can be found by thorough search in organic plantations with optimum shade and moisture.

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Amphibian Conservation Workshop in India

By Don Church

Chief Minister Oommen Chandy inaugurates the workshop, 'Advancing frontiers of amphibian conservation'.

On August 8, 2011, a workshop entitled 'Advancing frontiers of amphibian conservation' was held at the Kerala Forest Department Auditorium in Thiruvananthapuram, India. The Chief Minister of Kerala, Oommen Chandy, inaugurated the workshop that was jointly organized by the University of Delhi and the Kerala State Forest Department.

Minister for Forests, K.B Ganesh Kumar, presided over the function. Prof Dinesh Singh, Vice Chancellor of the University of Delhi, S D Biju, faculty of the Department Environmental Biology of University of Delhi and Forest Chief Conservator T.M Manoharan were also present, in addition to over 100 Forest Department officials from the states of Kerala, Tamil Nadu, Karnataka, Maharashtra and Gujarat. In addition, the meeting was attended by several journalists and resulted in over 30 newspaper articles and a forthcoming CNN-IBN special report that will address amphibian conservation in India.

Herpetologists presented their most current analyses of species richness, diversity and conservation priorities within specific areas of the Western Ghats. Forest Department officials delivered presentations that overviewed how their current management practices address amphibian conservation needs. Chief Minister Chandy announced, "Government will take all necessary steps to protect the amphibian community". Following the workshop he has begun to schedule meetings with biologists to discuss next steps toward advancing conservation actions for amphibians.

An interactive closing session was led by CNN-IBN journalist, Bahar Dutt, to address how media can better report on the situation amphibians are in and what needs to be done to reverse their declines.

Funding for the workshop was provided by the US Fish and Wildlife Service, Global Wildlife Conservation, Kerala State Forest Department, and the University of Delhi.

More Frog Bounties from India's Peninsular Mountains

By Robin Abraham

The Western Ghats hold many microhabitats that supports an exceptional diversity of amphibians. Photo: Robin Abraham

India's Western Ghats mountain range has been in the news, on and off in the recent past for a wide array of biological discoveries made here. This is thanks to an increasing spurt of interest by various experts, which has only added stronger evidence to the significance of these ancient mountains as a very important biodiversity hotspot[1]. Amphibians are one group that has been at the forefront of these discoveries here. Over a period of ten years from the year 2000 to 2010, almost 40 new species of frogs have been described under various genera and even a new family, all of which are restricted to the Western Ghats. In fact, more than 85% of frog species found in this region are endemic.

But, the discovery of an additional ten species this year takes the total tally of documented frog species in the Western Ghats to 145. A team led by Dr. Anil Zachariah announced these novelties in August 2011[2,3]. Dr. Zachariah was fundamental in supporting the expeditions that lasted close to five years, mainly sustained by his veterinary practice in the Department of Animal Husbandry in Wayanad, Kerala. The other team members constituted of Prof. E. Kunhikrishnan of the University of Kerala, C. Radhakrishnan, K.P. Dinesh and M. Jafer Palot of the Zoological Survey of India, voluntary researchers S. Kalesh and C.K. Vishnudas along with two keen, enthusiastic young naturalists, Sandeep Das and David Raju.

Top left: *Raorchestes theuerkaufi*. Photo: Anil Zachariah. Top right: *Raorchestes manohari*. Bottom left: *Raochestes crustai* (male). Bottom right: *Raochestes crustai* (female). Photo: Sandeep Das.

A person who was not part of the team, but contributed to the discovery of one of the novelties in this study, is Ravi Chandran, a shopkeeper from Wayanad who has accompanied Dr. Zachariah on his field visits in the past. To honour his contribution, the species he discovered was named *Raorchestes ravii*. The modest backgrounds of many members of the team and the absence of external funding, justifies that even non-professionals, with genuine dedication and commitment can make relevant contributions to the pursuit of knowledge. After all, the pioneer naturalists of India, whose documentations we follow today, were not established scientists when they started out, but amateurs who took up the task by sheer passion.

The team documented the new species, all belonging to the family Rhacophoridae, over a wide geographical expanse of the southern Western Ghats, from the Upper Nilgiris south to the Agasthyamalai Hills. Their encounters with the novelties were made not only in sanctuaries or parks, but also in forest fragments in monoculture plantations outside of protected areas.

One of the most beautiful frogs unearthed in this study is *Raorchestes manohari*, the species name being suggestive of its attractive nature; 'manohari' being the Malayalam word for 'pretty'. This novelty was spotted accidentally when the team had just made another remarkable find, that of *Raorchestes chalazodes*, way back in 2008. Both species are specialized forms inhabiting reed brakes (*Ochlandra spp*.), making the reed their home. When Albert Günter had made the original description of *R. chalazodes* in 1876, he made no account of the habitat, since it was Lt. Col. R. H. Beddome who provided him with a preserved specimen[4]. This lack of detail in the original literature and the threat of elephants that have an inherent preference for reed brake habitats, prevented subsequent generations of researchers from exploring them systematically, delaying the rediscovery of the species for more than 130 years since it's initial collection.

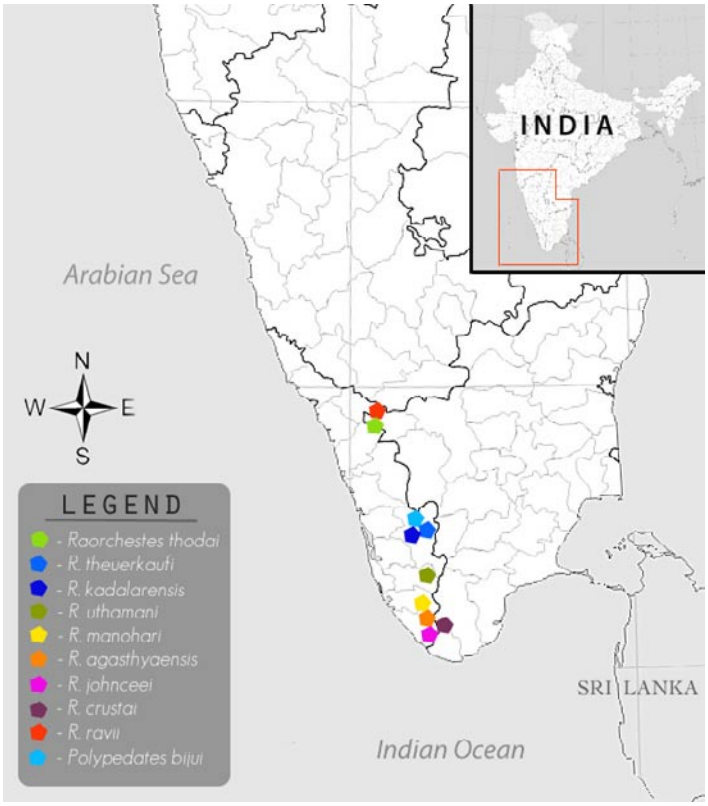
Another interesting frog among the novelties is *Polypedates bijui*, which remains inconspicuous for most of the year, but emerges only once during the breeding season. Where is it that this species disappears to, and how it survives during the remainder of the year is a mystery.

Raorchestes crustai, whose call is similar to that of the canopy frog *R. nerostagona*[5] in producing a sound comparable to a waterdrop falling into a pool of water, is also a frog of the canopies. However, unlike the latter, it is sexually dimorphic, where males exhibit a mixed pattern of dark cream and brown hues, akin to a tree's bark, whereas the females sport a bright green colour mixed with dark grey. This could be perhaps because of the males using tree trunks as primary habitat, while the female spends most of their time on mossy and lichen patches on tree branches. The other species encountered in this discovery are *Raorchestes thodai*, *R. kadalarensis*, *R. johnceei*, *R. uthamani*, *R. agasthyaensis* and *R. theuerkaufi*.

Dr. Zachariah's penchant for frogs goes beyond documentation. His interests include understanding their behavior, reproductive strategies and distribution patterns. In fact, he has made many fascinating observations on this diverse group over the past 17 years. His silent efforts and contribution to batrachology was acknowledged in 2006, when an endemic bushfrog was named after him[6].

But, Dr. Zachariah's observations have also brought out a precarious picture for some of these sensitive and delicate creatures. He has noted, for example, that the irregularities in monsoon rainfall in recent years and the shift in flowering patterns of tree species on which the reproduction of some species of frogs and toads is dependent, has negatively impacted their populations (Zachraiah 2010, pers. observ.).

Polypedates bijui. Photo: Sandeep Das



Distribution map of ten new frog species discovered in 2011 from the Western Ghats of India. © Robin Abraham

Other dominant threats to frogs are the conversion of habitat to monocultures, and more recently, to resorts catering to the burgeoning tourism industry, which are mushrooming in many mountain habitats. The discharge of untreated sewage mixed with oils and detergents, from resorts into hill streams is responsible for the mortality of tadpoles of many endemic frog species.

Dead tadpoles in a stream near a tourist resort adjacent to critical amphibian habitat. Photo: Sandeep Das

Indiscriminate harvesting of wild reeds is also now understood to be a major hazard for some of the specialized forms of frogs. For instance, one of the team members, Sandeep Das, while sipping tea outside a tea-stall on a highway, was surprised to hear the call of *Raorchestes manohari*. When he started following the source of the call, he was alarmed to find the calls coming from a truck loaded with harvested reeds, making it's way to a paper pulp factory. With many unique species making reeds their home, including ones that remain yet to be described, we may never know what we're losing in terms of our biological heritage. These are truly, the real 'lost species'.

Harvested reeds (*Ochlandra spp.*) being loaded onto a truck, at a forest reserve. Photo: E. Kunhikrishnan

The challenge now is to make progress past cataloguing species and identify ways to conserve and sustain this wonderful diversity into the future. Individuals like Dr. Anil Zachariah are inspiring models to emulate while making critical examinations on the problems faced by amphibians today, which needs to be of a multidimensional nature. Frogs are ideal mascots for integrating the conservation of varied habitats since the life history of many species includes an aquatic youth and a land dwelling adult phase. To effectively conserve them, we need to preserve streams, swamps, forests, grasslands and even reed brakes, among other threatened habitats, both inside and outside existing protected areas. If members of civil society can contribute to the identification and description of these remarkable creatures, then surely the responsibility in helping to appreciate and conserve them can come too.

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A dozen new Night frog species discovered from dwindling rainforests in India

Researchers based at the University of Delhi and affiliated with Global Wildlife Conservation and the IUCN/SSC Amphibian Specialist Group have found a dozen new species of frogs in the forests of Western Ghats, India. This exciting news was published in the latest issue of Zootaxa (International Journal of Zoological Taxonomy). Prof. S.D. Biju of University of Delhi discovered the new species and published the results with co-researchers from the Bombay Natural History Society, the Zoological Survey of India and Vrije University, Brussels.

The twelve species were identified after a revision of the Night frog genus *Nyctibatrachus*, following twenty years of field studies in the Western Ghats of India (Kerala, Tamil Nadu, Karnataka, Goa, Maharashtra states). The Western Ghats are a global biodiversity hotspot for wildlife richness and endemism. Morphological traits and molecular markers were used to recognize the new species.

Findings include the rediscovery of three **'lost species'**: Kempholey Night Frog (*Nyctibatrachus kempholeyensis*), Coorg Night Frog (*Nyctibatrachus sanctipalustris*) and Forest Night Frog (*Nyctibatrachus sylvaticus*). C.R. Narayan Rao from Karnataka described these frogs between 1920 and 1937. However, for the decades following their original descriptions, no further reports of these three little known species were made.

From top left to bottom right: GAVI NIGHT FROG - *Nyctibatrachus gavi*, DANIEL'S NIGHT FROG - *Nyctibatrachus danieli*, INDRANEIL'S NIGHT FROG - *Nyctibatrachus indraneili*, PERIYAR NIGHT FROG - *Nyctibatrachus periyari*, VUB NIGHT FROG- *Nycyibatrachus vrijeuni.*, DEVEN'S NIGHT FROG - *Nyctibatrachus deveni*, JOG'S NIGHT FROG - *Nyctibatrachus jog*, PILLAI'S NIGHT FROG - *Nyctibatrachus pillaii*, SHIRADI NIGHT FROG - *Nyctibatrachus shiradi*, WAYANAD NIGHT FROG - *Nyctibatrachus grandis*, SPINULAR NIGHT FROG - *Nyctibatrachus acanthodermis*. Photo: S.D. Biju

These new discoveries bring the number of new species described by herpetologist SD Biju and his colleagues to an astounding forty-five. Among the new species described, is the "Deven's Golden Night Frog" (*Nyctibatrachus deveni*), which is restricted to a small area of forest within the Indian state of Kerala. This frog is named after Deven Brian Sheth, in honor of his wildlife philanthropic parents, Adria Sheth and Brian Sheth, who is President of Vista Equity Partners, a private equity firm focused on software and technology-enabled businesses.

Previous discoveries include the famed "Purple Frog" (*Nasikabatrachus sahyadrensis*) belonging to a new family of frogs, Nasikabatrachidae; the diminutive *Nyctibatrachus minimus*, the smallest tetrapod in India; the first Indian canopy frog, *Raorchestes nerostagona*, and the first Asian leaf folding frog *Rhacophorus lateralis*, among others.

Frogs are environmental barometers and are very sensitive to subtle changes in their environment. They lived alongside dinosaurs, which have long since disappeared, but amazingly frogs continue to exist. Unfortunately, their existence is precarious. If the present trends in extinction continue, many frogs could disappear forever. Thirty-two percent of the world's amphibian species are threatened with extinction. Every twenty minutes a species is pushed to extinction and more than 1000 acres of forests are destroyed. But there is still a small ray of hope for a brighter future for frogs. To begin, they have lived on earth for a period that is 5000 times longer than that of humans. Also, there is a rapidly growing interest in frogs among scientists and nature lovers alike.

"Amphibians are popularly known as environmental barometers. They indicate the state of environmental health. Their conservation is extremely vital not only from amphibians point of view but also from the perspective of overall nature conservation" explains Delhi University Professor S D Biju, who led the research.

Six out of the twelve new species are from unprotected, highly degraded habitats and require immediate attention to conserve these species and their habitats. The night frogs require unique habitats - either fast flowing streams or moist forest floor for breeding and survival. Further, it is the only group of frogs that can achieve fertilization and reproduction without any physical contact. This paper also reported the reproductive strategy in six species, and provided evidence for parental care behavior.

"The major threat to amphibians in India is massive habitat loss. Taking any conservation effort for amphibians will indirectly conserve several other important biodiversities of that area" SD Biju.

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"Lost" frogs found! from left to right: KEMPHOLEY NIGHT FROG - *Nyctibatrachus kempholeyensis*, COORG NIGHT FROG - *Nyctibatrachus sanctipalustris*, FOREST NIGHT FROG - *Nyctibatrachus sylvaticus*. Photo: S.D. Biju

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Some observations of malformation, eye disease, parasitic and viral infection and the effects of agrochemicals on amphibians in Sri Lanka

By Anslem de Silva

There is archaeological, historical and literary evidence to show that from early Christian times amphibians have attracted the attention of the people of Sri Lanka. This is evident from the discovery of bronze casts of frogs belonging to the 6th to 8th century AC, including a unique and accurately made gold cast of a *Euphlyctis cyanophlyctis* or the Skipper frog (Figure 1).

Figure 1. Gold casts of a frog (6th to 8th century AC). Photo Anslem de Silva

There are also about 150 villages, ponds and marshes with names associated with frogs dating from the time of the early Sinhalese kings. Thus, it is reasonable to assume that the early inhabitants of the island would have understood the ecological role played by amphibians in agriculture, their association with water and the beneficial effects played by frogs through preying on insect pests.

A study was conducted in the 3 main climatic zones (wet, intermediate and dry zones) of the country from July 2008 to July 2009 during which various malformations, eye diseases, infections and the effects of agrochemicals on amphibians were identified (de Silva, 2009). Others have also shown assorted threats to the amphibian populations in Sri Lanka (de Silva, 2001a; de Silva, 2001b; de Silva and de Silva, 2001; de Silva et. al., 2008; de Silva et. al., 2009a; de Silva et. al., 2009b; de Silva and Dawundasekara, 2010; Rajakaruna at al., 2007).

The following are some of what we recorded during the study:

1. Malformations

Among the malformations to amphibians observed were:

Figure 2. Opaqueness and Brachygnathia *Fejervarya kirtisinghei*. Photo Anslem de Silva

1.1. Lower jaw deformity (Brachygnathia)

A case of deformed lower jaw in a female *Fejervarya kirtisinghei* (Manamendra-Arachchi & Gabadage, 1996) measuring 45 mm from Ambagamuwa (Figure 2).

1.2. Body Deformities (Curvature/Scoliosis)

Body deformities in frog species *Sphaerotheca breviceps* and *Fejervarya kirtisinghei*. The conditions were also evident in the radiographs (Figures 3, 4).

Figure 3. (left) Scoliosis, *Sphaerotheca breviceps*. Photo Anslem de Silva
Figure 4. (right) Radiograph of *Sphaerotheca breviceps*. Photo Anslem de Silva

1.3. Forelimb malformations

Several adult frogs (e.g. *Fejervarya greenii, Fejervarya limnocharis, Hylrana gracilis, Microhyla ornata, Kaloula taprobanica, Duttaphrynus scaber* and *Pseudophilautus auratus*) with various stages of deformities ranging from missing fingers to no hand (wrist downwards) (Figure 5).

Figure 5. *Hylrana gracilis* with no hand. Photo Anslem de Silva

1.4. Hind limb malformations

The following examples of malformed hind limbs:

a. Ectromelia of the left hind limb in a male *Ramanella variegata* (Stoliczka, 1872) measuring 25 mm and weighing 0.8 g in anthropogenic habitat in Mihintale (Figure 6).

b. Ectromelia of the right hind limb in a *Euphlyctis cyanophlyctis* Schneider, 1799 measuring 23 mm in a stream at Labugama (Figure 7).

Figure 6. (left) Ectromelia of *Ramanella variegata*. Photo Anslem de Silva.
Figure 7. (right) Ectromelia of *Euphlyctis cyanophlyctis*. Photo Anslem de Silva

2. Eye Disease

2.1. A case of small right eye (Microphthalmia) was observed in a relict frog species, *Lankanectes corrugatus* (Nyctibatrachidae) measuring 39 mm from Yagirala (Figure 8).

Figure 8. (left) Microphthalmia in *Lankanectes corrugatus*. Photo Anslem de Silva
Figure 9. (right) Opaqueness in left eye *Pseudophilautus fulvus*. Photo Anslem de Silva

2.2. Opaqueness in the right eye of a female *Fejervarya kirtisinghei* (Manamendra-Arachchi & Gabadage, 1996), measuring 45 mm from Ambagamuwa (Figure 2).

2.3. Opaqueness in the left eye of a female *Pseudophilautus fulvus* (Manamendra-Arachchi & Pethiyagoda, 2005) (Figure 9) measuring 57 mm from Knuckles.

3. Parasitic infections

During the survey we investigated 181 free living specimens of the Saddled Tree frog *Taruga eques* that were inhabiting marshes, forest ponds, agro-wells and vegetable farms from 1600-2300 m above sea level. Of this sample 31 (30 male and 1 female) specimens were infected with encysted Proteocephlan plerocercoids, a cestode (species not yet identified). The highest frequency of occurrence of this cestode was on the ventral side of the thigh. Only in 2 specimens did we observe a cestode on the forelimb (Figures 10, 11).

Figure 10. (left) *Taruga eques* parasitic infections. Photo Anslem de Silva
Figure 11. (inset) Cestodes removed. Photo Anslem de Silva

4. Possible Viral Infection

During the survey all frog species which are primarily aquatic such as *Euphlyctis cyanophlyctis, E. hexadactylus, Fejervarya greenii, F. kirtisinghei, F. limnocharis, Hoplobatrachus crassus* and *Lankanectes corrugatus* were assessed. Only in *Euphlyctis cyanophlyctis* did we observe a conspicuous 'red patch' above the eye on the dorsal aspect of the head in some specimens. This observation was made in many different locations. It was present in both sexes (Figures 12). Even after death the particular 'red patch' was inflamed and distinct (Figure 13).

Figure 12. (left) Red patch in *Euphlyctis cyanophlyctis*. Photo Anslem de Silva Figure 13. (right) Conspicuous Red patch in a dead frog. Photo Anslem de Silva

5. Agrochemicals and Farming Methods

Modern agricultural methods have been considered a major cause for deformed frogs as the widely used herbicides, atrazine and phosphate elevate trematode infections in amphibians (Rohr et al., 2008).

A wide variety of agrochemicals are used in Sri Lanka in large quantities in rice fields, vegetable plots and tea plantations. Invariably, different agrochemicals are applied to the same field at different stages of cultivation - to kill weeds, condition and enrich the soil, destroy soil fungus, application of pesticides to control pests and the addition of chemical fertilizers for growth etc. Thus, large quantities of agrochemicals are accumulated in the fields.

We observed two incidents in which amphibians and reptiles were killed with severe skin burns (lesions) a few hours after fields were sprayed with agrochemicals. This was possibly due to their sensitive skin having permeability to such chemicals. The following are the two incidents:

a. A hectare of virgin land was cleared and the soil treated with a fumigant (Methyl bromide) for new strawberry cultivation at Udabulathgama (Ambagamuwa). The following morning six specimens of the caecilian *Ichthyophis glutinosus* and about 20 fossorial snakes of the Family Uropeltidae (*Rhinophis homolepis*) were found dead (de Silva and Dawundasekera, 2010).

b. A quarter hectare tea plantation adjoining the author's land in Gampola was sprayed with a herbicide known as Round-up (Glyphosate) to kill the undergrowth of weeds. Within 5-7 hours after spraying there were three *Ichthyophis glutinosus* wriggling with fresh burn-like wounds (Figure 14) that eventually died (de Silva, 2009).

In one of two studies conducted at Mihintale (North-Central Province) 69% of the farmers interviewed had seen dead frogs and lizards after the application of agrochemicals to paddy fields (Somathilaka et al., 2010). The other study showed that even the

Figure 14. *Ichthyophis glutinosus* with fresh burn-like wounds. Photo Anslem de Silva

use of small quantities of Paraquat (herbicide) and Dimethione used to control sucking insects and Malathion used to destroy mosquitoes and flies in the Rajarata University Park (Mihinthale, Sri Lanka) may have resulted in mortality in frogs (Chalalochani et al., 2010).

A Final Word

Amphibians in Sri Lanka face a multitude of threats. The rate of depletion of forests and wild life habitats in Sri Lanka is considered one of the highest in South Asia (McNeely et al., 1990). Dwindling marshlands and paddy fields due to rapid urbanization and industrialization have reduced or completely obliterated many amphibian habitats. In addition, many streams and canals are becoming highly polluted or getting dried up. Habitats that are altered for agricultural use are treated with a toxic mix of chemicals with little regard to the impact on wildlife. Never has the need for action to address our issues been greater

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Amphibian Research in Sri Lanka

By Madhava Meegaskumbura, Gayan Bowatte, Kelum Manamendra-Arachchi & Suyama Meegaskumbura

In this article we are highlighting some of the ongoing and recently completed research by the Amphibian Research Group at the Department of Zoology, Faculty of Science, University of Peradeniya, Sri Lanka. Some of the work, especially the taxonomic research by us, is essentially an extension of the rigorous explorations and descriptions carried out by the Wildlife Heritage Trust of Sri Lanka in the late 90s and early 00s.

The Island's inventory of *Pseudophilautus* now stands at 67 species, with a well-resolved phylogeny available for all extant and also nearly 40 undescribed species (Meegaskumbura, PhD Thesis work). While this discovery underlines Sri Lanka's status as a global biodiversity hotspot (Meegaskumbura et al. 2002, Bossuyt et al. 2004), we also show that 19 species of Sri Lankan *Pseudophilautus* have become extinct between 1850 and 1940 (Manamendra-Arachchi and Pethiyagoda 2005, Meegaskumbura et al. 2007), which are known only from their type series in natural history museums, representing an extraordinary ~ 50% of the 38 global amphibian extinctions confirmed by IUCN's Red List. These developments in Sri Lanka are especially pertinent given that they come at a time when amphibian populations worldwide are declining, in many cases inexplicably. Of the surviving Sri Lankan tree frogs, Red List considers a total of 35 species to be threatened with extinction, mandating urgent measures to carryout extensive research based conservation work.

Taxonomy and Systematics

We have so far described 39 *Pseodophilautus* species including several extinct species as being new to science. The extant species descriptions were based on taxonomic explorations carried out

from the mid-nineteen nineties, up to 2005. Extinct species are described from reference collections that were made up to over 100 years ago. Continuing with the taxonomic descriptions, this year, we described two new species, *P. hankeni* (Fig. 1) and *P. schneideri* (Fig. 2) using molecular, morphological and morphometric data (Meegaskumbura and Manamedra-Arachchi 2011). One of these species, *P. hankeni* is a high elevation point endemic species from the Knuckles mountain range. The other species is a mid-elevation species from the South Eastern rainforest region of Sri Lanka, including the Sinharaja World Heritage Site. Both species were named after two eminent biologists and teachers, who have helped enormously in the effort of describing the Sri Lankan frog diversity, Prof. Christopher Schneider (Boston University) and Prof. James Hanken (Harvard University). There are nearly 25 new species of frogs from Sri Lanka which we are in the process of describing.

Fig. 1. (left) *Pseudophilautus hankeni*, a high elevation, point endemic species from the high peaks of Knuckles mountain range, named after Prof. James Hanken for his contributions to teaching and research in Herpetology. Fig. 2. (right) *Pseudophilautus schneideri*, a mid to low-elevation species from the South Eastern rainforests of Sri Lanka, named after Prof. Christopher J. Schneider for his contributions to Sri Lankan amphibian research. Photo: Madhava Meegaskumbura.

We recently highlighted an independent evolutionary lineage that we recognize as a new genus which we named *Taruga* (Meegaskumbura et al 2010). This species is found in montane and submontane regions of Sri Lanka, and both the tadpoles and adults can be distinguished from its sister clade *Polypedates* in terms of several unique morphological features (Fig. 3).

We are also in the process of publishing the results of molecular analyses into evolution of development and breeding strategies of Sri Lankan frogs.

Tadpole Development

We have started studying the development and life history of various tadpole species, including the terrestrial direct developing forms. In Sri Lanka, as currently understood, there is only a single genus, *Pseudophilautus*, which is characterized by direct development. Though a staging table has been made for them, we continue in describing the variation in both tempo and mode within this genus.

Fig. 3. Tadpoles of *Polypedates cruciger* and *Taruga eques;* showing some of the easily distinguishable generic characters such as the absence of a flagellum in *Taruga* when compared to *Polypedates*. Photo: Madhava Meegaskumbura.

We also have put in a lot of effort in documenting the development of amphibians with aquatic development stages (Fig. 4 and Fig. 5). We not only monitor external, buccal and osteological development (all of which are also of value in systematic studies), but also document the environmental and water quality conditions that are needed for their survival. To determine species identity, we grow the metamorphs up to six months (or more in some instances) until they become distinguishable using taxonomic keys (Fig. 6).

Fig. 4. (top) Drawing of *Microhyla rubra* tadpole, showing off the crescent shaped lobe on ventral tail fin, flagellum and anal tube in tail. Photo: Gayan Bowatte. Fig. 5. (lbottom) A full body photo of *Ramanella obscura*. Photo: Madhava Meegaskumbura.

Fig. 6. Newly emerged froglets of *Taruga eques*. Photo: Madhava Meegaskumbura.

We are also looking at how the habitat and environmental parameters affect the body shape of tadpoles and adults. Using *Polypedates cruciger*, we have found that predator presence affects the body shape of tadpoles and also that prevalence of predators induces early metamorphosis. These results will be published soon (Fig. 7).

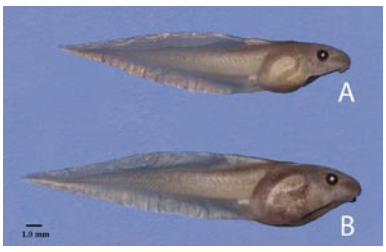

Fig. 7. Differences in body shape in tadpoles reared A. in the presence of a predator and B. in the absence of a predator. Photo: Madhava Meegaskumbura.

Diseases and emerging threats

From the vicinity of University of Peradeniya, we are noticing a group of heavily malformed tadpoles of *Polypedates cruciger*. Observations on development of these tadpoles have shown that the malformations at base of tail region carry through even to juveniles after metamorphosis. We are now studying how these malformations are affecting jumping performance of these frogs, as they become adults and also if malformations affect also the reproductive capability of these frogs. Detailed studies on this

system will reveal not only the causes of malformations, but also how these malformations affect these frogs if they are to survive to reproductive age (Fig. 8, 9, 10).

Over the past ten months we have begun noticing greater incidence of fly attacks on the foam nests of *P. cruciger*. So far, we have observed nearly 15 foam nests of these frogs, of which five were infected with fly larvae. These larvae often destroy entire nests or sometimes tadpole survival is dramatically reduced. There seems to be a correlation with the advent of rain and fly infections; we continue in gathering more data to test this

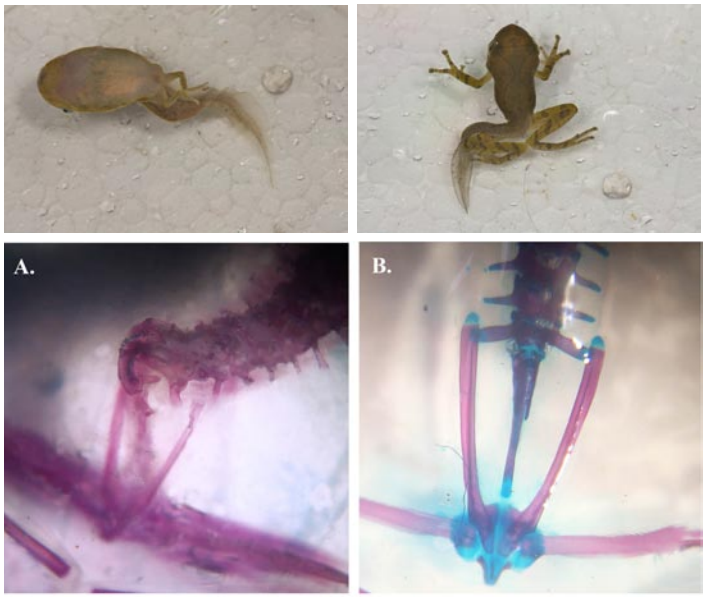

Fig. 8. (top left) A severely malformed *P. cruciger* tadpole swimming upside down, Fig. 9. (top right) Malformed froglet of *P. cruciger* ready to metamorphose. Photo: Madhava Meegaskumbura. Fig. 10. (bottom) A. Deformed urostyle region of a double stained froglet and B. the normal condition. Photo: Gayan Bowatte.

hypothesis statistically. Surprisingly, we are not noticing fly larvae attacks in nearly 15 *Taruga equ*es nests that we observed; however we are not sure if this is due to the absence of the fly species under issue in *T. eq*ues habitat or if these nests are tolerant of these fly attacks.

We also continue to swab the amphibians to determine the presence of the dreaded Chytrid fungus, which if spread in Sri Lanka could potentially cause havoc as has been observed in many regions of the world. Studies done on Sri Lankan frogs so far indicate that the fungus is probably present in Sri Lankan frog populations, mandating urgent continuation of monitoring activities.

Amphibian breeding observations

We are now observing the breeding patterns of various frog species (Fig. 11). We are concentrating on the endemic forms in the wild, and later when we get government permission, we are hoping to also do captive breeding trials, not for reintroduction, but to fine tune

Fig. 12. Measuring microhabitat parameters in the field. Photo: Madhava Meegaskumbura.

Fig. 11. *Pseudophilautus femoralis* is one of a very few species that lay direct developing eggs on leaves. Photo: Madhava Meegaskumbura.

the conservation effort, by understanding the critical conditions needed for their breeding and factors needed for survival of various life history stages.

Function of foam nest material

We are studying how foam-nesting material may facilitate the survival of eggs and early stage tadpoles within the foamy mass in both Polypedates and Taruga. We are now beginning to test chemical composition and protein structure of the material that the foam nests are made with. We are finding that the blue color observed in *P. cruciger* nests is due to Cu^{2+} ions. We are also testing the anti-fungal and anti-bacterial nature of the foam nest material.

Amphibian microhabitat monitoring

Shrub frogs are restricted largely to the rain-forested southwestern 'wet-zone' region of the island, where annual precipitation usually exceeds 2000 mm (only a single species is restricted to the dry zone). Many of these frogs are specialized in habitat use (Meegaskumbura and Manamedra-Arachchi 2005; Meegaskumbura, PhD thesis work). Of the 43 extant species, it is of concern that as many as 15 are known only from a single site each, and 11 from only two—usually nearby—sites each (Manamendra-Arachchi and Pethiyagoda 2005; Meegaskumbura and Manamendra-Arachchi 2005). Since 1815, about 95% of Sri Lanka's rainforests have been lost to coffee, cinchona and tea plantations (Meyer 1998), supporting the idea that extinctions are mainly caused by habitat loss.

We also suspect that recent climatic changes may also have served to stress the shrub-frog populations. Bahir et al. (2005) show for several highland species, that breeding only occurs during periods of sustained rainfall that is reflected by continuously high relative humidity (80-100 %). While historical relative-humidity data are lacking for Sri Lanka, trends calculated by Schaefer (1998) show that at Nuwara Eliya (1,800 m elevation) in central mountains, average annual temperature had increased by 1.3° C and average annual precipitation had decreased by ~20 % in the period 1869-1995; similar desiccation and warming trends were noted also in other parts of the country.

To determine causes of threat by understanding not only the major features of their habitats, but also the more subtle, yet equally important, microhabitat utilization patterns and changes in microclimatic conditions that are important for their spatial distribution, reproduction and survival. With this in mind, we are now starting to monitor the habitats and populations of various frog species in several bioclimatic zones within Sri Lanka, including the Knuckles WHS (Fig. 12), Morningside and Center for Tropical Forest Science's 25 ha plot at Sinharaja.

We are also in the process of starting a habitat enrichment project for threatened species.

Environmental toxicology

Most of the amphibian breeding habitats are polluted by nitrates, the main source of nitrate to the fresh water bodies in Sri Lanka are through excessive usage of nitrate containing fertilizers. The effects of nitrates on the development of amphibians are poorly known for Sri Lanka. We are now documenting naturally occurring levels of nitrates in amphibian breeding sites, and the species inhabiting those, in various bioclimatic regions of Sri Lanka throughout a year.

Experimentally, tadpoles of four species are exposed to predetermined nitrate concentration series and changes in development (developmental anomalies) are being observed. The levels of nitrates in most water bodies fluctuate dramatically, depending on factors such as amount of nitrate fertilizers used, bio-load, time of day, rainfall, drought conditions, distance from cultivated areas to amphibian habitats etc.. Because of this it is extremely difficult to test for the effects of nitrate on amphibian development in the field. Hence controlled laboratory experiments are essential to carry out this research. The conclusions of this research will be important for amphibian species conservation in Sri Lanka.

Fig. 13. Searching for Miocene fossils in the Aruwakkalu fossil bed, N.W. Sri Lanka. Photo: Madhava Meegaskumbura.

Bioacoustics

We are using bioacoustics to distinguish between sister species, and we have already used vocalization data even in describing species. However, so far, we have not used bioacoustics to differentiate and monitor frog populations. Now we are documenting all frog calls of Sri Lankan species, so that frog populations can be monitored remotely with least disturbance to the species.

Restoration ecology

We are currently carrying out the habitat monitoring work with the intention of restoring habitats of several critically endangered species of amphibians. We will be providing more details of this as these studies progress.

Paleontology

We have started work on an ambitious project to document the paleodiversity and the paleoenvironment of the known fossil beds in Sri Lanka (Fig. 13). However, we are yet to find any frog remnants from these fossil beds. Two students are currently going through various collections to determine the paleodiversity of these beds.

Acknowledgments

The Department of Wildlife Conservation of Sri Lanka and the Forest Department of Sri Lanka have been quite supportive in granting permission to carryout this work; when the restoration component of the work begins, we are hoping to actively collaborate with these two organizations and also other organizations that work for conservation of our amphibians and their habitats. We wish to acknowledge the Amphibian Specialist Group (IUCN/SSC), Global Wildlife Conservation, Amphibian Redlisting Authority (ARLA/IUCN/SSC), Center for Tropical Forest Sciences (CTFS) for support in various forms. Rohan Pethiyagoda, Christopher J. Schneider, James Hanken, Simon Stuart, Don Church, James Lewis and Ariadne Angulo are acknowledged for their support and contributions to Sri Lanka's amphibian research/conservation efforts.

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Species richness and diversity of amphibians in conventional and chemical free agricultural systems in highlands of Sri Lanka

By D. M. N. P. K. Dawundasekara and Anslem de Silva

Sri Lanka has been an agricultural country from prehistoric times. Recent microscopy studies on fossil pollen from Horton Plains National Park indicate that selected species have been grown there since 7000 BP (Premathilake and Nilsson, 2001).

Traditional techniques utilized by farmers in Sri Lanka have included using plant extracts to repel insects, bird and wild animals from crops however, pesticides were first introduced to Sri Lanka in 1946 to control malaria. Since then there has been a substantial increase in their use. It was estimated by the United Nations that in 2005 over 1000 brand pesticide products were registered (FAO, 2005). During 2005-2009 Sri Lanka imported the following metric tonnages (mt) of a) non-diluted insecticides 761.6 mt; herbicides 1008.7 mt and of b) diluted insecticides 7083 mt; herbicides 15,110 mt; fungicides 3952.5 mt (Registrar of Pesticides, 2010).

Top left. *Pseudophilautus alto* observed in 5 plots. Top right. *Pseudophilautus microtympanum* observed in 7 plots. Bottom. *Taruga eques* observed in 9 plots. Photo: Anslem de Silva and D. M. N. P. K. Dawundasekara.

A considerable number of human deaths occur in Sri Lanka annually due to the toxic effects of pesticides. According to the Ministry of Health (2007) it is the 12th ranking cause of hospital death in Sri Lanka: often due to self ingested pesticides as poison while some poisoning is caused while spraying pesticides on paddy and vegetable fields. There are, however few reports of the direct effects of pesticides on amphibians in Sri Lanka (de Silva, 2009; de Silva & Dawundasekara, 2010). Frogs that were once common in paddy fields in the past are now less common (de Silva, 2001). Based on a whole range of previous studies it is reasonable to assume that the use of pesticides and herbicides in paddy, vegetable and ornamental flower cultivation could be a factor responsible for reducing frog populations (de Silva and Dawundasekara, 2010) in these habitats. High application rates of nitrogen fertilizer may be another contributory factor. Nearly one third of Sri Lanka's land is cropped, and according to the World Bank in 2008 farmers in Sri Lanka used 284.3 kg of fertilizer per hectare of arable land which is a higher level of usage than elsewhere in the region (e.g. India – 153.5 kg.; Bangladesh – 164.5kg.; Indonesia – 189.1kg).

One hundred and ten species of amphibian are known from the country (de Silva, 2009; Manamendra-Arachchi & Pethiyagoda, 2006; Meegaskumbura & Manamendra-Arachchi. 2011).
The ongoing island-wide survey to investigate the pattern of malformations, injuries and parasitic infections in the amphibians of Sri Lanka by one of us (AdS) has shown several interesting cases of malformations of amphibians, including direct toxic effects of agrochemicals (de Silva, 2009).

The present preliminary study was carried out to see the effects of the use of agrochemicals on the species diversity and richness of amphibians in some high altitude vegetable plantations.

Material and Methods

Ten vegetable plots at Blackpoll (app 1600 m above sea level), Nuwara Eliya district were surveyed using patch and visual encounter survey methods (de Silva & Mahaulpotha, 2007). Each vegetable plot was approximately 0.1 hectare in extent. Amphibians, reptiles and insects present were hand collected for identification, examination and recording and then released at the point of collection. Full water chemistry and bacteriological examination of each agro-well was conducted at the National Water Board Laboratory, Peradeniya. The data was analyzed using the SAS System using Two Sample T-test (pooled).

Results

The frogs and toads that were observed in the ten plots and around the agro-wells are given in tables 1 to 10.

Species	Sex	Length	Number of observed
Fejervarya greenii	Male	33 mm-38 mm	03
	Female	45 mm	01
Taruga eques	Male	31.2 mm-41mm	07
	Female	68.5 mm	01
Pseudophilautus alto	Female	23.5mm-29mm	04
Pseudophilautus asankai	Female	26 mm	01
Pseudophilautus femoralis	Male	30mm-34mm	02
Pseudophilautus viridis	Male	25.5 mm	01
	Female	32mm-46 mm	02
Pseudophilautus microtympanum	Male	22mm-26mm	09
	Female	36.6mm-44.6mm	03

Table 1. Plot 01. A chemical free Potato plot. (Date: 03 January 2009, time 20 00 to 21 00 hours. Atmospheric temperature 15° C. RH 90%)

Species	Sex	Length	Number of observed
Fejervarya greenii	Male	35mm-36 mm	02
Taruga eques	Male	27m-41mm	11
Pseudophilautus alto	Male	16.8mm-18mm	02
Pseudophilautus microtympanum	Male	24.3mm-29.2mm	05
	Female	37.25mm-43 mm	03
Microhyla zelanika	Male	19 mm	01

Table 2. Plot 02. A chemical free Potato plot (Date: 03 January 2009, time 21 00 to 22 00 hours. Atmospheric temperature 15° C, RH 90%)

Species	Sex	Length	Number of observed
Fejervarya greenii	Male	31mm-39 mm	06
	Female	48.5mm	01
Taruga eques	Male	24mm-38mm	08
	Female	55.5mm	01
Pseudophilautus microtympanum	Male	23.5mm-28mm	06
	Female	Both 45 mm	02
Pseudophilautus viridis	Male	28mm-30mm	02
Duttaphrynus melanostictus	Male	53mm-56mm	03
	Female	72mm	01

Table 3. Plot 03. A chemical free Potato plot. (Date: 04 January 2009, time 20 00 to 21 00 hours. Atmospheric temperature 14.5° C, RH. 75 %)

Species	Sex	Length	Number of observed
Taruga eques	Male	32mm-38.5mm	04
Fejervarya greenii	Female	34.5mm	01
Philautus microtympanum	Female	43.5mm	01

Table 4. Plot 04. A chemical applied plot with Carrot. (Date: 14 January 2009, time 20 00 to 21 00 hours, Atmospheric temperature 14° C, RH. 95 %)

Species	Sex	Length	Number of observed
Taruga eques	Male	30.5mm-36mm	03
Fejervarya greenii	Male	36mm	01
	Female	39mm - 50mm	02
Microhyla zeylanica	Male	18 mm	01

Table 5. Plot 05. A chemical applied plot with Leeks. (Date: 15 January 2009, time 20 00 to 21 00 hours, Atmospheric temperature 15.5° C, RH. 90 %)

Species	Sex	Length	Number of observed
Taruga eques	Male	34 mm-37.5mm	02
Fejervarya greenii	Male	31 mm-35mm	03
Pseudophilautus alto	Male	18 mm	01

Table 6. Plot 06. A chemical applied plot with Cabbage. (Date: 21 January 2009, time 20 00 to 21 00 hours, Atmospheric temperature 14.5° C, RH. 84 %)

Species	Sex	Length	Number of observed
Fejervarya greenii	Male	35mm-38mm	02
Taruga eques	Male	31mm-39mm	04
Philautus microtympanum	Male	29mm-34mm	03
	Female	44 mm	01

Table 7. Plot 07. A chemical applied plot with Potato. (Date: 22 January 2009, time 20 00 to 21 00 hours, Atmospheric temperature 14° C, RH. 87 %)

Species	Sex	Length	Number of observed
Pseudophilautus microtympanum	Male	30 mm	01
Pseudophilautus alto	Male	18.5mm	01

Table 8. Plot 08. A chemical applied plot with Leeks. (Date: 22 January 2009, time 21 00 to 22 00 hours, Atmospheric temperature 14° C, RH. 87 %)

Species	Sex	Length	Number of observed
Fejervarya greenii	Male	33 mm	01
Taruga eques	Male	37 mm	01
Pseudophilautus microtympanum	Male	29 mm-33mm	02

Table 9. Plot 09. A chemical applied plot with Beetroot. (Date: 26 January 2009, time 20 00 to 21 00 hours, Atmospheric temperature 16° C, RH. 75 %)

Species	Sex	Length	Number of observed
Fejervarya greenii	Male	31mm-34 mm	02
Taruga eques	Male	33mm-35.5mm	02
Pseudophilautus alto	Female	22.5 mm	01

Table 10. Plot 10. A chemical applied plot with Beetroot. (Date: 12 February 2009, time 20 00 to 21 00 hours, Atmospheric temperature 13° C, RH. 67 %)

Agricultural system	Plot No	Species Richness	Species Diversity
Chemical free	01	34	07
Chemical free	02	24	05
Chemical free	03	30	05
Chemical applied	04	06	03
Chemical applied	05	07	03
Chemical applied	06	06	03
Chemical applied	07	10	03
Chemical applied	08	02	02
Chemical applied	09	04	03
Chemical applied	10	05	03

Table 11. Species Richness and Diversity according to use and non-use of chemicals

Discussion

Our preliminary investigations indicate that the three chemical-free and the seven chemical-applied vegetable plots surveyed have a distinct variation in both the species richness and the diversity of amphibians. This was also true for both reptiles and insects. The fewer insects and possibly the strong odor after application

Hand spraying a strawberry plot in the highlands. Inset. Hundreds of dead earthworms, day after application of insecticides to the soil. Photo: Anslem de Silva and D. M. N. P. K. Dawundasekara.

of chemicals could be reasons for less amphibians coming into these vegetable plots. In fact the Two-sample T test for chemical free (CF) 1 vs. chemical applied (CA) 1 were significant. However, the major draw back in this study was that the investigations were not repeated using variables. Nevertheless, the distinct and statistically significant species richness and diversity of amphibians in the chemical-free and chemical-applied vegetable plots is an indication of the effects of chemicals.

An earlier study on the stomach contents of amphibians and reptiles in a mid-country paddy field showed that 50% of the diet of the common frog (Fejervarya limnocharis) consisted of Hemipterens that were pest species (Nayana Pradeep and Wijegunasekera, 2004). These two authors showed that the amphibian species surveyed had taken more harmful insect pests than reptiles as main food items. Thus, amphibians play a significant role in the biological control of insect pests. We feel that farmers should be better informed of the importance of amphibians in their farmlands. Additionally, we agree with the FAO that farmers should be properly educated about alternatives to a 100% pesticide-based farming; about timing, frequency and dosage issues; the dangers of pest resistance through overuse; long-term damage to ground water (and consequent impact not just on wildlife but also their own livelihoods as their crops are adversely impacted) and irresponsible promotion of products in the field by the manufacturing companies and dealers.

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Prevalence and distribution of chytridiomycosis throughout Asia

By Andrea Swei, Jodi J. L. Rowley, Dennis Rödder, Mae L. L. Diesmos, Arvin C. Diesmos, Cheryl J. Briggs, Rafe Brown, Trung Tien Cao, Tina L. Cheng, Rebecca A. Chong, Ben Han, Jean-Marc Hero, Huy Duc Hoang, Mirza D. Kusrini, Duong Thi Thuy Le, Jimmy A. McGuire, Madhava Meegaskumbura, Mi-Sook Min, Daniel G. Mulcahy, Thy Neang, Somphouthone Phimmachak, Ding-Qi Rao, Natalie M. Reeder, Sean D. Schoville, Niane Sivongxay, Narin Srei, Matthias Stöck, Bryan L. Stuart, Lilia S. Torres, Dao Thi Anh Tran, Tate S. Tunstall, David Vieites, & Vance T. Vredenburg

The fungal disease, chytridiomycosis, caused by the chytrid fungus *Batrachochytrium dendrobatidis* (Bd) is the greatest known disease threat to vertebrate biodiversity (Skerrat et al 2007; Wake and Vredenburg 2008). Most of the focus and research on the emergence and impact of this disease has been in Australia, USA, Europe, and Central and South America, yet very little is known about the distribution or prevalence of Bd in Asia, a region that comprises a significant portion of global amphibian biodiversity and also contains high rates of endemism. We assembled a large international team of researchers to address the Bd knowledge gap in Asia and recently published our results in PLoS ONE (Swei et al. 2011).

Targeting the keritinized epidermal cells of post-metamorphic amphibians and the mouthparts of tadpoles, Bd has already been implicated in the decline of hundreds of amphibian species and is believed to be responsible for the extinction of several species (Skerrat et al 2007; Fisher et al 2010). The Bd pathogen is characterized by its ability to invade a region and quickly spread in a linear wave-like pattern through vast geographic areas while driving whole metapopulations and species to extinction (Vredenburg et al. 2010, Lips et al. 2006).

Though Bd research in Asia has been relatively rare, the few studies that have examined Bd in Asia have either failed to find it or found low prevalence. Interestingly, there are also currently no reports of major population declines due to Bd in Asia. This pattern deviates from reports in Central America, California, Europe and Australia. Furthermore, there is growing evidence that Bd intensity on an animal must reach a minimum threshold in order to induce mortality in amphibians; this has been termed the Vredenburg 10,000 rule (Kinney et al. 2011). The few studies that have detected Bd in Asia report very low pathogen intensity (but see Savage et al. 2011).

In our recent publication (Swei et al. 2011) we proposed three hypotheses to explain why Bd is not currently linked to significant amphibian declines in Asia: 1) Bd has not fully emerged in Asia, 2) Bd is endemic to Asia and shares an evolutionary history with native host species who are resistant, and 3) Bd emergence is inhibited due to abiotic or biotic conditions that are unique to Asia. We set out to evaluate these potential hypotheses by conducting the most extensive survey of Bd in Asia to date. Over the course of nearly a decade (2001-2009) our colleagues collected 3363 samples from frogs and amphibians from 15 countries in Asia, including Papua New Guinea. Most of these samples were tested using a quantitative PCR method that can determine the infection intensity on the animal measured in zoospores counts, but many samples were also tested using histology.

Rana similis is possibly declining at Mt. Palay-palay in the Philippines and has tested positive for Bd. Photo: Rafe Brown.

We found surprisingly low infection prevalence across the samples. Only 2.35% of all the animals sampled were positive for infection with Bd. Countries where Bd was found included Kyrgyzstan, Laos, Malaysia, the Philippines, South Korea, Sri Lanka, Vietnam, and Indonesia. On average the infection intensities were less than 300 zoospores per sample, far less than the documented mortality threshold of 10,000 zoospores.

In addition, we also compared the Bd distribution results to a Maxent species distribution model that was published by Rodder et al. (2010). The Rodder et al. model was based on existing prevalence data that did not include any presence data from Asia (because it did not exist prior to their study). We found that Bd tended to occur in the areas deemed suitable by the climate model but that Bd was not detected in many other areas of Asia that the model also predicted were suitable for Bd.

These findings suggest that Bd has not (yet) caused epidemic-level declines in Asia. If the disease is invading Asia, there appear to be multiple points of introduction because the distribution of the pathogen does not follow a clear geographic pattern that would suggest a linear, wave-like spread of the disease across an entire continent. Thus if the disease is emerging in Asia, it does not appear to be spreading at the same rate as it has been documented in other regions of Bd introduction and spread. The most complete temporal record of Bd invading a naive population is in the Sierra Nevada Mountains of California. There, researchers documented the rapid spread of the disease through populations

of the mountain yellow-legged frog over the course of several seasons, with metapopulations being driven to extinction within months (Vredenburg et al. 2010). This does not appear to be the pattern in Asia where several years of sampling have not revealed population-level declines.

The second hypothesis that Bd is endemic to Asia is based on genetic evidence of an ancestral Bd haplotype in Japan (Goka et al. 2009). If Bd is native to Asia, then the current biodiversity that was sampled is a post-disease landscape with extant amphibians representing Bd-resistant lineages. However, if this were the case, disease prevalence should be much higher. The prevalence that was found throughout Asia (2.35%) could not be sustained without continued reintroduction of the pathogen from a reservoir and indicates that the disease is probably not self-sustaining. In other regions where populations are co-existing with Bd in a post-epidemic situation, prevalence is much higher (Briggs et al. 2010). Further investigations of genetic strains of Bd in Asia and elsewhere is required to establish endemism. However, even if Bd is endemic to Asia, this recent study concluded that epidemiologically, it does not explain the lack of declines there.

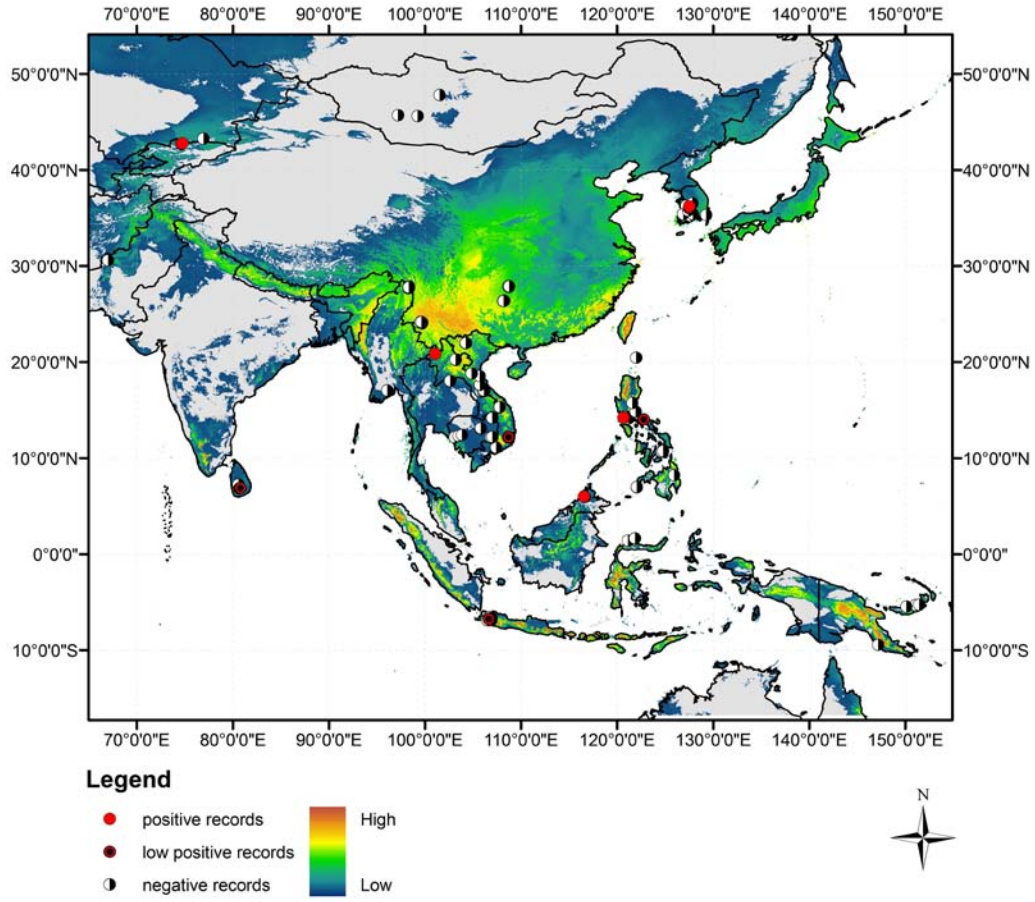

Figure 1. Map of predicted and observed *Batrachochytrium dendrobatidis* distribution in Asia. Map of Asia and Papua New Guinea showing Maxent predicted probability of (Bd) from low to high environmental suitability. Sample localities from field surveys are shown as black and white, red with black dot, and red circles indicating the highest level of Bd infection found.

The last hypothesis is quite broad and encompasses a large number of factors that could explain the difference in Bd behavior in Asia. One factor that could be important is the presence of symbiotic skin microbes that have been shown to have a protective, anti-Bd effect in other amphibians (Harris et al. 2009). Currently, there have not been any studies on the microbiota of Asian amphibians and whether they have similar protective effects on hosts. The authors suggest this is an area that deserves more research.

Our study showed that Bd is broadly distributed but at very low prevalence throughout Asia, however, sites were only visited once and with no data on disease dynamics it is difficult to predict if Bd is an immediate threat to amphibian populations in Asia. To date, no epidemics have been reported but that may change as global conditions change or as the disease spreads to more susceptible populations. Because we found high prevalence and relatively high infection intensities at one site in the Philippines, we caution that this site may represent a potentially emerging site.

In summary, we conclude that Bd has apparently not yet emerged in Asia. This may be because it has not been introduced in sufficient intensity or that the epidemiology of Bd is fundamentally different in Asia relative to other regions. Our study, being the first major survey in Asia was not designed to conclusively answer that kind of question. We stress that though prevalence and disease intensity were low in our study, a Bd epidemic may still occur and that the potentially changing dynamics of Bd in Asia warrants additional research.

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1st International Symposium on Ranaviruses

By Jake Kerby, Biology Department, University of South Dakota

The First International Symposium on Ranaviruses was held this summer at the annual Joint Meeting of Ichthyologists and Herpetologists (JMIH) in Minneapolis, MN. The full day symposium featured 23 speakers from nine countries to discuss the current status of knowledge among the world's experts regarding Ranavirus from a wide variety of perspectives.

Background

Ranaviruses are widespread pathogens known to infect ectothermic verterbrate species worldwide, and have been implicated as a cause of amphibian declines in many populations. The genus *Ranavirus* is one of five genera within the family *Iridoviridae*. Despite their name, ranaviruses infect not only amphibians, but also reptiles and fish. These double stranded DNA viruses are an emerging threat to cold-blooded vertebrates and are listed as a notifiable disease by the World Organization for Animal Health. Therefore, understanding their pathogenicity is of concern not only for herpetologists, but also for ichthyologists.

Despite the ability to detect ranaviruses via a number of methods (including PCR, cell culture and histology) and the relatively large amount of information known about ranavirus replication cycles, there is still relatively little known regarding the host-pathogen interactions of ranaviruses beyond the cellular level. With the current focus on chytridiomycosis, ranaviruses (and other amphibian pathogens) can easily be overlooked as a cause for mass die offs in wild populations. Ranaviruses can also be overlooked as a research priority because of perceptions that they may play only minor roles in host population ecology and persistence. This symposium sought to act as a summation of the current knowledge on the pathology, immunology, genetics, and ecology of ranaviruses. Risk assessment and conservation concerns were also discussed.

The symposium began with a historical talk from the keynote speaker, Dr. Greg Chinchar (University of Mississippi Medical Center). Ranaviruses were first isolated in 1965 by Allan Granoff (St. Jude's Children Research Hospital) from leopard frogs. One of the early isolates was from a frog bearing a tumor and was designated Frog Virus 3 (FV3). This strain of ranavirus has served as a model for much of the early and current work regarding the biology, immunology and pathogenicity of this group of iridoviruses. In the 1980s, 'frog' viruses were identified as the cause of mortality in several fish and reptilian species indicating that this genus possessed a much larger host range than previously thought. In view of that, a greater focus was cast on understanding both the pathogenicity and method of spread among species.

Pathogenicity and Immunology

The virus infects cells directly, although interestingly the cells and tissues targeted seem to vary by both strain and host. Unfortunately, comparative pathology is only in its beginning stages, but there are contemporary methods (e.g., immunohistochemical staining) that can identify tissues targeted by ranaviruses. A diseased amphibian displays hemorrhaging, subcutaneous edema and erythema, and epidermal ulcerations. Drs. Debra Miller (University of Tennessee), D. Earl Green (U.S. Geological Survey), and Ana Balsiero (SERIDA, Spain) described the presence of intracytoplasmic inclusion bodies in organs such as the kidneys, liver, and spleen as a strong indicator of ranaviral infection. An interesting difference was noticed between affected frogs from SE Asia in the presentation of the gross lesions. Many of the large facial lesions shown in slides from frogs in SE Asia have never been recorded by researchers in North America. Studies in *Xenopus laevis* also suggest a potential role of macrophages in persistence of infection. In addition, PCR primers have been developed that amplify a conserved sequence from the major capsid protein of the ranavirus genome. These primers can be used to determine the presence of a ranavirus in a sample but because it is such a conserved DNA sequence it is limited in its ability to determine anything regarding the type of ranavirus present.

Currently, there is no known cure or vaccine for ranavirus. Dr. Jacques Robert (University of Rochester Medical Center) has done extensive work examining the anti-viral immune defenses of amphibians using *X. laevis* as a model organism. Unfortunately, due to the limited availability of tools for typical immunological work in amphibians, this work has been challenging. The most exciting work from this is the recent generation of FV3 knock out mutants to better identify the genes involved. These discoveries will hopefully lead to the development of an attenuated viral vaccine that can be used in captive populations.

Distribution

Ranaviruses have been detected in nearly every area of the world. These pathogens have been detected on all continents, save Antarctica, and have been discovered in aquaculture facilities, zoos, and in wild populations. The symposium hosted presentations from Drs. Danna Schock (Keyano College, Canada), Amanda Duffus (Gordon College), Rolando Mazzoni (Universidade Federal de Goiás,

Brazil), Yumi Une (Azabu University, Japan), Somkiat Kanchanakhan (Aquatic Animal Health Research Institute, Thailand), Matt Allender (University of Illinois), Britt Bang Jensen (Norwegian Vet Institute, Norway) and Rachel Marschang (Hohenheim University, Germany) summarizing the state of ranavirus in several countries including: Australia, Brazil, Canada, Croatia, Denmark, Japan, Netherlands, Spain, Thailand, and the United Kingdom. While the mechanism of spread worldwide is still unclear, Dr. Angela Picco (U.S. Fish and Wildlife Service) discussed that the movement of ranavirus infected individuals both within the US and across the globe can and does occur via the pet, bait, and food trades. These routes are thought to be associated with outbreaks in the United States. Phylogenetic work by Dr. James Jancovich (California State University, San Marcos) has revealed that ranaviruses, originally fish pathogens, have jumped hosts several times to infect amphibians and reptiles. This reveals the adaptable nature of the pathogen and the importance of understanding its pathogenicity and methods for controlling it.

Mismatches in the local adaptation of host and pathogen can have severe impacts on a host's ability to fend off ranvirus disease. Dr. Andrew Storfer (Washington State University) reported that introduced ranavirus strains have been found in declining populations, and that there is some level of local adaptation occurring where some host populations are more resilient to more virulent strains of ranavirus. When these virulent strains are exposed to tiger salamander larvae from populations that co-exist with less virulent strains, there is a marked increase in salamander mortality. His lab is currently identifying the genes associated with this increase in virulence in the virus as well as associated genes in the salamanders. Dr. Jason Hoverman (University of Colorado) has shown differential effects of the same strain of ranavirus across 19 North American amphibian species, further validating that ranaviruses infect multiple hosts, and raising the possibility that community composition may impact the dynamics of a disease outbreak.

Ecology and Conservation

Dr. Matt Gray (University of Tennessee) discussed the threat of ranaviruses to wild populations, and presented an epidemiological explanation why ranaviruses can cause at least local extirpations of populations. He emphasized that the greatest threat of ranaviruses is to highly susceptible species that are uncommon (e.g., gopher frog) and coexist with species that function as ranavirus reservoirs. He emphasized the need for more extensive ranavirus surveillance and population monitoring, especially at reoccurring die-off sites.

Photo: Matt Niemiller

Virions can be spread in a number of ways, but work by Dr. Jesse Brunner (Washington State University) suggests that ranaviruses most typically spread in aquatic environments especially in close contacts among individuals. Their transmission is frequency-dependent, which allows them to drive their host populations to extinction. Moreover, they can persist in chronically infected individuals, alternate host species, and to at least some degree in the environment, so they may be difficult to control and isolate.

An important need for wild populations is better monitoring, including better non-lethal diagnostic tests for use in the field. It is clear that these viruses are found worldwide, with some having dramatic impacts on populations and others simply persisting in low level infections. With the recent focus on chytrid fungus in frogs, there is a prime opportunity to monitor populations for the presence of ranavirus as well. This is perhaps even more important given the potential for at least some ranaviruses to not only move among amphibian hosts, but to reptiles and fish as well. From the symposium, we surmise that at least 10 fish species, 40 amphibian species, and six reptile species can be infected by ranavirus. There is currently an effort underway to develop an online reporting system that can be used by researchers around the world.

A second need is for field-based studies to be sequencing ranaviruses detected during field surveys. Although most studies use the primers to amplify the highly conserved region of the genome previously mentioned, many don't take advantage of the important information that can be gleaned from that collected DNA. As a result, we are currently at very early stages of understanding the true diversity and distributions of ranaviruses in wild fish, amphibian and reptile populations.

Finally, there is a significant need to better understand the sub-lethal effects of infection. Some lab-based studies have demonstrated slowed growth rates and altered developmental rates in infected amphibian larvae. Both growth and developmental rates directly affect recruitment rates so understanding sub-lethal effects in wild populations will be key to understanding the role ranaviruses may play in host population dynamics.

Separate studies by myself and Dr. David Lesbarrères (Laurentian University, Canada) have demonstrated that the presence of both pesticide and metal pollutants can increase the susceptibilities of hosts to the pathogen. These findings emphasize the need to understand how anthropogenic stressors can significantly influence disease dynamics within a population.

Future Directions

At the close of the meeting, two roundtable discussions were held to identify the needs for future research at both the immunological and ecological levels. The organizers have established a website for the symposium that contains all of these future directions as well as copies of all the presentation files used in the symposium: http://fwf.ag.utk.edu/mgray/ranavirus/2011Ranavirus.htm Videos of these presentations are downloadable from iTunes as well: http://itunes.apple.com/us/itunes-u/2011-international-ranavirus/id452252707a

Both websites are excellent resources for those wanting to know more about ranavirus.

Support

This effort would not have been possible without the significant sponsorship (over $22,000) of several organizations: University of Tennessee Institute of Agriculture, Association of Reptilian and Amphibian Veterinarians, Australian Commonwealth Scientific and Industrial Research Organisation, Environment Canada, National Wildlife Research Centre, Morris Animal Foundation, Tennessee Wildlife Resources Agency, U.S. Forest Service, Pacific Northwest Research Station, American Society of Ichthyologists and Herpetologists, Missouri Department of Conservation, Partners in Amphibian and Reptile Conservation, Tennessee Herpetological Society, USGS Amphibian Research and Monitoring Initiative, Global Ranavirus Consortium, and the UT Department of Forestry, Wildlife and Fisheries. There are plans underway for a second international symposium to be held in 2013 and continued support is needed. Information will be posted on the ranavirus website (above) as it becomes available.

I offer a special thanks to Greg Chinchar, Jacques Robert, Debra Miller, Danna Schock, Angela Picco, and Jesse Brunner for editing and contributing to this summary and to Matthew Gray for organizing the symposium and final comments on this article.

ASH CONFERENCE 2011

36th Annual General Meeting of Australian Society of Herpetologists. November 8–11, 2011, Paluma, North Queensland

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You have a choice of two colour combinations: (1) A kiwi green shirt with a dark brown snake design, or (2) a dark chocolate shirt with a white snake design. See also the t-shirt sizing guide.

Checking in with Jamaica's endangered frogs

By Iris Holmes

Approximately 25 million years ago, an enterprising or very confused frog from the genus *Eleutherodactylus* washed up on the recently emerged Jamaican shore, most likely from Cuba (Hedges 1989). This ancestral *Eleutherodactylus* speciated into today's seventeen endemic Jamaican species, and occupied habitats on the island from sea-level limestone caves in tropical dry forest to elfin forest over 2000 meters in elevation to hot, wet tropical forest. The *Eleutherodactylus* joined (or were soon joined by) an ancestral *Osteopilus*, which bred in bromeliads and diverged into four species.

From fall 2010 to summer 2011, a team from the University of the West Indies including myself, Dr. Byron Wilson, and Dr. Kurt McLaren, conducted a status assessment and the first assay for the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (hereafter *Bd*) in the Jamaica frogs, including four recently introduced species. Jamaican frogs have been little studied in the past decades (prior to our work, six endemic species had not been sighted in over 20 years), but are one of the most endangered frog faunas in the world. Fourteen of the endemic species are considered Endangered or Critically Endangered by the IUCN, while only two are listed as Least Concern (IUCN 2011).

We surveyed in the known ranges of all the Jamaican species, with the goal of sampling all of the endemic species. We were unable to find six of the species, but did locate four of the six that had not been seen in over 20 years. We also sampled in every major habitat type on the island, and including intact habitats as well as those that were disturbed to varying degrees by selective logging, agriculture, and housing developments. We found that most endemic Jamaican species are relatively tolerant to selective logging, but very few species are found outside of closed canopy forests. As deforestation is a continuing threat to the wild areas in Jamaica, this sensitivity is worrying for long term conservation. Introduced species tend to have high population densities in disturbed areas, but do not penetrate far into wooded areas. The exception is the cane toad, *Rhinella marina*, which we found at high population densities in many habitats island wide.

An undescribed *Osteopilus sp.*
Photo: Tim Shields

We found *Bd* at fifteen of the seventeen sites we sampled (sample sizes per site ranged from two to 82). In the sites with the fungus, prevalence of *Bd* ranged from nine to 36% of sampled individuals. The zoospore load was less than 100 for the large majority of infected individuals, with many showing fewer than ten zoospore equivalents per sample. Only the two most infected individuals showed loads between 2000 and 3000 zoospore equivalents. Even these individuals, who had by far the highest loads in our dataset, were well below the critical threshold that signals a potential epidemic outbreak of the disease, per Vredenburg's 10,000 zoospore rule (Vredenburg et al. 2010). We also assessed each frog we caught for visible symptoms of chytridiomycosis, and saw none in any frog. We found no indication of an imminent outbreak of deadly levels of the fungus in any season or location on the island.

After reading that *Bd* has been found on crustaceans in Australia (Rowley et al. 2006), we swabbed a few of their Jamaican counterparts: two land crabs, and eleven freshwater shrimp, locally known as janga. We sampled these crustaceans from a stretch of a quick flowing river in the Blue Mountains above most human settlement. The only visible disturbances were was some small-scale agriculture on the ridges above the river, occasional use of the river by semi-domestic cattle, and some wild pig hunting. The river had substrate ranging from gravel to boulders, with very little organic matter. None of the frogs in the area is aquatic, but they do forage in the boulders by the riverside at night. We found two to three zoospore genome equivalents on one of the crabs and one of the janga. This infection rate may reflect the environmental levels of *Bd*, or the crustaceans may be an alternative host for the fungus. We were particularly interested in this finding, because the janga are periodically harvested by dumping large amounts of chlorine bleach in the stream. The bleach kills the janga, and they are collected in nets as they wash downstream. Since the standard protocol for sterilizing supplies for *Bd* is to wash them with ten percent bleach solution, we were surprised that *Bd* infection could persist in this environment, particularly without aquatic frogs to re-inoculate the water. While our sample size is much to small to draw any conclusions, it does lead to interesting questions about the prevalence of *Bd* in this environment. Further testing in Australia has cast doubt on the original work (Rowley et al. 2007), but regardless of the importance of crustaceans in *Bd* ecology, our positive tests on crustaceans may serve as a qualitative indicator of the prevalence of *Bd* in this environment.

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Recent Publications

Conservation and Ecology

Non-invasive invaders from the Caribbean: The status of Johnstone's Whistling frog (*Eleutherodactylus johnstonei*) ten years after its introduction to Western French Guiana

By Raffael Ernst, David Massemin & Ingo Kowarik

Biological invasions receive significant attention as a major threat to biodiversity and they are considered an important element of global change. Despite an increased awareness it was not until recently that problems associated with herptile invasions began to be noticed and documented systematically. Yet, the dynamics of these invasions remain poorly studied. We assessed the invasion status and potential of a mainland population of the introduced direct developing frog *Eleutherodactylus johnstonei* a decade after its introduction to Western French Guiana. *E. johnstonei*, assumed to be native to the Lesser Antilles, has been referred to as a highly invasive species on grounds of its wide distribution and is expected to extend its range significantly based on recent climate model assumptions. Despite the common notion that *E. johnstonei* is a rapidly spreading alien species that becomes highly invasive once introduced to novel environments, we found no clear evidence for these propositions in the established Guiana Shield mainland populations under study. We showed that, contrary to general belief, the species did not spread significantly and does not exhibit an alarmingly high invasion potential as has previously been reported from other species of the genus on oceanic islands. Frogs were restricted to urban garden habitats showing significantly higher abundance in gardens containing ornamental potted plants. Distribution patterns were best explained by two dispersal-related factors operating at different scales: (1) distance of occupied sites to nearest population indicating short-distance active dispersal using stepping stone habitats, and (2) distance of occupied sites to shore with a distinct bimodal pattern indicating long-distance passive or jump-dispersal, most likely due to the exchange or transfer of ornamental plants. Even though we believe that the invasion potential of *E. johnstonei* has previously been exaggerated, our results also indicate that further spread is possible, mainly as a result of rapid economic and social changes in the Guiana region. Our study therefore contributes to the current debate on monitoring and controlling invasive amphibian species in the Guiana Shield area. It provides essential data to counteract or react to recent developments and will hopefully foster a number of further studies aimed at this direction.

Full article: Ernst, R., Massemin, D. & Kowarik, I. (2011) Non-invasive invaders from the Caribbean: The status of Johnstone's Whistling frog (*Eleutherodactylus johnstonei*) ten years after its introduction to Western French Guiana. Biological Invasions 13: 1767–1777

Calling male of *Eleutherodactylus johnstonei*. Photo: D. Massemin

The influence of amphibians on mosquitoes in seasonal pools: can wetlands protection help to minimize disease risk?

Michael J. Rubbo, Jessie Lanterman, Richard C. Falco, & Thomas J. Daniels

Wetlands provide a variety of services to society; however, their use as breeding habitat by mosquitoes has caused concern that they pose a risk to human health. As mosquito-borne diseases are undergoing a global resurgence, there is a need to better understand the factors that influence mosquito production in wetlands. Seasonal pools offer a model system in which to study mosquito production as they provide breeding habitat for many mosquito species. In the northeastern US, larval spotted salamanders (*Ambystoma maculatum*) and wood frog tadpoles (*Lithobates sylvaticus*) are common in pools and may affect mosquito growth and survival through predation or competition. To determine if these species interact, we conducted surveys of pools and found that larval mosquitoes were less abundant in pools with higher densities of larval salamanders. Experiments on mosquito oviposition and survival found that mosquitoes avoided ovipositing in habitats containing larval salamanders and tadpoles and had low survival in the presence of salamanders. These data indicate that predation by larval salamanders may influence the breeding distribution of mosquitoes by imposing selective pressure on ovipositing adults. Therefore, developing measures to protect amphibians in seasonal pools may contribute to controlling mosquito production in wetlands, potentially minimizing disease risk to humans.

Full article: Rubbo, M.J., J.L. Lanterman, R.C. Falco, and T.J. Daniels. 2011. The influence of amphibians on mosquitoes in seasonal pools: can wetlands protection help to minimize disease risk? Wetlands 31:799-804.

Anthropogenic Disturbance and Edge Effects on Anuran Assemblages Inhabiting Cloud Forest Fragments in Colombia

By Paola Isaacs Cubides & Nicolás Urbina Cardona

Due to habitat fragmentation, anurans have been affected in the Andean forest leading to poor ensembles along the pasture-forest gradients. We evaluated edge effects on tropical cloud forest anurans in three landscapes with a different degree of anthropogenic disturbance, comparing with eight environmental variables. We survey 12 transects in each landscape (two per habitat type: streams in pastures, pastures, the outer limit of the pastures with the forest, the internal edge of the forest, the forest interior and streams inside the forest) using VES, to obtain 162 man-hours. We use Bootstrap and Jack 1 and 2 richness estimators. The species richness for each of the six habitats was estimated by three non-parametric richness estimators: Bootstrap, Chao 1 and Chao 2 and performed a non-parametric two-way analysis of similarity (ANOSIM subroutine) to test the hypotheses regarding the spatial differences in the amphibian composition. To determine patterns in anuran species composition

among habitats, we estimated similarity by a Principal Component Analysis and the Pearson correlation coefficient was calculated to identify the relationship between the environmental variables and to identify groups of non-correlated variables inside the microhabitats. We used forward stepwise multiple regression models in the software STATISTICA 6.0 (Statsoft 2001), to detect structural and environmental variables associated with the presence of the most common frogs. We recorded a total of 251 anurans of eight species. The richness was higher in the forest (seven species) than in pasture (four species). Most species of the ensemble (75%) inhabited the forest habitats, whereas 50% of the anuran species inhabited the pasture. Of the environmental variables, slope and distance to streams influenced the distribution of all modeled Pristimantis species, although this genus exhibits direct development and doesn't require bodies of water for its reproduction. The canopy cover had a high explanatory power (through beta regressors) on the presence of anuran species in the microhabitat; whereas temperature and relative humidity did not, suggesting that temperature and relative humidity may be less important for frog distributions along pasture-forest gradients in cloud forest landscapes. The anthropogenic disturbance in the landscape seems to affect the presence of two rare species (*Pristimantis ptochus* and *Pristimantis kelephas*) suggesting that these species display a high degree of sensitivity to the transformation of the cloud forest. Future cloud forest management research needs to incorporate anthropogenic disturbance effects, because it strongly interacts with edge and matrix effects, affecting the habitat quality and the persistence of species in the landscape.

Full article: Paola Johanna Isaacs Cubides & José Nicolás Urbina Cardona. Anthropogenic Disturbance and Edge Effects on Anuran Assemblages Inhabiting Cloud Forest Fragments in Colombia. Natureza & Conservação 9(1):39-46, July 2011.

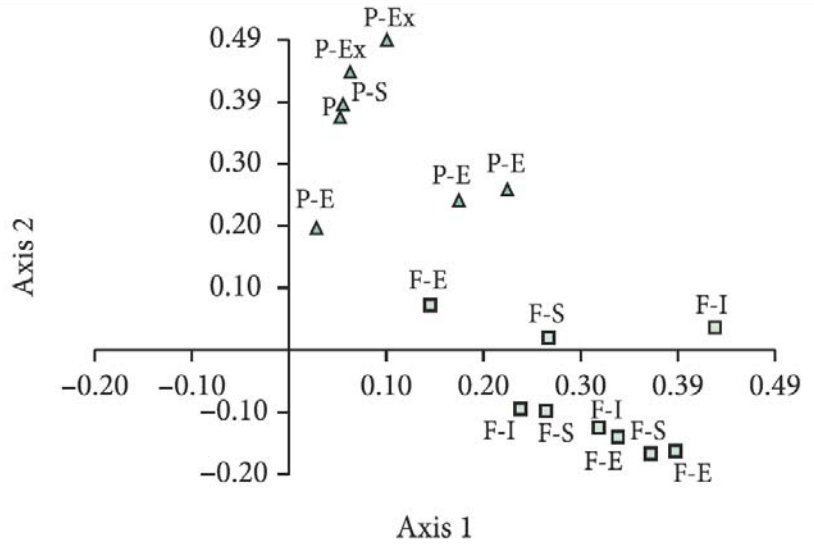


Figure 1. Principal Component Analysis based on the standardized abundances of the anuran species. Each triangle represents the coordinates of the species composition in each habitat. The first letter in the acronymus makes reference to Pasture (P in triangle) or Forest (F in square); the second letter (separated by a line) represents the habitats: stream (S), exterior (Ex), outer and internal edge (E) and interior (I). Isaacs & Urbina.

Composition of amphibian assemblages in agroecosystems from the central region of Argentina.

By Clarisa de L. Bionda, Ismael E. di Tada & Rafael C. Lajmanovich.

The conversion of forest to agricultural land is occurring at rapid rates in many Neotropical areas. This trend has spurred research to examine the role that agroecosystems play in providing habitat for Neotropical organisms. In this sense, Argentina is the third world's largest producer of soybeans (*Glycine max* Merril L). Particularly, the central region of Argentina has been most affected by agricultural development. Few studies, (e.g. Peltzer et al. 2006) however, have been conducted on the amphibian assemblage composition and dynamics of agroecosystems in central region of Argentina. Our main objective is to determine the species richness and diversity of anuran assemblages in agroecosystems from the central region of Argentina. We sampled two agroecosystems (AG) (AG 1, 9 ha: 33°05'S 64°26'W, AG 2, 12 ha: 33°05'S 64°25'W) in Rio Cuarto, Cordoba province, Argentina. We conducted surveys from December to April (2006-2007). Specimens were captured using live pitfall trap transects. The agroecosystem 1 (AG 1) was devoted to soybean crop and two agroecosystems were used for cattle grazing. The permanent and temporary ponds at each site are used for cattle consumption and irrigation to crop during periods of drought. A total of 561 amphibians of seven species, belonging to four families (Bufonidae, Leiuperidae, Cycloramphidae, and Leptodactylidae) were recorded. We find strong positive association between both species richness and anuran abundance with habitat variables as rainfall and rain-day. The anuran richness observed in the studied areas is similar to other sites with level of alteration comparable, but the anuran richness and abundance observed here is lower compared with the records of anuran species for the region before agricultural development. Agricultural landscapes represent environments where unpredictable in humidity, particularly at the start of breeding season, is a factor that may limit the modes and reproductive activity in amphibians. Moreover, the presence of a chemical contaminant in the breeding sites due to agricultural activities, also could contribute to regression of the assemblage anuran diversity and richness. Consequently, agricultural landscapes can possibly restrict the presence of certain species. Thus, these results have suggested that amphibians may be particularly affected by habitat modification and degradation due to agricultural activities in the central region of Argentina, and it may be contributing to regression of their diversity and richness.

Full article: Bionda C.L., di Tada I.E. and Lajmanovich R.C. 2011. Composition of amphibian assemblages in agroecosystems from the central region of Argentina. Russian Journal of Herpetology 18: 93-98.

Deep intra-island divergence of a montane forest endemic: phylogeography of the Puerto Rican frog *Eleutherodactylus portoricensis* (Anura: Eleutherodactylidae)

By Brittany S. Barker, Robert B. Waide & Joseph A. Cook

Hypotheses proposed for lineage diversification of tropical montane species have rarely been tested within oceanic islands. Our goal was to understand how basin barriers and Pleistocene climatic fluctuations shaped the distribution of diversity in *Eleutherodactylus*

A Mountain Coquí, *Eleutherodactylus portoricensis*, at "La Roca" de El Yunque, El Yunque National Forest. Photo: Alejandro Rios Franceschi.

portoricensis (Eleutherodactylidae), a frog endemic to montane rain forests of Puerto Rico. We generated mitochondrial DNA (mtDNA) control region sequences (*c.* 565 bp) from 144 individual *E. portoricensis* representing 16 localities, and sequenced 646 bp cytochrome *b* and 596 bp nuclear DNA (nDNA) rhodopsin exon and intron 1 from a subset of individuals. We conducted a phylogenetic analysis on the mtDNA sequence data and explored population substructure with maximum parsimony networks, a spatial analysis of molecular variance, and pairwise F_{ST} analysis. Coalescent simulations were performed to test alternative models of population divergence in response to late Pleistocene interglacial periods. Historical demography was assessed through coalescent analyses and Bayesian skyline plots. We found: (1) two highly divergent groups associated with the disjunct Luquillo and Cayey Mountains, respectively; (2) a shallow mtDNA genetic discontinuity across the La Plata Basin within the Cayey Mountains; (3) phylogeographic congruence between nDNA and mtDNA markers; (4) divergence dates for both mtDNA and nDNA pre-dating the Holocene interglacial (*c.* 10 ka), and nDNA suggesting divergence at the penultimate interglacial (*c.* 245 ka); and (5) historical demographic stability in both lineages. The low-elevation Caguas Basin is a long-term barrier to gene flow between the two montane frog populations. Measures of genetic diversity for mtDNA were similar in both lineages, but lower nDNA diversity in the Luquillo Mountains lineage suggests infrequent dispersal between the two mountain ranges and colonization by a low-diversity founder population. Population divergence began prior to the Holocene interglacial. Stable population sizes over time indicate a lack of demonstrable demographic response to climatic changes during the last glacial period. This study highlights the importance of topographic complexity in promoting within-island vicariant speciation in the Greater Antilles, and indicates long-term persistence and lineage diversification despite late Pleistocene climatic oscillations.

Full article: Barker, B.S., Waide, R.B. & Cook, J.A. 2011. Deep intra-island divergence of a montane forest endemic: phylogeography of the Puerto Rican frog *Eleutherodactylus portoricensis* (Anura: Eleutherodactylidae). Journal of Biogeography. DOI: 10.1111/j.1365-2699.2011.02578.x

The role of the matrix-edge dynamics of amphibian conservation in tropical montane fragmented landscapes

By Georgina Santos-Barrera & J. Nicolás Urbina-Cardona

Changes in land use that directly cause habitat fragmentation and loss have been identified as the most critical factor affecting amphibian survival. Edge effects are one of the most important consequences of habitat fragmentation determining the recovery of the forest fragments after the disturbance. At the same time the context of the anthropogenic matrix is expected to have some influence on forest fragment´s biodiversity and function, although this has been poorly documented in tropical studies. We studied the dynamics of seven species of frogs and salamanders occurring in 72 transects along tropical montane cloud forest (TMCF) with adjacent managed areas of shaded coffee or corn plantations in Guerrero, southern Mexico. We measured twelve environmental and structural variables: six variables were measured per transect (distance to the edge, altitude, distance to the town, distance to streams, canopy cover and slope) and six variables were measured on the site where each individual were first seen (temperature, relative humidity, leaf litter depth, height from forest floor, herbaceous cover and leaf litter cover). The TMCF interior, when limiting with shaded coffee plantations, provided higher relative humidity, leaf litter cover, and canopy cover that determined the presence of some amphibian species. The ensemble of species in the TMCF was dominated by the Mexican robber frog (*Craugastor mexicanus*) and the pygmy free-fingered frog (*Craugastor pygmaeus*) with 39.6 and 38% of the total captures, respectively. Along the corn plantation-forest edge-forest interior gradient, just four individuals (6.8% of the total captures) were recorded on the forest edge belonging to two dominant species. This could be because the corn plantation is an aggressive managed monoculture with a rotation management twice a year, that includes clearing the parcels, burning of the dried debris, planting of corn, harvesting and abandonment of the parcel, followed by the colonization by different shrubs and ferns. The use of shaded coffee plantations was preferred by the amphibians over the corn plots possibly due to the maintenance of native forest arboreal elements, low management rate and less intensity of disturbance than in the corn plots. In this regard, the diversity and abundance of amphibians in the forest mostly depended on the matrix context and management adjacent to the forest patches. Shaded coffee plantations reduce the edge effects in TMCF, improve the connectivity between TMCF fragments and increase habitat quality for the forest interior amphibian species. Future wildlife management research should take into account edge and matrix effects to understand species dynamics which move along anthropogenic-natural ecotones in managed ecosystems, thus prioritizing matrix contexts that buffer edge effects and increase habitat quality in remaining natural ecosystems.

Full article: Santos-Barrera, G., Urbina-Cardona, J.N. 2011. The role of the matrix-edge dynamics of amphibian conservation in tropical montane fragmented landscapes. Revista Mexicana de Biodiversidad 82(2):679-687 (nurbina@yahoo.com)

A small increase in UV-B increases the susceptibility of tadpoles to predation

By Lesley A. Alton, Robbie S. Wilson & Craig E. Franklin

Increases in ultraviolet-B radiation (UV-B) associated with stratospheric ozone depletion are potentially contributing to the loss and decline of numerous amphibian species around the world. Exposure to UV-B is known to reduce the survival of embryonic and larval amphibians as well induce a variety of sublethal effects, but our understanding of how exposure to UV-B impacts upon the fitness and subsequent population dynamics of amphibians is relatively superficial. Using a controlled laboratory study, we examined the independent and interactive effects of UV-B and non-lethal predatory chemical cues (PCC; cues that signal risk of predation) on a suite of traits (hatching time, hatching success, post-hatch survival, burst swimming performance, size and morphology) of striped marsh frog *Limnodynastes peronii* embryos and tadpoles, and assessed tadpole survival time in a predator environment to evaluate the potential fitness consequences. We found that exposure to a small (3-6%) increase in UV-B, which is comparable to changes in terrestrial UV-B associated with ozone depletion, had no effect on any of the traits measured except survival time in a predator environment, which was reduced by 22-28%. These findings suggest that increased exposure to UV-B has the potential to reduce the fitness of tadpoles by increasing their susceptibility to predation, but importantly there is potential to underestimate the effects of UV-B if future research relies only on measures of fitness proxies, such as burst swimming performance, which was not affected by increased exposure to UV-B.

Full article: Alton *et al.* (2011) A small increase in UV-B increases the susceptibility of tadpoles to predation. *Proc. R. Soc. B* 278: 2575-2583.

Adult striped marsh frog *Limnodynastes peronii*. Photo: Lesley Alton.

Islands in the sky or squeezed at the top? Ecological causes of elevational range limits in montane salamanders

By Matthew E. Gifford & Kenneth H. Kozak

Montane regions are species rich and often harbor many endemic species. In order to understand this widespread pattern and to accurately predict the potential response of species to climate change, it is critical to study the elevational range limits of species. However, because it is difficult to experimentally manipulate entire species distributions, the causes of species' elevational range limits (e.g. competitive interactions, physiological specialization) remain poorly understood. In this study, we developed new mechanistic approaches to examine the factors that drive the elevational replacement of two salamander species in the Appalachian Highlands. These approaches integrate fine-scale environmental maps of a given area with statistical functions describing the interactions of the organism with its environment (i.e., environmental sensitivity of metabolic rates, water loss rates, foraging energetics) to predict areas on the landscape where a population may persist. We also included competitive interactions in models to explore whether competition, physiological limitation, or some combination of factors might be driving observed distributional patters. We tested our model predictions against field estimates of salamander surface activity. Our results challenge the prevailing idea that competitive interactions drive the lower elevational range limits of montane species and that physiological stress prevents low-elevation species from expanding to inhabit high elevations. Instead, our modeling results suggest that the lower elevation range limit of the montane endemic species, *Plethodon jordani* is limited by physiological constraints, whereas competition with *P. jordani* is the predominant factor preventing the low-elevation species, *P. teyahalee*, from expanding its range to include higher-elevation habitats. Our results largely agree with the biogeography and behavior of other montane species, suggesting that similar mechanisms might underlie patterns of elevational zonation across other taxa and montane regions. Additional studies in other species pairs, examining behavior and physiological variation, are underway to further test the generality of these results.

Full article: Gifford, M.E., Kozak, K.H. Islands in the sky or squeezed at the top? Ecological causes of elevational range limits in montane salamanders. Ecography, in press DOI: 10.1111/j.1600-0587.2011.06866.x

The red-cheeked salamander (left), *Plethodon jordani*, is endemic to high elevation habitats in the Great Smoky Mountains. The distribution of this species is parapatric and largely non-overlapping with the southern Appalachian salamander, *P. teyahalee*, shown on the right. The southern Appalachian salamander (right), *Plethodon teyahalee*, is endemic to the Appalachian highlands and tends to inhabit lower elevations. This species will reach higher elevations in the absence of montane endemic congeners. Photo: Bill Peterman of the University of Missouri

Usefulness of volunteer data to measure the large scale decline of "common" toad populations

By: Anna Bonardi, G. Francesco Ficetola et al.

The common toad (*Bufo bufo*) is a widespread species, inhabiting large areas of Europe and Western Asia. Data suggested that this toad is declining in some European countries, but it is difficult obtaining quantitative measures of demographic trend for such a large-range species. We used data collected by volunteers saving amphibians on the road to evaluate the trend of common toad in Italy across broad spatial and temporal scales.

We collected data on 33 toad populations across Northern and Central Italy for the period 1993-2010. We used two approaches (meta-analysis; analysis of average change in population size) to evaluate the overall demographic trend. We incorporated measures of volunteer sampling effort into analyses, to take into account changes in detection probability and to obtain more reliable information.

Toad abundance significantly declined in the last decade. From 2000 to 2010, 70% of populations showed a strong decline, and only 10% increased. Trends were heterogeneous among populations, but taking into account sampling effort reduced heterogeneity by 40%. We detected a 76% cumulative average decline of toad populations, despite an increasing mean sampling effort.

It is difficult to identify the causes of such a widespread decrease; therefore we dread that the decline will continue in the next future. The common toad occurs in many modified habitats, nevertheless several factors may negatively affect its populations, including habitat loss, fragmentation, chytridiomycosis, road mortality, pollution and climate change; joint effects of multiple factors are also possible. Future studies are required to identify the drivers of toad decline.

Common toad (*Bufo bufo*). Photo: G. Francesco Ficetola

Full article: Bonardi, A. et al. (2011). Usefulness of volunteer data to measure the large scale decline of "common" toad populations. Biological Conservation, 144: 2328–2334. (anna.bonardi@unimib.it)

Managing Pond-Breeding Anurans in the Selectively Harvested Forests of Coastal New South Wales, Australia

Francis L. Lemckert

A series of protective prescriptions have been implemented to minimize the impacts on populations of anurans present in areas of selective forestry operations in coastal New South Wales. These prescriptions result in the retention of a range of undisturbed patches of habitat known or perceived to be of importance to their survival. I reviewed the information available on the ecology of anurans in these forests and the known impacts of forestry operations in order to assess the effectiveness of these prescriptions in protecting pond breeding species. Research has indicated that the protective buffer zones applied around ponds are likely to provide a significant level of protection to breeding individuals and the aquatic environment. Studies of the activity patterns of anurans demonstrate that non-breeding individuals generally use forest areas falling outside of pond-side buffers. These non-breeding habitats are afforded some protection through the retention of hollow-bearing habitat trees, identified important habitat patches and movement corridors, but significant areas can still be disturbed, and often severely, by logging machinery. Studies assessing the impacts of logging on Australian anuran populations indicate that they are generally robust to the effects of logging, with only habitat specialists showing obvious, but still limited declines. I postulate that anurans in this region are pre-adapted to coping with the changes produced by selective logging because they have evolved in a highly changeable environment. I conclude that current forestry practices are unlikely to have significant long-term negative effects if current protective measures are retained to protect identified sensitive habitats. However, if more intensive logging is adopted, a well planned adaptive monitoring program should be implemented to determine if this situation remains the case.

Telemetry work has indicated that most species in these forests, such as the threatened heath frog (*Litoria littlejohni*) use non-breeding habitats located well away from their breeding ponds. Photo: Francis Lemckert.

Full article: Lemckert, F.L. (2011) Managing pond breeding anurans in the selectively harvested forests of coastal New South Wales, Australia. *For. Ecol. Manage.* 262:1199–1204.

Do Tadpoles Affect Leaf Decomposition in Neotropical Streams?

By Scott Connelly, Catherine M. Pringle, Matt R. Whiles, Karen R. Lips, Susan Kilham, & Roberto Brenes

Of the relatively few studies that have examined consequences of amphibian declines on stream ecosystems, virtually all have focused on changes in algal-based food webs. Thus, little is known about potential tadpole effects on leaf decomposition. We experimentally compared leaf litter decomposition dynamics in two Neotropical streams: one with an intact community of tadpoles *(with frogs)* and one where tadpoles were absent as a result of a catastrophic extirpation event associated with a fungal pathogen, *Batrachochytrium dendrobatidis* (*frogless*). The stream with tadpoles contained a complete assemblage of larval anurans (23 species) and we identified five species of glass frog (Centrolenidae) tadpoles that were patchily distributed but commonly associated with leaf detritus and organic sediments in pools. We recorded densities of centrolenid tadpoles (0-318 tadpoles m^{-2}) and their biomass-specific excretion rates (0.063 ± 0.018 ug N mg tadpole^{-1} h^{-1}). We experimentally excluded tadpoles from single-species leaf packs incubated over a 40-day period in both the *with frogs* and the *frogless* streams. In the stream *with frogs*, *Centrolene prosoblepon* and *Cochranella albomaculata* tadpoles were patchily distributed in control leaf packs (0.0 – 33.3 m^{-2}). We observed a trend of higher fungal biomass (marginally significant; $P < 0.10$) in leaf packs containing tadpoles in control treatments versus exclusion treatments in the stream *with frogs* (56.9 vs. 42.7 mg C g^{-1}

AFDM) and we hypothesize that centrolenid tadpoles may play a role in stimulating growth of stream fungal communities at local scales However, leaf mass loss and temperature-corrected leaf decomposition rates in control treatments were almost identical in our stream *with frogs* (41.01% AFDM lost, $k_{\text{degree day}}$ = - 0.028 d^{-1}) and the *frogless* stream (41.81% AFDM lost, $k_{\text{degree day}}$ = - 0.027 d^{-1}) and between control and tadpole exclusion treatments within each stream. Likewise, there were no significant differences in leaf pack bacterial biomass, microbial respiration rates, or macroinvertebrate abundance between treatments or streams. Invertebrate community composition on leaf packs was similar between treatments (SIMI = 0.97) and streams (SIMI = 0.95) and was dominated by larval Chironomidae, Simuliidae (Diptera), and larval *Anchytarsus* spp. (Coleoptera).

Glass frogs eggs, ready to hatch, overhanging stream in El Cope, Panama. Photo: Scott Connelly

In contrast to the dramatic effects of grazing tadpoles on algal communities reported in our previous studies, tadpoles had largely insignificant effects on decomposition. While centrolenid tadpoles were common in the stream *with frogs*, patchy distributions in both experimental and natural leaf packs suggest that their effects on detrital dynamics and microbes are likely more localized than those of grazing tadpoles on algae.

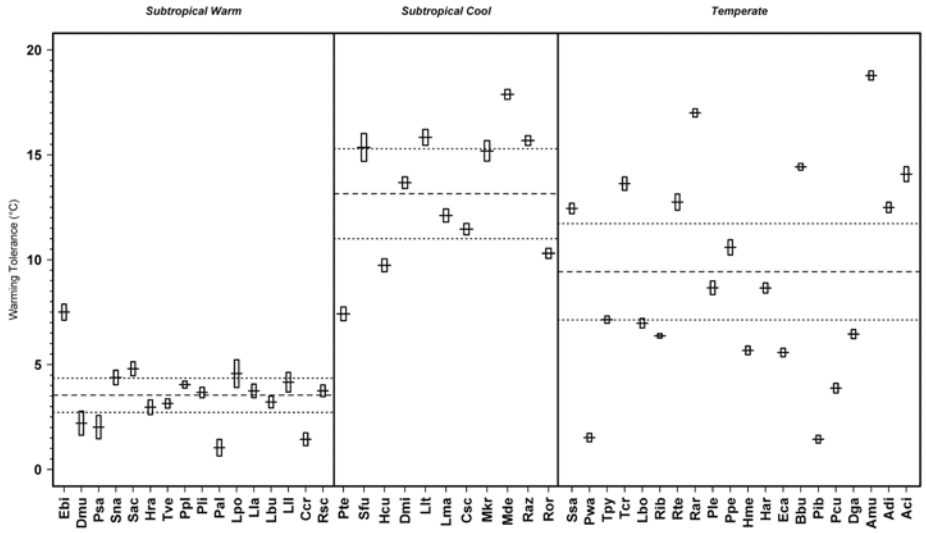
Full article: Connelly, S. et al. Do tadpoles affect leaf decomposition in Neotropical streams? (2011) Freshwater Biology 56, 1863–1875 doi:10.1111/j.1365-2427.2011.02626.x

Can amphibians take the heat? Vulnerability to climate warming in subtropical and temperate larval amphibian communities

By Helder Duarte, Miguel Tejedo, Marco Katzenberger, Federico Marangoni, Diego Baldo, Juan Francisco Beltrán, Dardo Andrea Martí, Alex Richter-Boix, & Alejandro González-Voyer

Predicting the biodiversity impacts of global warming implies that we know where and with what magnitude these impacts will be encountered. Amphibians are currently the most threatened vertebrates, mainly due to habitat loss and to emerging infectious diseases. Global warming may further exacerbate their decline in the near future, although the impact might vary geographically. We predicted that subtropical amphibians should be relatively susceptible to warming-induced extinctions because their upper critical thermal limits (CTmax) might be only slightly higher than maximum pond temperatures (Tmax). We tested this prediction by measuring CTmax and Tmax for 47 larval amphibian species from two thermally distinct subtropical communities (the warm community of the Gran Chaco and the cool community of Atlantic Forest, northern Argentina), as well as from one European temperate community. Upper thermal tolerances of tadpoles were positively correlated (controlling for phylogeny) with maximum pond temperatures, although the slope was steeper in subtropical than in temperate species. CTmax values were lowest in temperate species and highest in the subtropical warm community, which paradoxically, had very low warming tolerance (CTmax– Tmax) and therefore may be prone to future local extinction from acute thermal stress if rising pond Tmax soon exceeds their CTmax. Canopy-protected subtropical cool species have larger warming tolerance and thus should be less impacted by peak temperatures. Temperate species are relatively secure to warming impacts, except for late breeders with low thermal tolerance, which may be exposed to physiological thermal stress in the coming years.

Full article: Duarte, H., Tejedo, M., Katzenberger, M., Marangoni, F., Baldo, D., Beltrán, J.F., Martí, D.A., Richter-Boix, A., Gonzalez-Voyer, A. (2011) Can amphibians take the heat? Vulnerability to climate warming in subtropical and temperate larval amphibian communities. Global Change Biology (2011), doi: 10.1111/j.1365-2486.2011.02518.x



Warming Tolerance (WT, WT = CTmax-Tmax) for different amphibian larvae communities. The average for each species is represented by the middle line of boxplots, box height indicates upper and lower CI 95%. Dashed and dotted lines indicate the average WT and 95 % confidence intervals, respectively, for the overall community. Species codes appear ordered phylogenetically within community. Subtropical warm: Ebi: *Elachistocleis bicolor*, Dmu: *Dermatonotus muelleri*, Psa: *Phyllomedusa sauvagii*, Sna: *Scinax nasicus*, Sac: *Scinax acuminatus*, Hra: *Hypsiboas raniceps*, Tve: *Trachycephalus venulosus*, Ppl: *Pseudis platensis*, Pli: *Pseudis limellum*, Pal: *Physalaemus albonotatus*, Lpo: *Leptodactylus podicipinus*, Lla: *Leptodactylus latinasus*, Lbu: *Leptodactylus bufonius*, Lll: *Lepidobatrachus llanensis*, Ccr: *Ceratophrys cranwelli*, Rsc: *Rhinella schneideri*. Subtropical cool: Pte: *Phyllomedusa tetraploidea*, Sfu: *Scinax fuscovarius*, Hcu: *Hypsiboas curupi*, Dmi: *Dendropsophus minutus*, Llt: *Leptodactylus latrans*, Lma: *Limnomedusa macroglossa*, Csc: *Crossodactylus schmidti*, Mkr: *Melanophryniscus krauczuki*, Mde: *Melanophryniscus devincenzii*, Raz: *Rhinella azarai*, Ror: *Rhinella ornata*. Temperate: Ssa: *Salamandra salamandra*, Pwa: *Pleurodeles waltl*, Tpy: *Triturus pygmaeus*, Tcr: *Triturus cristatus*, Lbo: *Lissotriton boscai*, Rib: *Rana iberica*, Rte: *Rana temporaria*, Rar: *Rana arvalis*, Ple: *Pelophylax lessonae*, Ppe: *Pelophylax perezi*, Hme: *Hyla meridionalis*, Har: *Hyla arborea*, Eca: *Epidalea calamita*, Bbu: *Bufo bufo*, Pib: *Pelodytes ibericus*, Pcu: *Pelobates cultripes*, Dga: *Discoglossus galganoi*, Amu: *Alytes muletensis*, Adi: *Alytes dickhilleni*, Aci: *Alytes cisternasii*.

Do frogs get their kicks on Route 66? Continental U.S. transect reveals spatial and temporal patterns of *Batrachochytrium dendrobatidis* infection.

By Lannoo, M.J., C. Petersen, R.E. Lovich, P. Nanjappa, C. Phillips, J. C. Mitchell and I. Macallister.

The chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), has been devastating amphibian populations globally. We conducted a transcontinental transect of United States Department of Defense (DoD) installations along U.S. Highway 66 from California to central Illinois, and continuing eastward from there across to the Atlantic Seaboard along U.S. Interstate 64 to address the following questions: 1) Does *Bd* occur in amphibian populations on secure and protected DoD environments? 2) Is there a spatial pattern to the presence of *Bd*? 3) Is there a temporal pattern to the presence of *Bd*? and 4) Do our results shed light on whether *Bd* is acting as an epidemic or endemic infection across North America? This study incorporated data from 10% of United States amphibian species; half (15/30) tested *Bd* positive. There was a strong spatial component—the ten eastern temperate DoD installations had higher prevalences of *Bd* infection (18.9%) than the five bases situated in the arid west (4.8%). There was also a strong temporal (seasonal) component. In total, 78.5% of all positive samples came in the first (spring/early-summer) sampling period. These data support the conclusion that *Bd* is now widespread, and confirms that *Bd* can today be considered *endemic* across much of North America, extending from coast-to-coast, with the exception of remote pockets of naïve populations.

Full article: Lannoo, M.J., C. Petersen, R.E. Lovich, P. Nanjappa, C. Phillips, J. C. Mitchell and I. Macallister. 2011. Do frogs get their kicks on Route 66? Continental U.S. transect reveals spatial and temporal patterns of *Batrachochytrium dendrobatidis* infection. PLoS One PLoS ONE 6(7): e22211. doi:10.1371/journal.pone.0022211.

Movement patterns and migration distances in an upland population of California tiger salamander, *Ambystoma californiense*

Susan G. Orloff

The California Tiger Salamander, *Ambystoma californiense*, has been listed as both a federally and state threatened species. The importance of maintaining upland habitat surrounding breeding ponds for *A. californiense* has only recently been emphasized. Understanding terrestrial migration patterns is essential to establishing appropriate upland protection zones adjacent to breeding ponds. In this study I investigated the movement patterns and migration distances of an upland population of *A. californiense* during five winter breeding seasons (2000–2005) in Contra Costa County, California. I used a drift fence and pitfall trap array to partially enclose a proposed 27-ha housing project and capture migrating adult and juvenile salamanders. In an effort to reduce mortality from future development, I translocated all captured salamanders to outside the drift fence. I recorded substantial numbers of adults and juveniles (90–417 annually) farther from breeding ponds than previously reported. The majority of salamanders were captured at least 800 m from the nearest breeding pond while a smaller number of salamanders were captured as far as 2.2 km from the nearest breeding pond. This study indicates that recent recommendations to protect 630 m of upland habitat adjacent to *A. californiense* breeding ponds may leave large portions of some upland populations at risk. Adults appeared to exhibit fidelity to upland habitat, returning close to the initial point of capture. My data suggest that it may take multiple years of translocation efforts to significantly reduce the upland population size within a project site.

Full article: Orloff S. G. 2011. Movement patterns and migration distances in an upland population of California tiger salamander (*Ambystoma californiense*). Herpetological Conservation and Biology 6(2):266–276.

The Carolina Herp Atlas: An Online, Citizen-Science Approach to Document Amphibian and Reptile Occurrences.

By Steven J. Price & Michael E. Dorcas

Despite effectiveness in other scientific disciplines, citizen scientists have generally been underutilized in herpetological research and conservation. In this paper, we detail the project design, preliminary results, and data obtained from an online, citizen-science based herpetological atlas, known as the Carolina Herp Atlas (CHA). The CHA contains several features that ensure quality of submitted data, while allowing registered users to keep a personal database, and to employ a variety of data visualization tools such as species distribution maps, charts, tables, photos and other information on North and South Carolina's amphibians and reptiles. From 1 March 2007 to 22 September 2009, the CHA totaled 698 registered users and received 15,626 amphibian and reptile occurrence records. Specifically, distribution data for 32 frogs, 51 salamanders, 38 snakes, 12 lizards, 16 turtles, and the American alligator (*Alligator mississippiensis*) were obtained, with most commonly reported group being snakes (5,349 records). Additionally, several records of amphibians and reptiles considered priority species by North and South Carolina were contributed to the CHA. By gathering data from a large number of citizen scientists across large spatial scales, the CHA represents an important step in allowing the public to become involved in documenting occurrences of herpetofauna.

Full article: Price, S.J. and M.E. Dorcas. 2011. The Carolina Herp Atlas: An Online, Citizen-Science Approach to Document Amphibian and Reptile Occurrences. Herpetological Conservation and Biology 6: 287-296.

Diseases and Toxicology

New records of *Batrachochytrium dendrobatidis* in Chilean frogs.

Johara Bourke, Torsten Ohst, Yvonne Gräser, Wolfgang Böhme & Jörg Plötner

The amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*) was recently detected in Chile in an introduced species (*Xenopus laevis*) and in a native species (*Rhinoderma darwinii*). Between December 2009 and February 2010 we sampled *Bd* in eleven species of frogs from six localities in southern Chile. We detected *Bd* through molecular techniques in two localities (Coñaripe and Raúl Marín Balmaceda) and in three species: *Batrachyla leptopus*, *Pleurodema thaul* and *Rhinoderma darwinii*. Our findings expand the list of *Bd* hosts to include *B. leptopus* and *P. thaul* and extend the spatial distribution in Chile to include the southernmost *Bd* record at Raúl Marín Balmaceda.

These are alarming results for Chilean amphibians, which harbor the highest rate of threatened species (36.2%) and the highest level of endemism (69%) within Chilean vertebrates. Now, in addition to habitat loss through conversion to plantations, the threats to Chilean amphibian populations must include the amphibian chytrid fungus.

Full article: J. Bourke, T. Ohst, Y. Gräser, W. Böhme, J. Plötner. 2011. New records of *Batrachochytrium dendrobatidis* in Chilean frogs. DAO 95:259-261

Development and disease: How susceptibility to an emerging pathogen changes through anuran development

By Nathan A. Haislip, Matthew J. Gray, Jason T. Hoverman, and Debra L. Miller

Ranaviruses have caused die-offs of amphibians across the globe. In North America, these pathogens cause more amphibian mortality events than any other pathogen. Field observations suggest that ranavirus epizootics in amphibian communities are common during metamorphosis, presumably due to changes in immune function. However, few controlled studies have compared the relative susceptibility of amphibians to ranaviruses across life stages. Our objectives were to measure differences in mortality and infection prevalence following exposure to ranavirus at four developmental stages and determine whether the differences were consistent among seven anuran species. Based on previous studies, we hypothesized that susceptibility to ranavirus would be greatest at metamorphosis. Our results did not support this hypothesis, as four of the species were most susceptible to ranavirus during the larval or hatchling stages. The embryo stage had the lowest susceptibility among species probably due to the protective membranous layers of the egg. Our results indicate that generalizations should be made cautiously about patterns of susceptibility to ranaviruses among amphibian developmental stages and species. Further, if early developmental stages of amphibians are susceptible to ranaviruses, the impact of ranavirus epizootic events may be greater than realized due to the greater difficulty of detecting morbid hatchlings and larvae compared to metamorphs.

Full article: Haislip, NA, MJ Gray, JT Hoverman, and DL Miller. 2011. Development and disease: How susceptibility to an emerging pathogen changes through anuran development. PLoS ONE 6(7): e22307. doi:10.1371/journal.pone.0022307.

In amphibian larvae, gross lesions indicative of ranavirus infection include erythema at the base of the gills, ventrum, and legs, and swelling of the legs, body, and gular region. This image shows severe body swelling in an American bullfrog tadpole (*Rana catesbeiana*) that was experimentally infected with ranavirus. An uninfected tadpole is shown for comparison. Photo: Nathan A. Haislip

Antioxidant response and metal accumulation in tissues of Iberian green frogs (*Pelophylax perezi*) inhabiting a deactivated uranium mine

By Sérgio M. Marques, Sara C. Antunes, Bruno Nunes, Fernando Gonçalves & Ruth Pereira

Mining activities frequently create deeply impacted areas. These areas usually remain contaminated for large periods, originating extreme habitats where metal rich effluents with acidic pH are easily formed. Such is the case of the deactivated uranium mine in the village of Cunha Baixa (Portugal). In this work we determined metal accumulation and antioxidant response of Iberian green frogs (*Pelophylax perezi*) inhabiting the effluent pond in this mine (M) and compared the results with frogs from a reference site (REF). Metal accumulation was studied in liver, kidney, bones, muscle and skin of *P. perezi* and enzymatic activity was studied in liver, kidney, lung and heart by determining glutathione-S-transferases (GSTs), catalase (CAT), glutathione reductase (Gred), and glutathione peroxidase (GPx; both selenium-dependent and selenium-independent). Additionally, lipoperoxidation (LPO) was also assessed in the same tissues via thiobarbituric acid reactive substances (TBARS) assay and lactate dehydrogenase (LDH) activity was determined in muscle. Furthermore we analyzed the physical and chemical parameters of M and REF water as well as their metal content. Our results revealed that the majority of metals were in higher concentrations in tissues of M organisms. This trend was especially evident for U whose content reached a difference of 1350 fold between REF and M organisms. None of the organs tested for antioxidant defenses revealed LPO, nonetheless, with exception for liver, all organs from the M frogs presented increased total GPx activity and selenium-dependent GPx. This response was only significant for lung, probably as a consequence of the significant inhibition of CAT upstream and in order to cope with the subsequent increase in H_2O_2. Lungs were the organs displaying greater responsiveness of the anti-oxidant stress system in frogs from the uranium mine area.

Full article: Marques et al. (2011). Antioxidant response and metal accumulation in tissues of Iberian green frogs (*Pelophylax perezi*) inhabiting a deactivated uranium mine. Ecotoxicology 20; 1315-1327. (s.reis.marques@gmail.com)

Species-level correlates of susceptibility to the pathogenic amphibian fungus *Batrachochytrium dendrobatidis* in the United States

By Betsy A. Bancroft, Barbara A. Han, Catherine L. Searle, Lindsay M. Biga, Deanna H. Olson, Lee B. Kats, Joshua J. Lawler, & Andrew R. Blaustein

Disease is often implicated as a factor in population declines of wildlife and plants. Understanding the characteristics that may predispose a species to infection by a particular pathogen can help direct conservation efforts. Recent declines in amphibian populations world-wide are a major conservation issue and may be caused in part by a fungal pathogen, *Batrachochytrium dendrobatidis* (*Bd*). We used Random Forest, a machine learning approach, to identify species-level characteristics that may be related to susceptibility to *Bd*. Our results suggest that body size at maturity, aspects of egg laying behavior, taxonomic order and family, and reliance on water are good predictors of documented infection for species in the continental United States. These results suggest that, whereas local-scale environmental variables are important to the

spread of *Bd*, species-level characteristics may also influence susceptibility to *Bd*. The relationships identified in this study suggest future experimental tests, and may target species for conservation efforts.

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Behavioral responses of the Iberian waterfrog, *Pelophylax perezi* (Seoane, 1885), to three nitrogenous compounds in laboratory conditions

Andrés Egea-Serrano, Miguel Tejedo and Mar Torralva

Several studies have assessed the effects of pollutants such as pesticides or fertilizers (e.g. nitrogenous compounds) on amphibian behavior. Regarding nitrogenous compounds, however, few have focused on the effects of their combination with other stressors or on the variation of the response to pollutants among populations. We analyzed the effect of ammonium, nitrite and nitrate (both alone and in combination) on larval activity and location in the water column in four populations of *Pelophylax perezi* naturally exposed to different levels of eutrophication. Larval activity was highest and use of the bottom of the experimental beaker was lowest at lower concentrations of nitrogenous compounds acting singly, these responses being minimal and maximal, respectively, at both control and higher concentrations. This pattern appears to fit to an hormetic response. Additionally, the combination of nitrogenous compounds affected more severely the response variables than when ammonium or nitrite acted singly according to an additive model. Tadpoles from populations inhabiting highly polluted aquatic habitats marginally showed higher activity level than those from populations exposed to less polluted environments, especially when larvae were exposed to ammonium or when nitrite appeared in combination with other nitrogen forms. Levels of activity correlated positively with larval final mass. Moreover, for similar levels of activity, larvae from polluted populations had higher growth rates than those coming from reference populations which suggests intraspecific differences and possible local adaptation in behavioral sensitivity to nitrogenous pollutants.

Full article: Egea-Serrano, A., Tejedo, M. & Torralva, M. (2011) Behavioral responses of the Iberian waterfrog, *Pelophylax perezi* (Seoane, 1885), to three nitrogenous compounds in laboratory conditions. Ecotoxicology 20: 1246-1257.

Growth of the amphibian pathogen, *Batrachochytrium dendrobatidis*, in response to chemical properties of the aquatic environment

By Scott P. Boisvert & Elizabeth W. Davidson

Water samples from two of 17 field sites in Arizona (USA) inhibited growth of the amphibian pathogen, *Batrachochytrium dendrobatidis*. Chemical analyses of samples revealed statistically significant facilitating or inhibitory activity of certain elements. Although low levels of copper were found in environmental samples demonstrating facilitated growth, growth was inhibited at concentrations of $CuSO_4$ at or greater than 100 ppm.

Full article: Boisvert, S.P. & Davidson E.W. (2011) Growth of the amphibian pathogen, *Batrachochytrium dendrobatidis*, in response to chemical properties of the aquatic environment . J Wildl Dis 2011 47: 694-698

Examining the Evidence for Chytridiomycosis in Threatened Amphibian Species

By Matthew Heard, Katherine F. Smith, & Kelsey Ripp

Extinction risks are increasing for amphibians due to rising threats and minimal conservation efforts. Nearly one quarter of all threatened/extinct amphibians in the IUCN Red List is purportedly at risk from the disease chytridiomycosis. However, a closer look at the data reveals that *Batrachochytrium dendrobatidis* (the causal agent) has been identified and confirmed to cause clinical disease in only 14% of these species. Primary literature surveys confirm these findings; ruling out major discrepancies between Red List assessments and real-time science. Despite widespread interest in chytridiomycosis, little progress has been made between assessment years to acquire evidence for the role of chytridiomycosis in species-specific amphibian declines. Instead, assessment teams invoke the precautionary principle when listing chytridiomycosis as a threat. Precaution is valuable when dealing with the world's most threatened taxa, however scientific research is needed to distinguish between real and predicted threats in order to better prioritize conservation efforts. Fast paced, cost effective, in situ research to confirm or rule out chytridiomycosis in species currently hypothesized to be threatened by the disease would be a step in the right direction. Ultimately, determining the manner in which amphibian conservation resources are utilized is a conversation for the greater conservation community that we hope to stimulate here.

Full article: Heard M, Smith KF, Ripp K (2011) Examining the Evidence for Chytridiomycosis in Threatened Amphibian Species. PLoS ONE 6(8): e23150. doi:10.1371/journal.pone.0023150

Effects of previous sublethal pulse to ammonium nitrate on mortality and total length on *Epidalea calamita* larvae

By Enrique García-Muñoz, Francisco Guerrero & Gema Parra

Fertilizer pollution has been described as one of the major factors threatening amphibian populations throughout the world. Thus, nitrogen pollution of aquatic ecosystems is a recurrent phenomenon and is at present considered a major influence regarding global amphibian decline, altering between others, the chemical properties of breeding sites of many amphibian species or the amphibian larval survivorship or development. Some of these stresses are initiated gradually and occur over long periods of time, while others are relatively sudden and short term. Nutrients exhibit the second type of stress, being very dynamics with changes in concentration on various temporal scales, including influx or pulses that for example occur as a result of runoff in wetlands embedded in agricultural landscapes. When these pulses are recurrent in time, the organisms could acquire some degree of tolerance as a response to the previous exposure to toxicants. However, the opposite situation is also possible because sudden changes in concentration are much more stressful than constant concentrations.

The results obtained in the present study indicate that a previous sublethal pulse of ammonium nitrate have a significant negative effect on *E. calamita* larval survivorship and growth (in terms of total length reached). The toxicity of intermittent events increases with elevation in exposure duration or frequency, so lethality of subsequent exposures is assumed to be additive and then, the potency of the toxic is seemed to be incremented. However, the toxic itself does not change, but the species

sensitivity does it. This assumption could be analyzed through the probit regressions parameters. The steeper slope (b) in double exposure (DE) treatment really gives information about the increment in the range of sensitivity. The previous ammonium nitrate pulse induces the reduction in the LC50 values (DLC50), indicating a certain increment in the *E. calamita* larvae sensitivity. Although this information was obtained under laboratory conditions, could help us to understand what might be happening under these circumstances in aquatic ecosystems.

Full article: García-Muñoz, E. et al. (2011) Effects of previous sublethal pulse to ammonium nitrate on mortality and total length on *Epidalea calamita* larvae. Chemosphere 84 671–675

Amphibian immune defenses against chytridiomycosis: Impacts of changing Environments

By Louise A. Rollins-Smith[1], Jeremy P. Ramsey[2], James D. Pask[3], Laura K. Reinert[3] and Douglas C. Woodhams[4]

Amphibians are currently suffering devastating declines and extinctions in nearly all parts of the world due to the emerging infectious disease chytridiomycosis caused by the chytrid fungus, *Batrachochytrium dendrobatidis*. The publication linked to this abstract briefly reviews our current understanding of amphibian immune defenses against *B. dendrobatidis*. We review what is known about the impacts of temperature, environmental chemicals, and stress on the host-pathogen interactions and suggest future directions for research. Infectious zoospores or bacteria landing in the skin mucus must overcome chemical defenses, including antimicrobial peptides, lysozyme, secreted antibodies, and bacterial metabolites that may have antifungal or antibacterial activities. If *B. dendrobatidis* zoospores reach the growing epidermal cells, they would be expected to alter the properties of those cells and attract the attention of antigen-presenting cells such as dendritic cells or macrophages. These cells would be expected to recruit an adaptive cell-mediated and antibody-mediated lymphocyte response. However, factors produced by the fungus can interfere with lymphocyte responses by induction of apoptosis of lymphocytes. The immune defense against chytridiomycosis is impacted by a variety of factors that may affect the overall survival of the host. Because tadpoles carry mild infections in their mouthparts, changes in the immune system at metamorphosis may result in greater susceptibility to the development of disease at that time. Stress due to a number of environmental factors including poor nutrition in marginal habitats and enhanced activity during breeding may elevate corticosteroids. If infection by *B. dendrobatidis* impairs ion transport in the skin, the endocrine response that balances cutaneous ion transport may also elevate glucocorticoid or mineralocorticoid responses resulting in immune suppression. The immune system of amphibians is highly temperature sensitive, and even small reductions in temperature may impair immunity. Environmental chemicals may also impair innate and adaptive immune responses.

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This reference list is compiled by Professor Tim Halliday (formerly DAPTF International Director) (tim.halliday@homecall.co.uk). It lists papers on amphibian declines and their causes and papers on amphibian conservation, with an emphasis on those that describe methods for monitoring and conserving amphibian populations. Tim is always delighted to receive details of forthcoming papers from their authors.

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New Book Teaches Conservation of Amphibians and Reptiles

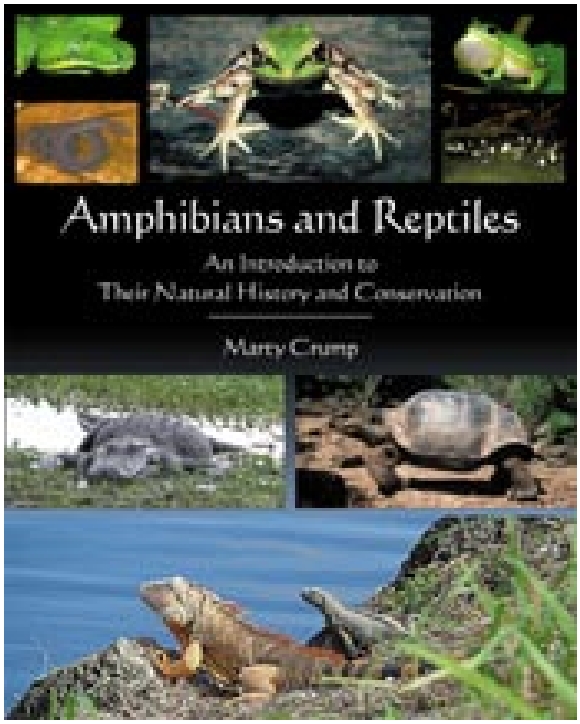
Intended for Middle School-age and older readers, Amphibians and Reptiles--An Introduction to Their Natural History and Conservation is a comprehensive, lively, and extensively illustrated introduction to the fascinating world of amphibians and reptiles.

The book is written by award-winning author Marty Crump, a prominent herpetologist and long-established advocate of amphibian and reptile conservation.

Well organized, clearly written, richly illustrated, and infused with substance, this book will inform the reader with knowledge about the basic biology, ecology, and natural history of amphibians and reptiles; about their declining populations throughout the world; about the causes of these declines; and about ways that human beings can help to save these important parts of Earth's biodiversity.

The book concludes with a chapter on what kids can do, and should not do, to help protect and preserve amphibians and reptiles, and includes a glossary, a list of additional resources and conservation organizations, place names based on amphibians and reptiles, and an index.

Dr. Marty Crump is an internationally respected and award-winning herpetologist, author of numerous non-fiction books on natural history. Crump wrote Amphibians and Reptiles--An Introduction to Their Natural History and Conservation because she believes that children need to appreciate nature before they can understand the value of protecting it. With over 40 years' experience as a herpetologist, the author is well-qualified to write this current book. She is a recipient of the Distinguished Herpetologist Award given by The Herpetologists' League in 1997.



Amphibians and Reptiles--An Introduction to Their Natural History and Conservation is available in softcover with 264 pages of text, along with 16 pages of color photographs, and more than 130 black-and-white photographs and illustrations. For more information about the book, including pricing and a special "New Title Discount," visit McDonald and Woodward's website at www.mwpubco.com/titles/amphibiansandreptiles.htm or contact them directly at 1-800-233-8787.

Founded in 1986, The McDonald and Woodward Publishing Company publishes books on cultural and natural history, natural resources, and educational resources.

General Announcements

Upcoming Meetings & Workshops

September

SEH-Conservation Committee Herpetofauna monitoring course Luxembourg, 24-25 September 2011. Details at http://www.seh-cc.org.

16th European Congress of Herpetology and 47. Deutscher Herpetologentag (DGHT) Luxembourg and Trier, 25-29 September 2011. Details at http://www.symposium.lu/herpetology/.

October

Conservation Needs Assessment workshop Singapore. October 17-18, 2011.

Amphibian husbandry/conservation workshop Singapore. October 19-21, 2011.

November

ASH Conference 2011 36th Annual General Meeting of Australian Society of Herpetologists. November 8–11, 2011, Paluma, North Queensland. http://www.australiansocietyofherpetologists.org/ASH_conference2011.html.

August 2012

7th World Congress of Herpetology. British Columbia 8-14 August 2012. http://www.worldcongressofherpetology.org/?section=64

Internships & Employment

The following information can be found at http://www.parcplace.org/resources/job-listings.html. Herp jobs are posted as a service to the herpetological community. If you would like to list a job opening for your organization, please send the announcement to herpjob@parcplace.org

Biological Aid - Bog Turtle and Bat Research - Delaware Natural Heritage and Endangered Species Program Smyrna, DE (9/9/11)

Threatened and Endangered Species Habitat Specialist - National Park Service Fort Collins, CO (9/1/11)

Post Doctoral Research Associate in Dendritic Network Ecology/Amphibians Patuxent Wildlife Research Center - Laural, MD (8/26/11)

Herpetological Intern - Herpetological Resource and Management, LLC Lower Michigan

Post Doctoral Research Associate - Reptiles and Amphibians Conservation & Management - University of California, Davis

Scientific Assistant, Division of Vertebrate Zoology, American Museum of Natural History New York, NY

Assistant Professor Position - Human Dimensions of Wildlife Conservation - University of Florida Gainesville

Assistant Curator of Reptiles and Amphibians - Carnegie Museum of Natural History Pittsburgh, PA

Crew Leader Position - Effects of Forest Management on Reptiles and Amphibians West Plains, MO

Technician Positions - Effects of Forest Management on Reptiles and Amphibians West Plains, MO

Timber Rattlesnake Field Technician - Purdue University Yellowwood and Morgan-Monroe State Forests, Indiana

Authorized Desert Tortoise Biologist/Monitor (On Call) - SWCA Environmental Consultants Las Vegas, NV

Authorized Desert Tortoise Biologist - SWCA Environmental Consultants Las Vegas, NV

Intern Positions (2) - Florida Sand Skink Research Archbold Biological Station, Lake Placid, FL

Government Affairs Associate - The Wildlife Society

Conservation Biologist, EDGE of Existence Programme London, UK

M.S. or Ph.D. Assistantship - Salamander Conservation Virginia Tech - Blacksburg, VA and Eglin Airforce Base, Niceville, FL

Desert Tortoise Monitoring Positions - EPG Inc. Phoenix, AZ

Assistant/Associate Curator of Herpetology - The Natural History Museum of Los Angeles County Los Angeles, CA

Full time Research Assistant required - Effects of habitat features and fragmentation on herpetofaunal communities in Western Sarawak

We are looking for a full time Research Assistant for a project entitled: 'Effects of habitat features and fragmentation on herpetofaunal communities in Western Sarawak'.

The project is supported by a Fundamental Research Grant from the Ministry of Higher Education, Government of Malaysia.

The project will commence soon as an appointment has been made, and the Research Assistant will be employed for 24 months. A month stipend of RM 1,000 is payable, in addition to travel claims. The candidate is expected to register for a PhD with the Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak. A brief description of the project is given below.

Western Sarawak (comprising the divisions of Kuching and Samarahan), comprising a land area of 9,527 sq km, and is home to several endemic lineages of plants and animals. Its landscape has been heavily modified since the early 1900s, and presently comprises a mosaic of remnant habitats- forests and flood plains, sometimes widely separated by urban and agricultural areas. Within forested fragments are areas protected as National Parks, although knowledge of critical habitat features required for target organisms are often absent. In such landscapes, the capacity to detect early change in assemblages and populations makes it possible to take proactive conservation and management measures.

In this study, we will test responses of

herpetofaunal communities of lowland forests and midhills to environmental/landscape features, fragmentation and isolation, through field sampling, as well as analysis of existing information (museum specimens and published records), using logistic regression and linear multiple and/or multivariate regression models to relate species presence in forest patches, to specific forest patch features and isolation. We will study habitat loss and fragmentation (that potentially lead to isolation and stochastic extinction), through investigations of movements and microhabitat use of selected groups of amphibians and reptiles. Finally, we will study the effects of highways on herpetological communities through examination of phenology of road-mortalities and the effect of low frequency noise to the auditory performance of advertising amphibians.

Anticipated benefits of the project would be answering the question whether the protected areas system protect representative herpetofaunal communities, creation of specimen-based herpetofaunal inventories of protected and other areas of western Sarawak, identification of key habitat features for species, improving habitat connectivity for long-term survival of populations, acquisition of species-specific ecological knowledge and understanding the effect of highways and vehicular traffic on communities, in order to make recommendations for the persistence of herpetological populations for posteriority. Interested candidates can apply with a cv, with list of publications and names and e-mail contacts of 3 referees to the undersigned.

Prof. Indraneil Das, Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia. E-mail: idas@ibec.unimas.my Telephone (work): ++ 60 82 581000 Handphone: ++ 60 128301208 Fax: ++ 60 82 583004

Funding Opportunities

The Conservation Leadership Programs website provides a comprehensive overview of a large array of funding available http://www.conservationleadershipprogramme.org/OtherFundingOptions.asp

The following information is kindly provided by the Terra Viva Grants Directory, for more information please visit: http://www.terravivagrants.org/.

August

New England Biolabs Foundation -- International Grants. The Foundation supports conservation of biological and cultural diversity by making community-level grants for protected areas, ecological restoration, alternative livelihoods, and use of the arts to convey environmental and social messages. Geographical priorities are Belize, Bolivia, Cameroon, Ecuador, El Salvador, Ghana, Guatemala, Honduras, Nicaragua, Papua New Guinea, Peru, and Tanzania. Applicants are community-based organizations, NGOs, and emerging support groups. The maximum grant is US$10 thousand. Applications must be preceded by a letter of inquiry (LOI). Application deadlines are 01 March and 29 August. Link

UK Natural Environment Research Council -- International Opportunities Fund. NERC announces grants of up to £300 thousand for up to three years to support international research collaboration on issues such as climate change, biodiversity, and natural hazards. Priority partner countries include Brazil, China, India, and South Africa as well as a number of industrialized countries (see the announcement). Each proposal requires substantial co-funding and/or in-kind support from the international partners. Prospective applicants must submit a declaration of intentions before 17 August 2011. Link

Weeden Foundation -- International Biodiversity Program. The Weeden Foundation makes grants for biodiversity conservation in forest ecosystems, riparian corridors, and riverine and aquatic environments of ecological importance. Weeden's international geographical priorities are the Patagonia region of Chile, and the Altai Republic of Russia. The Foundation requests letters of inquiry (LOI) at least one month before proposal deadlines. (TVG Note: The Terra Viva Grants Directory apologizes for the lateness of this posting.) The next deadline is 19 August 2011. Link

September

French Global Environment Facility -- Small Initiatives Program, First Call. The French Global Environment Facility (FFEM) announces Phase 3 of its Small Initiatives Program (PPI). The PPI supports local projects in biodiversity, climate change, and sustainable local livelihoods in Sub-Saharan Africa. Priority countries in Phase 3 are Burkina Faso, Cameroon, Dem Rep Congo, Ghana, and Togo. A lesser number of grants is available for other African countries. The average grant size is €35 thousand, with a maximum of €50 thousand. Applications are invited from civil society organizations in the eligible countries. Partnering international NGOs may be eligible under certain circumstances (see the guidelines). The application deadline for the first round of grants is 05 September 2011. Link

October

Buckminster Fuller Institute -- Buckminster Fuller Challenge 2012. The Challenge is an annual prize of US$100 thousand to invite ideas to radically advance human well-being and ecosystem health. Entries in prior years include several in energy, water, agriculture, natural disasters, etc., in developing countries. There is a fee of US$100 to enter the competition. The deadline for submissions is 24 October 2011. Link

Hongkong Bank Foundation -- Grants for Hong Kong and Mainland China. The

If you have any funding opportunities that you would like announced in FrogLog, please send details to James Lewis at jplewis@amphibians.org

Hongkong Bank Foundation funds a broad range of projects across the Hong Kong SAR and mainland China. The Foundation's interests include education, community welfare, and environmental protection -- and projects that enhance links between Hong Kong and mainland China. Applications are submitted in English. The next deadline for applications is 03 October 2011. Link

International Iguana Foundation -- Call for Proposals 2011. The International Iguana Foundation makes an annual call for proposals for iguana conservation. Priority is for projects related to survival of endangered iguanas and their habitats, that support established conservation programs, that have participation from the range countries, and that contribute matching funds. Applications are due by 07 October 2011. Link

Swiss Universities -- KHF Development Cooperation. The Rectors Conference of the Swiss Universities of Applied Sciences (KHF) announces the 7th call for proposals to fund Swiss university research cooperation with developing and transition countries. Proposals are invited from Swiss universities of applied sciences and teacher education in collaboration with partners in developing countries. Past projects include several in areas such as environmental education, agricultural production, pollution control, supply of drinking water, aquaculture, and others. The deadline for proposals is 10 October 2011. Link

U.S. National Science Foundation (NSF) -- Partnerships for International Research and Education 2011. Partnerships for International Research and Education (PIRE) is a program to make grants for international research collaboration across all NSF-supported disciplines. Especially encouraged is international collaboration on issues of global sustainability including climate change, clean energy, food security, biodiversity, and others. The lead applicant must be a U.S. academic institution which has granted PhDs in 2009-2010 in any research area supported by NSF. The deadline for pre-proposals is 19 October 2011. Link

Whitley Fund for Nature -- Whitley Awards 2012. The Whitley Fund makes grants for grass-roots conservation projects in developing countries. The grants are to nationals of eligible countries who lead pragmatic projects that combine conservation and long-term sustainability. Whitley Awards are up to £30 thousand, and the Gold Award provides an additional £30 thousand. The application deadline is 31 October 2011. Link

November

African Union -- Kwame Nkrumah Scientific Awards 2011. The African Union (AU) honors outstanding African scientists through the Kwame Nkrumah Scientific Awards for fields that include agricultural sciences, environmental sciences, and energy innovation (among others). The Regional Scientific Awards for Women are restricted to women applicants in each of the AU's five geographical regions; the application deadline is 30 September 2011. The Continental Scientific Award recognizes the achievements of senior scientists anywhere in Africa; the application deadline is 15 November 2011. Link

EC Research Directorate -- FP7 International Cooperation 2012. The European Commission invites research proposals in the theme of International Cooperation. The program aims to foster joint programs and projects between researchers in Europe and third countries in themes such as climate change, resource scarcity, energy, land management, pollution management, and others. The funding for regional capacity development will strengthen the EU's science collaboration with Sub-Saharan Africa, Latin America and the Caribbean, Mediterranean partner countries, and countries of Southeast Asia (Identifier: FP7-INCO-2012-1). Bilateral collaboration refers to the EU's S&T agreements (existing or in process) with Argentina, Brazil, Chile, China, India, Jordan, Mexico, Morocco, Russia, South Africa, Ukraine, and other countries (Identifier: FP7-INCO-2012-2.) The closing date for applications is 15 November 2011. Link

EU Erasmus Mundus -- Applications FONASO 2011. The EU's Erasmus Mundus includes the program Forest and Nature for Society (FONASO), jointly administered by seven European universities. FONASO invites applications from the EU and worldwide for fellowships in its doctoral program. Research in FONASO includes several projects on themes relevant in the developing world, e.g., tropical forest ecology, paying for ecosystem services, assessing the contribution of forests to poverty alleviation, increasing the value chains of non-timber forest products, and others. The grants (salary, operational funds, installation costs) are over €120 thousand for 36 months. The application deadline is 01 November 2011. Link

Schlumberger Foundation -- Funding for Women in PhD and Post-Doctoral Studies 2012. Schlumberger Foundation's "Faculty of the Future" supports women in developing and emerging economies to pursue PhD and post-doctoral studies at the international level. Grants are in the physical sciences, engineering, and related fields -- including past grants in subjects such as ecology and environment. The application period for online submissions is 12 September through 30 November 2011. Link

United States-India Educational Foundation (USIEF) -- Obama-Singh 21st Century Knowledge Initiative. The USIEF will support partnerships between U.S. and Indian institutions of higher education for exchange activities in the following fields: agricultural sciences and food security; energy; sustainable development; climate change; environmental studies; and several other themes. Grants are up to US$250 thousand for three years. Lead applicants for the grants must be accredited U.S. universities and colleges that choose partners in the U.S. and India. The closing date for applications is 01 November 2011. Link

December

Orskov Foundation -- Small Grants for Animal Agriculture. Orskov makes grants of up to £2,500 to support animal agriculture (livestock, aquaculture, bee keeping, etc.) in developing countries. One category of grants supports university students in agricultural studies related to poverty alleviation and environmental sustainabilty. The second category of grants is for community-based agriculture on a revolving-fund basis. Applications are accepted from 01 October through 31 December. Link

Phoenix Zoo -- Conservation and Science Grants. The Phoenix Zoo (Arizona, USA) makes small grants to support wildlife conservation and science worldwide. First-year grants are limited to US$3 thousand. Priority is for practical projects that help build capacity, and that involve local communities. The application period is 01 November through 01 December each year. Link

Prince Albert II of Monaco Foundation -- Pre-Applications 2012. The Prince Albert II of Monaco Foundation makes grants for global environmental stability in themes of climate change, biodiversity, access to water, and the fight against desertification. Its geographical priorities are the Mediterranean Basin, the Polar Regions, and the Least-Developed Countries. Pre-applications for grants are accepted from

02 March 2011 to 30 April 2011, and from 02 November 2011 through 31 December 2011. Link

January

British Ecological Society – Grants for Young Ecologists. The BES provides support of up to £20 thousand to help early-career ecologists launch research projects. The BES will look favorably on applications from individuals based outside of the UK who do not have a rich resource base in their own scientific communities. Applicants must be members of BES. Applications (first round) are due 31 January. Link

Conservation, Food, and Health Foundation -- Concept Applications 2011-2012. The CFH Foundation makes grants to nonprofit organizations for projects in conservation, sustainable agriculture, and health in developing countries. Most grants are US$15 thousand to US$30 thousand. Concept applications must be received by 01 January and 01 July in order to be reviewed for the Foundation's meetings in May and November, respectively. Link

Royal Geographical Society -- Application Deadlines January 2012. The RGS funds British students and researchers for international studies and projects, including many in ecology and environment in the developing world. Geographical fieldwork grants, RGS-IGB small research grants, and other categories of grants that can be used for international projects (e.g., Henrietta Hutton, Monica Cole), have deadlines on 20 January 2012. Link

Smithsonian Tropical Research Institute -- Research Grants 2012. The STRI offers grant support for university and postdoctoral research at its facilities in Panama in several disciplines of biology, ecology, soils sciences, anthropology, and others. Fellowships and internships are awarded to researchers from the USA and Latin America in several program areas. Deadline for the Earl S. Tupper post-doctoral grant is 15 January of every year. Other programs have deadlines in March, May, August, and November. Link

Volvo Adventure Competition -- Youth Projects in Environment 2012. Volvo Adventure is an educational program that makes grants for community environmental projects by youth worldwide, aged 13 to 16. Applications are submitted by teams of two to five members. Volvo will invite the finalists to Sweden to compete for cash prizes of US$10 thousand, US$6 thousand, and US$4 thousand. Guidelines for the competition are available in ten languages. Closing date is 31 January 2012. Link

Wildlife Conservation Network -- Partnership Applications 2012. The WCN supports wildlife projects worldwide, with emphasis on Latin America, Africa, and Asia. WCN invites letters of inquiry from registered nonprofit organizations engaged in wildlife conservation or animal welfare to apply for partnerships. Letters of inquiry are accepted through 15 January 2012.

World Wide Fund For Nature (WWF) -- Prince Bernhard Scholarships for Nature Conservation 2012. WWF announces the 2012 Prince Bernhard Scholarships to support professional training or formal studies of individuals working in disciplines directly relevant to nature conservation. Eligibility extends to mid-career nationals from Africa (including Madagascar); Asia and Pacific; Latin America and Caribbean; Eastern Europe; and the Middle East. WWF gives priority to applicants seeking support for studies or training in their own countries or regions. The maximum grant is CH10 thousand. Applications (in English, French, or Spanish) are due before 11 January 2012. Link

Keep In touch

If you would like to be added to the ASG mailing list, please send an email to froglog@amphibians.org with the subject heading "add me to mailing list".

Also follow us on Facebook for regular updates on the herpetological community and the latest news from the ASG.

http://www.facebook.com/AmphibiansDotOrg

Instructions to Authors

FrogLog publishes a range of articles on any research, discoveries or conservation news relating to amphibians. We encourage authors describing original research to first make submissions to a refereed journal and then, if appropriate, to publish a synopsis in FrogLog. Submissions to FrogLog should be in English, in the region of 1000 words, unless previously discussed with the editorial team, and follow the format of FrogLog 83 and above.

All graphics supplied for publishing should be submitted as separate files, ideally in original jpg format or alternative commonly used graphical format. Please ensure that the highest quality image is sent to allow for optimal reproduction.

Tables and charts may be included at the end of a word document with clear indication as to the appropriate title/legend.

All titles and legends should be listed one after the other, as part of the text document, separate from the figure files. Please do not write a legend below each figure.

Submission must include all authors first and surname which will be printed at the beginning of the published document.

Each submission will be referenced as follows at the back of the edition:

Tingley, R., Phillips, B. L. & Shine, R. (2011) Alien amphibians challenge Darwin's naturalization hypothesis. *FrogLog* 95. Author Contact: reid.tingley@gmail.com.

If you require further information on author affiliations, provide directly under this reference.

Examples of submissions can be found in previous editions of FrogLog and include:

- News and Comments
- Correspondence
- Obituaries
- Opinion
- Futures
- News & Views
- Insights, Reviews and Perspectives
- Upcoming meetings
- Recent Publications
- Books Releases
- Careers

Submission should be sent to froglog@amphibians.org.

Please name all files as follows, first author surname_brief title description_content i.e. tingle_darwins naturalization_paper, tingle_darwins naturalization_figure 1.

Students

The ASG has a particular interest in highlighting the vast amount of work being undertaken by students around the world and we invite students to submit synopsis of their thesis where appropriate.

Coming up in FrogLog Vol. 99

Maritime Southeast Asia and Oceania

Maritime Southeast Asia and Oceania ASG Update

Recent Publications

Grants

and much more.....

November 2011

Spotted Treefrog *Nyctixalus pictus.* Photo: Leong Tzi Ming